



# Uganda Advanced Certificate of Education

**TEACHING SYLLABI**

***VOLUME 1***

**Biology**  
**Chemistry**  
**Agriculture**

**2013**



**THE REPUBLIC OF UGANDA**  
Ministry of Education and Sports





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Last but not least, NCDC would like to thank all those who worked behind the scenes to finalise the documents.

NCDC takes full responsibility for any errors and omissions in the documents and welcomes suggestions to address them.

# FOREWORD

For a long time teachers have been using Uganda National Examinations Board (UNEB) syllabi to plan their teaching schemes. This approach has rendered the curriculum to be largely driven by examination.

Working with relevant subject panels, NCDC has produced the Teaching Syllabi for all the Advanced Level subjects. The subject content in the syllabi has been clarified using appropriate specific objectives. It should be noted that the content in the syllabi has remained largely the same except in a few subjects where it has been updated by removing obsolete and/or irrelevant material. Suitable teaching / learning strategies have been suggested to the teacher and other users.

Teachers will find the syllabi useful in planning the teaching / learning processes. The content therein will go a long way in enhancing the learners' educational experiences and guide the teachers towards successful delivery of meaningful learning experiences.

The teaching / learning strategies suggested in the Syllabi are just a guide to the teacher but are not meant to substitute the rich professional approaches that the teacher may opt to use to deliver knowledge, and to develop understandings, skills, values and attitudes.



Connie Kateeba

**DIRECTOR**

**National Curriculum Development Centre**



# GENERAL INTRODUCTION

This volume of the Advanced Level syllabi contains three subjects: **Agriculture**, **Biology** and **Chemistry**. There are other volumes containing other Advanced Level subjects. The purpose of this merger is twofold. First, NCDC considered the content relatedness of the subjects and second, the need to avoid extremely voluminous books.

These syllabi have been written in accordance with the National Objectives on Secondary Education. The syllabi content continues from that of the Ordinary Level curriculum. The syllabi have suggested a teaching order, teaching and learning strategies, and assessment strategies. In all cases the syllabi have tried as much as possible to integrate the theory and practicals. This means that the teaching and learning should be done through practical work as much as possible. The purpose is to make the learner acquire the necessary scientific skills.

The use of models or ICT opportunities should be exploited to help the learner visualise concepts which are rather hard or difficult to understand. The teachers are encouraged to help the learners acquire relevant mathematical skills so as to solve quantitative aspects of the subjects, including graphical methods and the use of logarithms.

The **Agriculture** syllabus has five topics: Basic Science, Crop Production, Animal Production, Agricultural Engineering and Farm Mechanisation and Economics. The topics have been coded "I" or "II", etc in order to differentiate them from the O level syllabus content. These topics are meant to address crucial issues, such as improved agriculture practices, new and appropriate crop and livestock technologies, high value crops, and practical skills.

The **Biology** syllabus comprises 14 topics: Cell Biology; Chemicals of Life; Cell Physiology; Levels of Organisation and Diversity of Life; Ecology; Inheritance and Evolution; Transport; Nutrition; Gaseous Exchange; Respiration; Homeostasis; Coordination; Support and Movement; and Reproduction, Growth and Development. The syllabus places emphasis on understanding, application, analysis and evaluation of Biology concepts relating them to everyday experiences.

The **Chemistry** syllabus has three main sections: Physical Chemistry, Inorganic Chemistry and Organic Chemistry. It is hoped that when teaching topics in the various sections, emphasis will be placed on the application of chemistry in East Africa, particularly in the industries and communities. The suggested teaching and learning strategies are meant to encourage understanding of the basics of chemical behaviour.

**Uganda Advanced  
Certificate of Education**

**Biology**

**TEACHING SYLLABUS**



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## SECTION I

### Introduction

This Biology Teaching Syllabus is a guide to teaching Uganda Advanced Certificate of Education (UACE) Biology course. However, other stakeholders of A level (UACE) may use it, as it is designed to assist the learning process. This teaching syllabus emphasises understanding, application, analysis, synthesis and evaluation of Biology concepts relating them to daily experiences. This necessitates use of a variety of teaching methods like experiments, projects through investigations, surveys, field studies, discussions, research, etc. It is expected to promote learning by providing a guide that requires use of challenging tasks. This encourages discovery, creativity, critical thinking, and team work among the learners.

The syllabus ensures that accurate facts, concepts and knowledge are presented to the learners to allow problem-solving with regard to new Biological situations in the communities for sustainable development.

The teaching syllabus is divided into fourteen topics. Each is sub-divided into sub-topics, arranged in a chronological sequence that presents concepts in a logical way, but not restricting the teaching procedures, and specific objectives.

### Purpose of the Teaching Syllabus

A teaching syllabus enables teachers to cover the syllabus content to the appropriate depth required by the academic level standard. The design of this syllabus emphasises the teaching approaches to be used for each sub-topic from among the general approaches given by the syllabus to achieve the general objectives of the syllabus. The periods allocated guide teachers to make effective plans so that they can complete the syllabus within the recommended study period of UACE.

### General Objectives

By the end of this course the learners should be able to:

- i) develop an interest in learning Biological natural trends of environment and communities.
- ii) apply Biological knowledge in their day to day life and have the ability to use Biological concepts to solve problems.
- iii) communicate or disseminate accurate Biological facts.
- iv) develop the ability to design and carry out practical investigations, interpret data and write logical, precise and clear reports.
- v) use available resources, local materials and facilities to carry out project work / research to obtain information.

- vi) relate various concepts and explain their relationship to aspects in the environment.
- vii) relate scientific information to prior experiences.
- viii) appreciate the ways by which human beings influence the natural trends of environment and communities.

## Target

This Biology teaching syllabus aims at guiding and enhancing teaching strategies for A level teachers of Biology at secondary school.

Teachers are expected to provide detailed content suitable for A level learners within the range indicated in the syllabus and use a variety of methods to enhance the learning process.

## Scope and Depth

The following table summarises the teaching sequence for A Level Biology. The topics are designed in a format that ensures that the teacher integrates theory and practical work in the teaching/learning process.

Topic	Sub-Topic	Periods
<b>1. Cell Biology</b>	1. Cell Structure 2. Diversity of Specialised Cells and Tissues 3. Chromosomes 4. Cell Division 5. Protein Synthesis	3
<b>2. Chemicals of Life</b>	• Acids, Bases and Salts • Water • Structure of Carbohydrates • Structure of Lipids • Structure of Proteins • Vitamins • Enzymes	46
<b>3. Cell Physiology</b>	1. Movement In and Out of Cells	18

<b>Topic</b>	<b>Sub-Topic</b>	<b>Periods</b>
<b>4. Levels of Organisation and Diversity of Life</b>	1. Diversity of Living things 2. Virus (Akaryotae) 3. Kingdom Monera 4. Kingdom Protocista 5. Kingdom Fungi 6. Kingdom Plantae 7. Kingdom Animalia	56
<b>5. Ecology</b>	1. Components of Environment 2. Concept of Ecosystem 3. Population and Natural Resources 4. Interdependence 5. Effects of Human Activities on Ecosystems	31
<b>6. Inheritance and Evolution</b>	1. Genetics 2. Chromosomes and Genes 3. Variation 4. Population Genetics 5. Origin of Life 6. Mechanisms of Evolution 7. Evidence of Evolution 8. Selection and Speciation	34
<b>7. Transport</b>	1. Necessity for Transport Systems 2. Water as a Medium Plants and Animals 3. Circulatory Systems in Animals 4. Defence against Diseases 5. Vascular System of Flowering Plants	36
<b>8. Nutrition</b>	1. Autotrophic Nutrition 2. Heterotrophism <ul style="list-style-type: none"> <li>• Holozoic Nutrition</li> <li>• Saprophytism</li> <li>• Mutualism</li> <li>• Parasitism</li> </ul>	42

Topic	Sub-Topic	Periods
<b>9. Gaseous Exchange</b>	1. Principles of Gaseous Exchange Systems 2. Gaseous Exchange in Plants 3. Gaseous Exchange in Animals	24
<b>10. Respiration</b>	1. Respiration	08
<b>11. Homeostasis</b>	1. General Principles of Homeostasis 2. Regulation of Glucose 3. Regulation of Carbon Dioxide 4. Temperature Regulation 5. Excretion 6. Osmoregulation	28
<b>12. Coordination</b>	1. Concepts of Reception and Response in Plants 2. Plant Hormones 3. Response and Behaviour in Animals 4. General Principles of Reception and Response in Animals 5. Nervous Coordination in Animals 6. Hormonal Coordination in Animals	56
<b>13. Support and Movement</b>	1. Support Systems in Plants and Animals 2. Support System in Organisms (practical) 3. Muscles 4. Movement / Locomotion	31
<b>14. Reproduction, Growth and Development</b>	1. Asexual Reproduction 2. Sexual Reproduction in Animals 3. Sexual Reproduction in Lower Organisms and Plants 4. Growth and Development	48

## Time Allocation

Time allocation in this syllabus is built on the assumption that there are ten (10) weeks of effective teaching in a term. A period is 40 minutes of teaching. It is recommended that 9 periods per week be allocated to the teaching of Biology on the school timetable; (six (6) for Biology theory and three (3) periods for Biology practical work.

## How to Use the Biology Teaching Syllabus

This Biology Teaching Syllabus is aimed at providing you with guidance required to teach Biology at Advanced level. The syllabus is a guide therefore, it is not meant to limit your creativity. However, use the available time allocated to cover the content and to assist the learners develop skills and competences required of an A level graduate.

The syllabus has the following features:

### **a) General Objective(s)**

This is a statement of the general learning outcome expected of a learner at the end of the topic.

### **b) Specific Objectives**

These further clarify the scope and depth of content. You should use the specific objectives to plan for the teaching -learning process suitable for the learner at Advanced level. Specific objectives also will guide you in evaluation at the end of concept or learning process.

### **c) Content**

Items in the content column have been listed but should be handled together with the specific objectives to develop a detailed presentation.

### **d) Teaching Aids**

These provide you with guidance, to effectively plan for the learning outcome, but should not restrict the innovations of the teacher.

### **e) Number of periods per sub-topic**

The suggested number of periods for each sub-topic is the guide to enable you cover the work effectively and adequately.

## Mode of Assessment

### ***Continuous Assessment (Formative assessment)***

It is recommended that you carry out continuous assessment during the teaching-learning process. The assessment should reflect acquisition of the following testable competences or learning outcomes:

**a) Knowledge of:**

- common principles and generalisation identified in the syllabus.
- trends and sequences of phenomena.
- classification and categorising.
- investigation, procedures and techniques or methods to acquire data.
- conventions and presenting facts accurately.
- ways and means of defining terms, and specifics.

**b) Comprehension: Ability to:**

- translate facts and communicate knowledge accurately in the correct language.
- interpret and explain concepts.
- extrapolate, describe and determine implications, and effects of a phenomenon.

**c) Application:** Ability to use abstract knowledge or situations to solve a problem.

**d) Analysis of:**

- scientific information.
- relationships and interaction of principles /concepts.
- principles, systematic arrangement/organisation and structure of concepts.

**e) Synthesis ability to:**

- develop ideas from experiences / knowledge.
- plan / propose a set of work /activities basing on situations or information provided.
- derive / make deductions from the data provided.

**f) Evaluation of:**

- terms and logical communication of knowledge.
- judgement of external criteria /materials /information.
- evidence, accuracy and consistency of information.

**g) Affective and practical abilities to be developed include:**

- Application of knowledge to practical situations
- Manipulation of the apparatus, performing experiments and integrating with theory
- Making and recording observations accurately
- Demonstrating understanding of observations
- Presentation of data in an appropriate form or selected format
- Drawing conclusions from observations made or responses.
- Assessing suitability of procedure, experiment and observations made in support of the conclusion
- Making drawings of natural structures accurately

**Summative Assessment**

Uganda National Examinations Board (UNEB) will administer a Biology principal subject examination at the end of the second year of study. The test blue print developed for this examination is based on the curriculum content specifications. UNEB will also provide the examination regulations.

**Examination Format**

There will be three papers. Papers one and two are theory while paper three is practical.

**Paper 1: (2 ½ hours)**

The paper will consist of **two** sections: **A** and **B**.

Section **A** will contain **40 compulsory** multiple choice questions based on any part of the teaching syllabus.

Section **B** will contain **six compulsory** short structured answer questions also based on any part of the syllabus.

(Total: **100 marks**)

**Paper 2: (2 ½ hours)**

The paper will consist of **two** sections: **A** and **B**. **Six** questions will be set as follows:

Section **A. One compulsory** question from any major topic (**40 marks**)

Section **B. Five** questions; Candidates will **answer only three** questions in this section. Each question carries **20 marks**.

(Total: **100 marks**)

**Paper 3: (3<sup>1</sup>/<sub>4</sub> hours)**

**Three compulsory** questions will be set. Candidates will be required to answer **ALL** questions.

(Total: **100 marks**)

## SECTION II

### SENIOR FIVE TERM ONE

#### Topic 1: Cell Biology

Duration: 36 Periods

##### Overview

The cell is a basic unit of life. A cell carries out a number of activities including protein synthesis, cell division and it is where the hereditary material is. Specialised cells constitute tissues.

##### General Objective

By the end of the topic, the learner should be able to describe the structure, function and organisation of cells in an organism.

##### Sub-Topic 1: Cell Structure and Microscopy

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• identify plant and animal cell structures visible under the light microscope.</li> <li>• draw and label detailed animal and plant cells.</li> <li>• state functions of cell structures as seen under an electron microscope.</li> <li>• distinguish between the plant cell and animal cell ultra structures as visible under the electron microscope.</li> <li>• explain the theory behind the structure of the plasma membrane.</li> <li>• describe the fluid mosaic model of the plasma membrane.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure of the animal and plant cell as seen under a light microscope</li> <li>• Detailed animal and plant cells</li> <li>• Functions of detailed cell structures indicating the interrelationship</li> <li>• Differences between plant cell and animal cell ultra structures</li> <li>• The theory behind the structure of the plasma membrane</li> <li>• The fluid mosaic model-plasma membrane</li> </ul>

**(Practical)**

The learner should be able to:

- explain the functioning principles of a light and electron microscope.
- prepare temporary mounts of cell and tissue slides.
- use simple stains in studying cells and tissues.
- identify different plant tissues using different laboratory stains.
- determine cell size.
- draw and label the different types of epithelial tissues.
- The functioning principles of a light and electron microscope: resolving power, etc
- Preparation of temporary mounts of cell and tissue slides
- Simple staining methods
- Staining plant tissues
- Estimation of cell size
- Epithelial tissues classification

**Teaching/ Learning Resources**

- Cell structures: charts, models, illustrations, photomicrographs, text books, simulations
- Staining reagents: iodine solution, acidified phloroglucinol, methylene blue, Leishman's stain
- Microscopes, slides, cover slips, plastic ruler graduated in millimetres, onion, cheek cells, prepared slides of cells and tissues

**Suggested Teaching Procedure**

- Discuss the structure and differences of animal and plant cells as seen with the aid of a light microscope.
- Discuss the:
  - differences in the functioning principles of a light and electron microscope.
  - cell structures as seen with the aid of an electron microscope using micrographs and charts.
  - functions of cell structures using models, animations, simulations, etc.
- Guide learners to carry out practical work using the light microscope to study plant and animal cells and tissues.
- Demonstrate the preparation of temporary slides on plant and animal cells and tissues.
- Guide learners to study and examine prepared slides of plant and animal tissues.

- Discuss the structure of the plasma membrane using micrographs and /animations.
- Guide the learners to carry out practical work on estimating the size of a cell.

### Assessment Strategy

- Evaluate the topic by giving practical exercises on how to use a microscope as well as oral and written questions on cell structure and functions.

## Sub-Topic 2: Diversity of Specialised Cells and Tissues

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• distinguish between prokaryotes and eukaryotes.</li> <li>• explain cell and tissue specialisation.</li> <li>• explain how epithelial tissues are adapted to diversity of functions in the body.</li> <li>• distinguish between the different levels of organisation.</li> <li>• state the advantages and disadvantages of being unicellular.</li> <li>• state the advantages of being multicellular.</li> </ul>	<ul style="list-style-type: none"> <li>• Differences between eukaryotic cells and prokaryotic cells</li> <li>• Specialised cells and tissues:- xylem, phloem, tracheids, sclerenchyma, collenchyma, parenchyma, connective and skeletal tissue</li> <li>• Function and adaptation of epithelial tissues</li> <li>• Levels of organisation: cell, tissue, organ and organ system</li> <li>• Advantages and disadvantages of being unicellular</li> <li>• Advantages of a multicellular state</li> </ul>

### Teaching/Learning Resources

- Illustrations and handouts
- Staining Reagents: Iodine solution, acidified phloroglucinol, methylene blue, Leishman's stain, microscopes, slides, cover slips, onion, cheek cells, plastic ruler graduated in millimetres, prepared slides of cells and tissues

## Suggested Teaching Procedure

- Discuss with illustrations the differences between eukaryotic and prokaryotic cells.
- Guide learners to examine bacteria, plant and animal tissues using a light microscope.
- Discuss levels of organisation.

## Assessment Strategies

- Evaluate the topic by giving a practical exercise on identification of plant and animal tissues.
- Give the learners oral questions on tissues and differences between bacteria and viruses.

### Sub-Topic 3: Chromosomes

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the composition of chromosomes and structure of nucleotides.</li><li>• describe the structure of DNA and RNA.</li><li>• distinguish DNA and RNA.</li><li>• explain the Watson Crick hypothesis of the nature of DNA.</li><li>• explain the process of DNA replication.</li><li>• describe the nature of genes.</li><li>• describe the structure of the genetic code.</li></ul>	<ul style="list-style-type: none"><li>• Composition of chromosomes and structure of nucleotides</li><li>• Structure of the nucleic acids DNA and RNA</li><li>• Differences between DNA and RNA</li><li>• The Watson- Crick hypothesis of the nature of DNA</li><li>• DNA replication</li><li>• Nature of genes</li><li>• Structure of the genetic code</li></ul>

## Teaching/Learning Resources

Models, illustrations, simulations, suitable model materials (wood/plasticins, toothpicks, ribbons etc) microscopes, electric wires/thread/straws of different colours, prepared slides on mitosis

## Suggested Teaching Procedure

- Discuss the structure of the nucleotide and illustrate the structure of nucleic acids (DNA and RNA) using charts, models/ simulations.
- Guide learners to make models of DNA and RNA.

- Discuss the Watson-Crick hypothesis and DNA replication.

### Assessment Strategy

- Give a written exercise on the structure of nucleic acids.

## Sub-Topic 4: Cell Division and Chromosome Concept

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe mitosis and meiosis.</li> <li>• compare mitosis and meiosis.</li> <li>• explain the significance of changes in the nucleus during cell division.</li> <li>• state the significance of mitosis and meiosis to living organisms.</li> </ul>	<ul style="list-style-type: none"> <li>• Mitosis and meiosis</li> <li>• Comparison of mitosis and meiosis</li> <li>• Significance of the cell division events e.g. formation of the spindle fibres, chiasmata, synapsis, bivalents and movement of chromosomes, etc</li> <li>• Role of mitosis and meiosis in living organisms</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• identify stages of mitosis from prepared slides.</li> <li>• draw cells at different stages of mitosis.</li> <li>• prepare models or illustrations of DNA and RNA.</li> </ul>	<ul style="list-style-type: none"> <li>• Cells at different stages of mitosis</li> <li>• Models of the nucleic acids: (DNA / RNA), double helix</li> </ul>

### Teaching/ Learning Resources

Diagrams illustrating the mitosis and meiosis, animations, prepared slides on root tip, microscopes, and computer aided learning materials

### Suggested Teaching Procedure

- Discuss the:
  - phases in mitosis and meiosis by illustrating with diagrams and animations.
  - significance of cell division events.
  - role of cell division in living organisms.

- Guide learners to examine prepared slides showing stages of mitosis in a root tip.

### Assessment Strategies

- Give practical work and a written exercise on identification of stages of mitosis and meiosis.
- Give a written exercise on the importance of cell division in organisms.  
*(See appendix 1: This is an example of Cell Biology practical).*

### Sub-Topic 5: Protein Synthesis

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• describe the formation of RNA.</li><li>• describe the process of protein synthesis.</li><li>• state the role of DNA and RNA in protein synthesis.</li></ul>	<ul style="list-style-type: none"><li>• Formation of RNA (mRNA)</li><li>• Process of protein synthesis</li><li>• Role of DNA and RNA in protein synthesis</li></ul>

### Teaching/Learning Resources

- Models, illustrations, simulations, charts

### Suggested Teaching Procedure

- Discuss the:
  - formation mRNA using models, illustrations, charts and simulations.
  - process of protein synthesis using illustrations.
  - role of DNA and RNA in protein synthesis.

### Assessment Strategy

- Give a written exercise on the process of protein synthesis highlighting the role of nucleic acids.

## Topic 2: Chemicals of Life

Duration: 46 Periods

### Overview

All cells are made up of a variety of substances some of which are organic while others are inorganic. Water forms the largest component and is also a medium for all reactions in a cell. The other substances include acids, bases, salts, vitamins, carbohydrates, lipids and proteins. There are enzymes and nucleic acids which perform a variety of functions.

### General Objective

By the end of the topic, the learner should be able to describe the composition, structure, properties and importance of inorganic and organic substances to the life of organisms.

### Sub-Topic 1: Acids, Bases and Salts

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>• describe properties of acids bases and salts.</li> <li>• explain the role of acids, bases and salts in maintaining a stable internal environment for physiological processes.</li> </ul>	<ul style="list-style-type: none"> <li>• Properties of acids, bases and salts</li> <li>• Functions of acids, bases and salts in organisms</li> </ul>
<b>(Practical)</b> The learner should be able to identify salts using quantitative and qualitative analysis.	<ul style="list-style-type: none"> <li>• Test for presence of mineral salts in food samples /extracts (refer to inorganic analysis in Chemistry practical)</li> </ul>

### Teaching/ Learning Resources

Charts, samples of urine/egg yolk /liver extracts, test tubes, 2M nitric acid, silver nitrate solution, dilute ammonium hydroxide, 2M hydrochloric acid, barium sulphate solution, ammonium molybdate solution, platinum wire, conc. hydrochloric acid, potassium hexacyanoferrate(II) solution, filter paper, mortar and pestle, source of heat

## Suggested Teaching Procedure

- Ask students to do prior reading on acids, bases and salts. (As an out of class activity).
- Discuss properties of acids, bases and salts.
- Discuss the functions of acids, bases and salts in organisms.
- Guide learners to test for ions in organic materials.  
*(See Appendix 2 and carry out a test for ions in organic materials).*

## Assessment Strategies

- Give oral questions on properties of acids, bases and salts.
- Give a written assignment on the functions of acids, bases and salts.

## Sub-Topic 2: Water

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>describe the molecular structure of water.</li><li>state functions of water.</li><li>explain the importance of water as a solvent.</li><li>relate the water properties to its role in the life of organisms.</li></ul>	<ul style="list-style-type: none"><li>Molecular structure of water</li><li>Functions of water</li><li>Water as a solvent</li><li>Role / significance of water in the life of organisms in relation to its properties</li></ul>
<b>(Practical)</b> The learner should be able to: <ul style="list-style-type: none"><li>test for water.</li><li>determine water content in tissues by using dry weight method.</li><li>investigate the natural relationship of water and organisms in a habitat (including humans).</li></ul>	<ul style="list-style-type: none"><li>Testing for water</li><li>Measuring water content in tissues</li><li>Field study on water habitats. (The natural relationship of water and organisms)</li></ul>

## Teaching/ Learning Resources

- Samples of plant organs, weighing balance, heat source /oven, crucibles, dishes, water habitat, cobalt chloride paper/ anhydrous copper sulphate / cobalt thiocyanate paper

## Suggested Teaching Procedure

- Discuss the molecular structure, properties and functions of water using illustrations, models and animations.
- Guide learners to test for water and measure water content in tissues. Guide learners to carry out a field survey on water habitats as an out of class activity, either individually or in groups and produce a report.
- Lead a discussion on the survey reports.

## Assessment Strategies

- Give a written exercise on functions of water in relation to its properties.
- Give oral questions on natural relationships of water and organisms.

## Practical Application

- Consider:
  - i) conservation of water habitats to conserve biodiversity.
  - ii) drinking sufficient quantities of water for normal body function (in humans and other animals).
  - iii) irrigation.

## Sub-Topic 3: Structure of Carbohydrates

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>describe the structure and components of various carbohydrates.</li> <li>explain the properties of carbohydrates.</li> <li>explain the functions of carbohydrates in organisms.</li> <li>describe the condensation of carbohydrates.</li> <li>describe the hydrolysis of carbohydrates.</li> </ul>	<ul style="list-style-type: none"> <li>Structure and components of carbohydrates</li> <li>Properties of carbohydrates</li> <li>Importance of carbohydrates: monosaccharide's, disaccharides, polysaccharides</li> <li>Condensation of carbohydrates</li> <li>Hydrolysis of carbohydrates</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>carry out food test for carbohydrates on food samples / extracts.</li> <li>demonstrate hydrolysis of non-reducing sugars.</li> </ul>	<ul style="list-style-type: none"> <li>Testing for carbohydrates</li> <li>Hydrolysis of non-reducing sugars to reducing sugars</li> </ul>

## Teaching/ Learning Resources

- Illustrations on carbohydrates structures, test tubes, heat sources, food samples/ extracts, water bath/beaker and water
- Reagents: iodine solution, Benedict's solution, dilute hydrochloric (HCl) acid, dilute sodium hydroxide (NaOH) solution

## Suggested Teaching Procedure

- Discuss the:
  - composition, properties and importance of monosaccharides, disaccharides and polysaccharides using illustrations.
  - condensation of monosaccharides and hydrolysis of carbohydrates.
- Guide the learners to carry out practical work on tests for carbohydrates and hydrolysis of non-reducing sugars to reducing sugars.

## Assessment Strategies

- Give a written exercise on composition, properties and importance of carbohydrates.
- Guide learners to carry out a practical exercise on tests for carbohydrates and hydrolysis of non-reducing sugars.

## Sub-Topic 4: Structure of Lipids

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the structure and components of lipid molecules.</li><li>• state properties of lipids.</li><li>• explain the functions of lipids in organisms.</li><li>• describe the structure of steroids.</li><li>• explain effects of lipids and steroids to organisms</li><li>• describe the condensation of fatty acids and glycerol to form lipids.</li><li>• describe the hydrolysis of lipids to fatty acids and glycerol.</li><li>• compare waxes and lipids.</li><li>• state the importance of cholesterol in organisms.</li></ul>	<ul style="list-style-type: none"><li>• Structure and components of lipids molecules</li><li>• Properties of lipids</li><li>• Importance of lipids in organisms</li><li>• Structure steroids</li><li>• Effects of lipids and steroids to organisms</li><li>• Condensation of fatty acids and glycerol to form lipids</li><li>• Hydrolysis of lipids to fatty acids and glycerol</li><li>• Comparison of waxes and lipids</li><li>• Importance of cholesterol in organisms</li></ul>

<b>(Practical)</b> <ul style="list-style-type: none"> <li>• The learner should be able to carry out food tests for lipids on food samples / extracts.</li> </ul>	<ul style="list-style-type: none"> <li>• Tests for lipids</li> </ul>
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## Teaching/ Learning Resources

- Illustrations on lipid structures and effects, test tubes, ethanol, food samples/ extracts, water, opaque piece of paper

## Suggested Teaching Procedure

- Discuss the:
  - composition, properties and importance of lipids using illustrations.
  - effects of lipids to organisms.
  - condensation of fatty acids and glycerol. And Hydrolysis of lipids.
- Guide learners to carry out practical work on tests for lipids.

## Assessment Strategies

- Give a written exercise on composition, properties and importance of lipids.
- Give a practical exercise on tests for lipids.

## Sub-Topic 5: Structure of Proteins

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>• describe the structure and components of proteins.</li> <li>• describe the properties of proteins.</li> <li>• explain the importance of proteins.</li> <li>• explain the functions of proteins in organisms.</li>   <li>• describe condensation of amino acids to form proteins.</li> <li>• describe the hydrolysis of proteins to amino acids.</li> <li>• explain effects of heat / temperature changes on proteins.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure and components of proteins</li> <li>• Properties of proteins</li> <li>• Importance of proteins</li> <li>• Functions of proteins in organisms : buffer, enzymes/catalytic, hormones, structural, growth, carriers etc</li> <li>• Condensation of amino acids to form proteins</li> <li>• Hydrolysis of proteins to amino acids</li> <li>• Effects of heat/temperature on proteins</li> </ul>

<b>(Practical)</b>	
<ul style="list-style-type: none"><li>The learner should be able to carry out food tests for proteins on food samples / extracts.</li></ul>	<ul style="list-style-type: none"><li>Tests for proteins</li></ul>

## Teaching/ Learning Resources

- Illustrations on protein structures, test tubes, heat sources, food samples/ extracts, reagents: 1% copper (II) sulphate solution, dilute sodium hydroxide NaOH solution

**Note:** Million's reagent is carcinogenic and its use is discouraged.

## Suggested Teaching Procedure

- Discuss the:
  - composition, properties and importance of proteins using illustrations
  - condensation of amino acids and hydrolysis of proteins.
- Guide learners to carry out practical work on food tests for protein.

## Assessment Strategies

- Give a written exercise on composition, properties, importance and functions of proteins.
- Give learners a practical exercise on test for proteins.

## Sub-Topic 6: Vitamins

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• state types of vitamins.</li> <li>• state the importance of vitamins in organisms.</li> </ul>	<ul style="list-style-type: none"> <li>• Types of vitamins: water soluble and fat soluble, essential and non essential</li> <li>• Importance of vitamins in the life of organisms: protection against diseases, formation of coenzymes role in blood clotting and component of visual pigment</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• test for vitamin C.</li> <li>• demonstrate effect of over boiling vegetables.</li> <li>• demonstrate the effect of storage on quality of fresh foods.</li> </ul>	<ul style="list-style-type: none"> <li>• Test for vitamin C</li> <li>• Effect of over boiling vegetables</li> <li>• Effects of storage on quality of fresh foods</li> </ul>

### Teaching/ Learning Resources

- DCPIP, vegetables, beakers, test tubes, droppers, source of heat

### Suggested Teaching Procedure

- Ask students to do prior reading on vitamins. (As an out of class activity)
- Discuss properties of vitamins.
- Discuss the importance vitamins in organisms.
- Guide learners to test for: mineral salts in organic materials, vitamin C in vegetables.

### Assessment Strategies

- Give a practical exercise on the relative abundance of vitamin C in different food extracts.
- Assess learners on the value of storage conditions on quality of food.

## Practical Application

- Consider:
  - i) effect of heating vitamin C and other water soluble vitamins.
  - ii) effect of storage on the quality of fresh food.
  - iii) use of acetic acid/vinegar as salad dressing.

## Sub-Topic 7: Enzymes

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the criteria for naming enzymes.</li><li>• explain the characteristics /properties of enzymes.</li><li>• state factors that affect enzyme action.</li><li>• explain the mechanism of enzyme action using the lock and key mechanism and induced fit.</li><li>• explain the role of enzymes in the organism's life.</li></ul>	<ul style="list-style-type: none"><li>• Criteria for naming enzymes :Use type of substrate, type of reaction</li><li>• Characteristics/ Properties of enzymes relating to factors affecting enzyme activities: Protein in nature, can be denatured, catalytic /change rates of reactions, work in small amounts, specific to reactions they catalyse, catalyse reversible reactions, can be inhibited, affected by temperature, pH, concentration of substrate and some require coenzymes/ cofactors</li><li>• Factors affecting enzyme action: pH, temperature, inhibitors, substrate concentration</li><li>• The enzyme action: lock and key mechanism, induced fit</li><li>• Role of enzymes in living organisms including inhibition, competitive/non competitive, reversible/non reversible</li></ul>

<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• demonstrate properties of enzyme action in specific temperature, pH range, substrate concentration.</li> <li>• identify enzymes in the different parts of the gut based on their actions on different food substances.</li> <li>• carry out food tests on gut contents.</li> </ul>	<ul style="list-style-type: none"> <li>• Enzyme properties relating to factors (temperature and pH, concentration of substrate) affecting enzymes' activities</li> <li>• Enzymes in the different parts of the gut based on their actions on different food substances</li> <li>• Food tests using the animal gut contents and enzymes</li> </ul>
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## Teaching/ Learning Resources

- Illustrations , model on the lock and key hypothesis, enzyme extracts, food / substrate extracts, acids, bases, salts and water, universal indicators, thermometers, heat source, incubator, cockroaches (gut), rat/toad, dissecting kits, reagents (depending on the food substrate)

## Suggested Teaching Procedure

- Discuss the:
  - naming and properties of enzymes.
  - mode of action of enzymes using illustrations and models.
- Discuss functioning of enzymes, including enzyme inhibitors, allosteric enzymes, cofactors and prosthetic groups.
- Guide the learners to carry out practical work on enzyme properties relating to: factors affecting enzyme activities, food tests on carbohydrates and proteins using enzymes of gut contents.

## Assessment Strategies

- Give written exercises on properties and functioning of enzymes.
- Give practical exercises on effects of gut enzymes on food substances.

**SENIOR FIVE TERM TWO****Topic 3: Cell Physiology**

Duration: 18 Periods

**Overview**

Materials move in and out of cells by the following processes: - Osmosis, diffusion, active transport, phagocytosis and pinocytosis. Some of these processes require energy while others do not. The materials include water, gases, enzymes, hormones, antibodies, among other solvents and solutes.

**General Objectives**

By the end of the topic, the learner should be able to:

- i) explain the physiological processes by which materials move in and out of cells.
- ii) explain the role of these processes in the life of organisms.

**Sub-Topic 1: Movement In and Out of Cells**

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe diffusion, osmosis, active transport, phagocytosis and pinocytosis.</li><li>• state the factors that affect the process of diffusion.</li><li>• describe the processes of osmosis.</li><li>• explain the significance of diffusion and osmosis in organisms.</li><li>• explain how solvents and solutes are exchanged in animal and plant tissues or cells across the cell membrane in relation to its</li></ul>	<ul style="list-style-type: none"><li>• Diffusion and osmosis, active transport, phagocytosis and pinocytosis: exocytosis and endocytosis</li><li>• Factors affecting process of diffusion</li><li>• Process of osmosis: including; turgidity, plasmolysis, water potential, osmotic potential, wall pressure</li><li>• Significance of the processes of diffusion and osmosis in organisms</li><li>• Exchange of solvents and solutes in plant and animal tissues or cells across the cell membrane in relation to its</li></ul>

<p>structure.</p> <ul style="list-style-type: none"> <li>● describe how unicellular organisms obtain water and food.</li> <li>● explain the relationship between structure and function of a cell membrane.</li> </ul>	<p>structure</p> <ul style="list-style-type: none"> <li>● Ways by which unicellular organisms obtain water and food</li> <li>● Relationship between structure and function of a cell membrane</li> </ul>
<p><b>(Practical)</b> The learner should be able to:</p> <ul style="list-style-type: none"> <li>● identify habitats with suitable media for organisms' survival.</li> <li>● demonstrate use of salt in food preservation.</li> <li>● demonstrate use of visking tubing, glass columns, microscope in diffusion and osmosis experiments.</li> <li>● demonstrate conditions affecting the rate of diffusion.</li> <li>● demonstrate effects of osmosis on the cells/ tissues.</li> </ul>	<ul style="list-style-type: none"> <li>● Habitats with suitable media for organisms' survival</li> <li>● Use of salt in food preservation</li> <li>● Use of visking tubing, glass columns and microscope in diffusion and osmosis experiments</li> <li>● Conditions affecting the rate of diffusion</li> <li>● Effect of osmosis in living cells/tissues</li> </ul>

## Teaching/ Learning Resources

- Illustrations on movement of materials in and out of cells, potassium permanganate, methylene blue, water, sucrose solutions, plant organs: (potato tubers/ pawpaw petioles unripe pawpaw fruits, *bidens sp.* stem cuttings.), filamentous algae, slides , microscopes, razor, cellophane / visking tubing, cork borer, knife, onion epidermis / *Tradescantia* /*Zebrina* leaf epidermis

## Suggested Teaching Procedure

- Discuss diffusion, osmosis, active transport, phagocytosis and pinocytosis using illustrations and demonstrations.
- Guide learners to carry out practical work on conditions affecting the rate of diffusion and on osmosis in living tissues.

## Assessment Strategies

- Give a written exercise on interpretation of data (in table / graph form) on movement in and out of cells.

- Give a practical exercise on movement in and out of cells.

### Practical Application

Consider practical application for example:

- i) Avoid exposing living organisms / tissues to concentrated media.
- ii) Food preservation by salting.

## Topic 4: Levels of Organisation and Diversity of Life

Duration: 56 Periods

### Overview

This topic involves application of biosystematics principles. These include identification, classification and nomenclature. It indicates the relationship among organism basing on their characteristics.

It should be noted that although viruses have non living characteristics they show some characteristics of living things when they are within the living cells of an organism.

### General Objective

By the end of the topic, the learner should be able to trace the relationships between groups of organisms.

### Sub-Topic 1: Diversity of Living Things

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the principles of taxonomy.</li> <li>• explain the principles of classification.</li> <li>• explain the importance of studying diversity.</li> <li>• list 3 criteria for classifying organisms.</li> <li>• state the hierarchy of classification according to Carl Linnaeus.</li> <li>• distinguish between scientific and local names.</li> <li>• explain the need to conserve</li> </ul>	<ul style="list-style-type: none"> <li>• Principles of taxonomy: identification, classification and nomenclature</li> <li>• Principles of classification: artificial and natural classification</li> <li>• Importance of studying diversity</li> <li>• 3 Criteria for classifying organisms: morphology, anatomy, physiology</li> <li>• Hierarchy of classification according to Carl Linnaeus (kingdom-phylum/ division - class-order-family-genus-species)</li> <li>• Scientific /binomial nomenclature and local names</li> <li>• Importance of conserving</li> </ul>

biodiversity.	biodiversity
<b>(Practical)</b> The learner should be able to: <ul style="list-style-type: none"><li>• identify organisms using observable features.</li><li>• construct simple biological keys.</li></ul>	<ul style="list-style-type: none"><li>• Identification of organisms using observable features</li><li>• Construction and use of simple biological keys</li></ul>

## Teaching/ Learning Resources

Use simple and common organisms or organs (e.g. arthropods, leaves, flowers, fruits, modified stems), charts, , preserved specimens and prepared slides

## Suggested Teaching Procedure

- Discuss the:
  - principles of taxonomy and principles of classification using illustrations, charts and specimens.
  - diversity of living things and significance of studying diversity using charts, preserved specimens and organisms in the school compound. Guide the learners to carry out a field study to observe biodiversity and collect some specimens in the school surroundings.
- Guide learners on the construction and use of simple biological keys.

## Assessment Strategy

- Give practical exercises on tabulation of observable structural features of organisms and using the features to construct dichotomous keys.

## Practical Application

- Consider conservation of biodiversity.

## Sub-Topic 2: Viruses (Akaryotae)

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the general structure of a virus.</li> <li>• explain characteristics of viruses.</li> <li>• describe the economic importance of viruses.</li> <li>• outline methods of preventing the spread of viral diseases.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure of viruses</li> <li>• Characteristics of viruses</li> <li>• Economic importance of viruses</li> <li>• Methods of preventing the spread of viral diseases</li> </ul>

### Teaching/ Learning Resources

- Computer aided study materials, charts, diseased plants and animals (CARE).

### Suggested Teaching Procedure

- Discuss the structure, characteristics and economic importance of viruses using charts, computer aided study material and specimens of diseased plants and animals.
- Give an out of class activity on prevention of common viral diseases.
- Guide a discussion on viral diseases in the next lesson.

### Assessment Strategy

- Give a written exercise on the structure and economic importance of viruses.

### Practical Application

- Consider prevention of viral diseases.

## Sub-Topic 3: Kingdom Monera

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>make a labelled diagram to show the structure of bacterial cell.</li><li>describe characteristics of bacteria.</li><li>differentiate between bacteria and viruses.</li><li>state the role of bacteria in the environment.</li></ul>	<ul style="list-style-type: none"><li>Structure of bacterial cell</li><li>Characteristics of bacteria: shape, cell wall, reproduction, movement</li><li>Differences between bacteria and viruses</li><li>Economic importance of bacteria in the environment</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>draw, label and state the types of bacteria</li><li>demonstrate the role of bacteria in the production of dairy products.</li><li>identify common bacterial diseases in plants and animals.</li><li>demonstrate methods of preventing the common bacterial diseases.</li></ul>	<ul style="list-style-type: none"><li>Types of bacteria</li><li>Role of bacteria in production of dairy products</li><li>Common bacterial diseases in plants and animals</li><li>Methods of preventing common bacterial diseases</li></ul>

### Teaching/ Learning Resources

- Illustrations, computer aided study materials, charts, prepared bacteria cultures from milk, soil and plant part extracts, stains, microscope, incubator, fridge, prepared slides, computer simulations

### Suggested Teaching Procedure

- Discuss the characteristics, structure and economic importance of bacteria using illustrations, computer simulations, prepared slides and charts.
- Guide the learners to carry out a field study on economic importance of bacteria as an outside class activity and lead discussion of their findings.

- Describe different types of bacteria using illustrations.

### Assessment Strategy

- Give a written exercise on characteristics, structure and economic importance of bacteria.

### Practical Application

- Consider:
  - i) prevention of bacterial diseases.
  - ii) role of bacteria in decomposition of organic matter.
  - iii) use of bacteria in the manufacture of dairy products e.g. butter, yoghurt, cheese, ghee.

### Sub-Topic 4: Kingdom Protostista

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• state characteristics of Protostista.</li> <li>• describe the structure of protozoa and algae.</li> <li>• outline the role of protozoa and algae in the environment.</li> <li>• Name common diseases caused by protozoa.</li> <li>• Outline methods of preventing spread of diseases caused by protostists.</li> </ul>	<ul style="list-style-type: none"> <li>• Characteristics of Protostista</li> <li>• Structure of protozoa and algae</li> <li>• Economic importance of protozoa and algae e.g. <i>Amoeba</i>, <i>Euglena</i>, <i>Entamoeba</i>, <i>Paramecium</i>, <i>Trypanosoma</i>, <i>Plasmodium</i></li> <li>• Common diseases caused by protozoa</li> <li>• Methods of preventing the spread of diseases caused by protostists</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• prepare temporary mount of <i>Spirogyra</i> filaments.</li> <li>• draw and label structure of <i>Spirogyra</i> as seen under a light microscope.</li> <li>• identify and draw protozoa from prepared slides.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure of the <i>Spirogyra</i></li> <li>• Structure of protozoa</li> </ul>

## Teaching/ Learning Resources

- Computer aided study materials, illustrations, microscope, slides, cover slips, Spirogyra, prepared slides of protozoa

## Suggested Teaching Procedure

- Discuss the structure and characteristics of protists using charts, computer aided study materials and prepared slides.
- Guide learners to observe the structure of Spirogyra as seen with the aid of light microscope.
- Discuss economic importance of the protists.

## Assessment Strategies

- Give a practical exercise on structure of spirogyra.
- Give a written exercise on the economic importance of protists.

## Practical Application

- Consider prevention of diseases caused by protozoa.

## Sub-Topic 5: Kingdom Fungi

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• state characteristics of fungi.</li><li>• state characteristics of <i>Rhizopus</i> or <i>Mucor</i>, yeast, and the mushroom.</li><li>• state the economic importance of fungi.</li><li>• name common fungal diseases.</li><li>• describe the methods of preventing the spread of fungal diseases.</li><li>• explain the use of yeast in brewing alcohol and bread making.</li></ul>	<ul style="list-style-type: none"><li>• Characteristics of fungi (feeding, reproduction).</li><li>• Characteristics of <i>Rhizopus</i> or <i>Mucor</i>, yeast, and the mushroom</li><li>• Economic importance of fungi</li><li>• Common fungal diseases</li><li>• Methods of preventing the spread of fungal diseases</li><li>• Use of yeast in brewing alcohol and bread making</li></ul>

<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• prepare temporary mount of yeast, <i>Mucor/Rhizopus</i>.</li> <li>• draw and label structure of <i>Rhizopus</i> or <i>Mucor</i>, yeast and the mushroom.</li> </ul>	<ul style="list-style-type: none"> <li>• Structures of yeast, <i>Mucor/Rhizopus</i> as seen under the light microscope</li> <li>• Structure of the mushroom</li> </ul>
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## Teaching/ Learning Resources

- Computer aided study materials, illustrations, charts, and specimens.
- Mould samples, microscope, slides, cover slips

## Suggested Teaching Procedure

- Discuss the structure, characteristics and economic importance of fungi using specimens, charts, photographs, and computer aided study materials.
- Guide learners to carry out practical work on mushrooms and temporary mounts of yeast, *rhizopus* or *mucor*.

## Assessment Strategies

- Give a written exercise on the structure, characteristics and economic importance of fungi.
- Give a practical exercise on the structure of yeast, rhizopus or mucor.

## Practical Application

- Consider:
  - i) prevention of fungal diseases in plants and animals.
  - ii) mushroom growing.
  - iii) use of yeast in bread making and brewing alcohol.
  - iv) preservation of food by drying to prevent fungal growth.
  - v) prevention of deterioration of natural materials e.g. leather and wood by keeping them dry to prevent fungal growth.

## Sub-Topic 6: Kingdom Plantae

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• identify lower plants and higher plants using structural features.</li><li>• name the plant groups to phyla.</li><li>• outline the characteristics and structures of the named plant groups.</li><li>• state the role of plants in the environment.</li></ul>	<ul style="list-style-type: none"><li>• Structural features of lower plants and higher plants</li><li>• Lower plants: Bryophyta and Pteridophyta (Ferns)/Filicinophyta Higher plants: Coniferophyta, Spermatophyta</li><li>• Characteristics and structures of named plant groups: Bryophyta, Filicinophyta, Coniferophyta, Spermatophyta: gymnosperms and angiosperms to class level</li><li>• Economic importance of plants in the environment</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• Identify distinguishing structural features of plant groups in lower plants.</li><li>• identify distinguishing structural features of plant groups in higher plants.</li></ul>	<ul style="list-style-type: none"><li>• Structural features of lower plants: Bryophyta, Pteridophytes/ Filicinophyta</li><li>• Structural features of higher plants: Coniferophyta, Spermatophyta: (gymnosperms, angiosperms)</li></ul>

### Teaching /Learning Resources

- Plant specimens, illustrations, computer aided study materials, charts, sample plant organs, hand lenses, microscopes

### Suggested Teaching Procedure

- Discuss characteristics and structural features of plant groups.
- Guide learners to do practical work on structural characteristics of the following plants:
  - moss
  - ferns

- coniferous plant
- angiosperms
- Guide the learners to make transverse sections of roots and stems of monocotyledonous and dicotyledonous plants.
- Discuss the economic importance of plants using illustrations and computer aided study materials.
- Guide learners to carry out a research on the role of plants in the habitat.

### **Assessment Strategy**

- Give a written exercise on structure, characteristics and economic importance of plants.

### **Practical Application**

- Consider:
  - i) growing ornamental plants.
  - ii) growth of plants for food, timber, nature conservation, medicine, raw material for crafts, fibre producing plants (sisal, hemp, cotton), etc.

## **Sub-Topic 7: Kingdom Animalia**

<b>Specific Objectives</b>	<b>Content</b>
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• state characteristics of invertebrates and vertebrates.</li> <li>• state the distinguishing structural features of organisms in different animal phyla.</li> </ul>	<ul style="list-style-type: none"> <li>• Characteristics of invertebrates and vertebrates</li> <li>• Distinguishing structural features of various animal phyla:           <ul style="list-style-type: none"> <li>- porifera</li> <li>- coelenterata/cnidaria</li> <li>- platyhelminthes</li> <li>- nematoda</li> <li>- annelida</li> <li>- mollusca</li> <li>- echinodermata</li> <li>- arthropoda down to classes. consider class insecta down to order</li> </ul> </li> </ul>

<ul style="list-style-type: none"><li>• explain the role of animals in the environment.</li><li>• discuss the welfare of domestic and wild animals.</li></ul>	<ul style="list-style-type: none"><li>- chordata down to vertebrate classes</li><li>• Economic importance of the animal groups</li><li>• Welfare of domestic (consider care and feeding) and wild animals (mention protection and conservation)</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• classify phylum Arthropoda to class level using structural features.</li><li>• identify structural features of class Insecta down to order level.</li><li>• state distinguishing structural features of animals other than Arthropoda.</li></ul>	<ul style="list-style-type: none"><li>• Structural features of Arthropoda down to class level</li><li>• Structural features of class Insecta down to order level</li><li>• Structural features of animals other than arthropods</li></ul>

### Teaching /Learning Resources

- Animal specimens, illustrations, computer aided study materials, photographs, sample organs, hand lenses, light microscope, identification keys

### Suggested Teaching Procedure

- Discuss the structural features of animals in the different phyla using specimens, photographs, sample organs, etc.
- Guide learners to carry out practical work using structural characteristics to classify animals.
- Discuss the economic importance of animals using illustrations and computer aided study materials.
- Guide learners to carry out research on animal welfare activities as an out of class activity.
- Then lead a discussion on their findings.

### Assessment Strategies

- Give written exercises on structure, characteristics and economic importance of animals.
- Give practical work on construction and use of dichotomous keys.

## Practical Application

- Consider:
  - i) welfare of domestic and wild animals
  - ii) use of beneficial insects
  - iii) plant and animal pests and diseases
  - iv) biological control

## Topic 5: Ecology

Duration: 31 Periods

### Overview

Ecology is the study of the relationship of living organisms with each other and their non living environment. The study of ecology lays a foundation for understanding agriculture, forestry, fisheries, conservation, impact of human activities on the ecosystem and how to remedy these impacts.

### General Objectives

By the end of the topic, the learner should be able to:

- i) describe the relationships of organisms with each other and their non living environment.
- ii) explain the impact of humans on the ecosystem and the need for conservation in nature.

### Sub-Topic1: Components of the Environment

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the abiotic and biotic components.</li><li>• state abiotic and biotic factors.</li><li>• explain how the components and environmental factors influence the distribution and abundance of organisms in an ecosystem.</li></ul>	<ul style="list-style-type: none"><li>• Abiotic components: air, water, soil Biotic components: living things</li><li>• Abiotic factors: light, temperature, humidity, atmospheric pressure, rainfall, edaphic factors Biotic factors: competition, predation, biological associations</li><li>• Influence of abiotic and biotic components and factors of the environment on distribution and abundance of organisms</li></ul>

<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• collection of data from field studies.</li> <li>• analyse and interpret data or literature on ecological principles.</li> </ul>	<ul style="list-style-type: none"> <li>• Collection of data on ecological components and factors of an ecosystem</li> <li>• Analysis and interpretation of data or literature on ecological principles</li> </ul>
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## Teaching /Learning Resources

- Illustrations, computer aided study materials, charts, photographs, school and community natural resources,(choose one or two natural resources for the study)
- Data in form of graphs, tables, charts, photographs, illustrations, CDs, quadrats, string, thermometers, tape measure, dry cobalt chloride paper, hand lenses, pooters, sweep nets, etc.

## Suggested Teaching Procedure

- Discuss the abiotic and biotic components and factors using illustrations and computer aided study materials.
- Guide learners to carry out a field study on collection and analysis of data on components and factors of the environment of the organism.  
*(See Appendix 4 field activity.)*

## Assessment Strategy

- Give learners an exercise to analyse and interpret data or literature on components and factors of the environment.

## Practical Application

- Consider environmental conservation.

## Sub-Topic 2: Concept of Ecosystem

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe an ecosystem.</li> <li>• state the types and properties of an ecosystem.</li> </ul>	<ul style="list-style-type: none"> <li>• Ecosystem: definition</li> <li>• Aquatic and terrestrial ecosystems and properties of an ecosystem: feeding relations,</li> </ul>

	cycling of materials, succession, climax, and homeostasis of an ecosystem/balance of nature
• explain the ecological factors influencing the life of organisms in an ecosystem.	Ecological factors influencing the life of organisms in an ecosystem: abiotic, biotic, edaphic
• explain changes in an ecosystem.	Changes in an ecosystem: ecosystem productivity, succession and climax
• describe feeding relations in an ecosystem.	Feeding relations: food chains, food webs, ecological pyramids
• explain energy flow and recycling of nutrients in an ecosystem.	Recycling of nutrients and energy flow in ecosystems
• describe biogeochemical cycles.	Biogeochemical cycles: nitrogen, carbon, water

### Teaching /Learning Resources

- Illustrations, computer aided study materials

### Suggested Teaching Procedure

- Discuss the concept of the ecosystem using illustrations.
- Guide learners in a field study on the interaction of organisms in a habitat / an ecosystem.

### Assessment Strategy

- Give a written exercise to analyse and interpret data related to ecological principles in an ecosystem or habitat.

### Practical Application

- Consider practical application, for example, living in harmony with our environment.

## Sub-Topic 3: Population and Natural Resources

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• state population characteristics.</li> <li>• explain factors affecting population density.</li> <li>• describe methods or techniques of estimating populations.</li> <li>• explain population growth patterns.</li> <li>• explain the terms renewable and non-renewable resources.</li> <li>• discuss environmental resistance and “balance of nature”.</li> <li>• discuss the importance of natural resources.</li> <li>• describe methods of conservation of natural resources.</li> </ul>	<ul style="list-style-type: none"> <li>• Population characteristics: density, age structure, sex, growth pattern, birth rate, death rate</li> <li>• Population density dependent factors and density independent factors</li> <li>• Methods or techniques of measuring and estimating population density</li> <li>• Population growth patterns</li> <li>• Natural resources types: renewable and non-renewable, importance, conservation</li> <li>• Environmental resistance: density dependent factors affecting “balance of nature”</li> <li>• Importance of natural resources</li> <li>• Methods of conservation of natural resources</li> </ul>
<p><b>(Practical)</b></p> <ul style="list-style-type: none"> <li>• The learner should be able to demonstrate the methods used in estimating populations.</li> </ul>	<ul style="list-style-type: none"> <li>• Methods of estimating population: quadrat, line transect, capture-recapture</li> </ul>

### Teaching /Learning Resources

- Illustrations, computer aided study materials, quadrat, sweep net, string / rope/peg, traps, specimen bottles /containers, beads of different colours, markers, videos

### Suggested Teaching Procedure

- Discuss population and natural resources using illustrations and videos.

- Guide learners in practical work on estimating populations using quadrats, line transect.
- Guide learners to estimate a population using capture-recapture method.  
*(See Appendix 3 simulation of capture-recapture).*

### Assessment Strategy

- Give written exercise on effect of population increase on natural resources.

### Practical Application

- Consider:
  - i) Wise use of natural resources
  - ii) Population control

### Sub-Topic 4: Interdependence

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• explain the various interactions of organisms in nature.</li><li>• state the significance of organisms' interactions in nature.</li></ul>	<ul style="list-style-type: none"><li>• Interactions among organisms and their effects: interspecific and intraspecific relationships between organisms: competition, parasitism, predation, saprophytism, mutualism, commensalism</li><li>• Significance of organisms' interactions in nature</li></ul>

### Teaching /Learning Resources

- Illustrations, computer aided study materials, video, photographs

### Suggested Teaching Procedure

- Discuss interactions between organisms using photographs, video, and computer aided study materials.
- Guide learners to carry out a field study on interaction of organisms in a habitat / an ecosystem.

*(See Appendix 4 field activity)*

## Assessment Strategy

- Ask learners to make presentation on interactions between organisms in different habitats / ecosystems.

## Sub-Topic 5: Effects of Human Activities on Ecosystems

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>discuss the impact of human activities on an ecosystem.</li> <li>explain the effects of human activities on ecological components and factors in a habitat.</li> <li>discuss natural resource utilisation and sustainable development.</li> </ul>	<ul style="list-style-type: none"> <li>Impact of human activities on an ecosystem</li> <li>Effects of human activities on ecosystem components and factors in a habitat:             <ul style="list-style-type: none"> <li>- interruption of biogeochemical cycles, natural resources imbalances, population imbalances, soil erosion, soil exhaustion, extinction, pollution, speciation.</li> </ul> </li> <li>Natural resources utilisation and sustainable development</li> </ul>
<p><b>(Practical)</b> The learner should be able to:</p> <ul style="list-style-type: none"> <li>demonstrate conservation practices.</li> </ul>	<ul style="list-style-type: none"> <li>Natural resource conservation practices: mulching, terracing, crop rotation, afforestation, reforestation, mixed farming, agro forestry, wise use of resources, etc.</li> </ul>

## Teaching /Learning Resources

- Illustrations, computer aided study materials, videos, photographs, and data.

## Suggested Teaching Procedure

- Discuss the effects of human activities on ecosystems using illustrations.
- Guide learners to demonstrate natural resource conservation practices.
- Guide learners to collect information on the effects of human activities on the ecosystems.

## Assessment Strategies

- Give a written exercise on effects of human activities on the environment.
- Give a written assignment on data analysis and interpretation.  
*(See appendix 4b ecology)*

## Practical Application

- Consider conservation of natural resources

## SENIOR FIVE TERM THREE

### Topic 6: Inheritance and Evolution

Duration: 34 Periods

#### Overview

Organisms show variations which may be as a result of the influences of the environment and genetic factors. These variations can be passed on from one generation to another.

Evolution and variation processes are linked because both cause changes in organisms.

#### General Objective

By the end of the topic, the learner should be able to explain the patterns of inheritance and evolution.

#### Sub-Topic 1: Genetics

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concept of inheritance.</li><li>• define genetics terms.</li><li>• describe Mendel's investigations on heredity.</li><li>• explain inheritance of traits using the monohybrid and dihybrid crosses.</li><li>• explain the two Mendel's laws of inheritance.</li><li>• discuss the challenges of inheritable disorders.</li></ul>	<ul style="list-style-type: none"><li>• Concept of inheritance</li><li>• Definition of genetics terms e.g. inheritance, gene, allele, chromosome, DNA, trait, etc</li><li>• Mendel's work on heredity</li><li>• Monohybrid inheritance and dihybrid inheritance.</li><li>• Mendel's laws of inheritance: law of independent assortment and law of segregation</li><li>• Challenges of inheritable disorders</li></ul>

**(Practical)**

The learner should be able to:

- demonstrate monohybrid and dihybrid inheritance.
- illustrate a pedigree.
- Monohybrid inheritance dominant and recessive traits: using uniform money coins/beads/seeds.
- Pedigree study: baldness, early greying of hair, haemophilia, eye colour, sickle cell, albinism

**Teaching / Learning Resources**

- Illustrations, charts, computer aided study materials, bean / cow pea seeds, uniform money coins or discs, beads, group of organisms /organs

**Suggested Teaching Procedure**

- Discuss concept of inheritance and Mendel's work on heredity using illustrations.
- Discuss monohybrid inheritance illustrating with crosses.
- Guide learners to work out dihybrid inheritance illustrating with crosses.
- Discuss challenges of heritable disorders, using relevant examples.
- Guide learners to carry out practical work on monohybrid and dihybrid inheritance using simulations (see appendix 5).
- Guide learners to interpret and illustrate pedigrees.
- Ask learners to gather information on pedigrees as an out of class activity.

**Assessment Strategies**

- Give written assignment on inheritance of characteristics.
- Give a written assignment on pedigree analysis.

**Practical Application**

- Consider:
  - i) paternity / maternity tests
  - ii) genetic counselling

## Sub-Topic 2: Chromosomes and Genes

Specific Objectives	Content
<ul style="list-style-type: none"> <li>The learner should be able to explain the terms: gene interactions, sex linkage, sex determination, sex limitation, lethal genes and polygenes.</li> <li>explain gene and chromosome mapping.</li> </ul>	<ul style="list-style-type: none"> <li>Terms: <ul style="list-style-type: none"> <li>gene interactions: definition and examples: linkage, multiple alleles, co-dominance, incomplete dominance, dominant and recessive traits, epistasis and complementary genes</li> <li>sex linkage definition, examples and inheritance</li> <li>sex determination: definition and examples in humans</li> <li>sex limitation: definition and examples</li> <li>lethal genes: definition and examples: phenyl ketonuria, neurospora, etc</li> <li>polygene: definition and examples</li> </ul> </li> <li>Gene and chromosome mapping</li> </ul>

### Teaching / Learning Resources

- Illustrations, computer aided study materials

### Suggested Teaching Procedure

- Discuss gene interactions using illustrations and examples.
- Work out problems based on gene interactions.
- Discuss gene and chromosome mapping using illustrations.

### Assessment Strategies

- Give written exercise on working out crosses based on gene interactions.
- Allow learners to present oral answers on gene interactions.
- Give written exercise on gene and chromosome mapping.

## Sub-Topic 3: Variation

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain population traits and types of variation.</li><li>• describe the causes of variation.</li><li>• define mutation.</li><li>• describe types and causes of mutations.</li><li>• distinguish between chromosomal and gene mutations.</li><li>• explain the significance of mutations.</li></ul>	<ul style="list-style-type: none"><li>• Population traits and types of variations: continuous (quantitative) and discontinuous (qualitative)</li><li>• Causes of variation: genetic and environmental factors</li><li>• Definition of mutation</li><li>• Types of mutations: gene and chromosomal mutation</li><li>• Causes of mutation: chance, radiation, chemicals</li><li>• Differences between the chromosomal and gene mutations</li><li>• Significance of mutations</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• identify variations in organisms.</li><li>• collect data on variations among themselves.</li></ul>	<ul style="list-style-type: none"><li>• Variations among organisms</li><li>• Data on variations among organisms (e.g. sex, height, tongue rolling)</li></ul>

### Teaching / Learning Resources

- Illustrations, computer aided study materials, charts, preserved specimens and learners

### Suggested Teaching Procedure

- Discuss, with illustrations the types, causes and significance of variation and mutations.
- Guide learners to collect data on variation.

### Assessment Strategy

- Give written assignment on interpretation of data on variation.

## Practical Application

- Consider selection of better varieties of crops, animals and ornamental plants.

## Sub-Topic 4: Population Genetics

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>explain gene frequency in the gene pool of a population.</li> <li>state the Hardy -Weinberg equilibrium.</li> <li>explain how different factors affect the gene frequency in a population.</li> </ul>	<ul style="list-style-type: none"> <li>Gene frequency in the gene pool of a population</li> <li>Causes of changes in gene frequency in a population</li> <li>Hardy-Weinberg equilibrium</li> <li>Factors affecting the Hardy-Weinberg equilibrium: natural selection, non random mating, mutation, migration, population size</li> </ul>

## Teaching / Learning Resources

- Illustrations, computer aided study materials

## Suggested Teaching Procedure

- Discuss the Hardy-Weinberg equilibrium and guide learners to calculate gene frequencies using data from relevant texts.

## Assessment Strategies

- Give calculations based on the Hardy-Weinberg equilibrium.
- Give written exercise on factors affecting gene frequencies.

## Sub-Topic 5: Origin of Life

Specific Objectives	Content
<ul style="list-style-type: none"> <li>The learner should be able to explain the theories related to the origin of life.</li> </ul>	<ul style="list-style-type: none"> <li>Theories of the origin of life: special creation, spontaneous generation, biochemical evolution</li> </ul>

**Teaching / Learning Resources**

- Illustrations

**Suggested Teaching Procedure**

- Discuss the theories of origin of life using illustrations.

**Assessment Strategy**

- Give reading and written assignments on the theories of origin of life.

**Sub-Topic 6: Mechanisms of Evolution**

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• discuss Lamarck's theory of evolution.</li><li>• explain Darwin's theory of natural selection.</li><li>• explain the importance of variation in evolution.</li><li>• discuss Neo-Darwinism.</li><li>• explain the causes of present day evolution.</li></ul>	<ul style="list-style-type: none"><li>• Lamarck's theory of evolution of acquired characters through use and disuse</li><li>• Darwin's theory of natural selection: observations and deductions</li><li>• Importance of variation in evolution</li><li>• Neo- Darwinism (present day theory of evolution)</li><li>• Causes of present day evolution: competition, changes in the environment, sexual reproduction, mutations, gene recombination, industrialisation, effects of drug / chemical resistance, artificial selection, polyploidy</li></ul>

**Teaching / Learning Resources**

- Illustrations, Computer aided study materials

**Suggested Teaching Procedure**

- Discuss the mechanisms of evolution using illustrations.

**Assessment Strategies**

- Give a competitive quiz based on the out of class reading assignment.
- Give written assignment on mechanisms of evolution.

## Sub-Topic 7: Evidence of Evolution

Specific Objectives	Content
<p>The learner should be able to</p> <ul style="list-style-type: none"> <li>• discuss evidence of evolution.</li> <li>• explain the emergence of variations among organisms.</li> </ul>	<ul style="list-style-type: none"> <li>• Evolution evidence based on: fossilisation, comparative study of anatomy, embryology, cytology, biochemistry, taxonomy, geographical distribution, vestigial structures, analogous structures, homologous structures</li> <li>• Emergence of variations among organisms</li> </ul>

### Teaching / Learning Resources

- Illustrations, computer aided study materials, photographs of fossils, fossils, videos, charts

### Suggested Teaching Procedure

- Discuss changes in living things and emergence of variations among organisms using illustrations.

### Assessment Strategies

- Organise a quiz on the terms related to evolution.
- Give written exercise on evidence of evolution.

### Practical Application

- Consider resistance to diseases, drugs, pesticides and herbicides.

## Sub-Topic 8: Selection and Speciation

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain natural selection and artificial selection.</li><li>• define speciation.</li><li>• describe allopatric speciation and sympatric speciation.</li><li>• state the roles of natural selection and artificial selection in speciation.</li><li>• describe mechanisms related to speciation of organisms.</li><li>• explain extinction.</li></ul>	<ul style="list-style-type: none"><li>• Natural selection and artificial selection</li><li>• Definition of speciation</li><li>• Allopatric speciation and sympatric speciation</li><li>• Role of natural selection and artificial selection in speciation</li><li>• Mechanisms related to speciation: continental drift, migration, adaptive radiation, divergent and convergent evolution, isolation i.e. ecological, reproductive and genetic</li><li>• Extinction: meaning, causes and effects</li></ul>

### Teaching / Learning Resources

- Illustrations, computer aided study materials, charts, photographs

### Suggested Teaching Procedure

- Discuss natural and artificial selection using illustrations.
- Discuss isolating mechanisms giving examples.
- Assign groups of learners to read about particular mechanisms of speciation as an out of class activity.
- Guide learners in the presentation of their findings.
- Discuss extinction giving examples.

### Assessment Strategies

- Organise a quiz on the terms related to selection and speciation.
- Give a written assignment on the mechanisms of speciation.

## Practical Application

- Consider:
  - i) emergence of varieties resistant to diseases, drugs, pesticides and herbicides
  - ii) genetic engineering

(See appendix 6: Genetics)

## Topic 7: Transport

Duration: 36 Periods

### Overview

The mode of transport of materials largely depends on the size of an organism. Transport systems have additional functions other than movement of materials within the organism. These include protection and support.

### General Objective

By the end of the topic, the learner should be able to describe the structure and functioning of transport systems.

### Sub-Topic 1: Necessity for Transport Systems

Specific Objective	Content
<ul style="list-style-type: none"><li>The learner should be able to explain the limitations of simple diffusion in the transport process.</li></ul>	<ul style="list-style-type: none"><li>Limitations of simple diffusion process: concept of surface area: volume ratio and its effect on diffusion rate</li></ul>

### Teaching / Learning Resources

- Illustrations, computer aided study materials, charts

### Suggested Teaching Procedure

- Discuss the necessity for transport systems using illustration or demonstration.

### Assessment Strategy

- Allow learners to give oral answers to questions on the need for a transport system.

### Sub-Topic 2: Water as a Medium in Plants and Animals

Specific Objective	Content
<ul style="list-style-type: none"><li>The learner should be able to explain the significance of water in transport.</li></ul>	<ul style="list-style-type: none"><li>Significance of water in transport: solvent, medium of transport</li></ul>

## Teaching / Learning Resources

- Charts, computer aided materials

## Suggested Teaching Procedure

- Discuss the role of water as a medium of transport in plants and animals using illustrations.

## Assessment Strategy

- Give a written exercise on the role of water in the transport of materials within organisms.

## Practical Application

- Consider oral rehydration, irrigation during dry season, watering animals, ensure sufficient intake of water by humans.

## Sub-Topic 3: Circulatory Systems in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe types of circulatory systems.</li> <li>• describe the circulatory systems in insects, annelids and mammals.</li> <li>• explain the advantages and disadvantages of open and closed systems in animals.</li> <li>• compare the structure and function of veins, arteries and capillaries.</li> <li>• compare the circulatory systems of fish and mammals.</li> <li>• describe the functioning of the mammalian heart.</li> <li>• explain the response of the heart to</li> </ul>	<ul style="list-style-type: none"> <li>• Types of circulatory systems: open and closed, single and double</li> <li>• Circulatory systems in insects, annelids and mammals</li> <li>• Advantages and disadvantages of open and closed systems in animals</li> <li>• structure and function of veins, arteries and capillaries</li> <li>• Structure of transport systems in fish and mammals</li> <li>• Functioning of the mammalian heart: cardiac cycle, blood pressure changes, myogenic property, control of the heart beat</li> <li>• Response of heart to body</li> </ul>

<p>body activities.</p> <ul style="list-style-type: none"><li>• explain how the heart beat rate is controlled.</li><li>• relate the action of adrenalin and acetylcholine to the innervation of the heart.</li><li>• interpret information on the effects of drugs and variation of temperature on the cardiac frequency.</li><li>• describe the role of blood components in the transport process.</li><li>• explain the diseases related to the circulatory system.</li></ul>	<p>activities</p> <ul style="list-style-type: none"><li>• Control of heart beat rate</li><li>• Action of adrenalin and acetylcholine on the innervation of the heart</li><li>• Effects of drugs and temperature variations on the cardiac frequency</li><li>• Blood constituents and functions</li><li>• Common diseases of the blood and heart, including, sickle cell anaemia and coronary artery disease</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• identify structural features of blood vessels.</li><li>• display and draw major structures of the circulatory systems in insects, toads, and mammals.</li><li>• describe the insects', toads' and mammals' circulatory system in relation to their functions.</li><li>• describe the structural adaptations of the muscles of the circulatory system of mammals.</li></ul>	<ul style="list-style-type: none"><li>• Structure of blood vessels (veins, arteries, capillaries)</li><li>• Circulatory systems in insects, toads and mammals: gross structure and fine structure</li><li>• Insects, toads and mammals circulatory systems in relation to functions</li><li>• Structural adaptation of cardiac muscle and smooth muscle of the circulatory system of mammals</li></ul>

## Teaching / Learning Resources

- Illustrations, computer aided study materials, models, charts, video, prepared slides of blood smear, prepared slides of blood vessels and cardiac muscle, microscopes, dissecting sets/kits, photographs, pins, boards, dishes, animal specimens, dissection guides, chloroform, cotton wool, thread

## Suggested Teaching Procedure

- Discuss the:
  - structure, types and functioning of the circulatory system in animals using illustrations.
  - blood constituents and their functions, common diseases of the blood and the heart using illustrations.
- Guide learners to carry out practical work on dissections and microscopy of the circulatory systems.

## Assessment Strategies

- Give written exercise on circulatory systems in animals.
- Give practical exercise on dissection, displaying, drawing and labelling blood vessels.
- Give practical work on identifying, drawing and labelling blood cells and blood vessels.

## Practical Application

- Consider:
  - i) first aid to stop bleeding.
  - ii) prevention of diseases of the circulatory system and blood.
  - iii) blood transfusion.

## Sub-Topic 4: Defence against Diseases

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the mechanism of blood clotting.</li> <li>• describe immune responses in humans.</li> <li>• state the role of the thymus gland in immunity.</li> <li>• explain the immune responses during blood transfusion.</li> <li>• describe the effects of the Rhesus factor during pregnancy.</li> </ul>	<ul style="list-style-type: none"> <li>• Mechanism of blood clotting</li> <li>• Immune responses in humans: definition, primary, secondary</li> <li>• The role of the thymus gland in immunity</li> <li>• Blood groups and blood transfusion</li> <li>• Effects of the Rhesus factor during pregnancy</li> </ul>

## Teaching / Learning Resources

- Illustrations, computer aided study materials, models, charts

## Suggested Teaching Procedure

- Discuss mechanism of blood clotting, immune responses, the role of the thymus gland using illustrations.
- Explain antigen-antibody reactions using blood groups and the Rhesus factor as an example.

## Assessment Strategy

- Give a written exercise on defence against diseases.

## Practical Application

- Consider
  - i) immunisation
  - ii) blood transfusion
  - iii) allergy

## Sub-Topic 5: Vascular System of Flowering Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the structural and functional adaptations of the vascular tissues to the transport process of materials in monocotyledonous and dicotyledonous plants.</li><li>• explain the mechanism of transporting materials in plants.</li><li>• describe the evidence for the path of materials in plants.</li><li>• describe translocation and uptake of water and mineral salts in plants.</li><li>• explain the role of transpiration in transport of water and dissolved mineral salts in plants.</li></ul>	<ul style="list-style-type: none"><li>• Structure and functional adaptations of vascular tissues in monocotyledonous and dicotyledonous plants</li><li>• Mechanism of transporting materials in plants</li><li>• Evidence for the path of materials in plants</li><li>• Uptake of water and mineral salts in plants</li><li>• Role of transpiration in transport of water and dissolved mineral salts in plants</li></ul>

<p><b>(Practical)</b></p> <ul style="list-style-type: none"> <li>• interpret data related to transport of materials.</li> <li>• identify types and the pattern of distribution of vascular bundles in plant organs.</li> <li>• stain and make temporary mounts of transverse sections (T.S) and longitudinal sections (L.S) of: stems, roots and T.S of leaves from herbaceous plant organs.</li> <li>• interpret T.S and L.S of stems, roots and T.S of leaves.</li> <li>• draw and label low power plans to show distribution of tissues in T.S and L.S of stems, roots and T.S of leaves.</li> <li>• make high power labelled drawings of vascular tissues in T.S and L.S of stems, roots and T.S of leaves.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure and distribution pattern of the vascular tissues in monocotyledonous and dicotyledonous plants</li> <li>• Transverse (T.S) and longitudinal sections (L.S) of: stems, roots and, T.S of leaves of monocotyledonous and herbaceous dicotyledonous plants</li> <li>• Labelled diagrams of T.S and L.S of stems, roots and T.S of leaves</li> </ul>
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## Teaching / Learning Resources

- Illustrations, computer aided study materials , models, charts, simple stains, microscopes, slides, cover slips, stems, roots, leaves of herbaceous plants, razor blades, concentrated hydrochloric acid (HCl) and sulphuric acid ( $H_2SO_4$ ) with phloroglucinol

## Suggested Teaching Procedure

- Discuss the structure and functioning of the vascular system of flowering plants using illustrations.
- Guide learners to carry out practical work on structure and distribution of vascular tissues in plant organs.

### Assessment Strategies

- Give practical exercises on distribution of vascular tissues in monocots and dicots.
- Give written exercises on vascular systems of flowering plants.

## SENIOR SIX TERM ONE

### Topic 8: Nutrition

Duration: 42 Periods

#### Overview

Organisms require food materials that supply them with nutrients. Autotrophs are able to manufacture food materials while the heterotrophies obtain already manufactured food.

#### General Objective

By the end of the topic, the learner should be able to explain the modes of obtaining nutrients by different organisms.

#### Sub-Topic 1: Autotrophic Nutrition

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the types of autotrophic nutrition.</li> <li>• describe chemosynthesis.</li> <li>• describe photosynthesis.</li> <li>• describe the structure of chloroplasts.</li> <li>• describe the absorption and action spectrum of chlorophyll.</li> <li>• interpret experimental evidence for the existence of a light and dark stage in the process of photosynthesis.</li> <li>• explain the environmental and internal factors influencing the rate of photosynthesis.</li> <li>• interpret experimental results concerning measurements of</li> </ul>	<ul style="list-style-type: none"> <li>• Types of autotrophic nutrition: chemosynthesis and photosynthesis</li> <li>• Photosynthesis including adaptations of C<sub>3</sub>, C<sub>4</sub> and CAM to different environmental conditions</li> <li>• Structure of chloroplasts</li> <li>• Absorption and action spectrum of chlorophyll</li> <li>• Evidence of the light and dark stages in the process of photosynthesis</li> <li>• Environmental and internal factors influencing the rate of photosynthesis (emphasise concept of limiting factors)</li> <li>• Data on experimental results concerning measurements of photosynthetic rate</li> </ul>

photosynthetic rate. <ul style="list-style-type: none"><li>• explain the importance of autotrophic nutrition in an ecosystem.</li></ul>	<ul style="list-style-type: none"><li>• The importance of autotrophic nutrition in the ecosystem</li></ul>
<b>(Practical)</b> The learner should be able to: <ul style="list-style-type: none"><li>• design and carry out experiments to investigate factors affecting the rate of photosynthesis.</li><li>• carry out experiments to test for starch production in terrestrial plants and oxygen in aquatic plants.</li></ul>	<ul style="list-style-type: none"><li>• Experiments to investigate factors affecting photosynthesis: light, carbon dioxide, availability of water, chlorophyll, temperature.</li><li>• Tests for starch in terrestrial plants and tests for oxygen in aquatic plants.</li></ul>

### Teaching / Learning Resources

- Illustrations, computer aided materials, data from experiments, aquatic plants, light source, clock, filter funnels, test tubes, heat source, beakers, water, white tiles, iodine solution, ethanol, sodium hydrogen carbonate, tripods, wire gauzes, droppers.

### Suggested Teaching Procedure

- Discuss autotrophic nutrition process in plants using illustrations.
- Guide learners to:
  - interpret data on factors affecting photosynthesis.
  - carry out experiments on factors affecting rate of photosynthesis.
  - test for starch in terrestrial plants and oxygen in aquatic plants.

### Assessment Strategies

- Give a written exercise on:
  - i) interpreting data collected from experiments on photosynthesis.
  - ii) explaining effects of limiting factors on the rate of photosynthesis.
  - iii) comparing C<sub>3</sub> and C<sub>4</sub> and CAM plants.

### Practical Application

- Consider:
  - i) use of green houses in horticulture
  - ii) importance of trees around homes in purifying air

## Sub-Topic 2: Heterotrophism

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• define heterotrophism.</li> <li>• state types of heterotrophism.</li> <li>• explain the importance of food in the body.</li> </ul>	<ul style="list-style-type: none"> <li>• Heterotrophism</li> <li>• Types of heterotrophism: holozoic, saprophytism, mutualism, parasitism</li> <li>• Food values, diet, and effects of deficiencies</li> </ul>
<p><b>2.1 Holozoic Nutrition</b></p> <ul style="list-style-type: none"> <li>• define holozoic nutrition.</li> <li>• describe the processes of digestion, absorption, assimilation and storage of digested food.</li> <li>• explain methods of feeding in mammals and insects.</li> <li>• explain nutrition in insectivorous plants.</li> <li>• relate structures of the alimentary canal to their functions.</li> <li>• Explain the role of the nervous and hormonal systems in digestion.</li> </ul>	<ul style="list-style-type: none"> <li>• Holozoic nutrition</li> <li>• Processes of digestion, absorption, assimilation and storage of digested food</li> <li>• Feeding methods in mammals (herbivores, omnivores, carnivores), and insects</li> <li>• Plants as heterotrophs (insectivorous plants)</li> <li>• Structure and function of the alimentary canal: mouth, stomach, intestine, liver, pancreas</li> <li>• The role of the nervous and hormonal systems in the regulation/ control of digestion</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• open up the animal and display the digestive system.</li> <li>• examine, draw and label the major parts of the animals' digestive systems.</li> <li>• observe and state structural adaptations of the parts of the digestive system.</li> </ul>	<ul style="list-style-type: none"> <li>• The digestive system of cockroach, toad/frog, birds, rat/rabbit/cow/goat</li> <li>• Parts of the digestive system</li> <li>• Function and structural adaptations of the digestive system parts</li> </ul>

<ul style="list-style-type: none"><li>• identify food substances in the different parts of the gut.</li><li>• Identify enzymes in the different parts of the gut.</li><li>• identify, draw the different parts that make up the mouth of insects, mammals and toad.</li><li>• state the functions of mouth parts of insects, mammals and toad.</li><li>• compare dentition in the animals.</li></ul>	<ul style="list-style-type: none"><li>• Food tests on gut content</li><li>• Gut extracts actions on different foods</li><li>• Structure of mouth parts of insects, mammals and toad</li><li>• Functions of mouth parts of insects, mammals and toad</li><li>• Dentition in animals</li></ul>
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### Teaching / Learning Resources

- Illustrations, computer aided materials, animal specimens, dissecting boards /dish, dissecting set/kit, pins, food test reagents, gut extract (enzymes), gut content(food), chloroform, cotton wool thread, microscopes, slides, cover slips

### Suggested Teaching Procedure

- Discuss the holozoic nutrition process in organisms using illustrations.
- Guide learners to carry out practical work on:
  - i) dissecting, displaying and drawing of digestive system parts in cockroach, toad/frog and rat / rabbit /Guinea pig.
  - ii) food tests on gut contents.
  - iii) investigating effect of gut extracts on different foods.
  - iv) identifying mouth parts of animals.

### Assessment Strategies

- Give a written exercise on:
  - i) hormonal and nervous control of digestion.
  - ii) interpreting data on action of gut enzymes on different foods.

### Practical Application

Consider balanced diet, caring for the teeth and digestive system.

<h3>2.2 Saprophytism</h3> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• define saprophytism.</li> <li>• describe the importance of fungi and bacteria as decomposers in an ecosystem.</li> <li>• identify the role of saprophytes in the carbon and nitrogen cycles.</li> </ul>	<ul style="list-style-type: none"> <li>• Definition of saprophytism.</li> <li>• Role of fungi and bacteria in the decomposition process</li> <li>• Role of saprophytes in the carbon and nitrogen cycles</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• identify bacteria and moulds growing on organic matter.</li> <li>• examine the structure and adaptation of a common mould.</li> <li>• investigate ecological role of saprophytes in a habitat.</li> </ul>	<ul style="list-style-type: none"> <li>• Growth of common bacteria and mould on bread/cow dung</li> <li>• Structure and adaptation of a common mould</li> <li>• Economic importance of saprophytes</li> </ul>

### Teaching / Learning Resources

- Illustrations, computer aided materials, microscopes, slides, cover slips, bread/cow dung

### Suggested Teaching Procedure

- Discuss saprophytism using examples and illustrations.
- Guide learners to carry out practical work on growth, structure and adaptations of moulds.
- Discuss the economic importance of microorganisms using illustrations.

### Assessment Strategy

- Give a written exercise on the role of saprophytes in the environment.

### Practical Application

Consider:

- i) storage of leather products, food, timber products, clothes, etc.
- ii) compost manure.
- iii) sewage treatment.

**2.3 Mutualism**

The learner should be able to:

- define mutualism.
- describe the role of mutualistic organisms in the nitrogen cycle.
- explain the relationships of mutualistic associations in an ecosystem.
- discuss the economic importance of mutualistic associations.
- Definition of mutualism
- Role of mutualistic organisms in the nitrogen cycle
- Mutualistic associations between organisms
- Economic importance of mutualistic associations

**Teaching / Learning Resources**

- Illustrations, computer aided materials

**Suggested Teaching Procedure**

- Discuss mutualism giving examples.

**Assessment Strategy**

- Give a written exercise on the significance of mutualistic relationship in an ecosystem.

**2.4 Parasitism**

The learner should be able to:

- define parasitism.
- discuss the parasitic mode of nutrition.
- explain adaptation of disease causing organisms in plants and animals.
- explain the effect of host-parasite relations.
- interpret data on effects of parasites on their hosts.
- Definition of parasitism
- Parasitic mode of nutrition
- Adaptations of disease causing organisms in plants and animals
- Interrelationship between parasites and hosts of the following: intestinal worms, a tick and one plant parasite
- Data on effects of parasites on their hosts

**Teaching / Learning Resources**

- Illustrations, computer aided materials, video, data from experiment

## Suggested Teaching Procedure

- Discuss parasitism using illustrations and demonstrations.
- Guide learners to interpret data on effects of parasites on their hosts.

## Assessment Strategies

- Give a reading assignment on current epidemics caused by parasites, followed by plenary session.
- Give a written exercise on adaptations of named parasites to their mode of life.

## Practical Application

- Consider biological control of pests and vectors.

## Topic 9: Gaseous Exchange

Duration: 24 Periods

### Overview

As organisms become larger they develop gaseous exchange surfaces which are modified to allow efficiency. Some organisms may utilize different gaseous exchange surfaces at different stages of development.

### General Objective

By the end of the topic, the learner should be able to explain mechanisms of gaseous exchange in organisms.

### Sub-Topic 1: Principles of Gaseous Exchange Systems

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the relationship between size and surface area to volume ratio.</li><li>• explain the role of diffusion in gaseous exchange.</li><li>• explain how a respiratory surface is modified to speed up diffusion process.</li><li>• state the characteristics of a gaseous exchange surface.</li></ul>	<ul style="list-style-type: none"><li>• Relationship between size and surface area to volume ratio principle</li><li>• Role of diffusion in gaseous exchange process between organisms and their environment across a gaseous exchange surface</li><li>• Modifications of gaseous exchange surface to speed up diffusion</li><li>• Characteristics of a gaseous exchange surface</li></ul>

### Teaching / Learning Resources

- Illustrations

### Suggested Teaching Procedure

- Discuss the principles of gaseous exchange using illustrations.

### Assessment Strategy

- Give an oral / written exercise on principles of gaseous exchange systems.

## Sub-Topic 2: Gaseous Exchange in Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the mechanism of opening and closure of a stoma.</li> <li>• explain conditions affecting the functioning of stomata.</li> <li>• explain how stomata, lenticels and breathing roots are adapted to their function.</li> <li>• compare gaseous exchange structures of aquatic and terrestrial plants.</li> <li>• relate the differences between the structure of aquatic and aerial leaves to a habitat.</li> </ul>	<ul style="list-style-type: none"> <li>• Mechanism of opening and closure of stoma</li> <li>• Conditions affecting functioning of stomata</li> <li>• Structural adaptation and function of the stomata, lenticels and breathing roots</li> <li>• Comparison of gaseous exchange structures in plants in terrestrial and aquatic habitats</li> <li>• Structural adaptation of aquatic and aerial leaves to a habitat</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• identify, draw and label stomata.</li> <li>• examine principles related to control of gaseous exchange in plants.</li> <li>• determine surface area to volume ratio in large and small objects.</li> </ul>	<ul style="list-style-type: none"> <li>• Structures of stomata</li> <li>• Principles related to control of gaseous exchange in plants</li> <li>• Surface area to volume ratio in large and small pieces of plant organs</li> </ul>

### Teaching / Learning Resources

- Illustrations, computer aided study materials, models, microscope, slides, cover slips, potato/unripe pawpaw, ruler, knife, prepared slides (lenticels)

### Suggested Teaching Procedure

- Discuss gaseous exchange in plants.
- Guide learners to carry out practical work on structure distribution, density and functioning of stomata, structure of lenticels, determining surface area to volume ratio.

## Assessment Strategies

- Give a practical exercise on structure and functioning of stomata.
- Give a written exercise on theories of stomata opening.

## Sub-Topic 3: Gaseous Exchange in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the characteristics of gaseous exchange surfaces in animals.</li><li>• explain the efficiency of gaseous exchange surfaces and structures.</li><li>• explain the significance of the counter current flow system.</li><li>• describe the role of the brain in controlling breathing.</li><li>• compare the gaseous exchange surfaces in aquatic and terrestrial animals.</li></ul>	<ul style="list-style-type: none"><li>• Characteristics of gaseous exchange surfaces in animals</li><li>• Structural adaptation of gaseous exchange surfaces in protozoa, worms, insects, fish, amphibians and mammals</li><li>• Significance of the counter current flow system</li><li>• The role of the brain in controlling breathing</li><li>• Comparison of gaseous exchange surfaces in land and water animals</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• dissect, display and draw gaseous exchange systems in animals.</li><li>• collect and analyse data on factors affecting breathing rate in animals.</li></ul>	<ul style="list-style-type: none"><li>• Structure of gaseous exchange systems in tadpoles, toad, fish, insect, and mammal</li><li>• Factors affecting rate of breathing in animals</li></ul>

## Teaching / Learning Resources

- Sample organisms, dissection set/kits, pins, dish/board, chloroform, illustrations, and computer aided study materials

## Suggested Teaching Procedure

- Discuss gaseous exchange in lower organisms and animals using illustrations.
- Guide learners to carry out practical work on gaseous exchange systems in tadpoles, toad / frog, fish, insect, mammal.

## Practical Application

- Consider:
  - i) diseases of respiratory systems.
  - ii) effect of smoking on lungs.
  - iii) ventilation of buildings, aquaria, etc.

## Assessment Strategies

- Give a written exercise on gaseous exchange in animals.
- Give practical exercise(s) on gaseous exchange systems in animals.

## Topic 10: Respiration

Duration: 08 Periods

### Overview

Energy is released from food by respiration which occurs in all living cells. All living things need usable energy to move, grow, reproduce and repair damaged structures. This energy is obtained through either aerobic or anaerobic processes.

### General Objective

By the end of the topic, the learner should be able to explain how living organisms obtain energy from food.

### Sub-Topic 1: Respiration

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the relationship between gaseous exchange and respiration.</li><li>• describe the structure and function of the mitochondrion.</li><li>• distinguish between aerobic and anaerobic respiration.</li><li>• describe the role of electron transport system, hydrogen acceptors, acetyl coenzyme A and pyruvic acid.</li><li>• explain the role of acetyl coenzyme A in the carbohydrate, lipid and protein metabolism.</li><li>• state the products of respiration.</li><li>• explain fermentation process.</li></ul>	<ul style="list-style-type: none"><li>• Relationship between gaseous exchange and respiration</li><li>• Structure and function of mitochondrion</li><li>• Types of respiration: aerobic and anaerobic</li><li>• Role of electron transport system, hydrogen acceptors, acetyl coenzyme A and pyruvic acid</li><li>• Role of acetyl coenzyme A in the metabolism of: carbohydrates, lipids, proteins</li><li>• Products of respiration: carbon dioxide, energy, ethanol, water, lactic acid</li><li>• Fermentation process</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• carry out experiments to demonstrate products of respiration.</li></ul>	<ul style="list-style-type: none"><li>• Products of respiration: carbon dioxide, energy,</li></ul>

<ul style="list-style-type: none"> <li>• carry out experiments to show the effect of temperature and activity on rate of respiration.</li> <li>• carry out experiments and analyse data on factors affecting aerobic and anaerobic respiration processes.</li> <li>• demonstrate fermentation process in yeast cells.</li> </ul>	<ul style="list-style-type: none"> <li>• ethanol, water, lactic acid</li> <li>• Factors affecting the rate of respiration: temperature and activity</li> <li>• Factors affecting aerobic and anaerobic respiration processes</li> <li>• Fermentation process: use in yeast cells</li> </ul>
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## Teaching / Learning Resources

- Illustrations, computer aided study materials, glucose, yeast, water, flask, rubber bung, thermometer, stop clock

## Suggested Teaching Procedure

- Review structure of a mitochondrion and discuss respiration using illustrations.
- Guide learners to demonstrate the products of anaerobic respiration.
- Guide learners to carry out experiments to show the effect of temperature and activity on rate of respiration.
- Guide learners to carry out experiments, collect and analyse data on factors affecting aerobic and anaerobic respiration processes.

## Assessment Strategies

- Give a written exercise on comparison between aerobic and anaerobic respiration.
- Give oral questions on the process of respiration.
- Give a written exercise on data analysis.

## Practical Application

Consider:

- i) brewing alcohol
- ii) bread making
- iii) ventilation in houses

## Topic 11: Homeostasis

Duration: 28 Periods

### Overview

Within the body of an organism components of an internal environment are constantly regulated to ensure a stable internal environment. This is done by negative feedback and elimination of wastes.

### General Objective

By the end of the topic, the learner should be able to appreciate why and how the internal environment of an organism is kept constant.

### Sub-Topic 1: General Principles of Homeostasis

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• explain the significance of a constant internal environment.</li><li>• state the factors which must be kept constant in the internal environment of the body.</li><li>• discuss the role of negative feedback mechanism.</li><li>• explain the feedback mechanism related to the endocrine and nervous systems.</li><li>• identify the main internal and external causes of changes in the internal environment.</li><li>• describe the formation, composition and movement of tissue fluid and its relationship to the blood and lymph.</li></ul>	<ul style="list-style-type: none"><li>• Significance of a constant internal environment</li><li>• Factors which must be kept constant in the body: glucose, temperature, pH, water, ions, respiratory gases, osmotic pressure of body fluids</li><li>• Role of negative feedback mechanism</li><li>• Feedback mechanism related to the endocrine and nervous systems in homeostatic activities</li><li>• Causes of changes in the internal environment</li><li>• Formation, composition and movement of tissue fluid and its relationship to the blood and lymph</li></ul>
<b>(Practical)</b> The learner should be able to relate organisms' ways of life to their environmental conditions.	<ul style="list-style-type: none"><li>• Adaptation of organisms to different environmental conditions</li></ul>

## Teaching / Learning Resources

- Charts

## Suggested Teaching Procedure

- Define homeostasis.
- Discuss the:
  - factors which must be kept constant in the internal environment using illustrations.
  - role of the negative feedback mechanism in homeostasis using illustrations.
- Guide learners to do field study on adaptations of organisms to different environmental conditions.

## Assessment Strategy

- Give a quiz on the general principles of homeostasis.

## Practical Application

- Consider liver diseases and social habits e.g. excessive consumption of alcohol, drug abuse, etc

## Sub-Topic 2: Regulation of Glucose

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the role of hormones in sugar regulation.</li> <li>• explain the negative feedback mechanism in the process of blood glucose control.</li> <li>• discuss the causes and effects of blood sugar imbalances in the body.</li> <li>• relate the microstructure of the liver and pancreas to their functions.</li> <li>• discuss the functions of the liver and the pancreas in regulation of glucose in the body.</li> </ul>	<ul style="list-style-type: none"> <li>• Action of insulin, glucagon and adrenalin in blood sugar control.</li> <li>• The negative feedback mechanism in the process of blood glucose control</li> <li>• Causes and effects of blood sugar imbalances in the body</li> <li>• Microstructure of the liver, pancreas and their functions</li> <li>• Role of the liver and the pancreas in glucose regulation</li> </ul>

<b>(Practical)</b> The learner should be able to: <ul style="list-style-type: none"><li>• test urine samples for sugar.</li><li>• relate structure of liver and pancreas to their function.</li></ul>	<ul style="list-style-type: none"><li>• Identification of sugar in urine</li><li>• Histology of liver and pancreas: microstructure and their function</li></ul>
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### Teaching / Learning Resources

- Charts/ illustrations, computer aided study materials, samples of urine from persons of different range of age and weight. Materials used to test for sugar, sections of pancreas and liver, microscopes

### Suggested Teaching Procedure

- Discuss regulation of glucose in the body using illustrations.
- Guide the learners to test for sugar in urine samples from persons of different ranges of age and weight.
- Guide learners to examine sections of the liver and pancreas.

### Assessment Strategy

- Give a written assignment on the causes, effects and control of blood sugar imbalances.

### Practical Application

- Consider management of diabetes mellitus.

## Sub-Topic 3: Regulation of Respiratory Gases

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• describe the regulation of respiratory gases.</li><li>• discuss the role of feedback mechanism in response to oxygen deprivation.</li><li>• explain the effects of fluctuations of respiratory gases on the rate of breathing.</li><li>• explain the role of respiratory centre in the brain in</li></ul>	<ul style="list-style-type: none"><li>• Control of respiratory gases</li><li>• Role of feedback mechanism in response to oxygen deprivation</li><li>• Effects of fluctuations in oxygen and carbon dioxide gases on the rate of breathing</li><li>• Role of medullary centres in controlling respiration and</li></ul>

<p>controlling respiration and blood circulation.</p> <ul style="list-style-type: none"> <li>describe the different physiological changes that take place during exercise and at high altitude.</li> </ul> <p><b>(Practical)</b></p> <ul style="list-style-type: none"> <li>The learner should be able to determine the rate of breathing at different levels of activity.</li> </ul>	<p>blood circulation</p> <ul style="list-style-type: none"> <li>Physiological changes that take place during exercise and at high altitude</li> </ul> <ul style="list-style-type: none"> <li>Effect of different levels of activity on the rate of breathing</li> </ul>
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## Teaching / Learning resources

- Charts, illustrations, human beings, stop clock

## Suggested Teaching Procedure

- Discuss regulation of carbon dioxide in the body using illustrations.
- Guide learners to investigate the effect of physical activities on the rate of breathing.

## Assessment Strategies

- Give a written exercise involving interpreting data on the effect of physical activities on the rate of breathing.
- Give a written exercise on adaptation of haemoglobin under different oxygen tensions.

## Practical Application

- Consider ventilation of houses

## Sub-Topic 4: Temperature Regulation

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>explain the importance of temperature regulation.</li> <li>discuss the morphological, physiological and behavioural adaptations to temperature changes in the environment.</li> <li>describe the responses to cold</li> </ul>	<ul style="list-style-type: none"> <li>Importance of temperature regulation</li> <li>Morphological, physiological and behavioural adaptations to temperature changes in the environment</li> <li>Response to cold and hot</li> </ul>

<p>and hot conditions by endothermic and ectothermic animals.</p> <ul style="list-style-type: none"><li>• explain the role of the brain and thermoreceptors in temperature regulation.</li><li>• describe the different processes in which plants minimise overheating.</li></ul>	<p>conditions by endothermic and ectothermic animals</p> <ul style="list-style-type: none"><li>• The role of the brain: hypothalamus and thermoreceptors in heat regulation.</li><li>• Temperature control in plants</li></ul>
<p><b>(Practical)</b></p> <ul style="list-style-type: none"><li>• The learner should be able to collect and interpret data related to effects of temperature on animal behaviour.</li></ul>	<ul style="list-style-type: none"><li>• Effects of temperature conditions on animal behaviour.</li></ul>

### Teaching / Learning resources

- Charts, illustrations, data related to temperature regulation

### Suggested Teaching Procedure

- Discuss temperature regulation in ectotherms and endotherms using illustrations.
- Guide learners to collect and analyse data on effects of temperature conditions on animal behaviour as an out of class activity.
- Guide learners to analyse data related to temperature regulation.

### Assessment Strategy

- Written exercise on interpreting data related to temperature regulation.

### Practical Application

- Consider acclimatisation to different environments

## Sub-Topic 5: Excretion

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the structure and role of excretory organs in mammals.</li> <li>• describe the structure and function of the nephron.</li> <li>• describe the formation of urea and urine.</li> <li>• describe excretion process in other organisms.</li> <li>• explain excretion in plants.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure and functions of excretory organs in mammals: kidney, liver, skin and lungs.</li> <li>• Structure and function of the nephron</li> <li>• Formation of urea and urine</li> <li>• Excretion in other organisms: protoctista, insects, fish, amphibians and birds</li> <li>• Excretion in plants</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• identify and draw sections of parts of kidney.</li> <li>• dissect, display, draw and label the urinary system.</li> </ul>	<ul style="list-style-type: none"> <li>• Histology of the kidney: cortex, medulla, different regions of the nephron</li> <li>• Urinary system of a toad, rat/rabbit/goat/cattle</li> </ul>

### Teaching / Learning Resources

- Illustrations, computer aided materials, microscope, prepared slides of kidney sections, insect, rat, and toad, dissecting kit, boards and dishes

### Suggested Teaching Procedure

- Discuss excretion using illustrations.
- Guide learners to dissect animals and display urinary structures of an insect, toad / frog and rat/ rabbit / Guinea pig.
- Guide learners to examine and draw sections of kidney using a microscope.

### Assessment Strategies

- Assess low power drawings of sections of the kidneys and dissections of urinary systems.

- Give a written exercise on the structure and function of excretory organs in mammals.
- Give oral questions on excretion in protocista, insects, amphibians, fish and birds.

### Practical Application

- Consider:
  - i) kidney failure and transplant.
  - ii) hygiene of the urinary system.

### Sub-Topic 6: Osmoregulation

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the role of the brain, endocrine glands and nephrons in osmoregulation.</li><li>• explain the negative feedback mechanism involving anti-diuretic hormone (ADH).</li><li>• discuss principles of osmoregulation in organisms living in marine, fresh water and terrestrial habitats.</li><li>• explain animals' adaptations to varying water availability in their habitats.</li><li>• explain osmoregulation in plants and how plants are adapted to varying water availability in their habitats.</li></ul>	<ul style="list-style-type: none"><li>• Role of the hypothalamus, pituitary gland, adrenal gland and nephrons in varying osmotic pressure of blood</li><li>• Role of negative feedback mechanism involving anti-diuretic hormone (ADH)</li><li>• Principles of osmoregulation in marine, fresh water and terrestrial organisms</li><li>• Adaptations of animals to varying water availability in habitats</li><li>• Osmoregulation in plants (xerophytes, hydrophytes, mesophytes, halophytes)</li></ul>

### Teaching / Learning Resources

- Illustrations, computer aided materials

### Suggested Teaching Procedure

- Discuss osmoregulation in organisms using illustrations.

## Assessment Strategies

- Give a written exercise on interpreting data on osmoregulation in organisms.
- Give a practical assignment on comparison of structures for adaptations in plants from different environments.

## Practical Application

- Consider sufficient intake of water.

## SENIOR SIX TERM TWO

### Topic 12: Coordination

Duration: 56 Periods

#### Overview

All organisms have the ability to detect and respond to changes in the external and internal environment. Plants and animals have developed control systems that receive stimuli, process them and initiate appropriate responses.

#### General Objective

By the end of the topic, the learner should be able to explain how organisms perceive and respond to stimuli.

#### Sub-Topic 1: Concepts of Reception and Response in Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain differences between types of plant responses.</li><li>• describe simple experiments to demonstrate tropisms.</li><li>• predict tropic responses in experimental situations.</li><li>• interpret data from experiments on how day length affects the flowering process.</li></ul>	<ul style="list-style-type: none"><li>• Distinguish between types of responses in plants: Tropic, nastic and photoperiodic responses(give examples of plant responses to stimuli)</li><li>• Simple experiments to demonstrate tropisms</li><li>• Parts that receive stimuli (meristem, leaves, petals)</li><li>• Effects of day length on flowering process</li></ul>

#### Teaching / Learning Resources

- Illustrations, computer aided materials, *Mimosa pudica*, seedlings, clinostats and dark box with window on one side

## Suggested Teaching Procedure

- Discuss the stimuli, the part that receives them and response in plants, using demonstrations/ illustrations.
- Guide learners to distinguish between nastic movements and tropisms.
- Guide learners to perform experiments to demonstrate nastic movements and tropisms.

## Assessment Strategy

- Give a written exercise on interpretation of data on tropisms and on how day length affects the flowering process.

## Practical Application

- Consider:
  - i) floriculture
  - ii) providing support for climbing plants e.g. vanilla, climbing beans, passion fruits
  - iii) not weeding peas

## Sub-Topic 2: Plant Hormones

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>explain how environmental factors affect distribution of plant hormones.</li> <li>discuss the influence of hormones on plant growth and related processes.</li> <li>interpret experimental data on the effect of hormones on different growth processes.</li> <li>explain the economic importance of plant hormones.</li> </ul>	<ul style="list-style-type: none"> <li>Environmental factors affect distribution of plant hormones</li> <li>Influence of hormones on plant growth: Role and effects of plant hormones (e.g. auxins, cytokinins, gibberellins, abscisic acid, and ethane) in regulating processes</li> <li>experimental data on the effect of hormones on different growth processes</li> <li>Economic importance of plant hormones</li> </ul>
(Practical) The learner should be able to: <ul style="list-style-type: none"> <li>design and perform experiments on effects of plant</li> </ul>	<ul style="list-style-type: none"> <li>Effects of plant hormones e.g. Auxins / Indole acetic acid (IAA),</li> </ul>

hormones on plant growth processes.  • demonstrate the economic importance of plant hormones.	gibberellic acid on different plant growth process: dormancy, weed control, flowering, fruiting etc  • Economic importance of plant hormones
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### Teaching / Learning Resources

- Illustrations, computer aided materials, charts, photographs, seeds/seedlings/ plant samples, hormones

### Suggested Teaching Procedure

- Guide learners to research in preparation for brainstorming and discussion on the role, effects and economic importance of plant hormones.
- Discuss the role, effects and economic importance of plant hormones using illustrations and demonstrations.
- Guide learners to investigate effects of plant hormones on plant processes using indole acetic acid (IAA).

### Assessment Strategies

- Give a written exercise on the effects of plant hormones on plant growth.
- Give a written exercise on the economic importance of plant hormones.

### Practical Application

- Consider:
  - pruning
  - use of plant hormones e.g. rooting hormone in nurseries to promote uniform sprouting of buds

## Sub-Topic 3: Response and Behaviour in Animals

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>explain reflex responses.</li><li>explain how types of behaviour result from sequential responses.</li></ul>	<ul style="list-style-type: none"><li>Reflex responses</li><li>Types of behaviour: orientation (kinesis, taxis, territorial, breeding, instinct and migration) learning</li></ul>

<ul style="list-style-type: none"> <li>• relate learning and response (Kinesis and taxis, orientation behaviour) for survival in the environment.</li> <li>• Explain welfare of animals.</li> </ul>	<p>(habitual, conditioned reflex, imprinting exploration, insight, trial and error)</p> <ul style="list-style-type: none"> <li>• Learning and responses for survival in the environment</li> <li>• Animal welfare: proper handling of animals in relation to behaviour</li> </ul>
<p><b>(Practical)</b> The learner should be able to:</p> <ul style="list-style-type: none"> <li>• demonstrate the welfare of animals.</li> <li>• design and perform experiments on orientation behaviour.</li> </ul>	<ul style="list-style-type: none"> <li>• Practices of animal welfare</li> <li>• Orientation behaviour</li> </ul>

## Teaching / Learning Resources

- Illustrations, computer aided materials, sample animals, (weevils, millipedes, woodlice, termites), artificial stimuli (electricity, light, etc) or natural stimuli in the environment, choice chamber, calcium chloride, cotton wool, wire gauze

## Suggested Teaching Procedure

- Discuss response and behaviour in animals using illustrations.
- Guide learners to investigate responses in animals.

## Assessment strategy

- Give a written exercise on interpretation of data on response and behaviour in animals.

## Practical application

- Consider:
  - i) storage of products e.g. seeds, timber
  - ii) trapping of grasshoppers, termites

## Sub-Topic 4: General Principles of Reception and Response in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the necessity of responding to internal and external changes in the environment.</li><li>• describe the types of stimuli.</li><li>• describe the structure and role of receptor organs in relation to the environmental stimuli.</li><li>• state the importance of different effectors in organisms.</li><li>• interpret data derived from experiments on animal responses to particular stimuli and on memory formation.</li></ul>	<ul style="list-style-type: none"><li>• Importance of responses to the internal and external environmental changes</li><li>• Types of chemical and physical stimuli</li><li>• Role of simple and complex receptors (including reception mechanisms) in relation to the environmental stimuli</li><li>• Importance of effectors in organisms</li><li>• Animal response to particular stimuli and on memory formation</li></ul>
<p><b>(Practical)</b></p> <p><b>The learner should be able to:</b></p> <ul style="list-style-type: none"><li>• identify sections of: skin, eye, retina, cochlea from prepared slides.</li><li>• identify locations of different taste buds on the tongue.</li></ul>	<ul style="list-style-type: none"><li>• Structure of: skin, eye, retina, cochlea from prepared slides</li><li>• Location of taste buds on the tongue.</li></ul>

### Teaching / Learning Resources

- Illustrations, computer aided materials, sample animals: toad / frog, cow/ rat/ rabbit/ guinea pig, arthropod, fish, reptile, microscopes, prepared slides of skin, eye, retina, and cochlea
- Solutions of different tastes: sweet, bitter, sour, salty
- Models of: eye, ear, skin

### Suggested Teaching Procedure

- Discuss the general principles of reception and responses in animals using illustrations.
- Guide learners to:

- i) observe responses in sample animals.
- ii) examine slides of sections of parts of receptor organs using microscopes.
- iii) perform an experiment to locate different types of taste buds on the tongue.

### Assessment Strategy

Give a written exercise on interpreting data on animal responses to particular stimuli and memory formation.

### Practical Application

Consider caring for sensory organs.

### Sub-Topic 5: Nervous Coordination in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the structure and functioning of a neuron.</li> <li>• state the roles of the parts of the nervous system.</li> <li>• describe the role of the nervous system in responses.</li> <li>• describe the autonomic responses.</li> <li>• state examples of autonomic responses.</li> <li>• distinguish between the roles of the autonomic and other peripheral nerves.</li> <li>• explain the events of generating and transmitting impulses.</li> <li>• describe the structure and functioning of the synapse and neuromuscular junction.</li> <li>• explain the importance of transmitter substances.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure and functioning of a neuron</li> <li>• Nervous system structure and function (central: brain, spinal cord and autonomic: cranial nerves, spinal nerves)</li> <li>• Role of the nervous system in responses</li> <li>• Autonomic responses (simple reflexes, conditioned reflexes)</li> <li>• Examples of autonomic responses</li> <li>• Role of the autonomic and peripheral nerves</li> <li>• Events of generating and transmitting impulses</li> <li>• Synapse and neuromuscular junction structure and functioning</li> <li>• Importance of transmitter substances</li> </ul>

<ul style="list-style-type: none"> <li>• explain summation, facilitation and inhibition.</li> </ul>	<ul style="list-style-type: none"> <li>• System functions: summation, facilitation and inhibition</li> </ul>
<p><b>(Practical)</b> The learner should be able to:</p> <ul style="list-style-type: none"> <li>• observe and record human responses to different stimuli.</li> <li>• dissect, display, draw and label the major parts of the insect's / toad's/ frog's, mammal's nervous system below the head.</li> </ul>	<ul style="list-style-type: none"> <li>• Reflex actions in human beings</li> <li>• Nervous system of a cockroach/toad /frog/rat/rabbit/Guinea pig</li> </ul>

### Teaching / Learning Resources

- Illustrations, computer aided materials, samples of animals, stimuli e.g. heat, cold, touch, sound. cockroaches, toad /frog, rat/ rabbit/Guinea pig, dissecting boards /dishes, dissecting set, thread, pins, chloroform, dissecting guide

### Suggested Teaching Procedure

- Discuss nervous coordination in animals using illustrations.
- Guide learners to:
  - investigate response of the sample animals (weevils, millipedes, woodlice, termites, humans) to stimuli.
  - dissect, display, draw and label the major parts of the nervous system of a cockroach, toad / frog, rat / rabbit / guinea pig.

### Assessment Strategies

- Give a written exercise on nervous coordination.
- Assess the drawings of dissections showing major parts of the nervous system of the sample animals (cockroach, toad/frog, rat/rabbit/guinea pig).

### Practical Application

- Consider survival reflexes

### Sub-Topic 6: Hormonal Coordination in Animals

Specific Objectives	Content
The learner should be able to:	<ul style="list-style-type: none"> <li>• describe the structure and</li> <li>• Structure and function of</li> </ul>

<p>function of the endocrine system.</p> <ul style="list-style-type: none"> <li>• explain the principle of negative feedback mechanism of hormonal action.</li> <li>• explain why hormonal balance is necessary for coordinating functions in the body.</li> <li>• explain effects of hormonal imbalances.</li> <li>• compare and contrast the action of the endocrine and nervous systems in the body.</li> </ul>	<p>endocrine system: location of endocrine glands and functions of their secretions</p> <ul style="list-style-type: none"> <li>• Principles of negative feedback mechanism of hormonal action: between pituitary and thyroid</li> <li>• Necessity of hormonal balances</li> <li>• Hormonal imbalances effects: diabetes, goitre, dwarfism, gigantism</li> <li>• Comparison of actions of the hormonal and nervous systems. Refer to: thyroxin, sex hormones, insulin</li> </ul>
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## Teaching / Learning Resources

- Illustrations, computer aided materials

## Suggested Teaching Procedure

- Discuss the:
  - i) location and functions of endocrine glands using illustrations /charts.
  - ii) negative feedback mechanism of hormonal action.
  - iii) effects of hormonal imbalance in mammals.
  - iv) similarities and differences between the structure and functioning of nervous and hormonal systems.

## Assessment Strategies

- Give a written exercise on comparison of the hormonal and nervous coordination in animals.
- Give a written exercise on comparison between hormonal control in plants and animals.

## Practical Application

- Consider hormonal therapy.

**SENIOR SIX TERM THREE****Topic 13: Support and Movement**

Duration: 31 Periods

**Overview**

Living things support themselves and maintain positions in which they can carry out life process. In all organisms the support systems maintain the shape of the body that is essential for consistent and coordinated functioning of its parts. Plant cells are surrounded by a cell wall which confers rigidity and support in turgid cells, whereas multicellular animals are supported and protected by a skeleton. Movement can occur at cell level, organ level and organism level.

**General Objective**

By the end of the topic, the learner should be able to appreciate the role of support and movement systems in organisms.

**Sub-Topic 1: Support Systems in Plants and Animals**

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the distribution of woody tissues in plants.</li><li>• describe the support function of woody tissues in plants.</li><li>• explain the role of cell turgor in non woody plants and hydrostatic skeletons in lower organisms.</li><li>• explain the role of modified roots leaves and stems in support.</li><li>• describe the role of secondary growth /thickening in support.</li><li>• describe the structure and role of skeletons.</li></ul>	<ul style="list-style-type: none"><li>• Distribution of woody tissues in plants</li><li>• Support function of woody tissues in plants</li><li>• Importance of cell turgor in non woody tissues and hydrostatic skeletons in protozoa, coelenterates and platyhelminthes</li><li>• Importance of plant organs modifications of: tendrils, prop roots, clasping roots, buttress roots</li><li>• Role of secondary growth/thickening in support</li><li>• Types of skeletons: Hydrostatic, exoskeleton, endoskeleton</li></ul>

<ul style="list-style-type: none"> <li>• compare the different types of skeletons.</li> <li>• describe the micro structure of cartilage and bone and relate their structure to function.</li> <li>• describe the role of limbs as props and vertebral column as girder.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure and role of the skeleton: hydrostatic, exoskeleton and endoskeleton</li> <li>• Micro structure and function of cartilage and bone</li> <li>• Role of limbs as props (for vertical support) and the vertebral column as girder (for horizontal support)</li> </ul>
<p><b>Support Systems in Organisms (Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• observe organisms of different sizes and relate their support systems to their sizes.</li> <li>• identify and draw support structures and tissues in plants and animals.</li> </ul>	<ul style="list-style-type: none"> <li>• Supporting systems and organism's size</li> <li>• Support structures and tissues in plants and animals</li> </ul>

## Teaching / Learning Resources

- Illustrations, computer aided study materials, models, sample study organisms (plants, earthworms, insects, fish, toads / frogs, mammals, birds), microscopes, prepared slides of cartilage and bone

## Suggested Teaching Procedure

- Discuss support systems in plants and animals using illustrations.
- Guide learners to:
  - i) examine prepared slides of cartilage, bone, T.S. stem.
  - ii) observe plant parts modified for support.

## Assessment Strategies

- Give a written exercise on relating the structure of support systems in organisms to their functions.
- Give a practical exercise on identifying support structures in plants, invertebrates and vertebrates.

## Practical Application

- Consider:
  - i) Proper feeding to ensure proper bone formation

- ii) First aid for fractures
- iii) Good posture
- iv) Diseases of support structures

## Sub-Topic 2: Muscles

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• describe the structure of a muscle and a joint.</li><li>• describe the arrangement and function of muscles and joints.</li><li>• explain the sliding hypothesis of muscular contraction.</li></ul>	<ul style="list-style-type: none"><li>• Structure of muscles and joints</li><li>• Arrangement and function of muscles and joints</li><li>• The sliding filament hypothesis of muscle contraction</li></ul>

## Teaching / Learning Resources

- Illustrations computer aided study materials, models, prepared slides of skeletal muscle fibres and T.S. muscle, microscope.

## Suggested Teaching Procedure

- Discuss the structure and contraction of skeletal muscle using illustrations.
- Guide learners to examine prepared slides of skeletal muscles and skeletal muscle fibre.

## Assessment Strategies

- Give written exercise on mechanism of muscular contraction.
- Assess the drawings of skeletal muscle.

## Practical Application

- Consider:
  - i) muscle pull therapy
  - ii) proper warming up before exercise and cooling down after exercise

## Sub-Topic 3: Movement / Locomotion

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain non-muscular movements in organisms.</li> <li>• describe the arrangement of muscles in fish.</li> <li>• explain how movements and support of fish are brought about in water.</li> <li>• describe support and movement on land.</li> <li>• compare flight in birds and insects.</li> <li>• compare jumping movements in grasshoppers and toads.</li> </ul>	<ul style="list-style-type: none"> <li>• Non- muscular movements or movement without muscles: amoeboid, ciliated, flagella, euglenoid</li> <li>• Arrangement of muscles in fish</li> <li>• Movement and support of fish in water: propulsion, stability</li> <li>• Support and movement on land / muscular skeletal basis of locomotion, propulsion in the: walking tetrapods (mammals), birds and annelids</li> <li>• Flight /movement in air in birds and insects</li> <li>• Comparison of jumping movements in grasshoppers and toads</li> </ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• observe and explain the relationship between muscles, joints and musculo-skeletal attachments.</li> <li>• observe and describe skeletal modifications in birds.</li> <li>• observe and explain how the support structures are related to the environment of the animal.</li> </ul>	<ul style="list-style-type: none"> <li>• Relationship between muscles, joints and musculo-skeletal attachments: Antagonistic muscles in animals: fish myotomes, pectoral muscles in birds, hind limb muscles and muscles in the pelvic region of amphibians and mammals</li> <li>• Fore limb and sternum modification in birds</li> <li>• Support structures in relation to the environment of the animal</li> </ul>

## Teaching / Learning Resources

- Illustrations computer aided study materials, models, sample study animals, boards, dishes, pins, chloroform, cotton wool, thread.

## Suggested Teaching Procedure

- Discuss movement / locomotion without muscles, movement in water, on land, and in the air, using illustrations.
- Guide learners to carry out dissection to show peripheral muscles.

## Assessment Strategies

- Give a written exercise on comparison of flight in birds and insects, jumping movements in grasshoppers and toads /frogs.
- Assess the displaying, drawing and labelling of muscles.

## Practical Application

- Consider:
  - i) structural engineering
  - ii) movements in sports and dancing
  - iii) care for the musculo-skeletal system

## Topic 14: Reproduction, Growth and Development

Duration: 48 Periods

### Overview

Organisms are able to multiply to maintain numbers and avoid extinction. They go through life cycles which ensure continuity of species.

### General Objective

By the end of the topic, the learner should be able to describe the processes of reproduction, growth and development in organisms.

### Sub-Topic 1: Asexual Reproduction

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>• describe the various methods of asexual reproduction in lower and higher organisms.</li> <li>• discuss the advantages and disadvantages of asexual reproduction.</li> <li>• describe the characteristics of vegetative reproductive parts in a flowering plant.</li> </ul>	<ul style="list-style-type: none"> <li>• Methods of asexual reproduction in lower and higher organisms</li> <li>• Advantages and disadvantages of asexual reproduction</li> <li>• Characteristics of vegetative reproductive parts in flowering plant</li> </ul>
<b>(Practical)</b> The learner should be able to: <ul style="list-style-type: none"> <li>• demonstrate the asexual reproduction mechanisms in lower organisms.</li> <li>• use the vegetative propagation techniques to produce economically important plants.</li> </ul>	<ul style="list-style-type: none"> <li>• Asexual reproduction in lower organisms: fragmentation in <i>Spirogyra</i>, budding in yeast, spore formation in <i>Mucor / Rhizopus</i></li> <li>• Vegetative propagation techniques: natural propagation in higher plants</li> <li>• Application of artificial propagation in growing improved varieties of plants</li> </ul>

## Teaching / Learning Resources

- Illustrations, computer aided study materials, activity sheet, charts, samples of organs of plants that reproduce vegetatively (consider food crops, ornamental and medicinal plant species), *Spirogyra*, yeast, *Mucor/Rhizopus*, microscopes, prepared slides on budding, fission and sporulation

## Suggested Teaching Procedure

- Discuss asexual reproduction in lower organisms and higher plants.
- Guide learner to:
  - i) observe asexual reproduction in lower organisms and write reports as an out of class activity.
  - ii) examine prepared slides on asexual reproduction in lower organisms.
  - iii) examine samples of plant organs that reproduce vegetatively.
  - iv) carry out a field study on natural and artificial propagation methods.

## Assessment Strategies

- Give a written exercise on asexual reproduction.
- Assess reports on:
  - i) asexual reproduction in lower organisms.
  - ii) field study on examples of plants growing vegetatively.

## Practical Application

Consider:

- i) vegetative production of plants of economic importance
- ii) control of weeds that produce vegetatively

## Sub-Topic 2: Sexual Reproduction in Animals

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• state the functions of reproductive system structures/parts in animals.</li><li>• describe the structure and function of gametes.</li><li>• describe the stages of oogenesis</li></ul>	<ul style="list-style-type: none"><li>• Reproductive system in animals: structure and function(s) of parts</li><li>• Gamete structure and function</li><li>• Stages of oogenesis and</li></ul>

<ul style="list-style-type: none"> <li>and spermatogenesis processes.</li> <li>• describe the relationship between stages of gametogenesis and meiosis.</li> <li>• explain the significance of gametogenesis.</li> <li>• describe copulation, fertilisation and implantation.</li> <li>• explain the role of the placenta in the development of an embryo.</li> <li>• explain the physiological changes in females during pregnancy.</li> <li>• explain gestation period and birth.</li> <li>• discuss the events and role of hormones in menstrual cycle.</li> <li>• discuss birth control methods and their limitations.</li> <li>• state the causes and ways of prevention of STDs.</li> <li>• explain external and internal fertilization.</li> <li>• outline the importance of external and internal fertilization.</li> <li>• explain the homeostatic mechanisms in amphibians and birds before hatching.</li> <li>• distinguish between diploid and haploid parthenogenesis.</li> </ul>	<ul style="list-style-type: none"> <li>spermatogenesis processes</li> <li>• Relationship between gametogenesis to meiosis</li> <li>• Significance of gametogenesis</li> <li>• Copulation, fertilisation and implantation</li> <li>• Role of placenta in the development of an embryo</li> <li>• Physiological changes in females during pregnancy</li> <li>• Gestation period and birth</li> <li>• Events and role of hormones in the menstrual cycle: menstruation, follicular development, ovulation, corpus luteum. And FSH, LH, oestrogen and progesterone. Mention the oestrous cycle</li> <li>• Birth control methods and limitations</li> <li>• Causes and prevention of Sexually Transmitted Diseases (STDs) e.g. infections by fungal bacterial and viral (HIV and AIDS).</li> <li>• Features of external and internal fertilization</li> <li>• Importance of external and internal fertilization</li> <li>• Homeostatic mechanisms in amphibians and birds before hatching</li> <li>• Parthenogenesis: definition, diploid in aphids, haploid in bees</li> </ul>
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<b>(Practical)</b> The learner should be able to: <ul style="list-style-type: none"><li>• prepare or use prepared slides to study structure of gametes.</li><li>• identify and draw the external features of the cockroach for sex identification.</li><li>• dissect, observe, draw and label the major parts of the insect's reproductive system</li><li>• identify and draw the external features of the toad/ frog for sex identification.</li><li>• dissect, examine, draw and label the major parts of the toad's reproductive system.</li><li>• relate the structure of reproductive parts to their functions.</li><li>• identify and draw the external features of the rat /rabbit/ Guinea pig for sex identification.</li><li>• dissect, examine, draw and label the major parts of the rat's reproductive system.</li><li>• relate the structure of reproductive parts to their functions.</li></ul>	<ul style="list-style-type: none"><li>• Structure of gametes</li><li>• Cockroach</li><li>• external features for sex identification</li><li>• Reproductive system of a cockroach</li><li>• External features of a toad or frog for sex identification</li><li>• Reproductive system of a toad/frog</li><li>• Rat/ rabbit/guinea pig external/features for sex identification</li><li>• Reproductive system of a rat/rabbit/Guinea pig</li></ul>
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### Teaching / Learning Resources

- Illustrations, computer aided study materials, microscopes, slides, samples of gametes/ prepared slides of gametes, hand lens, cockroach, toad/frog/rat, rabbit/guinea pig

### Suggested Teaching Procedure

- Discuss sexual reproduction in animals using illustrations.
- Guide learners to:
  - i) carry out practical work on reproductive structures (external and internal) of a male and female: cockroach, toad/frog and rat /rabbit/guinea pig.

- ii) examine structure of gametes using microscopes.

### Assessment Strategies

- Give a written exercise on sexual reproduction in animals.
- Assess the display, drawing and labelling of reproductive systems and gametes.
- Give a written exercise on comparison of homeostatic mechanisms in birds and mammals until the time of hatching /birth.

### Practical Application

- Consider:
  - i) prevention of sexually transmitted diseases
  - ii) population control and family planning
  - iii) maintenance of fertility

## Sub-Topic 3: Sexual Reproduction in Lower Organisms and Plants

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the conjugation in lower organisms.</li> <li>• discuss the significance of alternation of generations.</li> <li>• describe the types and structure of flowers.</li> <li>• describe pollination and fertilisation in flowering plants.</li> <li>• explain the events that take place in a flower after fertilization.</li> <li>• describe the types and structure of seeds and fruits.</li> </ul>	<ul style="list-style-type: none"> <li>• Conjugation in lower organisms: <i>Paramecium</i>, and algae</li> <li>• Alternation of generations in Bryophytes and Pteridophytes</li> <li>• Types and structure of flowers : (insect and wind pollinated flowers)</li> <li>• Mechanisms of pollination (self and cross pollination) and double fertilisation in flowering plants. Mention mechanisms to ensure or prevent self pollination</li> <li>• Events in a flower after fertilization</li> <li>• Types and structure of seeds and fruits</li> </ul>

<b>(Practical)</b> The learner should be able to: <ul style="list-style-type: none"><li>• relate floral structures to the mode of pollination.</li><li>• observe and draw pollen grain.</li><li>• describe floral parts.</li><li>• Write floral formulae of different flowers.</li><li>• draw floral diagrams of different flowers.</li><li>• draw and label structures of different fruits and seeds.</li><li>• dissect fruits to display and draw arrangement of seeds.</li><li>• describe the mechanisms of fruit and seed dispersal.</li><li>• distinguish between endospermic and non endospermic seeds.</li></ul>	<ul style="list-style-type: none"><li>• Structures of a flower and inflorescence in relation to pollination</li><li>• Pollen grain structure in relation to pollination</li><li>• Arrangement of floral parts in flowers with free petals, fused petals, keel and standard wing, and a grass flower</li><li>• Floral formulae</li><li>• Floral diagrams</li><li>• Types and structure of fruits and seeds</li><li>• Placentation</li><li>• Mechanisms of fruit and seed dispersal</li><li>• Endospermic and non endospermic seeds</li></ul>
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### Teaching / Learning resources

- Illustrations, computer aided study materials, prepared slides, microscopes, *Spirogyra*, sample flower types, hand lens, needle/pin, scalpel/razor blade, inflorescences e.g. guinea grass/maize, sunflower/black jack/ banana, *Tridax*, *Bougainvillea*, *Lantana camara*, Flowers e.g. *Hibiscus*, morning glory/sweet potato, *Cassia*, pea/bean family, flower with perianth, samples of fruits and seeds

### Suggested Teaching Procedure

- Brainstorm the principles of sexual reproduction.
- Discuss sexual reproduction in lower organisms and plants using illustrations.
- Guide learners to examine the structure of flowers, inflorescences, fruits and seeds.

## Assessment Strategies

- Give a written exercise on sexual reproduction in lower organisms and plants.
- Assess learners on identification, drawing and labelling of flowers, inflorescences, fruits and seeds.

## Practical Application

- Consider:
  - i) growing of ornamental plants
  - ii) growing fruit bearing plants
  - iii) manufacture of insecticides, perfumes, ph indicators
  - iv) apiculture (beekeeping)

## Sub-Topic 4: Growth and Development

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• define growth and development.</li> <li>• distinguish between growth and development.</li> <li>• explain factors affecting growth.</li> <li>• discuss the parameters of measuring growth in plants / animals.</li> <li>• explain patterns of growth.</li> <li>• interpret data related to the growth process.</li> <li>• explain the role of hormones in plant and animal growth and development.</li> <li>• explain metamorphosis.</li> <li>• describe the types and stages of germination.</li> </ul>	<ul style="list-style-type: none"> <li>• Definition of growth and development</li> <li>• Differences between growth and development</li> <li>• Factors affecting growth: internal and external</li> <li>• Parameters used in measurement of growth in an individual plant /animal: weight, length, height, volume, area</li> <li>• Patterns of growth: isometric, allometric, limited unlimited and intermittent</li> <li>• Role of hormones in growth regulation and control in plants and animals</li> <li>• Metamorphosis in insects and amphibians</li> <li>• Types and stages of germination</li> </ul>

<ul style="list-style-type: none"><li>• explain viability, seed dormancy and changes during germination.</li><li>• distinguish between primary and secondary meristems.</li><li>• distinguish between primary and secondary growth.</li><li>• discuss the role of meristems in plant growth.</li></ul>	<ul style="list-style-type: none"><li>• Viability, dormancy and germination of seeds</li><li>• Primary and secondary meristems in plants</li><li>• Primary and secondary growth in plants</li><li>• Role of meristems in plant growth</li></ul>
<p><b>(Practical)</b></p> <p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• Carry out germination of seeds that exhibit epigeal and hypogea germination.</li><li>• Demonstrate factors affecting growth.</li><li>• Examine and draw sections showing apical meristems and secondary thickening in dicotyledonous stems.</li><li>• Make accurate measurements of growth in an organism and record.</li><li>• Demonstrate hormonal control of plant growth.</li></ul>	<ul style="list-style-type: none"><li>• Epigeal and hypogea seed germination</li><li>• Factors affecting growth e.g. temperature, light, water, etc</li><li>• Apical growth, secondary growth</li><li>• Parameters of measuring growth</li><li>• Hormonal control of plant growth</li></ul>

### Teaching / Learning Resources

- Charts, computer aided study materials, microscope, slides, cover slips, sample seeds e.g. beans, maize/millet/sorghum/rice, cotton wool, petri dishes, beakers, prepared slides, young soft stems, staining reagents, reagents for food tests

### Suggested Teaching Procedure

- Discuss growth and development in plants and animals using illustrations.
- Guide learners to investigate seed germination.
- Guide learners to examine, draw and label meristems.

### Assessment Strategies

- Give a practical exercise on identification and drawing of the stages in life cycle of insects and amphibians.

- Give a practical exercise on identification of food content in germinating seeds at various durations of germination.
- Give a written exercise on explanation of changes in food content during germination.

### **Practical Application**

- Consider:
  - i) crop growth and development
  - ii) poultry birds rearing
  - iii) control factors promoting vector growth and development

## Appendices

### Appendix 1: Cell Biology

#### Aim

To make temporary slides showing various stages of mitosis in plants

#### Materials and Apparatus

Onion (*Allium cepa*) or broad beans (*Vicia faba*) that have been grown for 5 - 7 days, (Aceto - alcohol in the ratio of 1: 3 respectively to kill the cells and preserve cell structures), filter paper, watch glass, microscope slides, cover slips, droppers, 1M HCl, source of heat, scalpel blade, microscope and safranin stain.

#### What to do

Use root tips to show mitosis by following the procedure given below:

1. Place two drops of 1M hydrochloric acid on a microscope slide and add a drop of safranin stain.
2. Cut about 2mm from the tip of an onion/broad bean root and place it in the stain/acid mixture.
3. Warm the preparation over a Bunsen burner flame. **NB. Do not boil.** The acid will help to macerate the cells so that the stain can penetrate more easily.
4. Let it stand for five minutes.
5. Draw off the stain/acid mixture carefully using a piece of blotting paper at the edge of the liquid.
6. Add one drop of safranin stain and place a cover slip over the preparation.
7. Gently tap the cover slip with a pin or tooth pick.
8. Cover the preparation with filter paper and gently squash with your thumb to obtain a thin squash. Take care not to break the cover slip or slide.
9. Remove the filter paper and examine the squashed root tip under a microscope and identify the various stages of mitosis.

## Appendix 2: Tests for Minerals in Organic Materials

### *Test on urine*

#### **What to do**

1. Obtain a sample of urine. If it is cloudy, filter it. Keep the filtrate.
2. Divide the clear urine or filtrate into four parts.
3. Test each part separately as follows:
  - i) Acidify with 2M nitric acid and then add silver nitrate solution. A white precipitate, soluble in dilute ammonia, indicates CHLORIDE.
  - ii) Acidify with 2M hydrochloric acid and then add barium nitrate solution. A white precipitate indicates SULPHATE.
  - iii) To about 0.5 ml urine add 2-3 ml ammonium molybdate solution. Warm if necessary but do not boil. A yellow, crystalline precipitate indicates PHOSPHATE.
  - iv) Clean a platinum wire by dipping in concentrated hydrochloric acid and heating in a Bunsen flame until the flame is colourless. Dip in urine and hold the wire in the Bunsen flame. Yellow indicates SODIUM.

### *Test on liver extract*

#### **What to do**

1. Obtain some juice/blood from liver that has been crushed in mortar.
2. Treat separate samples as follows:
  - i) Filter some of the juice/blood and test for chloride, sulphate and sodium as above (i-iv).
  - ii) To a little filtrate add 2M hydrochloric acid and observe carefully. Small bubbles (of carbon dioxide gas confirm this) indicate BICARBONATE.
  - iii) Boil a little juice/blood with a little concentrated nitric acid. (CARE)
  - iv) Filter and to filtrate add a few drops of potassium hexacyanoferrate (II) solution. A blue colour or precipitate indicates IRON.

Try this test on juice/blood filtrate but do not boil with acid.

### *Test on egg yolk*

1. Boil a little egg yolk with 2M nitric acid then add silver nitrate solution. A white precipitate, soluble in dilute ammonia, indicates CHLORIDE.

2. To about 0.5 ml egg yolk add 2-3 ml ammonium molybdate solution. Warm if necessary but do not boil. A yellow, crystalline precipitate indicates PHOSPHATE

## Appendix 3: Estimating Population Density

You can use capture and recapture method to estimate the population of fish in a pond, grasshoppers in a field, birds in a park, flying insects etc.

### What to do

- Carry out this simulation activity of capture-recapture technique.

### What you need

- i) Hollow Beads(two colours)
- ii) Plastic beakers (500 ml)

Then proceed as follows:

- i) Fill a large beaker with a large number of beads all of the same colour and size.
- ii) Pick or “Capture” a sample of about 50 beads (**N<sub>1</sub>**)
- iii) ‘Mark’ the picked or “captured” beads and record. The best way to do this is to stain or exchange them with beads of a different colour.
- iv) Return the marked beads to the beaker i.e. to the “population”.
- v) Thoroughly mix the marked beads in the rest of the “population”.
- vi) Pick again or “recapture” a second sample of beads. The sample should be quite large and random or use a blind fold to ensure randomness.
- vii) Count the total number of beads in the second sample (**N<sub>2</sub>**) and the number of marked beads (**N<sub>3</sub>**) in this sample.
- viii) Work out the estimated “population”(**P**) of beads in the beaker using the formula below:

$$P = \frac{N_1 \times N_2}{N_3}$$

## Appendix 4: Field Activities

### What to do

1. Carry out this activity to show adaptation of organisms to their habitats.
2. Follow the procedure below:
  - i) Select a suitable habitat.
  - ii) Make a list of the physical factors in the habitat, which might affect the life of organisms.
  - iii) Collect and observe several animal and plant species from your habitat.
  - iv) List down the adaptive features of the organisms and explain how each of the features mentioned adapts the organisms to survive in this habitat.
  - v) Observe the organisms and construct suitable food chains and food webs to show the feeding relationship of these organisms. It might be necessary in some cases to dissect the gut and observe the contents. You can also examine the feeding structures to get a clue of what the organism feeds on.

## Appendix 5: Ecology

### Take an example of the ecology of millipedes.

Millipedes belong to phylum Arthropoda and class myriapoda. They are widely distributed and abundant throughout Africa. They are herbivorous or detritus feeders and most species are nocturnal in habit, spending the day hidden under piles of vegetation or stone or logs.

#### What to do

- **Follow the procedure below:**

1. Select a model community nearby or set up one using a tank area.
2. Making minimum disturbance, locate the millipedes in the model community or the one that has been set up in the tank area.
3. Record their whereabouts on a rough plan of the tank area.
4. Using standard cobalt chloride paper, investigate the hypothesis that millipedes select places with high moisture content in which to spend the day. Record your results in a suitable way on the plan of the tank area.

#### Questions

1. How does the millipedes' distribution in this model community compare with any observation that you have made under natural conditions?
2. Have you shown any relationship between moisture content and the places where you found millipedes?
3. What other physical factors might determine the selection of daytime habitats?
4. In the light of this, have you confirmed the hypothesis stated in no. 4 of the procedure?

The problem of interaction of variables is still with us in this investigation. It is quite possible that humidity or moisture has an important effect on millipedes' behaviour but we have not been able to exclude other possible factors. If possible investigate humidity more fully then, you need to carry out laboratory work where one variable can be changed and the rest controlled.

## Appendix 6: Genetics

### What to do

1. Guide the students to carry out the following activity I: Using beads to illustrate inheritance
2. Divide the class into groups and collect materials needed: Beakers or black Polythene bags (5 per group), blue beads (100), red beads (100), labels.
3. Then follow the procedure below:
  - i) Label 4 beakers 1 to 4
  - ii) Put 50 blue beads into beaker 1.
  - iii) Put 25 blue and 25 red beads into beaker 2 and mix them up thoroughly.
  - iv) Close your eyes and take a bead from each beaker.
  - v) Put the two beads together (offspring).
  - vi) Open your eyes.
  - vii) If the offspring is homozygous (either blue or red) then put it into beaker 3 and if heterozygous then put into beaker 4.
  - viii) Repeat steps 4, 5, 6 and 7 until all the beads have been transferred.

Give the following written exercise:

1. Count and record the number of;
  - i) Homozygous offspring.
  - ii) Heterozygous offspring.
  - iii) What do the beads represent?
  - iv) Name beaker 1, 2, 3 and 4.
2. What conclusion do you make from the results obtained in 9 above?
3. Assume that the characteristic shown by the blue bead is dominant and is represented by B. fill the spaces below 1, 2, 3 and 4 are the beakers:

Parents

Genotype                    1 .....                    2 .....

Gametes                    .....                    .....

Offspring (F1)

Genotypes                    3 .....                    4 .....

Ratio                        .....

Let students practice the following activity as an out of class assignment:

1. Put 50 blue and 50 red beads into each of the two beakers 1 and 2 and mix them thoroughly.
2. Close your eyes and then take a bead from each beaker.
3. Put the two beads together.
4. If the offspring is homozygous dominant (both blue) put it into beakers 3 and if it is heterozygous put it into beakers 4. If it is homozygous recessive (both red) then put it into beakers 5.
5. Repeat steps 2 and 3 until all the beads have been transferred, a pair at a time into beakers 3, 4, and 5.
6. Now count the number of;
  - i) Homozygous dominant offspring.
  - ii) Heterozygous offspring.
  - iii) Homozygous recessive offspring.
7. What conclusion would you make from the numbers counted?
8. Assume that the characteristic shown by the blue bead is the dominant and is represented by B. Complete the cross below:

Parents

Genotypes	1. ....	2. ....
-----------	---------	---------

Gametes	.....	.....
---------	-------	-------

Offspring

Genotypes	3.....	4.....	5.....
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Ratio	.....	.....	.....
-------	-------	-------	-------

#### 4. Another activity II: on Human Genetics

Give students to carry it out as a research work on phenotypes and genotypes of human traits. State that the following traits are determined by a single gene in humans:

- i) **Widow's peak** - the **W** allele for widow's peak (i.e. a pointed hairline) is dominant to the **w** allele for a straight hairline.
- ii) **Bent little finger**- lay your hands flat on the table and relax them. If the last joint of your little finger bends toward the fourth finger, you have the dominant allele **B**.
- iii) **Attached earlobes** – the **A** allele for free earlobes is dominant to the recessive **a** allele for attached earlobes.
- iv) **Tongue rolling** – the **R** allele allows you to roll your tongue into a U shape, and is dominant to the **r** allele for lack of this ability

- v) **Hitchhiker's thumb-** bend your thumb backwards as far as possible. If you can bend the last joint of the thumb back at an angle of 60 or more, you are showing the recessive allele **h**.
- vi) **Interlacing fingers** – casually fold your hands together so that your fingers interlace. The **C** allele for crossing the left thumb over the right thumb when you interlace your fingers is dominant over the **c** allele for crossing your right thumb over your left.
- vii) **Mid-digital hair-** the allele **M** for hair on the middle segment of your fingers is dominant to the **m** allele for no mid-digital hair. If hair is present on the mid-digit of any finger you have the dominant allele.
5. Let students carry out the above investigations and record the results in the table below.

No .	Characteristic	Your phenotype	Possible genotype	Phenotypes of class	
				Dominant	Recessive
i.	Widow's peak				
ii.	Bent little finger				
iii.	Attached earlobes				
iv.	Tongue rolling				
v.	Hitchhiker's thumb				
vi.	Interlacing fingers				
vii.	Mid-digital hair				

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**Uganda Advanced  
Certificate of Education**

**Chemistry**

**TEACHING SYLLABUS**

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## SECTION A

### Introduction

This Chemistry Teaching Syllabus is meant to aid teachers handling Chemistry at Uganda Advanced Certificate of Education (UACE). It is designed to build on and also taken to include the Chemistry Syllabus at Uganda Certificate of Education (UCE). Knowledge beyond that required for U. C. E. is not expected unless specifically mentioned in topics in the U. A. C. E. syllabus. The syllabus is divided into three broad sections; A, B, and C. Each of the Sections B and C is divided into several Topics and Sub-Topics which are arranged in a sequence that presents terms, concepts and procedures which should be learned before those that build on, extend or apply the knowledge gained.

### Purpose of the Teaching Syllabus

This teaching syllabus will enable teachers cover the syllabus content adequately up to appropriate depth at each level of study. The design of this syllabus is to emphasise the teaching approaches to be used for each sub-topic from among the general approaches given by the syllabus to achieve the general objectives of the syllabus. The periods allocated should also guide teachers to make effective plans so that they can complete the syllabus within the recommended period. The recommended methods must all be based on experiments and experimental-investigative approaches where students can participate individually or in groups.

### Aims of Teaching Chemistry

1. Enabling the learners to know:
  - i) the basic principles and concepts of Chemistry.
  - ii) how theories and models are used to explain concepts in Chemistry.
  - iii) the resources available to facilitate discovery about unfamiliar principles and concepts in Chemistry.
  - iv) the use of knowledge of the principles and concepts of Chemistry in everyday life situations.
2. Making the learners aware of the effects of scientific discoveries and knowledge on everyday life through some applications of Chemistry

3. Enabling learners to:
  - i) develop an experimental attitude by performing experiments in schools
  - ii) familiarise themselves with scientific methods.
  - iii) develop the necessary skills to design and carry out practical investigations based on the knowledge of Chemistry.
4. Preparing the learners for further studies in Chemistry and related fields
5. Enabling the learners to appreciate the applicability of Chemistry in other disciplines
6. Enabling the learners to develop:
  - i) an initiative for inventiveness.
  - ii) skills for practical investigation and exploration.
  - iii) capacity to design models and analytical schemes for use in problem solving schemes.

## General Objectives

The learners should be able to:

1. recognise problems that can be dealt with using methods, concepts, principles, models and theories of Chemistry.
2. recognise the use of, and manipulate apparatus and equipment common in a Chemistry laboratory.
3. design and carry out practical investigations and experiments, describe and explain the procedures used as well as their effectiveness and their limitations.
4. handle all practical work with the accuracy required to obtain the desired results.
5. define terms related to various concepts in Chemistry and explain their relationship to materials and phenomena in the environment.
6. discuss the use and effectiveness of theories or models in explaining physical phenomena as well as events in the laboratory and in the environment.

## Target

This teaching syllabus is aimed at enriching the teaching strategies employed by teachers of Chemistry in schools.

## Scope and Depth

The syllabus has been divided into four broad units, namely

1. Physical Chemistry
2. Inorganic Chemistry
3. Organic Chemistry
4. Applied Chemistry

## Teaching Sequence

Section	Topic/Sub-Topic
	<b>Senior Five Term I</b>
<b>Physical Chemistry</b>	Topic 1: Matter: Atoms, Molecules and Ions, Mole Concept, Measurement of Concentration and introduction to volumetric analysis, Empirical formula and Molecular Formula and Percentage Composition by Mass, Oxidation- Reduction (Redox) Reactions), Stoichiometry: Quantitative Relation in Reactions, Redox Titrations, Physical states of matter, Gaseous State of Matter, Liquid State of matter, Solid State of Matter
	<b>Senior Five Term II</b>
	Topic 2: Atomic Structure and Periodic Table: Fundamental Particles of the Atom and Radioactivity, Electronic Structure of Atoms , The Periodic Table
	<b>Senior Five Term III</b>
	Topic 3: Structure and Bonding: Chemical Bonding, Drawing Lewis Structures of Molecules and Polyatomic Ions. Shapes of Molecules
	Topic 4: Thermochemistry (Chemical Energetics): Chemical Energy, Types of Heat of Reactions, Calorimetry, Types of Enthalpy Changes
	<b>Senior Six Term I</b>
	Topic 5: Physical Equilibria: Systems, Phases and Component, Component System (Types of component systems), Types of Solutions, Colligative Properties
	Topic 6: Chemical Equilibria; The concept of Chemical Equilibrium, Comparison between $K_c$ and $K_p$ , Factors affecting the position of equilibrium in accordance with the Le' Chatelier's Principle, Applications of factors on industrial processes
	<b>Senior Six Term II</b>

	Topic 7: Ionic Equilibria; Acids, Bases and Salts, Buffer Solutions, Acid–Base Titrations, Solubility Equilibria
	Topic 8: Chemical Kinetics; Simple Rate Equations, Factors Affecting Rates of Reactions
	Topic 9: Electrochemistry; Electrolysis, Conductance and its Measurements, Electrochemical Cells
<b>Inorganic Chemistry</b>	<b>Senior Five Term I</b> Topic 10: Third Short Period of the Periodic Table, Trends in Atomic and Physical properties of the Elements, Chemical Reactions of the Elements, Compounds of the Elements  <b>Senior Five Term II</b> Topic 11: The Chemistry of group II elements (Alkaline earth metals); Trends in physical properties of the elements of group II, Chemical Reactions of group II elements, Compounds of Group II Elements
	<b>Senior Six Term I</b> Topic 12: The Chemistry of Group IV Elements; Trends in Physical Properties of Group IV Elements, Chemical Reactions of the Elements, Compounds of the Group IV Elements
	<b>Senior Six Term II</b> Topic 13: The Chemistry of Group VII Elements; Trends in Physical Properties of the Elements, Chemical Reactions of the Elements of Group II of Periodic Table, Compounds of the Elements
	<b>Senior Five Term I</b> Topic 14: The Chemistry of the d-block Transition Elements; The d-Block Transition Elements, Chemical Properties of the Elements and their Compounds
<b>Organic Chemistry</b>	<b>Senior Five Term I</b> Topic 15: Introduction to Organic Chemistry; Introduction  Topic 16: Hydrocarbons (Alkanes, Alkenes and alkynes); Introduction to Alkanes and their Physical Properties, Chemical Properties and uses of Alkanes, Introduction to Alkenes and their Physical Properties, Chemical Properties and Uses of Alkenes,  <b>Senior Five Term II</b> Introduction to Alkynes and Their Physical Properties,

	<p>Chemical Properties and Uses of Alkynes</p> <p>Topic 17: Halogen compounds (Alkyl halides); Introduction to Halogen Compounds and Their Physical Properties, Chemical Properties and Uses of Halogen Compounds</p>
	<p>Topic 18: Benzene and methyl benzene: Introduction to Benzene and its Physical properties of Benzene, Chemical Properties of Benzene, Introduction to Methyl benzene, Physical properties of methyl benzene</p>
	<b>Senior Five Term III</b>
	<p>Topic 19: Alcohols and Phenols; Introduction to Alcohols and their Physical Properties, Chemical Properties of Alcohols, Introduction to Phenol and its physical properties, Chemical Properties and Uses of Phenols</p>
	<b>Senior ix Term I</b>
	<p>Topic 20: Carbonyl compounds (Ketones and Aldehydes); Introduction to Carbonyl Compounds and Their Physical Properties, Chemical Properties and Uses of Carbonyl Compounds</p>
	<p>Topic 21: Carboxylic (Alkanoic) acids; Introduction to Carboxylic Acids and their Physical Properties, Chemical Properties and Uses Carboxylic Acids, Soaps and Soapless Detergents</p>
	<p>Topic 22: Esters; Introduction to Esters and their Physical properties, Chemical properties and uses of Esters</p>
	<b>Senior Six Term II</b>
	<p>Topic 23: Amines; Introduction to Amines and their physical properties, Chemical properties and uses of Amines</p>
	<p>Topic 24: Polymers and Polymerisation; Introduction to polymers, Rubber, Fibres Plastics</p>

## Practical

The practical skills will be derived from any of the branches of Chemistry. This aspect will cover the following areas:

- i) Introduction
- ii) Acid-base titrations i.e.
  - strong acid-strong base titrations (revision of O-level practical of titration i.e. standardisation)

- dilution factors (acid-base titration)
  - back titration
  - double indicators
- iii) Redox titration:
- Introduction: balancing redox equations
  - Permanganate titrations
  - Thiosulphate titrations
  - Iodometry and idiometry
- iv) Kinetics
- v) Determination of partition coefficient
- vi) Colligative properties
- vii) Precipitation reactions
- viii) Thermometric titrations
- ix) Qualitative analysis
  - Inorganic (identification of anions and cations)
  - Organic (identification of functional groups and nature of organic compounds)

## Time Allocation

The allocation of periods for each topic and for each term assumes that there will be nine (09) weeks of effective teaching available per term for two years except for the First Term of Senior Five and the Third Term of Senior Six. It is also recommended that there will be six (6) periods, each of 40 minutes of teaching per week for Chemistry theory and three (3) periods of laboratory practical work on the school timetable.

## How to Use the Syllabus

The Chemistry Teaching Syllabus is aimed at providing the teacher with guidance required to teach Chemistry at Advanced Level classes. It is not meant to substitute the creativity of the classroom teacher. The Chemistry Teaching Syllabus has the following features:

### Learning Objectives(s)

This is a statement of the general learning outcome expected of a learner at the end of the topic.

### Objectives

These clarify the content and scope. The teacher should use the competences to plan the teaching strategies suitable for the lesson. Competences also guide in evaluation at the end of the learning process.

## **Content**

Items in the content column have been simply listed but should be handled together with the specific objectives and the notes on the topic.

## **Teaching/Learning Strategies**

These provide the teacher with guidance, for example, of suitable methodology, experiments and strategies which the teacher may employ.

## **Notes**

These further clarify the scope and depth.

## **Number of Periods per Topic**

The number of periods suggested for each topic is only to be used as a guide to enable the teacher cover the work adequately.

## **Assessment**

### **Continuous Assessment**

It is recommended that the teacher carries out continuous assessment basing on each topic. The questions in the assessment should reflect acquisition of the following testable competences:

a) **Knowledge**

- i) knowledge of terminology
- ii) knowledge of specific facts
- iii) familiarity with experiments suggested in the syllabus
- iv) knowledge of common principles and generalisation identified in the syllabus

b) **Comprehension**

Ability to:

- i) explain standard phenomena from laws and models and to describe standard experiments met with before.
- ii) translate between various forms of information presentation.
- iii) use standard methods to solve familiar numerical types of problems.
- iv) draw conclusion from experiments of a straight forward type.

c) **Application and Higher Abilities**

Ability to:

- i) analyse presented information.
- ii) synthesis ideas from presented analyses and otherwise.
- iii) apply laws and generalisations already learnt to new situations.

- iv) devise experiments to test hypotheses and statements of models.
  - v) exercise evaluative judgment on suitability and results of scientific procedures.
- d) **Practical Abilities**  
The written tests will demand knowledge of, and familiarity with experiments in Chemistry relevant at this level. The practical component of the examination will further test acquisition of the following abilities:
- i) application of knowledge to practical situations.
  - ii) manipulation of the apparatus and performing experiments.
  - iii) making and recording observations accurately.
  - iv) presentation of data in an appropriate form.
  - v) drawing conclusions from observations made.
  - vi) assessing suitability of procedure, experiment and observations made in support of the conclusion.

## **Valuable Mathematical Skills to be acquired by Learners in the Study of Chemistry**

The expected Mathematical skills to be acquired by the learners include:

- ability to translate to graphical form and interpret graphical representation of data
- ability to perform simple operations of differentiation and integration
- familiarise with logarithmic functions to base ten and to base  $e$
- ability to visualise in three dimensions
- an understanding of elementary aspects of mathematical errors (i.e.  $\pm$ )

### **Summative Assessment**

Uganda National Examinations Board (UNEBO) will administer a Chemistry (Principal Subject) examination at the end of the second year of study.

### **Examination Format**

There will be **three** papers:

#### **Paper 1 (2 $\frac{3}{4}$ hours)**

The paper will consist of two sections: A and B. Seventeen questions will be set as follows:

Section A: nine questions from any part of the syllabus

Section B: eight questions from any part of the syllabus

Candidates will be required to attempt a total of fifteen questions including all questions in Section A (46 marks) and 6 (54 marks) questions from Section B. Candidates will be expected to write the answers in the spaces provided on the question paper.

**Paper 2 (2 ½ hours)**

The paper will consist of two sections: A and B. Eight questions will be set as follows:

Section A: Four questions from any part of the syllabus

Section B: Four questions from any part of the syllabus

Candidates will be required to attempt a total of five questions including three from Section A and not more than two from section B. Each question carries twenty marks. (Total: 100 marks)

**Paper 3 (3 ¼ hours)**

Three questions will be set. Candidates will be required to attempt the three questions.

N.B. SI units and SI nomenclature will be used in all question papers.

## SECTION B

### Part I: Physical Chemistry

SENIOR FIVE      TERM I

#### Topic 1: Matter

Duration: 38 Periods

##### General Objective

By the end of this topic, the learner should be able to explain the particulate nature of matter and use the knowledge in qualitative and quantitative applications.

##### Sub-Topic 1: Atoms, Molecules and Ions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concept of matter.</li><li>• describe the structure of an atom.</li><li>• describe the building blocks of matter.</li><li>• identify sub-atomic particles.</li><li>• describe properties of sub-atomic particles.</li><li>• explain the fundamental particles of the atom.</li><li>• write isotopic notation.</li><li>• use proper nomenclature.</li><li>• assign correct and unambiguous name to every</li></ul>	<ul style="list-style-type: none"><li>• What is matter?</li><li>• Atoms, molecules and ions as building blocks of matter</li><li>• The structure of an atom</li><li>• Sub-atomic Particles and Isotopic Notation</li><li>• Fundamental particles of the atom: electron, proton and neutron<ul style="list-style-type: none"><li>- The nucleus</li><li>- Proton number (<math>Z</math>), nucleon number (<math>A</math>)</li><li>- Isotopes</li></ul></li><li>• Isotopic notation</li><li>• Ions and ion formation</li><li>• IUPAC nomenclature for cations, anions and salts</li><li>• Naming monatomic ions – cations, anions</li></ul>

Specific Objectives	Content
<p>chemical compound.</p> <ul style="list-style-type: none"> <li>describe the essential parts and operation of the modern mass spectrometer.</li> <li>state the uses of the mass spectrometer.</li> <li>interpret the mass spectrum obtained from the results of a mass spectrometer analysis.</li> <li>demonstrate the ability to correctly use the data obtained from the mass spectrometer in calculations:- average atomic mass, relative atomic mass and relative molecular mass.</li> <li>explain the terms RAM, RMM.</li> </ul>	<ul style="list-style-type: none"> <li>Naming ionic compounds – made of two elements (binary), stock system (systemic name), common nomenclature system, the selection of correct Roman numeral, writing the formula of an ionic compound.</li> <li>Mass spectrometer and atomic mass</li> <li>The essential components of a modern mass spectrometer</li> <li>Operation of the mass spectrometer</li> <li>The relative abundance</li> <li>The use of mass spectrum</li> <li>Average atomic mass  <math display="block">= \frac{\sum f_i m_i}{\sum f_i}</math></li> <li>Relative atomic mass  <math display="block">A_r = \frac{\text{average mass of atom}}{\frac{1}{12} \times \text{mass of atom } {}^{12}\text{C}}</math>            - Relative Molecular Mass (<math>M_r</math>)  <math display="block">M_r = \frac{\text{mass of one the compound molecule of}}{\frac{1}{12} \times \text{mass of one atom } {}^{12}\text{C}}</math></li> </ul>

### Suggested Teaching and Learning Strategies

- Brainstorm and discuss what matter is, atoms, molecules, ions as building blocks of matter, fundamental particles, the nucleus, proton number (Z), nucleon number (A), isotopes, isotopic notation. IUPAC nomenclature for cations, anions and salts.
- Describe the structure of the mass spectrometer. Use models or computer simulations to explain the functions of its components.

- Guide a discussion on the interpretation of data from spectra and calculations involved.
- You may use models, charts, computer simulation to help explain the working of the mass spectrometer.
- You may take learners to resource centers where they can practically study about the mass spectrometer.

### Suggested Assessment

- Give class exercises that require the learners to:
  - describe the structure the structure of the mass spectrometer and explain its functioning of the mass spectrometer.
  - interpret and analyse spectral data.
  - carry out calculations using spectral data.

### Sub-Topic 2: Mole Concept

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the mole as a unit of measurement using Avogadro constant.</li><li>• calculate molar masses of elements and compounds.</li><li>• apply the conversion factors in calculations.</li></ul>	<ul style="list-style-type: none"><li>• The Mole Concept and Avogadro constant</li><li>• What the mole is</li><li>• Avogadro constant</li><li>• Moles of atoms of elements in one of a compound</li><li>• Molar mass of elements and compounds</li><li>• Calculating numbers of atom, moles and mass by using conversion factors</li></ul>

### Suggested Teaching and Learning Strategies

- Guide a discussion of the mole as a unit of measurement, use of Avogadro's constant in calculation, interconversions involving moles and mass.

### Practical Problem

- You may use a weighing balance to enable learners weigh masses of particular compounds and use conversion factors to calculate moles.

- Learners may work out problems involving interconversions of moles, mass and molecular mass.

### Assessment Strategies

- Give class exercise in explaining common terms used under the mole as a unit of measurement.
- Carry out calculations on molar mass- mole interconversions.

## Sub-Topic 3: Measurement of Concentration and introduction to volumetric analysis

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>use apparatus appropriately.</li> <li>abide by the laboratory safety rules when handling chemicals and apparatus.</li> <li>select appropriate apparatus.</li> <li>explain the concept of concentration in terms of amount of the substance (solid or liquid) dissolved in a solvent.</li> <li>interpret v/v; w/w percentages.</li> <li>carry out calculations involving concentration.</li> <li>differentiate between molality and molarity.</li> </ul>	<ul style="list-style-type: none"> <li>Handling of apparatus and chemicals</li> <li>Techniques of handling apparatus and chemicals</li> <li>Selection of apparatus for different experiments</li> <li>Laboratory rules and regulations</li> <li>Concentration           <ul style="list-style-type: none"> <li>- Explain the concept of concentration.</li> </ul> </li> <li>Percentage by mass, %w/w</li> </ul> $= \frac{\text{mass of solute (g)}}{\text{mass of solution (g)}} \times 100\%$ <ul style="list-style-type: none"> <li>Percentage by volume, %V/V</li> </ul> $= \frac{\text{volume of solute (mL)}}{\text{volume of solution (mL)}} \times 100\%$ <ul style="list-style-type: none"> <li>Molarity, M (<math>\text{mol L}^{-1}</math> or <math>\text{mol dm}^{-3}</math>)</li> </ul> $= \frac{\text{moles of solute (mol)}}{\text{volume of solution (dm}^3\text{)}} \times 100\%$ <ul style="list-style-type: none"> <li>Preparation of standard solutions from stock solutions.</li> <li>Common terms used in volumetric</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"><li>• prepare standard solutions from stock solutions.</li><li>• explain the common terms used in volumetric analysis.</li><li>• explain the concept of volumetric analysis. carry out acid-base titrations.</li></ul>	<p>analysis, (Titrant, Titrand, analyte, end-point, equivalence point, standard solution, etc.)</p> <ul style="list-style-type: none"><li>• Volumetric Analysis</li><li>• Concept of volumetric analysis</li><li>• Acid-base titrations</li></ul>

### Suggested Teaching and Learning Strategies

- Guide learners on handling apparatus and preparing solutions of particular concentrations from stock solutions and by dissolving solutes.
- Introduce volumetric analysis/titration.
- Carry out experiments about:
  - acid-base titrations
  - titration on redox reactions
  - back titrations

### Practical Problem

- Prepare standard solutions of hydrochloric acid, sulphuric acid by dilution of stock solutions.
- Prepare standard solutions by weighing and dissolving solids in water.
- Carry out acid-base titrations and use the data obtained to calculate concentration of solutions, (e.g. standardisation of hydrochloric acid using Borax).

### Assessment Strategies

- Give practical exercises on: preparing solutions, standardisation.
- Class exercises on calculations involving standardisation and dilutions.

## Sub-Topic 4: Empirical formula and Molecular Formula and Percentage Composition by Mass

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>determine the percentage composition by mass of each element in a compound.</li> <li>explain the concept of empirical formula and molecular formulae.</li> <li>carry out calculations on empirical and molecular formulae.</li> <li>carry out experiment to determine empirical formula.</li> </ul>	<ul style="list-style-type: none"> <li>Percentage by mass of a particular element  <math display="block">= \frac{n \times \text{molar mass of element}}{\text{molar mass of compound}} \times 100\%</math> <math>n = \text{number of atoms of element in the formula}</math> </li> <li>Empirical formula as the simplest formula that expresses the ratio in which each element is present in a given compound</li> <li>Determination of empirical formula</li> <li>Molecular formula as one that shows the number and kind of each element present in one molecule of the compound. Determining the molecular formula</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide a discussion on empirical and molecular formula and the practical determination of empirical formula.
- Guide learners to carry out calculations involving empirical formula, molecular formula and percentage composition by mass.

### Practical Problem

- Give a group experiment to determine the empirical formula of Copper(II) oxide using ethanol.

### Assessment Strategies

- Give class exercises on:
  - explaining the meanings of the terms empirical formula and molecular formula.
  - calculations involving determination of molecular formula from combustion data and other experimental data.

- calculation percentage composition by mass of an element in a compound.

### Sub-Topic 5: Oxidation-Reduction (Redox) Reactions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain concept of redox reactions</li><li>• state the rules for assigning oxidation states.</li><li>• use correct nomenclature to name polyatomic ions and compounds</li><li>• explain the characteristics of oxidation and reduction reactions.</li><li>• write balanced redox equations in acidic and alkaline media.</li></ul>	<ul style="list-style-type: none"><li>• Oxidation number (Oxidation state)</li><li>• What oxidation state is</li><li>• Rules for assigning oxidation number</li><li>• Naming of polyatomic ions and compounds.</li><li>• The characteristics of Oxidation – Reduction Reactions</li><li>• Balancing redox Equations<ul style="list-style-type: none"><li>- In acidic medium</li><li>- In alkaline medium</li></ul></li></ul>

### Suggested Teaching and Learning Strategies

- Explain the terms: redox, oxidation number, oxidising agent, reducing agent and oxidising agent.
- Determine oxidation numbers, write and balance redox equations in acidic and alkaline media and naming polyatomic ions and compounds

### Practical Problem

- Qualitative test tube tests should be carried out on common oxidising agents and reducing agents. (e.g.  $\text{Fe}^{2+}(\text{aq})$  /Conc. $\text{HNO}_3$ ,  $\text{VO}_3^-$ /Zn powder with HCl,  $\text{Fe}^{2+}(\text{aq})/\text{H}_2\text{O}_2$ )

### Assessment Strategies

- Give class exercises on the following:
  - Explanation of terms used in redox reactions
  - Determination of oxidation numbers, naming of poly atomic ions and compounds.
  - Writing and balancing of redox equations in acidic and alkaline media

## Sub-Topic 6: Stoichiometry: Quantitative Relation in Reactions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• demonstrate knowledge of stoichiometry by applying it in calculations.</li> <li>• explain concept of limiting and excess reactants.</li> <li>• calculate percentage yields from chemical reactions.</li> <li>• experimentally demonstrate the concept of limiting and excess reactant.</li> <li>• explain the avogadro's law.</li> <li>• apply the avogadro' law in calculations.</li> <li>• explain Gay-Lussac's law.</li> </ul>	<ul style="list-style-type: none"> <li>• What Stoichiometry is</li> <li>• Relating moles of reactants to moles of products</li> <li>• Limiting reactant - as that reactant which is completely used up in a chemical reaction and limits the quantities of products formed.</li> <li>• Excess reactant - as that reactant which remains after a chemical reaction</li> <li>• Percentage yield</li> </ul> $= \left( \frac{\text{actual yield}}{\text{theoretical yield}} \right) \times 100$ <ul style="list-style-type: none"> <li>• Avogadro's law</li> </ul> $V \propto n \quad (n = \text{number of moles of a gas})$ $V = kn$ <ul style="list-style-type: none"> <li>- Gay- Lussac's law</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide discussions on stoichiometry calculations from first principles. Ensure that the learners have a prerequisite knowledge of ratios.
- Form groups depending on the number of learners in the class to demonstrate the concept of limiting and excess reactants.
- Guide the learners on how to calculate the percentage yields from chemical reactions.
- Spend some time to explain Avogadro's law and how to apply it in calculations.

### Practical Problems

- Let the learners carry out calculations involving the relationship between quantities of reactants and products.

- Guide the learners to carry out experiments on the concept of limiting reactants and excess reactants from chemical reactions.

### Assessment Strategies

- Give class exercises on:
  - explaining the terms : stoichiometry, limiting reactants, excess reactant, percentage yield, etc.
  - stating and applying the Avogadro's and Gay Lussac's laws.
  - calculations involving stoichiometry.

### Sub-Topic 7: Redox Titrations

Specific objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• differentiate between primary and secondary standard</li><li>• prepare standard solutions</li><li>• carry out calculations from first principles.</li><li>• carry out redox titrations</li></ul>	<ul style="list-style-type: none"><li>• Primary and secondary standard</li><li>• Preparation of standard solutions of permanganate, thiosulphate solutions, etc.</li><li>• Standardise solutions</li><li>• Carrying out different types of redox titrations</li></ul>

### Suggested Teaching and Learning Strategies

- Guide discussions on the terms primary and secondary standards
- Conduct class experiments or practicals on redox titrations.

### Practical problem

- Carry out class experiments on common redox titrations e.g. solutions of permanganate, oxalates, iron(II) ions dichromates, hydrogen peroxide, thiosulphate, iodine, etc.

### Assessment Strategies

- Give class exercises on:
  - use of equations to explain common redox reactions
  - calculations on redox titrations

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the properties of different states of matter.</li> <li>• describe the differences between the various states of matter in terms of particle arrangement, forces of attraction and movement.</li> </ul>	<ul style="list-style-type: none"> <li>• States of matter: Solid, Liquid and Gas.</li> <li>• Interconversion of the physical states</li> <li>• Comparison of physical properties between solids, liquids and gases</li> <li>• Kinetic theory of matter</li> </ul>

## Sub-Topic 8: Physical states of matter

### Suggested Teaching and Learning Strategies

- Theoretically explain the properties of each of the states of matter using models or computer simulations.

### Practical Problem

Class exercises on:

- use of models
- computer simulations

### Assessment Strategies

- Give class exercises to explain properties of different states of matter.

## Sub-Topic 9: Gaseous State of Matter

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the gaseous state in terms of kinetic theory of matter.</li> <li>• explain the concepts of</li> </ul>	<ul style="list-style-type: none"> <li>• General properties of gas <ul style="list-style-type: none"> <li>- Ideal gas</li> <li>- Gas pressure</li> </ul> </li> </ul> <p><b>Pressure (P) = <math>\frac{\text{force}}{\text{area}}</math></b></p> <ul style="list-style-type: none"> <li>• Gas Laws:</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"> <li>different gas laws.</li> <li>carry out calculations involving gaseous volumes, pressure and temperature.</li> <li>demonstrate Boyle's law</li> <li>explain concept Charles' law</li> <li>demonstrate knowledge of ideal gas behaviour using graphs.</li> <li>describe behaviour of ideal gases.</li> <li>derive the relationship between Charles's and Boyle's law(<math>PV=nRT</math>).</li> <li>state Graham's law of diffusion of gases.</li> <li>explain mole fraction.</li> <li>describe the behaviour of a mixture of gases contained in a closed vessel.</li> <li>explain the molecular behaviour of gases in terms of the kinetic theory (qualitative treatment only required).</li> <li>use graphs to show deviation from ideal behaviour.</li> </ul>	<ul style="list-style-type: none"> <li>- Boyle's  <math>V \propto \frac{1}{P}</math> (at constant T and n)  <math>PV = k</math> (where <math>k</math> is a constant)</li> <li>- Charles's  <math>V \propto T</math> (at constant P and n)  <math>\frac{V}{T} = \text{Constant}</math></li> <li>Combined gas laws and ideal gas laws  <math>\frac{PV}{T} = \text{Constant}</math></li> <li>Ideal Gas Law  <math>V \propto \frac{nT}{P}</math>  <math>PV = nRT</math> (where R is the molar gas constant)</li> <li>Graham's law of gaseous diffusion.  <math>\text{rate of diffusion} \propto \frac{1}{\sqrt{\text{density}}}</math></li> <li>Mole fraction, <math>x</math>  <math display="block">x = \frac{n_i}{n_{\text{total}}}</math></li> <li>Dalton's law of partial pressure  <math>P_{\text{Total}} = P_1 + P_2 + P_3 + \dots + P_n</math></li> <li>The Molecular Behaviour of Gases <ul style="list-style-type: none"> <li>- Kinetic molecular theory of gases</li> </ul> </li> <li>Relationship of the gas laws to Kinetic Molecular Theory of Gases</li> <li>Maxwell-Boltzmann distribution</li> <li>Real gases - Deviation from</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"> <li>• explain the concept of real gas.</li> <li>• differentiate between ideal and real gases.</li> <li>• explain the conditions under which real gases can behave like ideal gases.</li> </ul>	<p>ideality</p> <ul style="list-style-type: none"> <li>• What real gas is</li> <li>• Real gas behaviour under different conditions of temperature and pressure.</li> </ul> <p>Correction of real gas behaviour by using van der Waals equation:</p> $\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$

## Suggested Teaching and Learning Strategies

- Expose and let the learners brainstorm states of matter, kinetic theory and the gas laws.
- Encourage the learners to write Mathematical statements of the gas laws.
- Guide class discussions on behaviour of ideal and real gases using graphs and give exercises to consolidate the knowledge.

## Practical Problems

- Computer simulation
- Class discussions and calculation

## Assessment Strategies

- Give class exercises on:
  - explaining physical properties of gases using gas laws.
  - explaining terms related to gas behaviour e.g. partial pressure, mole fraction, ideal gas, real gas, compressibility factor, critical temperature, isotherms, etc.
  - calculations involving gas laws.

## Sub-Topic 10: Liquid State of matter

Specific Objectives	Content
<p>The learners should be able to:</p> <ul style="list-style-type: none"><li>• explain the liquid state in terms of kinetic theory of matter.</li><li>• describe the various properties of a liquid such as viscosity, surface tension, diffusion, vaporisation, condensation and boiling.</li><li>• explain the concept of vapour pressure.</li><li>• describe how intermolecular forces affect vapour pressure.</li><li>• analyse the conditions under which boiling of a liquid takes place.</li></ul>	<ul style="list-style-type: none"><li>• Kinetic theory of matter</li><li>• Properties of Liquid<ul style="list-style-type: none"><li>- Compressibility</li><li>- Viscosity</li><li>- Surface tension</li><li>- Diffusion</li><li>- Vaporisation and condensation</li><li>- Boiling</li></ul></li><li>• Vapour Pressure</li><li>• Intermolecular forces affecting Vapour Pressure</li><li>• Temperature affecting Vapour Pressure</li></ul>

### Suggested Teaching and Learning Strategies

- Guide discussions on liquid state of matter and kinetic theory of matter
- Let the learners brainstorm on various properties of liquids and the concept of vapour pressure and conditions for boiling to take place.
- Give an ICT opportunity of simulation of some of the concepts to make the learners consolidate their knowledge of the concepts.

### Practical problem

- Guide class experiments e.g. movement of coloured substance like permanganate, copper(ii) sulphate in a clear liquid such as water.

### Assessment Strategies

- Give class exercises and tests on:
  - explaining properties of liquid state of matter using kinetic theory.
  - application of the properties of the liquid state (e.g. hydraulic brakes, car jack to explain compressibility of liquid, floating of objects, shielding effect of tents against rain to explain surface tension, distillation to explain condensation and evaporation)

- explaining how molecular forces between particles in liquids are related to vapour pressure exerted by the liquid.
- explaining the effect of change of external physical factor on vapour pressure of a liquid.

## Sub-Topic 11: Solid State of Matter

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the changes in solid phase.</li> <li>• explain the solid state in terms of kinetic theory of matter.</li> <li>• explain the terms; melting, freezing, sublimation and deposition.</li> <li>• describe with examples the behaviour of giant ionic solids.</li> <li>• describe with examples the behaviour of giant covalent, molecular and giant ionic solids.</li> <li>• describe with examples the characteristics of giant metallic solids.</li> </ul>	<ul style="list-style-type: none"> <li>• Phase changes in solids <ul style="list-style-type: none"> <li>- Melting point</li> <li>- Freezing point</li> <li>- Sublimation</li> <li>- Deposition</li> </ul> </li> <li>• Types of solids</li> <li>• Giant Ionic solids (e.g. sodium chloride, caesium chloride, Zinc blend)</li> <li>• Giant covalent solids (e.g. diamond, graphite, silicon and fullerene)</li> <li>• Molecular covalent solids (e.g. iodine, I<sub>2</sub> and Phosphorus, P<sub>4</sub>)</li> <li>• Giant metallic solids (e.g. iron, copper, titanium)</li> </ul>

### Suggested Teaching and Learning Strategies

- Let the learners brainstorm and discuss phases in changes of solids.

### Practical Problems

- Give learners group experiments on melting of ice, sublimation of NH<sub>4</sub>Cl, iodine, wax, naphthalene
- Guide discussions using models, charts, graphs and computer simulations.

## Assessment Strategies

- Give class exercises and tests on:
  - use of kinetic theory to explain structure of solids.
  - explaining the changes that take place during change of solid state.
  - explaining the differences in the physical properties of different solids.

## SENIOR FIVE TERM II

### Topic 2: Atomic Structure and Periodic Table

Duration: 24 Periods

#### General Objective

By the end of this topic, the learner should be able to analyse the structure of an atom and its relationship to the Periodic Table.

#### Sub-Topic 1: Fundamental Particles of the Atom and Radioactivity

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the development of the modern theory of the atom.</li> <li>• describe the discovery of the fundamental particles of the atom.</li> <li>• compare the characteristics of the different types of radiations.</li> <li>• carry out simple calculations involving half-lives of radioisotopes.</li> <li>• balance nuclear reaction equations.</li> <li>• differentiate between nuclear</li> </ul>	<ul style="list-style-type: none"> <li>• Historical Development of Atomic Theory</li> <li>- Modern theory of atom (John Dalton, J. J. Thomson, and Ernest Rutherford) should be discussed.</li> <li>• Fundamental particles of the atom (protons, electrons and neutrons) <ul style="list-style-type: none"> <li>- Discoveries and properties of the fundamental particles</li> </ul> </li> <li>• Radioactivity: <ul style="list-style-type: none"> <li>- Discovery</li> <li>- Properties of radiations,</li> </ul> </li> <li>• Radioisotopes <ul style="list-style-type: none"> <li>- Binding energy</li> </ul> </li> <li>• Nuclear reactions <ul style="list-style-type: none"> <li>- Radioactive decay</li> <li>- Half-life (<math>t_{1/2}</math>)</li> </ul> </li> <li>• Nuclear energy (discovery,</li> </ul>

Specific Objectives	Content
<p>and chemical reactions.</p> <ul style="list-style-type: none"> <li>mention factors that determine stability of a nucleus.</li> <li>correctly demonstrate knowledge of radioactive decay using graphs.</li> </ul>	<p>fission, fusion, nuclear power)</p> <ul style="list-style-type: none"> <li>Applications of radioactivity</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide discussions and explanations of the work of John Dalton, J. J. Thomson, and Ernest Rutherford leading to discoveries and properties of the fundamental particles of the atom.
- Guide discussions on the concept of radioactivity: discovery, properties of radiations, binding energy, stable and unstable nuclei, radioisotopes, nuclear reactions, comparison of nuclear and chemical reactions, radioactive decay, half-life  $t_{1/2}$  nuclear energy, applications of radioactivity.

### Practical problem

- Use ready models, charts or computer simulations to help you explain the concept of radioactivity.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain development of atomic according to Rutherford and Thomson.
  - explain the concept of radioactivity and state the properties of radiations.
  - draw and interpret radioactive decay curves.
  - carry out calculations involving half-life.
  - balance nuclear reactions.
  - state and explain uses of radioactivity.

### Sub-Topic 2: Electronic Structure of Atoms

Specific Objectives	Content
<p>The learners should be able to:</p> <ul style="list-style-type: none"> <li>explain the concept of spectrum.</li> </ul>	<ul style="list-style-type: none"> <li>Electromagnetic Radiation           <ul style="list-style-type: none"> <li>Electromagnetic radiation as quanta</li> </ul> </li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"> <li>• apply the equation in calculations.</li> <li>• describe different types of spectra.</li> <li>• explain what spectrum is.</li> <li>• describe the various types of spectrum.</li> <li>• describe and explain the hydrogen spectrum.</li> <li>• explain the significance of the lines in the hydrogen spectrum.</li> <li>• state the importance of convergence limit.</li> <li>• explain Bohr's atomic postulates.</li> <li>• discuss the weaknesses of Bohr's atomic model.</li> <li>• explain the concept of ionisation energies using atomic spectra.</li> <li>• relate the line series to the energy levels.</li> <li>• calculate ionisation energies .</li> <li>• state Heisenberg's uncertainty principle.</li> <li>• explain the concept of various quantum numbers.</li> <li>• relate the lines in the hydrogen spectrum to the energy levels</li> </ul>	<ul style="list-style-type: none"> <li>- Relationship between wavelength, <math>\lambda</math>, frequency, <math>v</math>, and energy, <math>E</math>.</li> <li>- <math>E \propto v</math>  <math>E = hv</math>            where <math>h</math> = Plank's constant,  <math>6.6256 \times 10^{-34}</math> Js            and  <math display="block">E = \frac{hc}{\lambda}</math></li> <li>• Atomic Spectra</li> <li>• What is Spectrum?</li> <li>• Types of spectra (emission and absorption)</li> <li>• Hydrogen Spectrum and Application of Rydberg Equation</li> <li>• Energy level diagram for hydrogen atom</li> <li>• Convergent limit</li> <li>• The Bohr's Model of the Hydrogen Atom           <ul style="list-style-type: none"> <li>- Bohr's Atomic Postulate</li> </ul> </li> <li>• The weaknesses of Bohr's Atomic Model</li> <li>• Ionisation Energy of Hydrogen</li> <li>• Concept of ionisation energy</li> <li>• Calculations involving ionisation energies</li> <li>• Heisenberg's Uncertainty Principle</li> <li>• Quantum numbers</li> <li>• energy levels</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"> <li>state the quantum numbers (<math>n</math>, <math>l</math>, <math>m</math> and <math>s</math>)</li> <li>explain the concept of electronic configuration as arrangement of electrons in shells</li> <li>write electronic configurations in terms of the energy levels, <b>spdf</b>.</li> <li>apply Hund's rule, Pauli's exclusion and Aufbau principle in the writing of electronic configuration.</li> </ul>	<ul style="list-style-type: none"> <li>principal quantum number, <math>n</math>.</li> <li>Azimuthal quantum number (angular momentum quantum number), <math>l</math></li> <li>magnetic quantum number, <math>m</math></li> <li>electron spin quantum number, <math>s</math></li> <li>Electronic Configuration of Atom <ul style="list-style-type: none"> <li>- Spdf notation</li> <li>- Orbital diagram</li> <li>- The Aufbau Principle</li> </ul> </li> <li>Hund's rule</li> <li>Pauli exclusion principle</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide discussions on electromagnetic radiation, wave length, frequency, energy, electromagnetic spectra, the hydrogen spectrum and Rydberg equation.
- Lead learners to discuss the Bohr's model of the atom, the weaknesses of Bohr's atomic model, ionisation energy and calculations involving ionisation energies. Also Heisenberg's Uncertainty Principle should be discussed.
- Guide learners to discuss the energy levels, types of quantum numbers, writing electronic configuration of atom using s, p, d, f notation, the Aufbau Principle Hund's rule and Pauli exclusion principle

### Practical Problem

- Use ready models, charts or computer simulations to help you explain the sub-Topic.

### Assessment Strategies

- Give class exercises requiring learners to:
  - differentiate between emission and absorption spectra.
  - differentiate between an orbit and orbital.
  - explain the hydrogen spectrum.
  - clearly state Bohr's postulates, and explain its weaknesses.
  - relate the line series to the energy levels.

- relate ionisation energies to atomic spectra.
- state and explain uses of radioactivity.
- write electronic configurations of atoms using spdf notation.
- calculate ionisation energies using spectral data.

### Sub-Topic 3: The Periodic Table

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the historical development of P.T.</li> <li>• describe the structure of the modern PT.</li> <li>• explain the unique position of h, in the periodic table.</li> <li>• explain the basis on which the modern Periodic Table was constructed.</li> <li>• place the elements of PT into Groups, Periods and Blocks.</li> <li>• describe factors influencing properties of metals.</li> <li>• explain the relationship between effective nuclear charge, nuclear charge and shielding effect.</li> <li>• explain the meanings of the</li> </ul>	<ul style="list-style-type: none"> <li>• Historical Development of the periodic table             <ul style="list-style-type: none"> <li>- Unique position of Hydrogen, H, in the Periodic Table</li> </ul> </li> <li>• The Modern Periodic table             <ul style="list-style-type: none"> <li>- Periods and Groups</li> <li>- Classification of the elements: based on electronic configuration of elements as: s, p, d and f blocks</li> <li>- Classification into metals, metalloids and non-metals</li> </ul> </li> <li>• Periodicity of Properties in the Periodic Table             <ul style="list-style-type: none"> <li>- Groups</li> <li>- Periods</li> <li>- Blocks</li> </ul> </li> <li>• Atomic Properties</li> <li>• Factors affecting atomic properties of elements             <ul style="list-style-type: none"> <li>- (<math>Z = \text{nuclear charge}</math>)</li> <li>- <math>S = \text{shielding effect}</math></li> <li>- Effective Nuclear Charge <math>Z_{\text{eff}} = Z - S</math></li> </ul> </li> <li>• Atomic radius:- Across Period (from left to right) and down a group             <ul style="list-style-type: none"> <li>- Ionic radius</li> <li>- Ionisation energy                     <ul style="list-style-type: none"> <li>▪ Variation of ionisation</li> </ul> </li> </ul> </li> </ul>

Specific Objectives	Content
<p>terms ; atomic radius, ionic radius, ionisation energy</p> <ul style="list-style-type: none"><li>describe the trends of the atomic properties across and down the PT</li><li>explain the trends of the atomic properties down and across the PT.</li><li>correctly demonstrate knowledge of graphical representation and interpretation of data on the atomic properties.</li><li>explain the concepts of electron affinity, electropositivity, electronegativity and valency.</li></ul>	<p>Energy (across a Period and down a group)</p> <ul style="list-style-type: none"><li>Anomalous cases (Be, B, N, O)</li><li>Use of successive ionisation energy to deduce the electronic configuration of elements.</li></ul> <ul style="list-style-type: none"><li>Electron affinity, EA; electronegativity; electropositivity ; valency<ul style="list-style-type: none"><li>- Metallic character</li><li>- Melting and boiling points</li></ul></li></ul>

SENIOR FIVE TERM III

## Topic 3: Structure and Bonding

Duration: 30 Periods

### General Objective

By the end of this topic, the learner should be able to outline bonding, molecular structures and their relationship to the properties of substances.

### Sub-Topic 1: Chemical Bonding

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept of chemical bonding.</li> <li>• describe the importance of Lewis dot symbols.</li> <li>• outline the importance of the octet rule in formation of ions and stability of compounds.</li> <li>• explain the formation of ionic bond.</li> <li>• explain the properties of ionic compounds.</li> <li>• explain covalency in ionic compounds.</li> <li>• explain the concept of a covalent bond.</li> <li>• distinguish between the different types of covalent</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction to chemical bonding</li> <li>• Lewis Dot Symbols</li> <li>• The Octet Rule and Ions</li> <li>• Ion Formation and Octet Rule</li> <li>• Ionic bond formation <ul style="list-style-type: none"> <li>- properties of Ionic Compounds</li> <li>- covalence in ionic compounds</li> </ul> </li> <li>• Covalent Bond formation <ul style="list-style-type: none"> <li>- properties of covalent compounds</li> <li>- types of bonding.(normal, polar, dative)</li> </ul> </li> <li>• covalent bond strength <ul style="list-style-type: none"> <li>- dative (coordinate) bonding</li> </ul> </li> </ul>

Specific Objectives	Content
bonding. <ul style="list-style-type: none"><li>• explain the formation of dative bond.</li></ul>	
The learner should be able to: <ul style="list-style-type: none"><li>• explain the factors that determine covalent bond strength.</li><li>• compare properties of ionic and covalent compounds</li><li>• explain ionic character in polar covalent compounds explain the effect of intermolecular forces to the physical properties of the compound.</li><li>• explain the concept of hydrogen bonding.</li><li>• describe the effect of hydrogen bonding on physical properties of substances.</li><li>• explain the concept of metallic bonding.</li><li>• explain the properties of metals.</li><li>• explain the factors affecting strength of metallic bonds.</li><li>• explain the VBT theory.</li><li>• differentiate between Sigma and pi bonds.</li></ul>	<ul style="list-style-type: none"><li>• Intermolecular Forces<ul style="list-style-type: none"><li>- van der Waals Forces<ul style="list-style-type: none"><li>i) Dipole-dipole interaction</li><li>ii) London/dispersion forces (Temporary dipole-dipole)</li></ul></li></ul></li><li>• The Hydrogen Bond<ul style="list-style-type: none"><li>- What hydrogen bond is</li><li>- Types of hydrogen bonding (intra- and intermolecular hydrogen bonding)</li><li>- Effects of hydrogen bonding on physical properties of substances: - Density of water, boiling points, Solubility, etc.</li></ul></li><li>• Metallic Bonding<ul style="list-style-type: none"><li>- Properties of metal: - Ductility and malleability of metal, electrical Conductivity and Thermal conductivity</li><li>- Strength of metallic bonds.</li></ul></li><li>• Valence Bond Theory<ul style="list-style-type: none"><li>- introduction: what Valence bond theory is</li></ul></li></ul>

Specific Objectives	Content
<ul style="list-style-type: none"> <li>• explain the concept of hybridisation.</li> <li>• use hybridisation to predict shapes of molecules.</li> <li>• explain the formation of a double, triple bond.</li> <li>• explain double bond formation in benzene.</li> </ul>	<ul style="list-style-type: none"> <li>- sigma (<math>\sigma</math>) and pi (<math>\pi</math>) bonds</li> <li>• hybridisation of Atomic Orbitals           <ul style="list-style-type: none"> <li>- hybrid orbitals (<math>sp</math>-, <math>sp^2</math>- and <math>sp^3</math>-hybridisation)</li> <li>- geometry for different types of hybridisation</li> </ul> </li> <li>• Hybridisation Involving Organic Compounds</li> <li>• Single, double and triple bond           <ul style="list-style-type: none"> <li>- Benzene molecule</li> </ul> </li> </ul>

### Suggested Teaching and Learning Strategies

- Lead a brainstorming session to develop the concept of bond formation, ion formation, ionic bond formation, structure of ionic compound and their properties.
- Guide a discussion and use models to explain the formation of covalent bonds, types of covalent bonds (normal, polar, dative), properties of covalent compounds, covalent bond strength and giant covalent structures.
- Guide discussions and use models to explain metallic bonding, strength of metallic bonds and properties of metals (ductility and malleability of metal, electrical conductivity thermal conductivity, melting and boiling points).

### Practical Problems

- Use ready models, charts or computer simulations to help you explain the Sub-Topic.
- Give the learners a project to model the different structures considered using locally available materials e.g modeling the structure of sodium chloride.
- Learners can also carry out practical exercises to test the polarity of different liquids e.g. cyclohexane, water, propanone, ethanol, trichloromethane, etc.

**Caution: Most organic liquids are flammable and toxic hence must be handled with great care.**

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain the importance of the octet rule in formation of ions and stability of compounds.
  - identify stable ions without an octet.
  - explain the formation of ionic bond.
  - draw and explain the structure of giant ionic structures.
  - explain the properties of ionic compounds.
  - explain covalent character in ionic compounds.
  - distinguish between the different types of covalent bonding.
  - explain the nature of giant covalent structures (network solids)
  - explain the formation of dative bond.
  - explain the factors that determine covalent bond strength.
  - compare properties of ionic and covalent compounds.
  - explain ionic character in polar covalent compounds.
  - explain the concept of metallic bonding.
  - explain the properties of metals.
- explain the factors affecting strength of metallic bonds

### Sub-Topic 2: Structure: Drawing Lewis Structures of Molecules and Polyatomic Ions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concept of Lewis structure</li><li>• draw Lewis structures of some molecules (ammonia, water, sulphur dioxide, carbon tetrachloride).</li><li>• apply the different rules in drawing Lewis structures of compounds.</li><li>• outline the exceptions to the octet rule.</li><li>• identify the different exceptions to the octet rule as incomplete,</li></ul>	<ul style="list-style-type: none"><li>• Lewis Structures</li><li>• Steps in writing Lewis structure for more complex molecules</li><li>• Lewis Structures of Polyatomic Ions</li><li>• Exceptions to the Octet Rule<ul style="list-style-type: none"><li>- Incomplete octet</li><li>- Expanded octet</li><li>- Odd number electron</li></ul></li></ul>

Specific Objectives	Content
<ul style="list-style-type: none"> <li>• expanded octet and odd number electron.</li> <li>• recognise the formal charges on different species (molecules and ions).</li> <li>• formulate shapes of molecules and ions.</li> <li>• illustrate how resonance structures arise.</li> <li>• explain the VSEPR theory.</li> <li>• outline the effect of lone pairs on molecular geometry.</li> <li>• compare the extent of repulsion between lone pairs and bond pairs.</li> <li>• draw molecules of compounds in three dimensions.</li> </ul>	<ul style="list-style-type: none"> <li>• Shapes of molecules and ions</li> <li>• Formal Charges = number of valence electrons in free atom-[number of non-bonding electrons + <math>\frac{1}{2}</math> number of bonding electrons]</li> <li>• Resonance – as the situation in which two or more possible Lewis structures can be written.</li> <li>• Valence Shell Electron Pair Repulsion (VSEPR) Theory</li> <li>• The Effect of Lone Pairs on Molecular Geometry</li> <li>• Lone pair – lone pair repulsion &gt; lone pair-bonding pair repulsion &gt; bonding pair-bonding pair repulsion</li> <li>• Molecular shapes that may result: - Bent (V-shaped), Trigonal pyramidal, Linear, Square pyramidal, square planar, triangular bipyramidal, Tetrahedral, octahedral</li> </ul>

### Suggested Teaching and Learning Strategies

- Use models to explain the valence shell electron pair repulsion theory, draw shapes of molecules, effect of electronegativity and lone pairs on size of bond angles.
- Discuss the factors determining polarity of molecules and identification of polar molecules.

## Practical Problems

- Let the learners model different molecules of compounds in three dimensions.
- Let the learners carry out an experiment to test for the polarity of molecules using different liquids (trichloromethane, ethyl ethanoate, ethanol, distilled water, cyclohexane -1- ol, propanone)
- Help the learners to carry out an experiment to compare the volatility of iodine, graphite and calcium chloride using a hard glass tube.

## Assessment Strategies

- Give class exercises requiring the learners to:
  - explain the valence shell electron pair repulsion theory.
  - draw molecules of compounds in three dimensions.
  - predict the approximate bond angles.
  - explain the effect of electronegativity on size of bond angles.
  - distinguish between polar and non-polar molecules.
  - explain the factors that determine the polarity of molecules.

## Sub-Topic 3: Shapes of Molecules

Specific objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• explain the concept of polar and non-polar molecules.</li><li>• model molecules of simple covalent compounds.</li></ul>	<ul style="list-style-type: none"><li>• Polar and Non-polar Molecules</li><li>• Modelling of simple covalent molecules</li></ul>

## Suggested Teaching and Learning Strategies

- Use models to explain the valence shell electron pair repulsion theory, draw shapes of molecules, effect of electronegativity and lone pairs on size of bond angles.
- Discuss the factors determining polarity of molecules and identification of polar molecules.

## Practical Problems

- Let the learners model different molecules of compounds in three dimensions.

- Let the learners carry out an experiment to test for the polarity of molecules using different liquids (trichloromethane, ethyl ethanoate, ethanol, distilled water, cyclohexane -1- ol, propanone)
- Help the learners to carry out an experiment to compare the volatility of iodine, graphite and calcium chloride using a hard glass tube.

### **Assessment Strategies**

- Give class exercises requiring the learners to:
  - explain the valence shell electron pair repulsion theory.
  - draw molecules of compounds in three dimensions.
  - predict the approximate bond angles
  - explain the effect of electronegativity on size of bond angles.
  - distinguish between polar and non-polar molecules.
  - explain the factors that determine the polarity of molecules

## Topic 4: Thermochemistry (Chemical Energetics)

Duration: 36 Periods

### General Objective

By the end of this topic, the learner should be able to comprehend energy changes that accompany chemical reactions.

### Sub-Topic 1: Chemical Energy

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concepts of thermochemistry.</li><li>• explain the concept of heat content of a substance</li><li>• demonstrate correctly that heat changes can be measured.</li><li>• recognise enthalpy change as heat content measured at s.t.p. during a chemical reaction</li><li>• perform simple calculations on enthalpy changes.</li><li>• demonstrate heat of reaction using simple experiments.</li></ul>	<ul style="list-style-type: none"><li>• Introduction to Chemical Energy Changes<ul style="list-style-type: none"><li>- What thermochemistry is</li><li>- What happens to bonds when chemical reactions take place</li></ul></li><li>• Enthalpy, <b>H</b><ul style="list-style-type: none"><li>- That every substance has some stored chemical energy</li></ul></li><li>• Enthalpy Change, <b>ΔH</b><ul style="list-style-type: none"><li>- As the change in heat content measured at constant temperature and pressure, during a chemical reaction.</li></ul></li><li>• Enthalpy change is called heat of reaction and is denoted as <b>ΔH<sub>rxn</sub></b></li></ul> $\Delta H_{rxn} = \sum H_{products} - \sum H_{reactants}$ <ul style="list-style-type: none"><li>• Demonstrate heat of reaction</li></ul>

## Suggested Teaching and Learning Strategies

- Discuss the meaning of Thermochemistry, enthalpy, enthalpy change. Write Thermochemical equations, demonstration of exothermic and endothermic reactions using simple experiments
- Let the learners carry out experiments to determine the heat capacity of a calorimeter
- Discuss enthalpy of formation, enthalpy of combustion and carry out experiment to determine enthalpy of combustion of low molecular mass alcohols
- Conduct a discussion on enthalpy of neutralisation and its experimental determination
- Discuss enthalpy of; displacement and its experimental determination, atomisation, ionisation, electron affinity, lattice, sublimation, hydration/solvation
- Conduct a discussion and an experiment on heat of solution and precipitation
- Explain to the learners Hess's law including its experimental justification, construction of enthalpy cycles and calculations related to it
- Explain the Born-Haber cycle (applying Hess's law to ionic compounds) including experimental justification and related calculations
- Let the learners discuss the various energy sources, how they are harnessed, efficiency of various fuels and their impact on the environment

## Practical Problems

- Guide learners to use simple test tube experiments to identify the endothermic and exothermic reactions.
- Guide a group experiment to determine heat capacity of a simple calorimeter.
- Guide a group experiment to determine heat of combustion of ethanol, propanol, butanol.
- Help the learners to carry out titration experiments to determine heat of neutralisation of strong acids and strong bases.
- Guide groups to carry out experiments to determine heat of displacement reaction for zinc powder and copper (II) sulphate solution.

- Lead group experiments to determine heats of solution of sulphuric acid and sodium hydroxide.
- Help learners to carry out simple test tube experiments to determine heat of precipitation of silver chloride using standard equal molar solutions of silver nitrate sodium chloride.
- Guide a group experiment to justify Hess's law using heat of solution for anhydrous and hydrated magnesium sulphate or copper (II) sulphate.

### Assessment Strategies

- Give class exercises requiring learners to:
  - calculate enthalpy changes bond dissociation energies.
  - construct born Haber cycles.
  - explain common terms used in thermochemistry.
  - apply Hess's law in calculating enthalpy changes.
  - discuss different energy sources, efficiency of fuels and their impact on the environment.
- Give laboratory exercises to determine enthalpies of;
  - displacement reaction
  - neutralisation
  - heat of solution

### Sub-Topic 2: Types of Heat of Reactions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain concepts of exothermic and endothermic reactions.</li><li>• sketch energy diagrams for an exothermic reaction taking place.</li><li>• give characteristics of exothermic</li><li>• explain concepts of endothermic</li></ul>	<ul style="list-style-type: none"><li>• Exothermic Reaction<ul style="list-style-type: none"><li>- Characteristics of exothermic reactions</li><li>- Energy level diagram</li><li>- Applications of exothermic reactions in everyday life</li></ul></li><li>• Endothermic Reactions<ul style="list-style-type: none"><li>- Characteristics of exothermic reactions</li><li>- Energy level diagram</li><li>- Applications of endothermic reactions in everyday life.</li></ul></li></ul>

Specific Objectives	Content
<p>reactions.</p> <ul style="list-style-type: none"> <li>sketch energy diagrams for an endothermic reaction taking place.</li> </ul> <p>give characteristics of endothermic reactions.</p>	Thermo chemical equations

### Suggested Teaching and Learning Strategies

- Discuss the characteristics of exothermic and endothermic reactions.
- Guide the learners to sketch the energy diagrams for exothermic and endothermic reactions.
- Help the learners to explain the concepts of exothermic and endothermic reactions using the energy diagrams they have sketched.
- Discuss the applications of endothermic and exothermic reactions in everyday life (for example, cold heat and hot packs).
- Guide the learners to write thermochemical equations and explain the meanings of the equations.

### Assessment Strategies

- Give the learners exercises on characteristics of endothermic and exothermic reactions.

### Sub-Topic 3: Calorimetry

Specific Objectives	Specific Objectives
<p>The learner is able to:</p> <ul style="list-style-type: none"> <li>determine the heat capacity of plastic cup calorimeter.</li> <li>outline bomb calorimeter experiment to determine calorific value of substances.</li> </ul>	<ul style="list-style-type: none"> <li>Heat Capacity and Calorimetry           <ul style="list-style-type: none"> <li>- Coffee-cup calorimeter</li> <li>- Bomb calorimeter</li> </ul> </li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss heat capacity of plastic cup calorimeter in terms of  $mc\Delta T$  (where  $m$  = mass,  $c$  = heat capacity  $\Delta T$  = change in temperature).

- Explain how bomb calorimeter is used to determine calorific value of substances.
- Carry out simple experiments on quantitative determination of calorific values of some food substances.

### Assessment Strategies

- Give the learners exercises on description of how to determine heat capacities of a plastic cup calorimeter and outline the bomb calorimeter experiment to determine caloric value of some food substances.

### Sub-Topic 4: Types of Enthalpy Changes

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain concepts of the different types of energy changes.</li><li>• carry out experiments on enthalpy of combustion.</li><li>• predict the relative stability of compounds from enthalpy of formation.</li><li>• restate standard enthalpy of combustion.</li><li>• perform experiment to determine heat of combustion of substances.</li><li>• correctly use data from experiments performed to carry out calculations.</li><li>• determine heats of combustion of various alcohols.</li><li>• explain the application of enthalpy of combustion in real life situation.</li><li>• underline fuel value of various</li></ul>	<ul style="list-style-type: none"><li>• Types of Enthalpy Changes</li><li>• Standard enthalpy of Formation, <math>\Delta H_f^\circ</math></li><li>• Determination of enthalpy of formation</li><li>• Calculating <math>\Delta H_{rxn}</math> using heats of formation</li><li>• Relative stability of compounds</li><li>• Standard Enthalpy of Combustion, <math>\Delta H_c^\circ</math></li><li>• The meaning of Heat of Combustion</li><li>• Determination of <math>\Delta H_c^\circ</math></li><li>• Calculating heats of combustion</li><li>• Heats of combustion of various Alcohols</li><li>• The fuel values of various fuels</li></ul>

Specific Objectives	Content
<p>fuels.</p> <ul style="list-style-type: none"> <li>• explain the concept of heat of neutralisation.</li> <li>• carry out experiments on enthalpy of neutralisation.</li> <li>• perform experiments to determine the heat of neutralisation of strong acids and alkalis.</li> <li>• investigate the difference between heat of neutralisation of between weak acid and strong acid with strong alkali.</li> <li>• determine heat of neutralisation between weak acid and strong alkali.</li> <li>• determine heat of neutralisation between weak acid and weak alkali.</li> <li>• correctly use data from experiments performed to carry out calculations.</li> <li>• explain the application of enthalpy of neutralisation in real life situations.</li> <li>• explain the concept of heat of precipitation.</li> <li>• carry out experiments on enthalpy of precipitation.</li> <li>• correctly use data from experiments performed to carry out calculations.</li> <li>• explain the application of enthalpy of precipitation in real life situations.</li> </ul>	<ul style="list-style-type: none"> <li>• Standard Enthalpy of Neutralisation, <math>\Delta H_{\text{neu}}^{\circ}</math></li> <li>• The meaning of Heat of Neutralisation.</li> <li>• Experimental determination of <math>\Delta H_{\text{neu}}^{\circ}</math></li> <li>• Determining the heat of neutralisation between strong acids and alkalis</li> <li>• Investigating the difference between heat of neutralisation between weak acid and strong acid with strong alkali</li> <li>• Heat of neutralisation between a weak acid and a strong alkali.</li> <li>• Heat of neutralisation between a weak acid and a weak alkali.</li> <li>• Calculating heats of neutralisation</li> <li>• Applications of enthalpy of neutralisation.</li> <li>• Concept of heat of precipitation</li> <li>• Determining the Heat of Precipitation</li> <li>• Calculations involving heats of Precipitation</li> <li>• Applications of enthalpy of precipitation</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"><li>• Carry out experiments on enthalpy of displacement.</li><li>• Correctly use data from experiments performed to carry out calculations.</li><li>• explain the application of enthalpy of displacement in real life situations.</li><li>• explain the meaning of the terms; enthalpy of atomisation, ionisation, electron affinity, lattice energy, enthalpy of sublimation</li><li>• carry out experiments on enthalpy of solution</li><li>• correctly use data from experiments performed to carry out calculations</li><li>• explain the application of enthalpy of solution in real life situations.</li><li>• carry out experiments on enthalpy of hydration.</li><li>• correctly use data from experiments performed to carry out calculations.</li><li>• explain the application of enthalpy of hydration in real life situations.</li><li>• explain Hess's law of constant heat summation.</li><li>• demonstrate Hess's law using an experiment.</li><li>• construct enthalpy cycles.</li><li>• apply Hess's law in calculations</li></ul>	<ul style="list-style-type: none"><li>• Heat of Displacement</li><li>• Concept of heat of displacement</li><li>• Determining the Heat of Displacement.</li><li>• Calculations involving heat of displacement</li><li>• Applications of heat of displacement</li><li>• Standard Enthalpy of Atomisation</li><li>• Ionisation Energy, IE</li><li>• Electron Affinity, EA</li><li>• Lattice Energy</li><li>• Enthalpy of Sublimation,</li><li>• The Standard Enthalpy of Solution</li><li>• The Standard Enthalpy of Hydration</li><li>• Determination of heat of hydration of hydrated and anhydrous compound (e.g. CuSO<sub>4</sub>.5H<sub>2</sub>O and CuSO<sub>4</sub>)</li><li>• Calculations of heats of hydration</li><li>• Application of heat of hydration</li><li>• Hess's Law</li><li>• Concept of Hess's law</li><li>• Experimental justification of Hess's law</li><li>• Construction of enthalpy cycles</li></ul>

Specific Objectives	Content
<p>involving two or more of the reactants are involved.</p> <ul style="list-style-type: none"> <li>• outline the relevance of Born Haber cycle.</li> <li>• identify the type of energy changes involved (and terms involved) in the various stages of the cycle.</li> <li>• correctly construct a Born-Haber cycle for ionic compounds or salts.</li> <li>• carry out calculations involving Born-Haber cycles.</li> <li>• explain bond energy.</li> <li>• differentiate between bond energy and average bond energy.</li> <li>• relate the energy change for reaction to bonds broken and bonds formed.</li> <li>• carry out calculations involving average bond energies.</li> <li>• use bond energies to explain differences in physical properties of compound (e.g. melting points, physical states of compounds some giant atomic).</li> </ul>	<ul style="list-style-type: none"> <li>• Calculations involving Hess's law</li> <li>• Born-Haber Cycle</li> <li>• Experimental justification</li> <li>• Terms used in the Born Haber cycle</li> <li>• Construction of Born-Haber cycle</li> <li>• Simple calculations using Born-Haber cycle</li> <li>• Average Bond Energies (Enthalpies)</li> <li>• What it is</li> <li>• Relationship between energy change and the formation and breaking of bonds.</li> <li>• Calculations involving average bond energies</li> </ul> <p>Importance of bond energies in relation to physical properties of substances</p>

### Suggested Teaching and Learning Strategies

- Lead a discussion of the various types of enthalpy changes and guide the learners to do the various calculations concerning the enthalpy changes.
- Guide the learners to do experiments to determine the various enthalpy changes in the laboratory.

## Assessment Strategies

- Give the learners exercises to:
  - describe the determination of the various types of heat changes at room temperature.
  - calculate enthalpy changes from given data.

## SENIOR SIX                            TERM I

### **Topic 5: Physical Equilibria**

Duration: 30 Periods

#### **General Objective**

By the end of this topic, the learner should be able to comprehend the concept of interconversion of phases due to changes in the physical conditions and its applications.

#### **Sub-Topic 1: Systems, Phases and Component**

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept of physical equilibrium.</li> <li>• distinguish between the terms: phases, components and systems.</li> <li>• discuss the characteristics of a system, phase and component.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction to physical equilibrium</li> <li>• System</li> <li>• Phase</li> <li>• Component</li> </ul>

#### **Suggested Teaching and Learning Strategies**

- Guide a discussion on the terms; system, phase, component system and one component system with its related phase diagrams.
- Guide learners to discuss two component systems; Raoult's Law ( $P_i = x_i P_i^0$ ) and ideal Solutions.
- Guide discussions on the characteristics of a system, phase and component.

#### **Assessment Strategies**

- Give class exercises requiring learners to:
  - explain of terms used in physical equilibria.
  - distinguish between the terms phase, system and a component.
  - state the characteristics of a phase, system and a component.

**Sub-Topic 1: Component System (Types of component systems)**

Specific objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>mention different types of component systems.</li><li>give examples of one-component system.</li><li>explain the cooling curves for pure substances.</li><li>explain the term phase diagram.</li><li>draw phase diagrams for a one component system.</li><li>explain what the different regions of a phase diagram represent.</li><li>give examples of two-component system.</li><li>explain the different types of two-component systems.</li><li>identify the different types of two-component systems.</li></ul>	<ul style="list-style-type: none"><li>One-Component system</li><li>Types of component systems</li><li>Examples of One-Component systems ( e.g. water, sulphur and Carbon dioxide)</li><li>Cooling curves for pure substances</li><li>Phase diagrams (water, carbon dioxide and sulphur)</li><li>Interpretation of phase changes from a phase diagram (melting point, triple point, influences of temperature and pressure on the phases)</li><li>Two-Component System</li><li>types of two-component systems (liquid mixture): Miscible (ethanol + water), partially miscible (ether + water) and immiscible (oil + water)</li></ul>

**Suggested Teaching and Learning Strategies**

- Guide discussion on types of component systems with examples.
- Let learners` explain the cooling curves for pure substances.
- Guide the larders to draw phase diagrams for the various substances.
- Let them interpret the phase changes as in the phase diagrams and explain the influences of various factors on the phases.

**Assessment Strategies**

- Give class exercises requiring learners to:
  - explain of terms used in physical equilibria.
  - distinguish between the terms phase, system and a component

## Sub-Topic 2: Types of Solutions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• state Raoult's law.</li> <li>• explain what ideal solution is.</li> <li>• give characteristics and examples of ideal solutions.</li> <li>• draw vapour-composition diagrams for ideal and real solutions.</li> <li>• interpret the vapour pressure-composition diagrams.</li> <li>• Carry out calculations on Raoult's law.</li> <li>• explain what real solution is.</li> <li>• Give characteristics and examples of real solutions.</li> <li>• draw vapour-composition diagrams for real solutions.</li> <li>• differentiate between negative and positive deviation from Raoult's law.</li> <li>• explain what is meant by the terms azeotropic mixtures and azeotropes.</li> <li>• explain what distillation is.</li> <li>• explain the process of fractional distillation.</li> <li>• apply the knowledge of phase diagrams to explain the process of fractional distillation of ideal and non-ideal solutions.</li> <li>• describe the process of various methods of separation of components of azeotropes.</li> </ul>	<ul style="list-style-type: none"> <li>• Raoult's Law (<math>P_i = x_i P_i^0</math>)</li> <li>• Ideal Solutions</li> <li>• Characteristics and examples of ideal solutions.</li> <li>• Vapour Pressure-composition diagrams</li> <li>• Boiling point-composition diagrams</li> <li>• Calculations involving Raoult's law</li> <li>• Two-Component System: Non-Ideal (Real) Solutions</li> <li>• Non-ideal solutions</li> <li>• Characteristics and examples.</li> <li>• Vapour pressure - composition diagrams.</li> <li>• Negative Deviation from Raoult's Law</li> <li>• characteristics of vapour pressure-composition diagrams</li> <li>• Maximum boiling - Point composition diagram (Negative deviation from Raoult's law) - Azeotropic mixture and Azeotropes.</li> <li>• Positive Deviation from Raoult's Law</li> <li>• its characteristics vapour pressure-composition diagrams.</li> <li>• minimum boiling point-composition diagram (positive deviation from Raoult's law)- azeotropic mixture and azeotropes</li> </ul>

Specific objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concept of distillation.</li><li>• describe the process of fractional distillation using phase diagrams.</li><li>• describe the process of purification of liquid mixture by using steam distillation.</li><li>•</li><li>• describe the production of alcohol by fractional distillation.</li><li>• explain the distillation of ideal and no-ideal solutions.</li><li>• explain the separation of components of azeotropes.</li><li>• explain the total vapour of immiscible liquid mixture in terms of the vapour of the components.</li><li>• calculate the composition of the vapour above a mixture of two immiscible liquids.</li><li>• calculate the composition of the distillate.</li><li>• state industrial application of steam distillation.</li><li>• explain the concept of distribution law</li><li>• experimentally determine KD.</li><li>• carry out Calculations involving distribution law.</li><li>• explain the application in: - chromatography, solvent extraction and Ion exchange.</li></ul>	<ul style="list-style-type: none"><li>• Distillation of a Binary Liquid Mixture</li><li>• What distillation is</li><li>• Explanation of fractional distillation of ideal and real solutions in terms of phase diagrams</li><li>• Fractional distillation (e.g. production of alcohol from fermented liquids i.e. waragi)</li><li>• Distillation of an Ideal solution, distillation of a non-ideal solution</li><li>• Separation of components of azeotropes.</li><li>• Immiscible liquids</li><li>• Vapour pressure of a system of two immiscible liquids.</li><li>• Composition of the vapour phase.</li><li>• Steam distillation (calculations involving steam distillation).</li><li>• Industrial application of steam distillation.</li><li>• Distribution Law (Partition Coefficients)<ul style="list-style-type: none"><li>- What it is</li></ul></li><li>• Experimental determination of KD</li><li>• Calculation involving KD</li><li>• Application of partition coefficients (solvent extraction, Paper chromatography, column chromatography, ion exchange).</li></ul>

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• sketch cooling curves of pure substances</li> <li>• explain the cooling curves for pure substances</li> <li>• draw phase diagrams for mixtures</li> <li>• explain the phase diagrams for mixtures.</li> <li>• explain concept/behaviour of eutectic mixtures.</li> <li>• compare the behaviour of eutectic mixture and a pure compound.</li> <li>• give examples of substances which form eutectic mixtures.</li> </ul>	<ul style="list-style-type: none"> <li>• Solid – liquid Equilibria</li> <li>• Cooling curves for pure substances</li> <li>• Cooling curves for mixtures</li> <li>• Phase diagram for mixtures</li> <li>• Explanations for phase diagrams for mixtures</li> <li>• Eutectic mixtures</li> <li>• Properties of pure substances and pure compounds</li> <li>• Examples of eutectic mixtures</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide learners to discuss two component systems; Raoult's Law ( $P_i = x_i P_i^0$ ) and ideal solutions.
- Explain non-ideal (Real) solutions and related vapour pressure-composition diagrams as well as azeotropic mixtures and separation of components of azeotropes.
- Guide a discussion of fractional distillation as an application of Raoult's law, immiscible liquids mixtures and application of Dalton's law of partial pressure in steam distillation and industrial application of steam distillation.
- Guide group discussions of distribution of a solute between immiscible liquids (the distribution law) and its application in separation of mixtures.
- Guide learners to brainstorm on solid-liquid equilibria; cooling curves for eutectic mixtures, and related phase diagrams.

## Practical problems

- Organise group practical work on steam distillation e.g. lemon oil from lemon grass, castor oil from castor seeds, and oil from tick berry leaves.
- Organise a study tour to a distilling plant e.g. Uganda Distillers.
- Carryout a thin layer chromatography using silica gel, alumina, fine chalk dust and water or acetone to separate components of fine paint, extracted from chlorophyll solution and black ink.
- Give individual practical work on titration to determine  $K_D$  of solute between two immiscible liquids.

## Assessment Strategies

- Give class exercises requiring learners to:
  - state Raoult's law.
  - apply Raoult's in calculations.
  - sketch cooling curves of pure substances and mixtures.
  - interpret cooling curves and phase diagrams.
  - interpret vapour pressure-composition diagrams.
  - accurately draw phase diagrams from given data.
  - explain ideal and non-ideal behaviour in solutions.
  - use boiling point-composition diagrams to differentiate between positive and negative deviations.
  - explain fractional distillation using boiling point-composition diagrams
  - explain the principle of steam distillation.
  - state the distribution law and use it to explain concepts of; chromatography, solvent extraction, and ion exchange.
  - apply the distribution law to determine amounts of solute extracted using solvent extraction.

## Sub-Topic 3: Colligative Properties

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>explain the concept of colligative properties .</li><li>give examples of colligative properties.</li><li>explain lowering of vapour</li></ul>	<ul style="list-style-type: none"><li>Colligative properties</li><li>Concept of Colligative properties</li><li>Examples of Colligative</li></ul>

Specific Objectives	Content
<p>pressure.</p> <ul style="list-style-type: none"> <li>• derive a relationship for vapour pressure lowering.</li> <li>• carry out calculations involving lowering of vapour pressure.</li> <li>• draw graph of vapour pressure lowering.</li> <li>• explain graphs of vapour pressure lowering.</li> <li>• explain limitations of colligative properties.</li> <li>• explain boiling point and boiling point elevation.</li> <li>• explain the relationship between vapour pressure and boiling point of a solution.</li> <li>• explain how the presence of a solute affects the boiling point of a solvent.</li> <li>• explain elevation of boiling point using vapour pressure-temperature graph.</li> </ul>	<p>properties</p> <ul style="list-style-type: none"> <li>• Vapour Pressure Lowering</li> <li>• Why does a solute influence the vapour pressure of water(liquid)</li> <li>• Vapour pressure lowering, <math>\Delta P = P_A - P_A^0</math></li> <li>• Graphical representation of vapour lowering</li> <li>• Limitations of Colligative properties</li> <li>• Boiling Point Elevation</li> <li>• Calculations involving pressure vapour lowering.</li> <li>• How VP affects boiling point of liquids.</li> <li>• How the presence of a solute affects the boiling point of a solvent</li> <li>• Vapour pressure-temperature diagrams and boiling points.</li> </ul> $\Delta T_b = T_{b(solution)} - P_{b(solution)}^0$ <p>, and <math>\Delta T_b = K_b m</math></p> <ul style="list-style-type: none"> <li>• Where <math>m</math> is the Molality of the solute in solution.</li> <li>• Experimental Determination of molecular mass using boiling point elevation method.</li> </ul> <p>Calculations involving molal boiling point elevation constant, <math>K_b</math> (ebullioscopic constant)</p>
<ul style="list-style-type: none"> <li>• describe an experiment that can be carried to determine molecular mass using boiling point elevation method.</li> <li>• carry out calculations involving boiling point elevation.</li> </ul>	

Specific Objectives	Content
<ul style="list-style-type: none"><li>• explain freezing point, and freezing point depression.</li><li>• explain depression of freezing point using vapour pressure- temperature graphs.</li><li>• experimentally determine molecular mass using freezing point depression method.</li><li>• carry out calculations involving freezing point depression.</li><li>• explain osmosis and osmotic pressure.</li><li>• explain why osmotic pressure method is the most suitable method for determining molecular mass of large molecules e.g polymers.</li><li>• carry out calculations involving osmotic pressure.</li><li>• carry out calculations involving molar masses and osmotic pressures.</li></ul>	<ul style="list-style-type: none"><li>• Freezing point depression</li><li>• Vapour pressure – temperature diagrams and freezing points</li><li>• Experimental Determination of molecular mass using freezing point depression</li><li>• <math>\Delta T_f = P_{f(solver)}^0 - T_{f(solution)}</math>, and <math>\Delta T_f = K_f m</math></li><li>• Where m is the molality of the solute in solution</li><li>• Calculations involving molal freezing point depression constant, <math>K_f</math>. (cryoscopic constant)</li><li>• Osmotic Pressure, <math>\pi</math></li><li>• What is osmosis and osmotic pressure</li><li>• Suitability of using Osmotic pressure in determining molecular mass of large molecules e.g polymers</li><li>• Methods of measuring osmotic pressure, <math>\pi</math></li><li>• Osmotic pressure, <math>\pi</math>, = <math>cRT</math>, where, <math>c</math>, is the solute concentration and <math>R</math> = molar gas constant and <math>T</math> is the absolute temperature.</li><li>• Calculations of molar masses from osmotic pressures.</li></ul>

## Suggested Teaching and Learning Strategies

- Guide a discussion of the term colligative property, stating the colligative properties of solutions and explaining how dissolved solutes cause lowering of vapour pressure of the solvent.
- Guide learners into discussing the derivation of the expression for vapour pressure lowering, carrying out calculations involving vapour pressure lowering to determine molecular mass of dissolved solute and interpretation of the vapour pressure-temperature graphs.
- Lead a discussion on how dissolved non-volatile solutes cause elevation of boiling point, describing an experiment to determine molecular mass of the dissolved solute using boiling point elevation, deriving an expression for boiling point elevation and carrying out calculations involving boiling point elevation.
- Discuss how dissolved non-volatile solutes cause depression of freezing point, describing an experiment to determine molecular mass of the dissolved solute using freezing point depression (Rast's or Beckmann freezing point apparatus), deriving an expression for freezing point depression, carry out calculations involving depression of freezing point and carrying out experiment to determine depression in freezing points using Rast's method.
- Discuss the meaning of osmosis and osmotic pressure and draw or sketch and explain the pressure-concentration graphs. Discuss calculations involving osmotic pressure, limitations to colligative properties as a method of determining molecular mass of non-volatile solutes and why osmotic pressure is most suitable for determining molecular mass of non-volatile large molecules.

## Practical Problems

- Guide practical investigations on the effect of adding common salt to the boiling point of water.
- Guide a practical survey on the common practice of adding maize flour to hot water meant for mingling posho before it boils.
- Lead learners to determine osmotic pressure of different solutions using cellophane membrane.
- Guide learners to determine depression in freezing point of Naphthalene using Camphor as solute.

- Guide learners to determine molar mass of Camphor using depression in freezing point of Naphthalene.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain common terms applied to colligative properties.
  - state the four Colligative properties.
  - sketch or draw vapour pressure-temperature and pressure-concentration graphs.
  - interpret vapour, and pressure-temperature graphs.
  - explain the effect of dissolved non-volatile solute on boiling point and freezing point of a solvent.
  - explain the relationship between vapour pressure and boiling point of a liquid.
  - calculate; molar mass, elevation in boiling point, depression in freezing point, and osmotic pressure.
  - describe experiments to determine molar mass of non-volatile solute by boiling point elevation and freezing point depression.

## Topic 6: Chemical Equilibria

Duration: 10 Periods

### General objective

By the end of this topic, the learner should be able to explain the concept of reversible reactions and its applications.

### Sub-Topic 1: The concept of Chemical Equilibrium

Specific Objectives	Content
The learner should be able to:- <ul style="list-style-type: none"> <li>• explain the concept of chemical equilibrium.</li> <li>• distinguish between reversible and irreversible reactions.</li> <li>• explain dynamic equilibrium.</li> <li>• differentiate between homogeneous and heterogeneous reversible system.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction to chemical equilibrium</li> <li>• Equilibrium reactions</li> <li>• Irreversible and reversible reactions</li> <li>• Dynamic equilibrium</li> <li>• Homogeneous and heterogeneous reversible systems</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide learners to brainstorm the definition of concepts of equilibrium constants.
- Guide the learners to discuss the differences between reversible and irreversible reactions with examples.
- Guide learners to carry out a laboratory experiment to determine the equilibrium constant for the hydrolysis of ethylethanoate using dilute hydrochloric acid.

### Assessment Strategies

- Give class exercises and tests requiring learners to:
  - explain the concept of chemical equilibrium.
  - distinguish between reversible and irreversible reactions.
  - explain dynamic equilibrium.
  - differentiate between homogeneous and heterogeneous reversible systems.
  - apply the law of mass action in writing equilibrium expressions.
  - carry out calculations involving use of  $K_c$  and  $K_p$

- derive a general expression relating  $K_c$  and  $K_p$ .
- compare  $Q$  and  $K_c$  to determine the direction of chemical reaction.
- explain Lé Chatelier's principle.
- apply Lé Chatelier's principle in explaining the effects of various factors on the equilibrium of reversible chemical reaction.
- describe an experiment to determine  $K_c$ .
- correctly apply the knowledge of chemical equilibria to justify conditions used in industrial processes.

### Sub-Topic 2: Comparison between $K_c$ and $K_p$

Specific Objectives	Content
<p>The learner should be able to:-</p> <ul style="list-style-type: none"><li>• restate the law of mass action.</li><li>• apply the law of mass action in writing equilibrium expressions.</li><li>• derive a general expression relating <math>K_c</math> and <math>K_p</math>.</li><li>• carry out calculations involving use of <math>K_c</math> and <math>K_p</math>.</li><li>• Compare concentration equilibrium constant and pressure equilibrium constant (<math>K_c</math>, <math>K_p</math>).</li><li>• compare <math>Q</math> and <math>K_c</math> to determine the direction of chemical reaction.</li><li>• interpret the magnitude of value of <math>K_c</math> or <math>K_p</math> in relation to the</li></ul>	<ul style="list-style-type: none"><li>• Equilibrium Constant, <math>K_c</math> and <math>K_p</math></li><li>• Law of mass action or equilibrium law, hence equilibrium constant <math>K</math></li><li>• Expressions of equilibrium constants (for homogeneous aqueous solutions and gaseous systems; and heterogeneous systems)</li><li>• Derivation of expressions for <math>K_c</math> and <math>K_p</math></li><li>• Calculations involving <math>K_c</math> and <math>K_p</math></li><li>• Compare <math>K_c</math> and <math>K_p</math></li><li>• The Equilibrium Constant for a Gas Phase Reaction: <math>K_p</math> vs <math>K_c</math></li><li>• Use of ideal gas law to relate <math>K_p</math> and <math>K_c</math><math display="block">PV = nRT</math><math display="block">K_p = K_c(RT)^{\Delta n},</math>where <math>\Delta n = (p + q) - (a + b)</math><math display="block">= \text{change in number of moles of gases (product - reactant)}</math></li><li>• Interpretation of magnitude of equilibrium constant and the</li></ul>

Specific Objectives	Content
<p>equilibrium position.</p> <p>explain what reaction quotient is.</p>	<p>position of equilibrium. When K is large, small or nearly equal to one.</p> <ul style="list-style-type: none"> <li>• Reaction quotient, Q</li> </ul>

## Suggested Teaching and Learning Strategies

- Guide learners to brainstorm the definition of concepts of equilibrium constants.
- Guide the learners to discuss the differences between reversible and irreversible reactions with appropriate examples.
- Guide learners to carry out a laboratory experiment to determine the equilibrium constant for the hydrolysis of ethylethanoate using dilute hydrochloric acid.

## Assessment Strategies

- Give class exercises and tests requiring learners to:
  - explain the concept of chemical equilibrium.
  - distinguish between reversible and irreversible reactions.
  - explain dynamic Equilibrium.
  - differentiate between homogeneous and heterogeneous reversible systems.
  - apply the law of Mass Action in writing Equilibrium expressions.
  - carry out calculations involving use of  $K_c$  and  $K_p$
  - derive a general expression relating  $K_c$  and  $K_p$
  - compare  $Q$  and  $K_c$  to determine the direction of chemical reaction.
  - explain Lé Chatelier's principle.
  - apply Lé Chatelier's principle in explaining the effects of various factors on the equilibrium of reversible chemical reaction.
  - describe an experiment to determine  $K_c$ .
  - correctly apply the knowledge of chemical equilibria to justify conditions used in industrial processes.

### Sub-Topic 3: Factors affecting the position of equilibrium in accordance with the Le' Chatelier's Principle

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain Le' Chatelier's principle.</li><li>• apply Le' Chatelier's principle in explaining the effects of various factors on the equilibrium of reversible chemical reaction.</li><li>• experimentally determine <math>K_c</math> using esterification reaction.</li></ul>	<ul style="list-style-type: none"><li>• Le' Chatelier's Principle and Factors Affecting Chemical Equilibrium.</li><li>• concept of Le' Chatelier's principle</li><li>• factors affecting equilibrium</li><li>• Effects of changes in: Concentration or Partial Pressures of a reactant or Product temperature, Pressure and Volume Changes</li><li>• Effects of adding noble Gas: (At Constant Volume and Constant Pressure)</li><li>• Effects of adding Catalyst</li><li>• Experimental determination of <math>K_c</math></li></ul>

#### Suggested Teaching and Learning Strategies

- Guide learners to brainstorm on the concept of Le'Chatelier's principle.
- Guide the learners to brainstorm on the factors affecting equilibrium and explain the factors in terms of Le'Chatelier's principle.

#### Practical Problems

- Instruct the learners to carry out an experiment to determine the  $K_c$  using esterification reaction.

## Assessment Strategies

- Give learners exercises involving calculations on:
  - concentration equilibrium constant ( $K_c$ )
  - pressure equilibrium constant ( $K_p$ )

## Sub-Topic 4: Applications of factors on industrial processes

Specific objectives	Content
The learner should be able to show the importance of equilibrium constant factors on industrial processes.	<ul style="list-style-type: none"> <li>• Industrial Application of Chemical Equilibrium</li> <li>• Haber process (manufacture of ammonia), Contact Process (manufacture of sulphuric acid), Ostwald process (manufacture of nitric acid)</li> </ul>

## Suggested Teaching and Learning Strategies

- Guide the learners to use Le' Chatelier's principle to explain what happens if an 'instantaneous' change is imposed on an equilibrium in a named industrial process.

## Assessment Strategies

- Give the learners an exercise to:
  - describe the manufacture of ammonia and sulphuric acid.
  - explain the factors that affect the yield of the products in terms of Le'Chatelier's principle.

**SENIOR SIX TERM II****Topic 7: Ionic Equilibria**

Duration: 26 Periods

**General Learning Objective**

By the end of this topic, the learner should be able to describe the behaviour of acids, bases and salts in aqueous solutions.

**Sub-Topic 1: Acids, Bases and Salts**

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concepts of acids and bases according to various theories.</li><li>• explain the concept of conjugate bases and conjugate acids.</li><li>• classify acids and bases on basis of their degree of ionisation.</li><li>• explain ionisation constants for weak acids and weak bases <math>K_a</math> and <math>K_b</math>.</li><li>• derive a general expression for <math>K_a</math> and <math>K_b</math>.</li><li>• correctly apply knowledge about <math>K_a</math> and <math>K_b</math> in calculations.</li><li>• explain auto ionisation(self ionisation) of water</li><li>• derive an expression of <math>K_w</math>.</li><li>• explain the concept of pH scale of 1-14</li></ul>	<ul style="list-style-type: none"><li>• Acids and Bases</li><li>• Concepts of acids and bases definitions of acids, bases according to Arrhenius, Brønsted-Lowry and Lewis</li><li>• Conjugate Acid-base Pair<ul style="list-style-type: none"><li>- Conjugate base and acid</li></ul></li><li>• Classifying Strong acids and bases, weak acids and bases<ul style="list-style-type: none"><li>- Strong acids, strong bases, weak acids and weak bases</li></ul></li><li>• Relative Strength of Brønsted – Lowry acids and bases</li><li>• <math>K_a</math> and <math>K_b</math> as measures of strengths of acids and bases, respectively.</li><li>• Expressions of acid dissociation constant, <math>K_a</math> and base dissociation constant, <math>K_b</math><ul style="list-style-type: none"><li>- Calculations involving <math>K_a</math> and <math>K_b</math></li></ul></li><li>• The Autoionisation (Self Ionisation) of Water</li></ul>

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept pH and pOH.</li> <li>• correctly apply knowledge pH and pOH and <math>pK_w</math> in calculation involving strong acids and bases.</li> <li>• explain the relationship between <math>K_a</math> and <math>K_b</math> for an acid-base conjugate pair.</li> <li>• derive expression of pH for weak acids and bases.</li> <li>• carry out calculation on pH for weak acids and bases.</li> </ul>	<ul style="list-style-type: none"> <li>- Ionic product of water</li> <li>- <math>K_w = [H_3O^+][OH^-] = 10^{-14}</math></li> <li>• The pH Scale (1 – 14)</li> <li>- Concept of pH           <ul style="list-style-type: none"> <li>▪ <math>pH = -\log_{10} [H_3O^+]</math></li> <li>▪ <math>pOH = -\log_{10}[OH^-]</math></li> <li>▪ <math>pK_w = -\log_{10}K_w</math></li> </ul> </li> <li>- calculations involving Ph</li> <li>• The Relationship between <math>K_a</math> and <math>K_b</math> for an Acid-base Conjugate</li> <li>• Consider the acid-base conjugate pair of <math>NH_4^+</math> and <math>NH_3</math></li> <li>• Derivation of the relationship, <math>K_a \times K_b = K_w</math></li> <li>• Expression of pH for weak acids and bases</li> <li>• pH calculations pH calculation for weak acid and weak base</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide learners to brainstorm the theories of acids and bases according to Arhenius, Bronsted and Lowry and Lewis; conjugate acids and bases and classification of acids and bases on the basis of their degree of ionisation.
- Explain the derivation of a general expression for  $K_a$  and  $K_b$ , deducing strength of acids and bases using their ionisation constants explaining ionisation constants for weak acids and weak bases  $K_a$  and  $K_b$  and correctly applying knowledge about  $K_a$  and  $K_b$  in calculations.
- Discuss auto ionisation of water, deriving an expression of  $K_w$ , the concept pH and pOH, calculations involving pH of strong acids and bases, relationship between  $K_a$  and  $K_b$  for an acid-base conjugate pair, deriving the expression of pH for weak acids and bases, carrying out calculation on PH for weak acids and bases and carrying out a class experiment on comparing pH of different solutions.

## Practical Problems

- Guide learners to carry out laboratory experiments to compare the pH of different solutions using:
  - a pH meter( if available).
  - pH papers.
  - universal indicator.

**Caution:** *Most strong acids are corrosive and should be handled with care or using gloves.*

## Assessment Strategies

Give class exercises requiring learners to:

- explain the concepts of acids and bases according to various theories.
- explain the meaning of conjugate bases and conjugate acids.
- classify acids and bases on basis of their degree of ionisation.
- derive a general expression for  $K_a$  and  $K_b$ .
- deduce strength of acids and bases using their ionisation constants.
- explain ionisation constants for weak acids and weak bases  $K_a$  and  $K_b$ .
- correctly apply knowledge about  $K_a$  and  $K_b$  in calculations.
- explain auto ionization(self ionisation) of water.
- derive an expression of  $K_w$
- explain the meaning of pH and pOH.
- carry out calculations involving pH of strong acids and bases.
- explain the relationship between  $K_a$  and  $K_b$  for an acid-base conjugate pair.
- derive expression of pH for weak acids and bases.
- carry out calculation on pH for weak acids and bases.

## Sub-Topic 2: Hydrolysis of Salts

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain what a salt is.</li> <li>• explain the concept of salt hydrolysis.</li> <li>• derive an expression of <math>K_h</math>.</li> <li>• identify the various types of salts.</li>   <li>• correctly apply knowledge of <math>K_h</math> in calculations.</li> <li>• explain the pH of the resultant solutions derived from hydrolysis of salts.</li> </ul>	<ul style="list-style-type: none"> <li>• Salt</li> <li>• Salt Hydrolysis</li> <li>• What hydrolysis is</li> <li>• Hydrolysis constant <math>K_h</math></li> <li>• Salt of strong acid and strong base, strong acid and weak base; weak acid and strong base</li> <li>• Calculation involving <math>K_h</math></li> <li>• pH of resultant solution</li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the meaning of a salt, salt hydrolysis identification of the various types of salts, predicting the pH of a salt solution basing on its composition, deriving an expression of  $K_h$  and correctly applying knowledge of  $K_h$  in calculations.
- Lead learners to explain the pH of the resultant solutions derived from hydrolysis of salts.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain the meaning of a salt.
  - explain the concept of salt hydrolysis.
  - identify the various types of salts.
  - predict the pH of a salt solution basing on its composition.
  - derive an expression of  $K_h$ .
  - correctly apply knowledge of  $K_h$  in calculations.

### Sub-Topic 3: Buffer Solutions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept of buffer.</li> <li>• classify buffer and give examples of each type.</li> <li>• explain the action of a buffer.</li> <li>• describe the preparation of a buffer.</li> <li>• derive the Henderson-Hasselbalch equation.</li> <li>• carry out calculations of pH for buffers.</li> <li>• explain application of buffers.</li> </ul>	<ul style="list-style-type: none"> <li>• Buffer solutions</li> <li>• What buffer solution is</li> <li>• Types of buffers: Acidic and Basic a basic</li> <li>• Action of an acidic and basic buffer solutions</li> <li>• Preparation of buffer solutions.</li> <li>• Henderson-Hasselbalch Equation</li> </ul> $\text{pH} = \text{pK}_a + \log \frac{[\text{conjugate base}]}{[\text{weak acid}]}$ $\text{pOH} = \text{pK}_b + \log \frac{[\text{conjugate acid}]}{[\text{weak base}]}$ <ul style="list-style-type: none"> <li>• Calculations involving buffer solutions</li> <li>• Application of buffers</li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the concept of buffer, classifying buffers and giving examples of each type, the action of a buffer, describing the preparation of a buffer and derivation of the Henderson-Hasselbalch's equation.
- Discuss calculations involving pH of buffers, application of buffers and carrying out a class experiment on preparation of a buffer.

### Practical Problems

- Allow learners to carry out a laboratory experiment to prepare a buffer by mixing:
  - Molar solutions of ethanoic acid and sodium ethanoate.
  - Molar solutions of ammonia and ammonium chloride.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the meaning of a buffer.
  - classify buffers and give examples of each type.
  - explain the action of a buffer.
  - describe the preparation of a buffer.
  - derive the Henderson-Hasselbalch equation.
  - carry out calculations on pH of buffers.
  - explain applications of buffers.

## Sub-Topic 4: Acid-Base Titrations

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept of titration.</li> <li>• define the terms used in titration.</li> <li>• explain the action of an indicator.</li> <li>• give examples of indicators.</li> <li>• describe how an indicator works.</li> <li>• explain the concept of pH range.</li> <li>• choose a suitable indicator for use in acid base titrations.</li> </ul> <p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• carry out acid-base titrations.</li> </ul> <p>• sketch different types of pH-volume curves for acid-base titration.</p>	<ul style="list-style-type: none"> <li>• Titrations</li> <li>• What titration is</li> <li>• Titrant, titrand (analyte), equivalent point, end point</li> <li>• Acid-Base Indicators           <ul style="list-style-type: none"> <li>- What an indicator is (HIn)</li> </ul> </li> <li>• Examples of indicators</li> <li>• How an indicator works</li> <li>• pH ranges for indicators</li> <li>• choice of indicator</li> <li>• Types of Acid-Base titrations</li> <li>• Titration of strong acid-strong bases: (Examples NaOH and HCl); weak acid-strong base titrations: (Examples CH<sub>3</sub>COOH and NaOH ); strong acid-weak base (Examples: HCl and NH<sub>3</sub> solution)and weak acid-weak base (example: CH<sub>3</sub>COOH and NH<sub>3</sub> solution)</li> <li>• Titration curves for the various types of titrations</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"><li>calculate pH changes during acid-base titrations.</li></ul>	<ul style="list-style-type: none"><li>Calculations involving acid-base titrations</li></ul>

### Suggested Teaching and Learning Strategies

- Guide learners to brainstorm the meaning of an indicator, examples of indicators, the action of an indicator, the meaning of pH range and identification of pH ranges of different indicators.
- Discuss the choice of suitable indicators for use in acid-base titrations basing on pH range, pH changes during titration, calculating pH changes during acid-base titrations, sketching different types of pH-volume curves for acid-base titrations and interpreting pH-volume curves for acid-base titrations.

### Practical Problems

- Let the learners carry out acid-base titrations in the laboratory as individuals or in groups of at most five students.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain the meaning of an indicator.
  - give examples of indicators.
  - explain how an indicator works.
  - explain the meaning of pH range.
  - identify pH ranges of different indicators.
  - choose suitable indicators for use in acid base titrations basing on pH range.
  - explain pH changes during titration.
  - calculate pH changes during acid-base titrations.
  - sketch different types of pH-volume curves for acid-base titrations.
  - interpret pH-volume curves for acid- base titrations.

## Sub-Topic 5: Solubility Equilibria

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept of solubility.</li> <li>• carry out an experiment to determine solubility of a salt.</li> <li>• explain the factors that affect solubility of a salt.</li> <li>• plot solubility curves for soluble salts.</li> <li>• interpret the solubility curves.</li> <li>• explain the applications of solubility curves.</li> <li>•</li> <li>• explain the concept of dynamic equilibrium in a saturated salt solution.</li> <li>• explain the factors that affect solubility of sparingly soluble salts.</li> <li>• carry out calculations for solubility.</li> <li>• derive an expression for solubility product.</li> <li>• carry out an experiment to determine solubility product.</li> <li>• calculate <math>k_{sp}</math>.</li> <li>• carry out calculations involving solubility product.</li> <li>• explain the relationship between ionic product, <math>K_{sp}</math> and precipitation.</li> <li>• explain the applications of <math>K_{sp}</math>.</li> <li>• explain the concept of common ion effect.</li> <li>• explain the application of common ion effect.</li> </ul>	<ul style="list-style-type: none"> <li>• Solubility</li> <li>• What solubility is; Soluble salts</li> <li>• Molar Solubility</li> <li>• experimental determination of solubility of a salt</li> <li>• factors affecting solubility</li> <li>• solubility curves</li> <li>• application of solubility curves (fractional crystallisation)</li> <li>• Calculation of solubility</li> <li>• Soluble and Sparingly soluble salts</li> <li>• Factors affecting solubility of sparingly soluble</li> <li>• Solubility Product</li> <li>• What solubility product is</li> <li>• Expressions for Solubility Product</li> <li>• Experimental determination of solubility product</li> <li>• Calculations involving solubility and Solubility Products.</li> <li>• Solubility Product and Precipitation</li> <li>• When does precipitation take place?</li> <li>• Ionic product</li> <li>• Effective concentration</li> <li>• Application of <math>K_{sp}</math></li> </ul>

## Suggested Teaching and Learning Strategies

- Brainstorm the concept of solubility, factors that affect solubility of a salt, drawing and interpreting solubility curves, applications of solubility in fractional crystallisation, calculations for solubility, and also carrying out a class experiment to determine solubility of a salt.
- Discuss the concept of dynamic equilibrium in a saturated salt solution, the concept of solubility product, the factors that affect solubility of sparingly soluble salts, deriving an expression for solubility product, calculations involving solubility product, relationship between ionic product solubility product and precipitation, applications of solubility product, concept of common ion effect, application of common ion effect and carrying out an experiment to determine solubility product.

## Practical Problems

- Guide learners to carry out a laboratory experiment to determine the solubility of a salt at different temperatures using potassium nitrate or potassium chlorate (V).
- Let learners also carry out a class experiment to determine the solubility product of calcium hydroxide.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the concept of solubility.
  - describe an experiment to determine solubility of a salt.
  - explain the factors that affect solubility of a salt.
  - draw and Interpret the solubility curves.
  - explain the applications of solubility in fractional crystallisation.
  - carry out calculations on solubility.
  - explain the concept of dynamic equilibrium in a saturated salt solution.
  - explain the concept of solubility product.
  - explain the factors that affect solubility of sparingly soluble salts.
  - derive an expression for solubility product.
  - describe an experiment to determine solubility product.
  - carry out calculations involving solubility product.
  - explain the relationship between ionic product, solubility product and precipitation.

- explain the applications of solubility.
- explain the meaning of common ion effect.
- explain the applications of common ion effect.

## Topic 8: Chemical Kinetics

Duration: 06 Periods

### General Objective

By the end of this topic, the learner should be able to appreciate that different reactions occur at different rates and explain why they do so.

### Sub-Topic 1: Simple Rate Equations

Specific objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concept of rate of reaction.</li><li>• explain the law of mass action and its application.</li><li>• explain order of a reaction and rate constant</li><li>• define the different terms used in kinetics.</li><li>• relate mechanism of reactions to kinetics</li><li>• describe the experimental procedure to determine the orders of a reaction.</li><li>• explain the concept of half-life.</li></ul>	<ul style="list-style-type: none"><li>• Introduction to rates of chemical reactions</li><li>• What chemical kinetics is</li><li>• Law of mass action</li><li>• Simple rate equations</li><li>• Definition of rate equations, Rate constant; order of reaction and molecularity.</li><li>• Mechanism of reactions.</li><li>• Mathematical derivation of zero, first and Second order rate equations.</li><li>• Half-lives, <math>t_{\frac{1}{2}}</math></li></ul>

### Suggested Teaching and Learning Strategies

- Guide learners to brainstorm the concept of chemical kinetics and rate of reaction. Let them practically demonstrate experimental determination of rate of reaction.
- Explain the term, order of reaction, relating mechanism of reaction and kinetics of reaction, molecularity and distinguishing between molecularity and order of a reaction.
- Guide a discussion on the derivation of expressions for order of reaction, half-life and sketching and interpreting the graphs obtained.
- Lead learners to experimentally determine orders of reaction.

## Practical Problems

- Guide learners to carry out laboratory experiments to determine rates of reaction and orders of reaction using:
  - reaction between iodine and propanone.
  - sodium thiosulphate and hydrochloric acid.
  - hydrogen peroxide and potassium manganate (VII).
  - hydrogen peroxide and potassium iodide.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the law of mass action and its application.
  - explain the term rate of reaction.
  - describe an experiment for determination of the rate of reaction.
  - explain the terms order of a reaction and rate constant.
  - explain the relationship between orders and rates of reactions.
  - explain the term molecularity of a reaction.
  - distinguish between order and molecularity.
  - apply the knowledge rate equations in sketching and interpreting graphs.
  - explain the concept of half-life.

## Sub-Topic 2: Factors Affecting Rates of Reactions

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the theories of collision.</li> <li>• use theories of reaction to explain factors affecting rates of reaction.</li> <li>• derive an expression for half-life of zero order, first order and second order reactions in terms of rate constant.</li> <li>• use the theories of reaction to explain factors that affect rates of reaction.</li> </ul>	<ul style="list-style-type: none"> <li>• Factors Affecting Rates of Reactions</li> <li>• Theories of reaction (Collision theory, transition theory)</li> <li>• Effects of: temperature (energy barrier concept; Activation energy of activated complex), concentration (pressure and volume for gases), catalyst (industrial production of polymers, processes such as Haber process, manufacture of <math>\text{HNO}_3</math> acid, etc), particle size.</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"><li>apply the knowledge rate equations in sketching and interpreting graphs.</li><li>discuss the relationship between mechanism of a reaction and molecularity.</li><li>carry out designed experiments to generate kinetic data for determining order of reaction, rate of reaction and rate constants.</li><li>carry out calculation rates of reaction.</li></ul>	<ul style="list-style-type: none"><li>differential and integral forms of first order reaction, half-life (only zero and first order)</li><li>Molecularity and mechanism of reactions</li><li>effect of temperature on reactions, Arrhenius theory - activation energy, collision theory of reaction rate (no derivation).</li><li><b>Experiments</b><ul style="list-style-type: none"><li>- 1<sup>st</sup> Order</li><li>- 2<sup>nd</sup> Order</li></ul></li><li>Calculations involving the given experiments</li></ul>

### Suggested Teaching and Learning Strategies

- Guide learners to brainstorm the collision and transition state theory of chemical reaction.
- Discuss the factors that affect chemical reactions which include: temperature, light, concentration, particle size, pressure for gaseous reactants and catalysis.
- Guide learners to discuss the calculations on rates of reactions.
- Guide learners to experimentally investigate the factors affecting rates of chemical reactions.

### Practical Problems

- Guide learners to carry out laboratory experiments to demonstrate the effect of different factors on rate of reaction using:
  - calcium carbonate and hydrochloric acid(particle size).
  - sodium thiosulphate and hydrochloric acid( concentration and temperature.)

## Assessment Strategies

- Give class exercises requiring learners to:
  - use the theories of reaction to explain factors that affect rates of reaction.
  - explain the types and working of catalysts.
  - give applications of the factors that affect rates of chemical reactions.
  - carry out calculation involving rates of reaction.
  - draw graphs from rate of reaction data.
  - interpret graphs obtained from rate of reaction data.
  - interpret rate of reaction data.

## Topic 9: Electrochemistry

Duration: 12 Periods

### General Objective

By end of the topic, the learner should be able to outline the effect of electric current on substances and the ability of substances to generate electricity.

### Sub-Topic 1: Electrolysis

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• identify the different modes of conduction in substances.</li><li>• explain the concept of electrolysis.</li><li>• explain the common terms used in electrolysis.</li><li>• distinguish between weak and strong electrolytes with examples.</li><li>• explain the principles of selective discharge of ions.</li><li>• apply the laws of electrolysis in calculations.</li><li>• identify applications of electrolysis in industry.</li></ul>	<ul style="list-style-type: none"><li>• Modes of Conduction in Substances</li><li>• Electrolysis</li><li>• Concept of electrolysis</li><li>• Terms used in electrolysis (electrolytes, anode, cathode, discharge)</li><li>• Weak and strong electrolytes</li><li>• Principles of Electrolysis; - (selective discharge of Ions).</li><li>• Laws of Electrolysis</li><li>• Calculations on electrolysis</li><li>• Applications of electrolysis: (extraction of metals e.g. Al, Na, etc, manufacture of NaOH and Cl<sub>2</sub>, metal refining).</li></ul>

### Suggested Teaching and Learning Strategies

- Lead a discussion on the modes of conduction by different substances, concept of electrolysis and the different terms used in electrolysis.
- Guide the learners to understand the principle of selective discharge of ions, calculations involving electrolysis and its applications.

## Practical Problems

- Guide learners to carry out electrolysis of copper (II) sulphate using copper electrodes to demonstrate the effect of anode on the products of electrolysis.
- Guide learners to also carry out experiments to determine the Faraday constant using electrolysis of copper (II) sulphate with copper electrodes.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the different modes of conduction.
  - explain the common terms used in electrolysis.
  - explain the changes that take place during electrolysis.
  - distinguish between weak and strong electrolytes and give examples.
  - apply the laws of electrolysis in calculations.
  - explain applications of electrolysis in industry.

## Sub-Topic 2: Conductance and its Measurements

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept of conductance.</li> <li>• explain the factors affecting conductivity of electrolytes.</li> <li>• explain conductance in weak and strong electrolytes.</li> <li>• differentiate between molar and specific conductance.</li> <li>• explain relationship between molar and specific conductance.</li> <li>• describe measurement of conductance.</li> </ul>	<ul style="list-style-type: none"> <li>• Concept of Conductance and Terms used in Conductance</li> <li>• Factors affecting conductance of electrolytes</li> <li>• Conductance in different types of electrolytes</li> <li>• Conductance of weak and strong electrolytes</li> <li>• Types of conductance: - (Molar Conductance and Specific Conductance)</li> <li>• Molar conductance and specific conductance</li> <li>• Measurement of Conductance</li> <li>• Kholrausch's law of</li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"><li>• apply Kholrausch's law in calculation of molar conductivity at infinite dilution of weak electrolytes.</li><li>• apply the concept of conductance in conductimetric titrations, determination of solubility and solubility product, and degree of ionisation.</li><li>• carry out calculations involving electrolytic conductance.</li></ul>	<p>Independent migration of ions and its application</p> <ul style="list-style-type: none"><li>• Application of conductance<ul style="list-style-type: none"><li>-Conductimetric titrations: - (strong acid-strong base, strong acid-weak base, weak acid-weak base); determination of solubility and solubility products; determination of degree of ionisation of weak electrolytes</li><li>• Calculations involving electrolytic conductance</li></ul></li></ul>

### Suggested Teaching and Learning Strategies

- Lead a discussion to brainstorm the concept of conductance and factors affecting conductance with examples. Guide them on how to carry out calculations involving of molar conductivity at infinite dilution of weak electrolytes by applying Kalrauch's law, electrolytic conductance and solubility of sparingly soluble salts.

### Practical Problems

- Guide the learners to carry out laboratory experiments on conductimetric titrations and determination of solubility of sparingly soluble salts like calcium hydroxide.

### Assessment Strategies

- Give class exercises and tests requiring the learners to:
  - explain the concept of conductance and factors affecting conductivity of electrolytes.
  - explain conductance in weak and strong electrolytes and differentiating between molar and specific conductance.
  - explain the relationship between molar and specific conductance and measurement of conductance.

- apply Kholrausch's law in calculations of molar conductivity at infinite dilution of weak electrolytes , the concept of conductance in Conductimetric titrations, determination of solubility and solubility product, and degree of ionisation.

### Sub-Topic 3: Electrochemical Cells

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain the concept of electrode potential.</li> <li>• describe the electrochemical series.</li> <li>• use electrochemical series to explain the absolute and relative electrode potential.</li> <li>• describe the structure and functioning of standard hydrogen electrode.</li> <li>• describe the measurement of standard electrode potential.</li> <li>• explain the term reduction potential.</li> <li>• apply reduction potentials to explain the metal/metal ion convention for cells.</li> <li>• construct an electrochemical cell.</li> <li>• write the cell notation.</li> <li>• calculate the e.m.f. of a cell.</li> <li>• use the calculated values of e.m.f. to predict spontaneity of reactions.</li> <li>• use the Gibb's free energy expression to predict feasibility of reactions.</li> <li>• describe the construction of Danniell cell.</li> <li>• explain the functioning of a battery.</li> <li>• explain the conversion of one form of energy to another.</li> </ul>	<ul style="list-style-type: none"> <li>• Electrode Potentials <ul style="list-style-type: none"> <li>- What electrode potential is</li> </ul> </li> <li>• Electrochemical series</li> <li>• Absolute and relative electrode potential</li> <li>• Standard hydrogen electrode <ul style="list-style-type: none"> <li>- Measurement of electrode potential of metals against the Standard Hydrogen Electrode (SHE).</li> </ul> </li> <li>• Reduction Potentials</li> <li>• Metal/Metal ion Convention for cells (LHS and RHS)</li> <li>• Construction of electrochemical cell</li> <li>• Cell notation <ul style="list-style-type: none"> <li>- Calculation of cell e.m.f</li> <li>- Prediction of spontaneity of reactions</li> </ul> </li> <li>• Gibb's Free Energy, <math>\Delta G</math>, in relation to electrode potentials as a measure of spontaneity</li> <li>• Construction of Daniel cell</li> <li>• Uses of Batteries</li> <li>• Conversion of energy (Chemical to electrical)</li> </ul>

## Suggested Teaching and Learning Strategies

- Lead a discussion to brainstorm the concept of electrode potential and development of the electrochemical series in relation to the absolute and relative electrode potentials. Guide them to discuss the construction and functioning of the standard hydrogen electrode.
- Let the learners to understand the term reduction potential and guide them to construct an electrochemical cell, write the cell notation and calculate the e.m.f. of the cell.

## Practical Problems

- Let learners carry out class experiment to construct an electrochemical cell using copper (II) sulphate and Zinc sulphate.

## Assessment Strategies

- Give class exercises requiring the learners to:
  - use electrochemical series to explain the concept of electrode potential.
  - explain the difference between absolute and relative electrode potential.
  - explain the structure and functioning of standard hydrogen electrode using a diagram.
  - use the reduction potential to construct electrochemical cells.
  - write the cell notation and calculate the e.m.f.
  - calculate the cell e.m.f and use the values to predict spontaneity of reactions.
  - use the expression for Gibb's and sign convention to predict spontaneity/feasibility of a reaction.

## PART II: INORGANIC CHEMISTRY

### SENIOR FIVE TERM I

#### Topic 10: Third Short Period of the Periodic Table

Duration: 12 Periods

##### General Objective

By the end of this topic, the learner should be able to outline the behaviour of elements in the 3<sup>rd</sup> short period and their compounds.

##### Sub-Topic 1: Trends in Atomic and Physical properties of the Elements

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>give a brief description of the classification of the elements in the Periodic table according to periods, groups and blocks.</li><li>identify the elements of period 3 of the Periodic Table.</li><li>describe the trends in the physical properties of the elements.</li><li>state and explain any anomalies in the general trends</li><li>draw graphs of variations in atomic and physical properties.</li></ul>	<ul style="list-style-type: none"><li>Brief introduction to the Periodic table</li><li>Elements of 3rd Short period</li><li>Variation in physical properties of elements ;m.pts, b.pts, ionisation energy, atomic and ionic radius, electronic structures, electron affinity, electronegativity, electro-positive, electrode potential, and electrical conductivity</li><li>Anomalous trends in atomic and physical properties of elements in period 3</li><li>Graphs showing variations in atomic and physical properties of period 3 elements</li></ul>

## Suggested Teaching and Learning Strategies

- Guide learners to discuss the trends in electronic structures, melting point, boiling point, electrical conductivity and electropositivity
- Discuss the trends in atomic and ionic radius, ionisation energy, electron affinity, electronegativity and electrode potential.

## Practical Problems

- Guide learners to construction and interpret graphs from provided data on atomic and physical properties of the elements.

## Assessment Strategies

- Give class exercises requiring learners to:
  - state general trend in atomic and physical properties of the elements.
  - explain the trends in the atomic and physical properties of the elements.
  - state any anomalies in the general trends.
  - explain any anomalies in the general trends.
  - accurately draw graph showing variations in atomic and physical.

## Sub-Topic 2: Chemical Reactions of the Elements

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• give equations for the reactions.</li><li>• state conditions for the reactions and expected observations for each reaction.</li><li>• explain trends in reactivity of the elements.</li></ul>	<ul style="list-style-type: none"><li>• Reactions of the elements with air (oxygen), water, dilute acids (<math>\text{HCl}</math>, <math>\text{H}_2\text{SO}_4</math>), dilute sodium hydroxide, chlorine</li><li>• Conditions for reactions</li><li>• Trends in the reactivity of the elements with the reagents above</li></ul>

## Suggested Teaching and Learning Strategies

- Guide learners to do simple practical exercise for the reactions with air and water.
- Guide learners to discuss and carry out simple practical exercises for the reactions with dilute acid, dilute sodium hydroxide and chlorine, and qualitative tests to identify  $\text{Al}^{3+}$ ,  $\text{SO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NO}_3^-$ .

## Practical Problems

- Guide learners to carry out test tube experiments for the reactions of the elements with water, dilute acids and sodium hydroxide.
- Let them do qualitative tests to identify  $\text{Al}^{3+}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ .

## Assessment Strategies

- Give class exercises requiring learners to:
  - write equations for the reactions of the elements with; air, water, dilute acids ( $\text{HCl}$ ,  $\text{H}_2\text{S}_2\text{O}_4$ ), dilute Sodium hydroxide, chlorine where applicable.
  - state conditions for the reactions.
  - explain any trends in the reactions.
  - carry out simple qualitative tests to identify  $\text{Al}^{3+}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$ .

## Sub-Topic 3: Compounds of the Elements

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>• identify elements of group II</li> <li>• explain the trends in physical properties of the elements down the group.</li> </ul>	<ul style="list-style-type: none"> <li>• The Elements of Group II</li> <li>• The Physical Properties of Group II elements               <ul style="list-style-type: none"> <li>- m.p.ts, b.p.ts, ionisation energy, atomic and ionic radius, electronic structures, electron affinity, electronegativity, electro - positivity, electrode potential, electrical conductivity</li> </ul> </li> </ul>

Specific Objectives	Content
<ul style="list-style-type: none"><li>• explain any anomalies in the general trends.</li><li>• draw graphs of variations in atomic and physical properties.</li></ul>	<ul style="list-style-type: none"><li>• Anomalous trends in atomic and physical properties of elements in Group II</li><li>• Graphs showing variations in atomic and physical properties of period 3 elements</li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the formation of the oxides and their physical properties in relation to their structure and bonding.
- Discuss the reactions of the oxides with water, acids and sodium hydroxide including the simple test-tube experiments.
- Discuss structures of the oxo-acids of sulphur, phosphorus, chlorine and varying acid strength for oxo-acids of chlorine.
- Discuss the formation of the chlorides, their structure and bonding, physical properties and reactions with water including the simple test-tube experiments.
- Discuss the formation of the hydrides, their structure and bonding, physical properties and reactions with water including the simple test-tube experiments.
- Discuss industrial processes for the manufacture of; chlorine and sodium hydroxide, nitric and sulphuric acid and phosphate and nitrate fertilizers.

### Practical Problems

- Guide learners to carry out test tube experiments for the reactions of the chlorides with water and subsequent changes in pH of the resultant solutions.
- Let them model structures of oxo-acids of chlorine, sulphur and phosphorus.
- Use 3D-structures of the chlorides and hydrides of the elements to explain the physical properties of the compounds.
- Guide learners to carry out test tube experiments on the oxides of the period 3 elements to determine; solubility, pH of resultant solution and acid-base nature.

## Assessment Strategies

- Give class exercises requiring learners to:
  - write chemical formulae of the oxides, chlorides and hydrides.
  - describe the suitable methods for the preparation of oxides, chlorides and hydrides.
  - describe the reactions of the oxides, chlorides and hydrides with water.
  - explain the physical properties of the oxides, chlorides and hydrides in terms of bonding and structure.
  - compare acid strengths of the various oxo-acids.
  - use simple test tube experiments to identify the acid-base nature of the oxides.
  - describe the industrial processes for the manufacture of; sulphuric acid, nitric acid, chlorine, sodium hydroxide, phosphate and nitrate fertilizers.

## SENIOR FIVE TERM II

### Topic 11: The Chemistry of Group II Elements (Alkaline Earth Metals)

Duration: 10 Periods

#### General Objective

By the end of this topic, the learner should be able to appreciate the behaviour of group II elements and their compounds.

#### Sub-Topic 1: Trends in Physical Properties of the Elements of Group II

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>identify elements of group II.</li><li>explain the trends in physical properties of the elements down the group II.</li><li>explain any anomalies in the general trends.</li><li>draw graphs of variation in atomic and physical properties.</li></ul>	<ul style="list-style-type: none"><li>The Elements of Group II</li><li>The Physical Properties of Group II elements<ul style="list-style-type: none"><li>mpts, bpts, ionisation energy, atomic and ionic radius, electronic structures, electron affinity, electronegativity, electropositivity, electrode potential, electrical conductivity</li></ul></li><li>Anomalous trends in atomic and physical properties of elements of group II</li><li>Graphs showing variation in atomic and physical properties of period 3 elements</li></ul>

#### Suggested Teaching and Learning Strategies

- Guide learners to discuss electronic structures, electrical conduction, trends in melting point, boiling point, electropositivity, electronegativity and electrode potential.

- Discuss the trends in atomic and ionic radius, ionisation energy and electron affinity.

### Practical Problems

- Guide learners to construct and interpret graphs from provided data on atomic and physical properties of the elements.

### Assessment Strategies

- Give class exercises requiring learners to:
  - state general trend in atomic and physical properties of the elements.
  - explain the trends in the atomic and physical properties of the elements.
  - state any anomalies in the general trends.
  - explain any anomalies in the general trends.
  - accurately draw graphs of variations in atomic and physical properties of elements.

## Sub-Topic 2: Chemical Reactions of Group II Elements

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>• explain the trends in chemical properties of the elements down the group.</li> <li>• compare the physical and chemical properties of group I and II element.</li> </ul>	<ul style="list-style-type: none"> <li>• Reactions of Group II Elements</li> <li>• Chemical properties of the elements(reaction with <math>\text{H}_2\text{O}</math>, dil. Acids, air, <math>\text{Cl}_2</math>)</li> <li>• Compounds of the elements(oxides, hydroxides,</li> </ul>

### Suggested Teaching and Learning Strategies

- Guide learners to carry out simple practical exercise for the reactions of elements in group II with air, water, dilute acids ( $\text{HCl}$ ,  $\text{H}_2\text{SO}_4$ ) and chlorine.
- Discuss the reactivity of the elements with dilute sulphuric acid, reaction of beryllium with sodium hydroxide.

## Practical Problems

- Carry out test tube experiments for the reactions of the elements with; water, dilute acids and chlorine.
- Carry out computer simulations to compare reactions of Group(I) and Group(II) elements.

## Assessment Strategies

- Give class exercises requiring learners to:
  - write equations for the reactions of the elements with: air, water, dilute acids ( $HCl$ ,  $H_2SO_4$ ), dilute Sodium hydroxide and chlorine where applicable.
  - state conditions for the reactions.
  - explain any trends in the reactions.

## Sub-Topic 3: Compounds of Group II Elements

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the trend in variation of the physical and chemical properties of the compounds.</li><li>• carry out test tube experiments to identify group II cations.</li><li>• explain trend in solubility of the sulphates and hydroxides of group II relation to lattice and hydration energies.</li><li>• describe the process of manufacture of cement.</li><li>• state uses of common compounds of group II elements.</li></ul>	<ul style="list-style-type: none"><li>• Physical Properties of the Compounds (Chlorides, Hydrides, Sulphates <math>CO_3^{2-}</math> and <math>HCO_3^-</math>)</li><li>• Solubility, thermal stability, structure and bonding, reaction with acids(oxides, hydroxides), reaction with sodium hydroxide (oxides, hydroxides)</li><li>• Qualitative analysis of Group II cations</li><li>• Solubility of sulphates and hydroxides in relation to lattice and hydration energies</li><li>• Manufacture of cement</li><li>• Uses of compounds of group II elements</li></ul>

## Suggested Teaching Procedure

- Discuss of the formation of the oxides and chlorides, their melting points in relation to bonding, formation of hydrides and their reaction with water.
- Discuss the solubility and thermal stability of the carbonates and hydrogen carbonates in comparison to Group(I).
- Discuss the solubility of the hydroxides and sulphates in relation to lattice and hydration energy, qualitative analysis for;  $Mg^{2+}$ ,  $Ca^{2+}$  and  $Ba^{2+}$ .
- Discuss the anomalous behaviour of beryllium and its compounds and industrial manufacture of cement.

## Practical Problems

- Guide the learners to carry out simple qualitative tests to identify  $Mg^{2+}$ ,  $Ca^{2+}$  and  $Ba^{2+}$ .
- Guide the learners to carry out practical tests on thermal stability of carbonates and hydrogen carbonates of Group(II) elements.
- Carry out an experiment to get the action of dilute hydrochloric acid or dilute sulphuric acid on the oxides.
- Carry out an experiment to get the action of dilute hydrochloric acid or dilute sulphuric acid on the carbonates and hydrogen carbonates.

## Assessment Strategies

- Give class exercises requiring learners to:
  - carry out simple qualitative tests to identify  $Mg^{2+}$ ,  $Ca^{2+}$ ,  $Ba^{2+}$ .
  - describe the suitable methods for the preparation of oxides, chlorides and hydrides.
  - describe the reactions of the oxides, and hydrides with water.
  - explain the trend in melting points of the oxides and chlorides of the elements.
  - explain the trend in solubility of the hydroxides and sulphates down the group in relation to lattice energy and hydration energy.
  - account for the difference in thermal stability between carbonates/hydrogen carbonates of Group(I) and Group(II).
  - explain the anomalous behaviour of beryllium.

## SENIOR FIVE TERM II

### Topic 12: The Chemistry of Group IV Elements

Duration: 08 Periods

#### General objective

By the end of this topic, the learner should be able to appreciate trends in the behaviour of group IV elements and their compounds.

#### Sub-Topic 1: Trends in Physical Properties of Group IV Elements

Specific Objectives	Content
<p>The learner should be able to :-</p> <ul style="list-style-type: none"><li>• explain the trends in physical properties of the elements down the group.</li><li>• explain the catenation of carbon.</li></ul>	<ul style="list-style-type: none"><li>• Physical Properties Group IV Elements</li><li>• m.pts, b.pts, electronic structures , ionisation energy electropositivity, transition from non - metal to metal down the group, conductivity and structure and bonding</li></ul>

#### Suggested Teaching and Learning Strategies

- Discuss the electronic structures, oxidation states, ionisation energy, electropositivity and metallic character and electrical conduction.
- Discuss the structure and bonding in the elements and trends in melting points.

#### Practical Problems

- Guide the learners in the construction and interpretation of graphs from provided data on atomic and physical properties of the elements.

#### Assessment Strategies

- Give class exercises requiring learners to:
  - write electronic configurations of carbon and silicon.

- state the common oxidation states exhibited by the elements.
- state the general trend in ionisation energy, electropositivity and electrical conduction of the elements.
- explain the trends in ionisation energy, electropositivity and electrical conduction of the elements.
- explain melting points in relation to structure and bonding.
- state any anomalies in the general trends.

## Sub-Topic 2: Chemical Reactions of the Elements

Specific Objectives	Content
<p>The learner should be able to :-</p> <ul style="list-style-type: none"> <li>• explain the trend in chemical properties.</li> <li>• explain trends in the variation of the stability in oxidation states.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical Properties           <ul style="list-style-type: none"> <li>- reaction with: air, dilute and concentrated acids, alkalis, chlorine, water, sulphur</li> </ul> </li> </ul>

### Suggested Teaching and Learning Strategies

- Guide learners to discuss and carry out simple practical exercises on the reactions of Group(IV) elements with conc. and dilute acids (HCl, H<sub>2</sub>SO<sub>4</sub>, HNO<sub>3</sub>).
- Discuss the reactions of the elements with; air, water, chlorine, sulphur, conc. and dilute sodium hydroxide.

### Practical Problems

- Guide learners to carry out test tube experiments for the reactions of the elements with dilute and conc. Acids.

### Assessment Strategies

- Give class exercises requiring learners to:
  - write equations for the reactions of the elements with; air, water, dilute acids (HCl, H<sub>2</sub>SO<sub>4</sub>), conc. acid, (HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>, HCl), dilute Sodium hydroxide and with chlorine where applicable.
  - state the conditions for the reactions.

### Sub-Topic 3: Compounds of the Group IV Elements

Specific Objectives	Content
<p>The learner should be able to :-</p> <ul style="list-style-type: none"><li>• explain the trend in physical properties of the compounds.</li><li>• explain the trend in chemical properties.</li><li>• explain the hydrolysis of the chlorides.</li><li>• relate the thermal stability of the halides ad hydrides to size of the cations.</li><li>• explain the Inert Pair Effect.</li><li>• explain reactions for qualitative analysis of tin and lead.</li><li>• mention the uses of the group(IV) elements.</li><li>• describe the confirmatory test for <math>Pb^{2+}</math></li><li>• explain the concept of green house effect.</li></ul>	<ul style="list-style-type: none"><li>• Physical Properties of the Compounds, oxides, chlorides, hydrides (structure and bonding, M.P, B.P, )</li><li>• Chemical properties of compounds (oxides, chlorides, hydrides)<ul style="list-style-type: none"><li>- reaction with dilute acids</li><li>- reaction with alkali</li><li>- redox properties of the oxides</li><li>- combustion of the hydrides</li></ul></li><li>• Hydrolysis of chlorides</li><li>• Thermal stability of halides or hydrides</li><li>• Inert Pair Effect</li><li>• Brief chemistry of Tin, and lead</li><li>• Uses of Group IV elements</li><li>• Test tube experiment for lead (confirmatory test of <math>Pb^{2+}</math>)</li><li>• Mention the green house effect of <math>CO_2</math></li></ul>

### Suggested Teaching and Learning Strategies

- Guide learners to write the chemical formulae of the hydrides, chlorides and oxides. Lead them to discuss the methods used to prepare the oxides, chlorides and hydrides.

- Explain the trends in melting points of the oxides, chlorides and hydrides in relation to structure and bonding.
- Discuss the trends in thermal stability of the oxides and chlorides and acid-base character of the oxides.
- Discuss the reactions of the oxides with; dilute and conc. acids, dilute and conc. sodium hydroxide including simple test tube experiments.
- Discuss the stability of +2 and +4 compounds (inert pair effect), reaction of tri-lead tetra oxide with dilute nitric acid and conc. hydrochloric acid, reaction of tetra chlorides of the elements with water and reducing reactions of Tin(II) ions, including simple test tube experiments.
- Discuss the difference in solubility of the dichloride of Tin and Lead in water and conc. hydrochloric acid and combustion of the hydrides of the elements.

### Practical Problems

- Guide learners in the preparation of Tin (IV) and Lead (IV) oxide by action of warm conc. nitric acid on the metals.
- Guide learners in the experiment of the reactions of Tin (IV) and Lead (IV) oxides with conc. hydrochloric acid, conc. sodium hydroxide and acidified potassium iodide.
- Guide learners in an experiment of the decomposition of the dioxides and dichloride of Tin and Lead.
- Guide learners in an experiment of the combustion of the hydrides.
- Guide learners in an experiment of the reaction of tetra chlorides with water.

### Assessment Strategies

- Give class exercises requiring learners to:
  - write the chemical formulae of the compounds in +2 and +4 oxidation states.
  - describe by use of equations methods for the preparation of; the dioxides, dichloride and tetra chlorides and hydrides of the element.
  - explain the trend in melting points of the oxides, chlorides and hydrides of the elements in relation to structure and bonding.

- describe the reactions of the oxides with conc. and dilute acids and sodium hydroxide.
- explain the trend in acid-base character of the oxides down the group.
- describe the reactions of the chlorides of the elements with water.
- explain the reactions of tri lead tetra oxide with acids.
- explain the trend in stability of +2 and +4 oxidation states.
- describe the reducing reactions of Tin(II) ions.
- account for the difference in solubility of the dichloride of Tin and Lead in water and conc. hydrochloric acid.
- describe with use of equations the combustion of the hydrides.

## SENIOR SIX TERM I

### Topic 13: The Chemistry of Group VII Elements

Duration: 20 Periods

#### General objective

By the end of this topic, the learner should be able to appreciate the behaviour of group VII elements and their compounds.

#### Sub-Topic 1: Trends in Physical Properties of the Elements

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• describe the general methods for preparing halogens.</li><li>• explain the trends in the variation of physical properties down Group.</li></ul>	<ul style="list-style-type: none"><li>• General methods of preparing halogens</li><li>• Variation in physical properties of the elements</li><li>• M.pts, B.pts, ionisation energy, atomic and ionic radius and electronic structures, electron affinity, electronegativity, electrode potential</li><li>• structure and bonding</li></ul>

#### Suggested Teaching and Learning Strategies

- Discuss the physical appearance of the elements, electronic structures, structure and bonding, trends in melting point, boiling point and ionisation energy.
- Discuss the trends in atomic and ionic radius, ionisation energy, electron affinity, electronegativity and electrode potential.

#### Practical Problems

- Guide the learners in the construction and interpretation of graphs from provided data on atomic and physical properties of the elements.

### Assessment Strategies

- Give class exercises requiring learners to:
  - state general trends in atomic and physical properties of the elements.
  - describe the physical appearance of the elements.
  - explain the trends in the atomic and physical properties of the elements.
  - state any anomalies in the general trends.
  - explain any anomalies in the general trends.
  - accurately draw graphs variation in atomic and physical properties.
  - interpret graphs on atomic and physical properties of the elements.

### Sub-Topic 2: Chemical Reactions of the Elements of Group II of Periodic Table

Specific Objectives	Content
<p>The learner should be able to :-</p> <ul style="list-style-type: none"><li>• explain the trend in chemical properties of the elements.</li><li>• explain the chemical reactions with the identifying reagents.</li></ul>	<ul style="list-style-type: none"><li>• chemical properties of the elements</li><li>• Reaction with hydrogen, water, sodium hydroxide</li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the reactions of halogens with: water, sodium hydroxide solution and their oxidising action.

### Practical Problems

- Guide learners to carry out test tube experiments to show displacement reactions of the halogens.
- Guide learners to carry out test tube experiments between dilute sodium hydroxide and aqueous solutions of bromine and iodine.

### Assessment Strategies

- Give class exercises requiring learners to:
  - describe the reactions of the halogens with; Water, Sodium hydroxide solution
  - state conditions for the reactions

## Sub-Topic 3: Compounds of the Elements

Specific Objectives	Content
<p>The learner should be able to :-</p> <ul style="list-style-type: none"> <li>• write the chemical formulae of the hydrides</li> <li>• describe the general methods of preparing hydrides</li> <li>• explain in physical properties of the hydrides</li> <li>• explain the trend in acid strength of the hydrides</li> <li>• carry out test tube experiment to identify <math>\text{Cl}^-</math>, <math>\text{Br}^-</math> and <math>\text{I}^-</math>.</li> <li>• describe the extraction of sodium chloride from the natural deposits.</li> </ul>	<ul style="list-style-type: none"> <li>• Compounds of the elements Hydrides,</li> <li>• Preparation of the Hydrides</li> <li>• Hydrogen Bonding (Its effect on physical properties of the hydrides)(NB: Little emphasis on oxides except for their acidity)</li> <li>• Test tube experiments for <math>\text{Cl}^-</math>, <math>\text{Br}^-</math> and <math>\text{I}^-</math></li> <li>• Occurrence, extraction and utilisation of natural salt deposits be covered e.g. <math>\text{NaCl}</math></li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the formation of the hydrogen halides, trend in boiling points, thermal stability and acid strength.
- Discuss the trends in reducing action of the hydrogen halides and qualitative analysis for the halides.

### Practical Problems

- Guide learners to carry out simple qualitative tests to identify  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$

### Assessment Strategies

- Give class exercises requiring learners to:
  - carry out simple qualitative tests to identify  $\text{Cl}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$ .
  - describe the suitable methods for the preparation of hydrogen halides.
  - explain the trends in boiling points of the hydrogen halides.
  - explain the trends in thermal stability of the hydrogen halides.
  - explain the trends in acid strength.
  - explain the trends in reducing action of the hydrogen halides.
  - explain the anomalous behaviour of fluorine and hydrogen fluoride.

## SENIOR SIX TERM II

**Topic 14: The Chemistry of the d-block Transition Elements**

Duration: 10 Periods

**General Objective**

By the end of this topic, the learner should be able to appreciate the behaviour of d-block transition elements and their compounds.

**Sub-Topic 1: The d-Block Transition Elements**

Specific Objectives	Content
<p>The learner should be able to :-</p> <ul style="list-style-type: none"><li>• define transition elements.</li><li>• distinguish between a transition element and d-block elements.</li><li>• explain the trend in physical properties of the elements.</li><li>• compare the physical properties of the d-block and main block elements.</li><li>• explain the general characteristics of the transition elements.</li></ul>	<ul style="list-style-type: none"><li>• Concept of the transition elements (first series of the d-block)</li><li>• Physical properties</li><li>• M.pts, B.pts, ionisation energy, atomic and ionic radius, electronic structure, electrode potential, electro-positivity and conductivity</li><li>• General Characteristics of d-block Elements<ul style="list-style-type: none"><li>- variable oxidation states, formation of interstitial compounds, catalytic activities e.g. Iron in Haber, complex formation (<math>H_2O</math>, <math>Cl^-</math>, <math>NH_3</math>, <math>OH^-</math>, <math>CN^-</math>, <math>I^-</math>, ligands), paramagnetism and formation of coloured compounds</li></ul></li></ul>

## Suggested Teaching and Learning Strategies

- Brainstorm the concept of d-block elements, the transition elements and physical properties (M.pts, B.pts, ionization energy, atomic and ionic radius, electronic structure, electrode potential, electropositivity, conductivity).
- Discuss the general characteristics of transition elements (variable oxidation states, formation of interstitial, compounds, catalytic activities, complex formation, paramagnetism, formation of coloured compounds).

## Practical Problems

- Guide learners to model the structures of different complexes.
- Guide learners to also carry out class experiments to make solutions of some complexes e.g. by reacting ammonia solution with copper(II) Sulphate.
- Guide learners to carry out an experiment to investigate the use of cobalt(II) Ions as a catalyst for oxidation of 2,3-dihydroxybutanedioate by hydrogen peroxide.
- Guide learners to carry out a class experiment to investigate variable oxidation states using ammonium vanadate (V) and zinc.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain what is meant by a d- block element.
  - explain what is meant by a transition element/ metal.
  - distinguish between a transition element and d-block elements.
  - explain the trends in the physical properties of the elements.
  - compare the physical properties of the d-block and main block elements.
  - explain the differences and similarities between transition elements and main group elements.
  - explain the general characteristics of the transition elements.
  - draw and name some common complexes.

## Sub-Topic 2: Chemical Properties of the Elements and their Compounds

Specific Objectives	Content
<p>The learners should be able to :</p> <ul style="list-style-type: none"><li>• explain the chemical properties of the elements.</li><li>• describe the preparation of common oxides, hydroxides and chlorides.</li><li>• identify transition metal cations except Ti, Sc, V.</li><li>• identify oxo-anions of V, Cr, Mn.</li><li>• explain the amphoteric behaviour of Zn, Cr.</li><li>• draw and name the shapes of the common oxo-anions.</li><li>• explain the redox behaviour of the oxo-anions.</li><li>• explain the importance of oxo-anions in redox titrations.</li><li>• carry out test tube experiments to identify d-block oxo-anions.</li><li>• describe how iron, zinc and copper are extracted from their ores.</li><li>• explain how steel is formed from Iron.</li></ul>	<ul style="list-style-type: none"><li>• Chemistry of each element</li><li>• Chemical properties of the elements (reaction with H<sub>2</sub>O, acids, air, NaOH and oxidising agents)</li><li>• Compounds of the element Oxides, hydroxide, oxo-anions (for V, Cr, Mn), chlorides, oxo-salt</li><li>• Test Tube Experiments for Identifications of Transition</li><li>• Metal Cations except Ti, Sc, V</li><li>• Identification of d-block oxo-anions</li><li>• Amphoteric behaviour of the compound (oxides of Cr, Zn)</li><li>• Structures and names of the shapes of the common oxo-anions</li><li>• redox reactions f the oxo-anions</li><li>• Volumetric Analysis :<ul style="list-style-type: none"><li>• permanganate</li><li>• dichromate (acidification with H<sub>2</sub>SO<sub>4</sub>)</li></ul></li><li>• Extraction of Fe, Zn, Cu</li><li>• Production of steel from pig Iron</li></ul>

## Suggested Teaching and Learning Strategies

- Lead a discussion on the reactions of transition metals with; water, acids, sodium hydroxide solution and oxidising agents. Let them also discuss the preparation of the common oxides, hydroxides and chlorides. Let the learners understand the techniques of identification of the metal ions and practically carry out the experiments. Guide the learners to understand the importance of oxo.anions in redox titrations. Lead a discussion on the extraction of some named metals.
- Discuss the general procedures for extraction of metals including iron, zinc and iron. Let them also discuss the uses of the metals.

## Practical Problems

- Give group practical work on electrochemical purification of copper.
- Guide learners to carry out test tube experiments to identify transition metal cations using dilute sodium hydroxide, aqueous ammonia solutions and other confirmatory reagents.

## Suggested Assessment Strategies

- Give class exercises requiring learners to:
  - state the three main stages involved in the extraction of a metal.
  - explain the underlying principles in each of the three main stages of metal extraction.
  - name the ores of Iron.
  - write chemical formulae of the ores of Iron.
  - describe the conversion of siderite/spathic ore, iron pyrites to iron (III) oxide.
  - describe the chemical reduction of haematite, or magnetite.
  - differentiate between wrought and pig iron.
  - give uses of pig and wrought iron.
  - name the main components of steel.
  - give the uses of steel
  - name the ores of copper.
  - write the chemical formulae of the ores of copper.
  - describe the concentration and roasting of copper ores.
  - describe the process of smelting.
  - describe the reduction and refining processes in copper extraction.
  - give uses of copper.
  - name the common alloys of copper.
  - name the ores of zinc.
  - write the chemical formulae of zinc ores.
  - describe the concentration and roasting processes of zinc ores.
  - describe the reduction process in zinc extraction.
  - name the common alloys of zinc.
  - give uses of zinc.

## PART III: ORGANIC CHEMISTRY

### SENIOR FIVE TERM I

#### Topic 15: Introduction to Organic Chemistry

Duration: 06 Periods

##### General Objective

By the end of the topic, the learner should be able to comprehend and apply the knowledge of carbon chemistry.

##### Sub-Topic 1: Introduction

Specific Objectives	Content
<p>The learner should be able to;</p> <ul style="list-style-type: none"><li>state three places in which peat occurs naturally and give its applications.</li><li>state unique properties of carbon.</li><li>explain the concept of hybridisation with specific reference to carbon.</li><li>differentiate between aliphatic and aromatic compounds.</li><li>explain the various terms.</li><li>identify the various functional groups.</li><li>explain the type of organic reactions.</li><li>explain the different types of</li></ul>	<ul style="list-style-type: none"><li>Occurrence of Carbon<ul style="list-style-type: none"><li>- coal and wood, composition and uses of coal, making of charcoal from wood</li></ul></li><li>Unique properties of carbon<ul style="list-style-type: none"><li>- carbon – skeleton (chains and rings)</li></ul></li><li>Hybridisation and multiple bond formation</li><li>Aliphatic and Aromatic compounds</li><li>Terms used in organic chemistry<ul style="list-style-type: none"><li>- homologous series, isomerism, functional groups and hydrocarbons</li></ul></li><li>Types of reactions<ul style="list-style-type: none"><li>- substitution, addition and elimination</li></ul></li><li>Organic reaction mechanism:</li></ul>

Specific Objectives	Content
reaction mechanisms.	types of cleavage (bond polarity), inductive effect, electrophiles, nucleophile, free radical and ionic mechanism

## Suggested Teaching and Learning Strategies

- Lead a discussion on the occurrence of carbon, its uniqueness and bonding in carbon. Discuss the concept of hybridization in carbon. Let learners understand the different terms used in organic chemistry.
- Guide learners to discuss hydrocarbons, functional groups and isomerism.
- Lead a discussion on the types of reactions, reaction mechanisms and important terms used in organic chemical reactions, including but not limited to: inductive effect, electrophiles, nucleophiles, bond polarity, heterolytic fission and homolytic reaction.
- Also discuss the different types of reactions and their mechanisms.

## Practical Problems

- Learners can model the structures indicating formation of single, double and triple bonds through hybridisation of carbon

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the uniqueness in forming numerous compounds.
  - explain how hybridisation leads to formation of single and multiple bonds in carbon.
  - explain the meaning of aliphatic and aromatic compound.
  - identify the different types of hydrocarbons.
  - explain the various terms used .
  - identify the various functional groups and state the homologous series they represent.
  - explain the reaction types and mechanism.
  - explain the common terms commonly used in organic reactions.

## Topic 16: Hydrocarbons (Alkanes, Alkenes and Alkynes)

Duration: 14 Periods

### General Objective

By the end of the topic, the learner should be able to explain the nature, chemistry and uses of alkanes, alkenes and alkynes as hydrocarbons.

### Sub-Topic 1: Introduction to Alkanes and their Physical Properties

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>state the sources of alkanes.</li><li>describe the process of separation of alkanes from oil.</li><li>name the first 20 alkanes.</li><li>state general formula of alkanes.</li><li>draw and name the structures of the isomers using IUPAC system.</li><li>describe the lab preparations of alkanes.</li><li>state the physical properties of alkanes.</li></ul>	<ul style="list-style-type: none"><li>Occurrence:</li><li>natural gas and petroleum</li><li>Isolation (Fractional distillation)</li><li>Nomenclature of alkanes up to the 20th</li><li>general formula, functional groups, nomenclature using IUPAC rules</li><li>Structures and Isomers</li><li>Laboratory Preparation of Alkanes</li><li>Physical Properties solubility, boiling point and melting point, density</li></ul>

### Suggested Teaching and Learning Strategies

- Introduce and discuss the physical properties of alkanes. Guide the learners on the process of separation of alkanes from crude oil. Discuss the nomenclature of the alkanes according to the IUPAC system.

### Practical Problems

- Learners can carry out class exercises on the combustion of different alkanes

## Assessment Strategies

- Explaining sources of alkanes and principles of isolation of different alkanes isolated (fractional distillation of crude oil)
- Use of IUPAC rules in naming of alkanes (including cycloalkanes)
- Identification of alkanes using knowledge of their general formula, their isomers and physical properties.
- Laboratory preparation of alkanes

## Sub-Topic 2: Chemical Properties and uses of Alkanes

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain chemical reactions of alkanes with chlorine and oxygen</li> <li>• write mechanisms of the reactions.</li> <li>• explain the effect of combustion of fuels on the environment.</li> <li>• explain uses of alkanes.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical reactions of Alkanes combustion, chlorination and cracking</li> <li>• Mechanism of reaction for chlorination of methane</li> <li>• Effect of combustion of fuels on the environment</li> <li>• Uses of alkanes</li> </ul>

## Suggested Teaching and Learning Strategies

- Lead a discussion on chemical properties of alkanes. Let the learners understand mechanism of reaction for chlorination of methane. Brainstorm the effect of combustion of fuels on environment.

## Practical Problems

- Experiments on bromination using cyclo alkanes and paraffin (care should be taken as bromine vapour is poisonous).
- Experiment should be done outside the lab and learners should not inhale the vapour.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the chemical reactions, conditions and mechanisms of chlorination of methane.
  - describe effect of combustion of fuels on the environment.
  - mention uses of alkanes (fuel, cracking, synthesis gas etc).

## Sub-Topic 3: Introduction to Alkenes and their Physical Properties

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• state natural sources of alkenes.</li><li>• name alkenes using IUPAC system.</li><li>• show structures of Alkenes.</li><li>• prepare alkenes in laboratory.</li><li>• explain physical properties of alkenes.</li></ul>	<ul style="list-style-type: none"><li>• Occurrence: Crude oil</li><li>• Nomenclature of alkenes<ul style="list-style-type: none"><li>- Structure and positional isomerism</li></ul></li><li>• Laboratory preparation methods</li><li>• Physical state<ul style="list-style-type: none"><li>- solubility, mpt, bpt, density</li></ul></li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the general formula, functional group, nomenclature, isomerism, preparation (laboratory and industrial cracking) and physical properties of alkenes.

### Practical Problems

- Guide the learners to use models to construct structures of different alkenes and their isomers.

### Assessment Strategies

- Give class exercises requiring learners to:
  - state general formula of alkenes.
  - describe the process of preparation of alkenes by catalytic cracking of alkanes.
  - describe the lab preparations of alkenes from alcohols and alkyl halides.
  - name alkenes using IUPAC system.
  - explain the physical properties of alkenes.

## Sub-Topic 4: Chemical Properties and Uses of Alkenes

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain chemical reactions of alkenes.</li> <li>• write the mechanisms of reactions involved.</li> <li>• carry out test tube experiments to identify the functional group.</li> <li>• state uses of alkenes.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical properties: <ul style="list-style-type: none"> <li>- addition reactions (<math>H_2</math>, <math>Br_2</math>, <math>Cl_2</math>, <math>HCl</math>, <math>H_2SO_4</math> and <math>H_2O</math>) and the mechanisms involved.</li> <li>- Combustion reactions: (<math>O_2</math>)</li> <li>- Oxidation: (<math>O_2</math>, <math>O_3</math>).</li> </ul> </li> <li>• Practical identifications of the functional group</li> <li>• Uses of alkenes</li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the chemical properties of alkenes (combustion, hydration, halogenations, hydroxylation, hydrogenation, addition of hydrogen halides and reaction with concentrated sulphuric acid).
- Use models to build structures of different alkenes, carry out preparation of alkenes and carry out test tube reactions. Use of charts to illustrate mechanisms and synthesis reactions.

### Practical Problems

- Guide learners to carry out test tube experiments to identify the functional group.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain chemical properties of alkenes including mechanisms of the reactions.
  - carry out test tube experiments to identify the functional group.
  - explain the chemical reactions for the identification of the functional group.
  - explain uses of alkenes.

## SENIOR FIVE TERM II

### Sub-Topic 5: Introduction to Alkynes and their Physical Properties

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• give structures of alkynes.</li><li>• name alkynes using IUPAC system.</li><li>• explain physical properties of alkynes.</li><li>• explain the preparation of alkynes.</li></ul>	<ul style="list-style-type: none"><li>• Structure and positional isomerism.</li><li>• Nomenclature of alkynes</li><li>• Physical state<ul style="list-style-type: none"><li>- solubility, mpt, bpt and density</li></ul></li><li>• Laboratory preparation methods</li></ul>

### Suggested Teaching and Learning Strategies

- Brainstorm the structure, preparation and physical properties and uses of alkynes.

### Practical Problems

- You may use models to build structures of different alkynes, carry out preparation of alkynes and carry out test tube reactions with them. Use charts to illustrate mechanisms and synthesis reactions.

### Assessment Strategies

- Give class exercises requiring learners to:
  - state general formula of alkynes.
  - name alkynes using IUPAC system.
  - describe the lab preparations of alkynes from di-halo alkanes.
  - explain the physical properties of alkynes.

## Sub-Topic 6: Chemical Properties and Uses of Alkynes

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• explain chemical properties of alkynes.</li> <li>• write the mechanisms of the reactions (for halogen halides, bromine, <math>\text{H}_2\text{O}/\text{H}^+</math>).</li> <li>• carry out test tube experiments to identify the functional group.</li> <li>• state the uses of alkynes.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical reactions:           <ul style="list-style-type: none"> <li>- addition reaction (<math>\text{H}_2</math>, <math>\text{Br}_2</math>, <math>\text{Cl}_2</math>, <math>\text{HCl}</math>, <math>\text{H}_2\text{SO}_4</math> and <math>\text{H}_2\text{O}</math>)</li> <li>- the mechanisms involved</li> </ul> </li> <li>• Practical identifications of the functional group (with ammoniacal silver nitrate and copper I chloride)</li> <li>• Uses</li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss chemical properties of alkynes (combustion, hydration, halogenations, addition of hydrogen halides and reaction with concentrated sulphuric acid).
- Carry out test tube experiments to identify the functional group in alkynes.
- Carry out an experiment of reaction of alkynes with ammoniacal silver nitrate and ammoniacal copper(I) chloride.

### Practical Problems

- Guide learners to prepare ethyne using calcium dicarbide and carrying out chemical reactions of alkynes (combustion, hydration, halogenations, hydrogenation, and addition of hydrogen halides).
- Guide learners in the practical identifications of the functional group reaction with ammoniacal silver nitrate and copper(I) chloride.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain chemical properties of alkynes including mechanisms of the reactions (for halogen halides, bromine,  $\text{H}_2\text{O}/\text{H}^+(\text{aq})$ ).
  - carry out test tube experiments to identify the functional group.
  - explain the chemical reactions for the identification of the functional group.
  - explain the functional group reaction with ammoniacal silver nitrate and ammoniacal copper I chloride.

## Topic 17: Halogen compounds (Alkyl halides)

Duration: 06 Periods

### General Objective

By the end of this topic, the learner should be able to appreciate the nature, chemistry and uses of Halogen compounds.

### Sub-Topic 1: Introduction to Halogen Compounds and Their Physical Properties

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>name alkyl halides.</li><li>show structures of alkyl halides.</li><li>explain physical properties of alkyl halides.</li><li>describe the preparation of alkyl halides in laboratory.</li></ul>	<ul style="list-style-type: none"><li>Nomenclature</li><li>Structure and isomers</li><li>Physical properties of halogen compounds<ul style="list-style-type: none"><li>- Solubility, density, melting point and boiling point</li></ul></li><li>Preparation methods</li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the general formula, nomenclature, preparation, physical properties of halogen compounds.
- Explain the effect of halogen group on the stability of the benzene ring.

### Practical Problems

- Guide learners to prepare ethyne using calcium dicarbide and carrying out chemical reactions of alkynes (combustion, hydration, halogenations, hydrogenation, and addition of hydrogen halides).
- Guide learners in the practical identifications of the functional group reaction with ammoniacal silver nitrate and copper(I) chloride.

## Assessment Strategies

- Give class exercises requiring learners to:
  - draw the structure of halo-alkanes and halo benzene.
  - name halogen compounds using IUPAC.
  - explain inductive effects of halogen group on the stability of the benzene ring.
  - explain how halogen compounds are prepared in the laboratory.
  - explain the physical properties of halogen compounds.

## Sub-Topic 2: Chemical Properties and Uses of Halogen Compounds

Specific Objectives	Content
<ul style="list-style-type: none"> <li>• The learner should be able to:</li> <li>• explain chemical reactions of alkyl halides.</li> <li>• write mechanisms for the reactions.</li> <li>• state uses of alkyl halides.</li> </ul>	<ul style="list-style-type: none"> <li>• Chemical reactions           <ul style="list-style-type: none"> <li>- with <math>\text{H}_2\text{O}</math>, <math>\text{NaOH}</math>, <math>\text{NH}_3</math>, <math>\text{KCN}</math>, alcohol, <math>\text{Na}</math>, <math>\text{CH}_3\text{COOAg}</math></li> </ul> </li> <li>• mechanism of reaction showing <math>\text{SN}_1</math>, <math>\text{SN}_2</math> nucleophilic substitution, elimination reactions to produce alkenes and alkynes.</li> <li>• Uses of alkyl halides: <math>\text{CCl}_4</math>, <math>\text{CHCl}_3</math>, CFCs (chlorofluorocarbons)</li> </ul>

## Suggested Teaching and Learning Strategies

- Brainstorm the writing of equations and mechanisms; explain the difference between  $\text{SN}_1$  and  $\text{SN}_2$ ,  $\text{E}_1$  and  $\text{E}_2$  mechanisms, drawing energy diagrams for the mechanisms.
- Discuss the conditions for the reactions of alkyl halides with alkalis, concentrated ammonia, silver salts and oxide, cyanides, metals and write the equations and mechanisms of the reactions involved (except for metals and silver oxide).
- Discuss the reactions of halo benzene including; nitration, sulphonation, halogens, alkylation, acylation, hydrogenation and also explain the difference in reactivity between halo benzene and alkyl halides.

## Practical Problems

- Guide learners to carry out a laboratory experiments to differentiate between halo benzene and halogeno alkanes ( $\text{NaOH}$ ,  $\text{HNO}_3$ ,  $\text{AgNO}_3$ ).

## Assessment Strategies

- Give class exercises requiring learners to:
  - write the equations and mechanisms of the reactions involved (except reaction with metals and silver oxide)
  - explain the difference between  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$  and also  $\text{E}_{\text{1}}$  and  $\text{E}_{\text{2}}$  mechanisms
  - draw energy diagrams for the mechanisms
  - state conditions required for the different reactions
  - write the equations and mechanisms of the reactions involved (except oxidation and hydrogenation).
  - explain the differences in reactivity between halo benzene and alkyl halides.

## Topic 18: Benzene and methyl benzene

Duration: 30 Periods

### General Objective

By the end of this topic, the learner should be able to appreciate the nature, chemistry and uses of benzene and methyl benzene.

### Sub-Topic 1: Introduction to Benzene and its Physical properties of Benzene

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• draw the structure of benzene ring.</li> <li>• explain the stability of benzene ring.</li> <li>• describe the preparation of benzene.</li> <li>• explain the physical properties of benzenes.</li> </ul>	<ul style="list-style-type: none"> <li>• Structure (delocalisation of pi electrons, resonance, bond angles and bond length)</li> <li>• stability of benzene ring</li> <li>• Preparation (from ethyne, bromo benzene, decarboxylation of benzoic acid, reduction of phenol using zinc dust)</li> <li>• Physical properties             <ul style="list-style-type: none"> <li>- solubility, boiling point and melting points, density</li> </ul> </li> </ul>

### Suggested Teaching and Learning Strategies

- Brainstorm and discuss the structure of benzene using models.
- Lead a discussion on the stability of benzene ring.
- Guide learners in the preparation of benzene (from ethyne, bromo benzene, decarboxylation of benzoic acid, reduction of phenol using zinc dust).
- Discuss physical properties (solubility, boiling point and melting points, density).

### Practical Problems

- Guide learners can make models, charts of benzene.
- Guide learners to use chalkboard illustration, experiments on combustion, computer simulation to understand and explain the

structure of benzene (benzene vapour is highly toxic and must be used in **small amounts since it is carcinogenic**).

### Assessment Strategies

- Give class exercises requiring learners to:
  - draw the structure of benzene ring
  - explain the stability of benzene ring.
  - describe the preparation of benzene.
  - explain the physical properties of benzene.

### Sub-Topic 2: Chemical Properties of Benzene

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the chemical properties of benzene (include mechanisms, except combustion, hydrogenation).</li><li>• state conditions required for the different reactions.</li><li>• carry out test tube experiments to identify the functional group.</li><li>• explain the chemical reactions for the identification of the functional group.</li></ul>	<ul style="list-style-type: none"><li>• Chemical reactions:<ul style="list-style-type: none"><li>- With bromine and chlorine,</li><li>- alkylation, nitration, sulphonation, Acylation, combustion, hydrogenation in presence Raney nickel</li></ul></li></ul>

### Suggested Teaching and Learning Strategies

- Lead discussion on:
  - chemical properties of benzene (include mechanisms , except combustion, hydrogenation)
  - conditions required for the different reactions
  - test tube experiments to identify the functional group
  - the chemical reactions for the identification of the functional group
  - the uses of benzene

## Practical Problems

- Guide learners to do experiments on reaction between benzene and bromine in presence of iron. (**benzene vapour is highly toxic and must be used in small amounts since it is carcinogenic**)

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the chemical properties of benzene (include mechanisms , except combustion, hydrogenation).
  - state conditions required for the different reactions.
  - carry out test tube experiments to identify the functional group.
  - explain the chemical reactions for the identification of the functional group.
  - explain the uses of benzene.

## Sub-Topic 2: Introduction to Methyl benzene

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>draw the structure of methyl benzene.</li> <li>identify the Para and ortho-, meta positions.</li> <li>state the groups that are ortho-, meta- and para- directing.</li> </ul>	<ul style="list-style-type: none"> <li>Structural and molecular formula</li> <li>Preparation from benzene</li> <li>Inductive orientation on benzene ring in relation to methyl group (Para and ortho position).</li> <li>Examples of ortho-, meta- and para- directing groups</li> </ul>

## Suggested Teaching and Learning Strategies

- Lead a discussion on:
  - structural and molecular formula.
  - preparation from benzene.
  - inductive orientation on benzene ring in relation to methyl group (para and ortho position).
  - examples of ortho-, meta- and para-directing groups.
  - physical properties of methyl benzene.
  - comparison of physical properties of methyl benzene and benzene.

## Practical Problems

- Learners can make models and experiments on combustion using small quantities

## Assessment Strategies

- Give class exercises requiring learners to:
  - draw the structure of methyl benzene.
  - identify the Para and ortho-, meta positions.
  - state the groups that are ortho-, meta- and para- directing.
  - explain inductive effects of methyl group on the stability of the benzene ring.

## Sub-Topic 3: Physical Properties of Methyl Benzene

Specific Objectives	Content
<p>The learner should be able to;</p> <ul style="list-style-type: none"><li>• explain the physical properties of methyl benzene.</li><li>• explain inductive effects of methyl group on the stability of the benzene ring.</li><li>• compare the physical properties of methyl benzene with those of benzene.</li></ul>	<ul style="list-style-type: none"><li>• Physical properties of methyl benzene</li><li>• Physical properties of methyl benzene and benzene compared</li></ul>

## Suggested Teaching and Learning Strategies

- Discuss the physical properties of methyl benzene and let the learners understand the inductive effects of methyl group on the stability of the benzene ring.
- Brainstorm the comparison of the physical properties of methyl benzene and of benzene.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the physical properties of methyl benzene.
  - compare the physical properties of methyl benzene with those of benzene.

## SENIOR FIVE TERM III

### Topic 19: Alcohols and Phenols

Duration: 10 Periods

#### General Objectives

By the end of this topic, the learner should be able to appreciate the nature, chemistry and uses of alcohols and phenol.

#### Sub-Topic 1: Introduction to Alcohols and their Physical Properties

Specific Objectives	Content
The learner should be able to: <ul style="list-style-type: none"><li>• name and classify Alcohols</li><li>• explain physical properties of alcohols.</li><li>• describe methods of preparing alcohols.</li></ul>	<ul style="list-style-type: none"><li>• Nomenclature, structure and classification of alcohols.</li><li>• Physical properties<ul style="list-style-type: none"><li>- solubility, volatility</li></ul></li><li>• Preparation methods</li></ul>

#### Suggested Teaching and Learning Strategies

- Discuss the general formula, preparation (fermentation, industrial by hydration of alkenes, hydrolysis of alkyl halides, use of Grignard reagent, reduction of carbonyl compounds and carboxylic acids, from primary amines), nomenclature and physical properties of alcohols.

#### Practical Problems

- Guide learners to carry out a laboratory experiments to compare the solubility of different alcohols
- Guide learners to perform group experiments on fermentation of local materials to produce alcohol.

#### Assessment Strategies

- Give class exercises requiring learners to:
  - state general formula of alcohols

- describe the preparations of alcohols( fermentation and laboratory methods)
- name alcohols using IUPAC system.
- explain the physical properties of alcohols

## Sub-Topic 2: Chemical Properties of Alcohols

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain chemical properties of alcohols.</li><li>• write mechanisms of the reactions.</li><li>• describe essential preparation methods of ethanol.</li><li>• explain chemical properties of alcohols.</li><li>• carry out test tube experiments to identify the functional group.</li><li>• state uses of ethanol.</li></ul>	<ul style="list-style-type: none"><li>• Chemical properties:<ul style="list-style-type: none"><li>- reaction with Na, HCl, <math>\text{PCl}_5</math>, <math>\text{SOCl}_2</math>, <math>\text{CH}_3\text{COCl}</math> , <math>\text{CH}_3\text{COOH}</math>, and mechanisms</li><li>- dehydration and etherification (mechanism of reaction)</li><li>- Oxidation of alcohols: (<math>\text{MnO}_2</math>, <math>\text{CrO}_2\text{Cl}_2</math>, <math>\text{KMnO}_4</math>, <math>\text{K}_2\text{Cr}_2\text{O}_7</math>)</li></ul></li><li>• Study of ethanol: Preparation methods</li><li>• Test for alcohols</li><li>• Practical identifications of the functional group</li><li>• Uses of ethanol</li></ul>

## Suggested Teaching and Learning Strategies

- Discuss the general chemical properties (pH, reaction with:  $\text{H}_2\text{SO}_4$ , or  $\text{H}_3\text{PO}_4$ ,  $\text{HX}$ , Na,  $\text{PCl}_3$ ,  $\text{PCl}_5$ ,  $\text{SOCl}_2$ , esterification, oxidation, uses, effects of abuse of alcohols and also carrying out laboratory experiments on the chemical properties of alcohols.

## Practical Problems

- Guide learners to identify the alcohol functional group.
- Guide learners to distinguish between different classes of alcohols.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain chemical properties of alcohols including mechanisms of the reactions (except oxidation, reaction with phosphorus halides, sodium and thionyl chloride).

- carry out a test to distinguish the different classes of alcohols.
- explain uses of alcohols.
- carry out test tube experiments to identify the functional group in alcohols.
- explain the chemical reactions for the identification of the functional group.
- discuss the effects of alcohol abuse.

### Sub-Topic 3: Introduction to Phenol and its physical properties

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• write the formula of phenol.</li> <li>• draw the structure of phenol.</li> <li>• describe the different of preparing phenol.</li> <li>• explain the inductive effect of OH group on the properties of phenol.</li> <li>• explain the physical properties of phenol.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction ( general formula, functional groups)</li> <li>• Structure of phenol</li> <li>• Preparation           <ul style="list-style-type: none"> <li>- lab. Preparation (from chlorobenzene, hydrolysis of diazonium salts, benzene sulphonic acid)</li> <li>- industrial preparation (from petroleum oil, the Cumene process)</li> </ul> </li> <li>• Physical properties:           <ul style="list-style-type: none"> <li>- appearance, melting and boiling points, solubility</li> </ul> </li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the general formula, preparation (Laboratory and industrial), nomenclature, physical properties of phenol and effect of the OH group on the properties of phenol.

### Practical Problems

- Guide learners to model the structure of phenol.

### Assessment Strategies

- Give class exercises requiring learners to:

- write the formula of phenol.
- draw the structure of phenol.
- describe the different methods of preparing phenol.
- explain the physical properties of phenol.
- explain the inductive effect of OH group on the properties of phenol.

### Sub-Topic 4: Chemical Properties and Uses of Phenols

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the chemical properties of phenol.</li><li>• compare the reactivity of OH group of phenol with those of aliphatic alcohols.</li><li>• carry out confirmatory tests for phenol.</li><li>• carry out test tube experiments to identify the functional group.</li><li>• explain the chemical reactions for the identification of the functional group.</li><li>• give uses of phenol.</li></ul>	<ul style="list-style-type: none"><li>• Chemical Reactions<ul style="list-style-type: none"><li>- pH, reaction of -OH group (Na, acid chlorides, <math>\text{PCl}_5</math>, zinc dust, sodium hydroxide and Esterification); reactions of the benzene ring(hydrogenation, nitration, sulphonation, halogenations, alkylation, Acylation)</li><li>- Chemical test for Phenol</li><li>- Practical identifications of the functional group</li></ul></li><li>• Uses of phenol</li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the chemical properties of phenol [ pH, reaction of -OH group (Na, acid chlorides,  $\text{PCl}_5$ , Zinc dust, sodium hydroxide and Esterification), reactions of the benzene ring (hydrogenation, nitration, sulphonation, halogenations, alkylation, acylation), chemical test for Phenol, and also carrying out laboratory experiments on the chemical properties of phenol.

### Practical Problems

- Guide learners to identify the functional group in phenol
- Guide learners to carry out laboratory experiments on the chemical reactions of phenol

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain the chemical properties of Phenol.

- compare the reactivity of OH group of phenol with those of aliphatic alcohols.
- explain the confirmatory test for phenol.
- explain the chemical reactions for the identification of the functional group.
- give uses of phenol.

## SENIOR SIX TERM I

**Topic 20: Carbonyl Compounds (Ketones and Aldehydes)**

Duration: 08 Periods

**General Objectives**

By the end of this topic, the learner should be able to appreciate the nature, chemistry and uses of carbonyl compounds.

**Sub-Topic 1: Introduction to Carbonyl Compounds and their Physical Properties**

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>state general formulae of carbonyl compounds.</li><li>name aldehydes and ketones using IUPAC system.</li><li>prepare the preparations of carbonyl compounds.</li><li>explain the physical properties of carbonyl compounds.</li><li>compare the physical properties of aldehydes and ketones in relation to their structure.</li><li>compare the physical properties of carbonyl compounds and those of alcohols.</li></ul>	<ul style="list-style-type: none"><li>Introduction (general formula, functional groups, nomenclature using IUPAC rules)</li><li>Lab. Preparations<ul style="list-style-type: none"><li>- oxidation of alcohols</li><li>- hydrolysis of dihalides</li></ul></li><li>Solubility,<ul style="list-style-type: none"><li>- physical states</li></ul></li><li>Boiling points and melting point</li><li>Physical properties</li></ul>

## Suggested Teaching and Learning Strategies

- Discuss the general formula, preparation, nomenclature and physical properties of aldehydes and ketones.

## Practical Problems

- Guide learners to carry out an experimental demonstration to prepare carbonyl compounds by oxidation of alcohols using acidified potassium dichromate.

## Assessment Strategies

- Give class exercises requiring learners to:
  - state general formulae of carbonyl compounds.
  - state how carbonyl compounds are prepared.
  - name aldehydes and ketones using IUPAC system.
  - explain the physical properties of carbonyl compounds.
  - compare the physical properties of aldehydes and ketones in relation to their structure.
  - compare the physical properties of carbonyl compounds and those of alcohols.

## Sub-Topic 2: Chemical Properties and Uses of Carbonyl Compounds

Specific objectives	Content
The learner should be able to: <ul style="list-style-type: none"> <li>explain the chemical properties of carbonyl compounds giving mechanisms for the reactions (except oxidation, reduction).</li> <li>interpret chemical reactions with Fehling's and Tollens' reagent.</li> <li>carry out tests to identify the carbonyl functional groups.</li> <li>carry out tests distinguish between aldehydes and ketones.</li> </ul>	<ul style="list-style-type: none"> <li>Chemical properties addition reactions (<math>\text{NaHSO}_3</math>, <math>\text{CN}^-</math>)</li> <li>Reduction (<math>\text{LiAlH}_4</math>, <math>\text{NaBH}_4</math>, <math>\text{Na/ethanol}</math>, <math>\text{H}_2/\text{Ni}</math>)</li> <li>Condensation reactions (hydroxamines, hydrazine, phenyl hydrazine, 2,4-dinitrophenyl hydrazine (Brady's reagent)</li> <li>Oxidation reactions (<math>\text{Cr}_2\text{O}_7^{2-}/\text{H}^+</math>, <math>\text{KMnO}_4/\text{H}^+</math>, <math>\text{I}_2/\text{OH}^-</math>)</li> <li>Distinguishing reaction between aldehydes and ketones</li> </ul>

Specific objectives	Content
<ul style="list-style-type: none"><li>• explain the chemical reactions for the identification of functional groups.</li><li>• give uses of carbonyl compounds.</li></ul>	<ul style="list-style-type: none"><li>• Practical identifications of the functional groups</li><li>• Uses of carbonyl compounds (methanol and acetone)</li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the chemical properties and uses of carbonyl compounds and also carrying out laboratory experiments on the chemical properties of carbonyl compounds.

### Practical Problems

- Guide learners to identify the carbonyl functional group.
- Guide learners to distinguish between aldehydes and ketones of carbonyl compounds.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain the chemical properties of carbonyl compounds giving mechanisms for the reactions (except oxidation, reduction).
  - carry out tests to identify the carbonyl functional group.
  - explain the chemical reactions for the identification of the functional group.
  - carry out test tube experiments to show the chemical properties of carbonyl compounds.
  - carry out tests to distinguish between aldehydes and ketones of carbonyl compounds.
  - state the uses of carbonyl compounds.

## Topic 21: Carboxylic (Alkanoic) acids

Duration: 06 Periods

### General Objective

By the end of the topic, the learner should able to outline the nature, chemistry and uses of carboxylic acids.

### Sub-Topic 1: Introduction to Carboxylic Acids and their Physical Properties

Specific Objectives	Content
<p>The learner should be able:</p> <ul style="list-style-type: none"> <li>• state general formula of alkanoic acids.</li> <li>• name alkanoic acids using IUPAC system.</li> <li>• describe the general methods of preparations of alkanoic acids.</li> <li>• explain the physical properties of alkanoic acids.</li> <li>• compare the physical properties of carboxylic acids with those of alcohols and carbonyl compounds.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction (general formula, functional group, nomenclature using IUPAC rules)</li> <li>• Lab. Preparations <ul style="list-style-type: none"> <li>- oxidation of primary alcohols, aldehydes</li> <li>- use of Grignard reagent</li> <li>- hydrolysis of nitriles, esters, acid amides</li> </ul> </li> <li>• Physical properties, <ul style="list-style-type: none"> <li>- melting point and boiling point, solubility, physical state (volatility)</li> </ul> </li> </ul>

### Suggested Teaching and Learning Strategies

- Brainstorm the general formula, preparation, nomenclature and physical properties of carboxylic acids.

### Practical Problems

- You can carry out experimental demonstrations to prepare carboxylic acids by oxidation of alcohols and aldehydes using acidified potassium dichromate.

## Assessment Strategies

- Give class exercises requiring learners to:
  - state general formulae of carboxylic acids.
  - state how carboxylic acids can be prepared.
  - name carboxylic acids using IUPAC system.
  - explain the physical properties of Carboxylic acids.
  - explain the role of hydrogen bonding on the physical properties of carboxylic acids.
  - compare the physical properties of Carboxylic acids with those of alcohols and carbonyl compounds.

## Sub-Topic 2: Chemical Properties and Uses Carboxylic Acids

Specific Objectives	Content
<p>The learner should be able:</p> <ul style="list-style-type: none"><li>• describe chemical properties of carboxylic acids .</li><li>• discuss the unique properties of methanoic acid</li><li>• carry out test tube experiments to identify the functional group.</li><li>• state uses of carboxylic acids.</li></ul>	<ul style="list-style-type: none"><li>• Chemical properties<ul style="list-style-type: none"><li>- acidic behaviour (effect on litmus, metals, NaOH, carbonates/hydrogen carbonates)</li><li>- effect of substituent on acid strength</li><li>- esterification</li><li>- reaction with; PCl<sub>5</sub>, Cl<sub>2</sub></li><li>- reduction with LiAlH<sub>4</sub>, H<sub>2</sub></li><li>- decarboxylation</li></ul></li><li>• Uses of carboxylic acids</li></ul>

## Suggested Teaching and Learning Strategies

- Discuss the chemical properties and uses of carboxylic acids. Carry out laboratory experiments on the chemical properties of carboxylic acids.

## Practical Problems

- You can carry out a laboratory experiment to demonstrate the preparation of carboxylic acids using oxidation of alcohols and aldehydes with acidified potassium dichromate.

- The learners can carry out laboratory experiments to identify the functional group in carboxylic acids

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain chemical properties of alkanoic acids including mechanisms of the reactions for Esterification.
  - explain uses of alkanoic acids.
  - discuss the unique properties of methanoic acid.
  - carry out test tube experiments to identify the functional group of alkanoic acids.
  - explain the chemical reactions for the identification of the functional group.
  - give uses of alkanoic acids.

### Sub-Topic 3: Soaps and Soapless Detergents

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>describe the preparation of soaps and soapless detergents.</li> <li>explain the cleansing action of soap and soapless detergents.</li> <li>explain the advantages and disadvantage.</li> <li>explain the effect of soaps and soapless detergents on the environment.</li> </ul>	<ul style="list-style-type: none"> <li>Preparation of soaps and detergents</li> <li>Preparation of soapless detergents</li> <li>Cleansing action of soap and soapless detergents</li> <li>Advantages and disadvantages of soaps and detergents (effect of soaps and detergents on the environment)</li> </ul>

### Suggested Teaching and Learning Strategies

- Brainstorm the preparation of soap and detergents, advantages and disadvantages of soap and detergents, effect of soap and detergents on the environment. Carry out a class experiment to prepare soap in the laboratory.

## Practical Problems

- You can carry out an experimental demonstration to prepare soap in the laboratory
- Learners can also visit a soap manufacturing plant to observe the industrial manufacture of soap and also the effects of soap on the environment.

## Assessment Strategies

- Give class exercises requiring learners to:
  - describe the preparation of soap
  - describe the preparation of soap less detergent
  - explain the cleansing action of soap and soapless detergents
  - explain the advantages and disadvantages of soap and soapless detergents
  - explain the effect of soaps and soapless detergents on the environment

## Topic 22: Esters

Duration: 04 Periods

### General Objective

By the end of the topic, the learner should be able to explain the nature, chemistry and uses of esters.

### Sub-Topic 1: Introduction to Esters and their Physical properties

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• state general formula of esters.</li> <li>• name esters using IUPAC system.</li> <li>• describe the preparations of esters.</li> <li>• explain the physical properties of esters.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction (occurrence, general formula, functional group, nomenclature using IUPAC rules)</li> <li>• Laboratory preparations (Esterification reaction)</li> <li>• Physical properties: Smell, solubility, melting points and boiling points</li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the occurrence, general formula, nomenclature, laboratory preparation and physical properties of esters.

### Practical Problems

- You can practically demonstrate preparation of esters from carboxylic acids and alcohols.

### Assessment Strategies

- Give class exercises requiring learners to:
  - state general formula of esters.
  - describe the preparations of esters.
  - name esters using IUPAC system.
  - explain the physical properties of esters.

## Sub-Topic 2: Chemical Properties and Uses of Esters

<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain chemical properties of esters including mechanisms of the reactions.</li><li>• explain the chemical reactions for the identification of the functional group.</li><li>• explain uses of esters.</li></ul>	<ul style="list-style-type: none"><li>• Chemical properties<ul style="list-style-type: none"><li>- Hydrolysis</li><li>- Reduction</li><li>- Ammonolysis</li></ul></li><li>• Uses of esters</li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the chemical reactions of esters and their mechanisms (hydrolysis, reduction, ammonolysis) and uses of esters.

### Practical Problems

- You can practically demonstrate identification the functional group of esters.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain chemical properties of esters including mechanisms of the reactions.
  - explain uses of esters

SENIOR SIX

TERM II

## Topic 23: Amines

Duration: 08 Periods

### General Objective

By the end of this topic, the learner should be able to describe the nature, chemistry and uses of amines.

### Sub-Topic 1: Introduction to Amines and their physical properties

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• state general formula of amines.</li> <li>• name amines using IUPAC system.</li> <li>• describe the preparations of amines.</li> <li>• explain the physical properties of amines.</li> <li>• explain the basic properties of amines.</li> </ul>	<ul style="list-style-type: none"> <li>• Introduction (general formula, functional group, nomenclature using IUPAC rules), Classification of amines</li> <li>• Laboratory preparations; reduction of nitro compounds, nitriles, amides using LiAlH<sub>4</sub> reaction between alkyl halide and ammonia ;Hofmann's degradation</li> <li>• Physical properties Solubility, Melting points and boiling points</li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the occurrence, general formula, nomenclature, laboratory preparation and physical properties of amines.

## Practical Problems

- Guide learners to carry out preparation of the amines in the laboratory.

## Assessment Strategies

- Give class exercises requiring learners to:
  - state general formula of amines.
  - name amines using IUPAC system.
  - describe the preparations of amines.
  - explain the physical properties of amines.

## Sub-Topic 2: Chemical properties and uses of Amines

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain chemical properties of amines (include mechanisms for alkylation).</li><li>• explain the effect of temperature on reaction with nitrous acid.</li><li>• carry out test tube experiments to identify the functional group.</li><li>• explain the chemical reactions for the identification of the functional group.</li><li>• state uses of amines.</li><li>• state the uses of dyes (social and economic aspects).</li></ul>	<ul style="list-style-type: none"><li>• Chemical properties:<ul style="list-style-type: none"><li>- pH</li></ul></li><li>• the effect of substituent on basic strength, reaction with acids, Acylation, alkylation</li><li>• Reaction with nitrous acids<ul style="list-style-type: none"><li>- Diazotisation</li><li>- Bromination, sulphonation, nitration, of aromatic amines</li></ul></li><li>• Practical identifications of the functional group</li><li>• Uses amines</li><li>• Uses of dyes</li></ul>

## Suggested Teaching and Learning Strategies

- Discuss the chemical reactions ( pH, the effect of substituent on basic strength, reaction with acids, acylation, alkylation, reaction with nitrous acids, diazotisation bromination , sulphonation, nitration, of aromatic amines), uses and also carrying out chemical tests for amines.

## Practical Problems

- Guide learners to carry out laboratory experiments on the chemical properties of amines including the chemical tests for the functional group and distinguish between classes of amines using NaNO<sub>2</sub>/concentrated HCl

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain chemical properties of amines.
  - describe chemical tests for amines a test for amines.
  - give uses of amines.

## Topic 24: Polymers and Polymerisation

Duration: 06 Periods

### General objective

By the end of this topic, the learner should be able to explain polymers and polymerisation and describe formation of natural and synthetic polymers with their uses.

### Sub-Topic 1: Introduction to Polymers

Specific Objectives	Content
<p>The leaner should be able to:</p> <ul style="list-style-type: none"><li>• explain the process of polymerisation.</li><li>• differentiate between addition and condensation polymerisation.</li><li>• describe the structures of the different classes of polymers.</li><li>• explain the different types of polymers.</li></ul>	<ul style="list-style-type: none"><li>• What Polymers and are</li><li>- concept of polymers and polymerisation.</li><li>• types of polymerisation (addition and condensation)</li><li>• classes of polymers (natural and synthetic polymers)</li><li>• Types of Polymers</li><li>- rubbers, fibres and plastics</li></ul>

### Suggested Teaching and Learning Strategies

- Discuss the process of polymerisation, difference between addition and condensation polymerisation, different classes of polymers, different types of polymers.

### Practical Problems

- You can use models to show the different monomers and how they can combine to form polymers.

### Assessment Strategies

- Give class exercises requiring learners to:
  - explain the process of polymerisation.
  - differentiate between addition and condensation polymerisation.
  - describe the structures of the different classes of polymers.
  - explain the different types of polymers.

## Sub-Topic 2: Rubber

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• describe the occurrence, structure, properties and vulcanisation of natural rubber.</li> <li>• describe the process of preparation of artificial rubber.</li> <li>• give the properties and uses of artificial rubber.</li> </ul>	<ul style="list-style-type: none"> <li>• Rubber           <ul style="list-style-type: none"> <li>- Natural rubber(occurrence, structure , properties vulcanisation)</li> <li>- Synthetic rubber(preparation, structure and properties)</li> </ul> </li> <li>• Uses</li> </ul>

### Suggested Teaching and Learning Strategies

- Discuss the occurrence, structure, properties and vulcanisation, process of manufacture of synthetic rubber, properties and uses.

### Assessment Strategies

- Give class exercises requiring learners to:
  - describe the occurrence, structure, properties and vulcanisation of natural rubber.
  - describe the process of preparation of synthetic rubber.
  - give the properties and uses of synthetic rubber.

## Sub-Topic 3: Fibres

Specific objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"> <li>• mention the occurrence of natural fibres and their uses.</li> <li>• explain the properties of natural fibres.</li> <li>• give examples of natural and artificial fibres.</li> <li>• explain the preparation of synthetic fibres.</li> <li>• explain the properties of artificial fibres.</li> <li>• give the uses of artificial fibres.</li> </ul>	<ul style="list-style-type: none"> <li>• Fibres</li> <li>• Natural fibres(occurrence, examples and uses)</li> <li>• Examples: starch, cotton, silk, proteins</li> <li>• Synthetic fibres(preparation, structure and uses)</li> <li>• Examples: nylon and terylene, Propeno-nitrile fibre</li> </ul>

## Suggested Teaching and Learning Strategies

- Discuss the occurrence, structure, properties, examples and uses of natural fibres, process of manufacture, properties examples and uses of artificial fibres.

## Practical Problems

- Guide learners to identify natural and synthetic fibres.

## Assessment Strategies

- Give class exercises requiring learners to:
  - describe the occurrence of natural fibres and their uses.
  - explain the properties of natural fibres.
  - give examples of natural and artificial fibres.
  - explain the preparation of synthetic fibres.
  - explain the properties of artificial fibres.
  - give the uses of artificial fibres.

## Sub-Topic 4: Plastics

Specific Objectives	Content
<p>The learner should be able to:</p> <ul style="list-style-type: none"><li>• explain the concept of plastics.</li><li>• explain the differences between thermo setting and thermo softening plastics.</li><li>• describe the process of preparation of selected plastics.</li><li>• identify monomers and the related polymers of plastics.</li><li>• construct a unit structural formula of a polymer from a monomer.</li><li>• give uses of natural and synthetic polymers.</li><li>• identify environmental effects of artificial polymers.</li></ul>	<ul style="list-style-type: none"><li>• Plastics</li><li>- thermo setting plastics (thermoplastics)</li><li>- thermo plastics (thermo softening)</li><li>- structure</li><li>- preparation</li><li>- properties</li><li>- examples: PVC, polyethene, polypropene</li><li>• Uses</li><li>• Effects of plastics on the environment</li></ul>

## Suggested Teaching and Learning Strategies

- Discuss the preparation, structure, properties, examples, uses of plastics and also the environmental effects of artificial polymers.

## Practical Problems

- You can organise a field trip to a plastic manufacturing plant.

## Assessment Strategies

- Give class exercises requiring learners to:
  - explain the meaning of plastics.
  - explain the differences between thermosetting and thermosoftening plastics.
  - describe the process of preparation of selected plastics.
  - identify monomers and the related polymers of plastics.

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**Uganda Advanced  
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## Introduction

This Agriculture teaching syllabus is intended for the Advanced Level Agriculture course as a principle subject in Uganda secondary schools. The syllabus gives guidance as much as possible on what is to be taught. It emphasises that teaching of Agriculture must be as participatory as possible. This means that most of the learner's time should be spent on practical or actual farming activities.

The content developed in this syllabus has taken care of the contemporary issues and evolving trends in Agriculture. It calls for the learners to utilise their previous experiences and skills. This demands that both the teacher and learners must engage in hands-on activities interpreted and designed from the content. This is because learning is best achieved by doing.

On the other hand, the teacher is encouraged to use the locally available resources to organise the practical activities for the learners.

The Agriculture teaching syllabus is keenly linked to the requirement of Advanced level certificate that prepares students for entry into tertiary institutions. The purpose of the syllabus is to assist students and teachers to effectively prepare for the Uganda Advanced Level Certificate of Education.

It covers all the topics expected to be covered at this level. It also assumes that the topics covered in Uganda Certificate of Education are not repeated.

## Rationale

The economy of Uganda depends largely on agriculture. However, Uganda's agriculture is still largely subsistence and productivity is low. There is a high population growth rate in the country, which has exerted pressure on the existing farmland, aggravated the food security situation and increased poverty levels in the communities especially in the rural areas. These factors have led to encroachment on protected areas resulting in environmental degradation. Urban farming is also gaining popularity and it is meeting some of the food needs of the urban people besides supplementing their income through sale of some of the produce.

Therefore, agriculture transformation is necessary to move it from subsistence to commercial farming and to improve productivity and quality of farm produce. Government has made interventions, such as the Plan for Modernisation of Agriculture (PMA), the National Development Plan (NDP)

and Development Investment Strategy Programme (DISP), which aim at addressing key factors responsible for low agricultural productivity. These factors include low educational levels of farmers, lack of information and lack of skills especially in modern agricultural production. These factors limit the ability of farmers to access and benefit from livelihood opportunities. Human capital, must, therefore, be developed in order to transform agriculture and hence eradicate poverty. This can partly be done through informal and formal education.

The aim of agricultural education in schools is to equip young people with necessary knowledge and skills to implement the transformation of the agricultural sector and improve agricultural productivity. The advanced level certificate Principles and Practices of Agriculture syllabus besides equipping the students with higher level of knowledge and skills for agricultural production, it prepares them for progression to tertiary institutions. The syllabus therefore, addresses crucial issues, such as improved agriculture practices, new and appropriate crop and livestock technologies, high value crops, and practical skills. Aware that agricultural productivity needs to be sustained, the syllabus relates production practices to proper environmental management. It also addresses issues related to population and gender in agricultural production.

## Purpose of the Syllabus

The syllabus is aimed at equipping students with the necessary knowledge, skills and attitudes to pursue further studies in agricultural fields, engage in gainful agricultural employment and to use natural resources sustainably for agricultural production.

## General Objectives

The learner should be able to:

- acquire knowledge and practical skills required for increased and sustainable agricultural production.
- develop a positive attitude towards agriculture and have respect for work.
- make informed farming decisions.
- acquire entrepreneurial skills for profitable agricultural production.
- apply knowledge and skills to improve agricultural production in his or her locality.
- acquire necessary knowledge and practical skills in processing, preserving and adding value to agricultural products.
- apply practical agricultural skills for self-reliance and self-employment.

- integrate gender issues into agricultural production.
- gain the necessary background agricultural knowledge and skills to further their education.

## Entry Requirements

For one to qualify to offer agriculture at Advanced level, one should have done Agriculture at O level and passed it with at least a credit.

### ***Subject combination***

Agriculture at Advanced level should be offered in combination with other science subjects.

### ***Minimum requirements***

Minimum requirements for a secondary school to offer agriculture at advanced level are:

- Qualified graduate trained agriculture teachers
- School farm with adequate facilities for a student to carry out practical work and projects
- Laboratory facilities for practical lessons
- Relevant instructional materials, tools and equipment for agriculture

## Examining Authority

The Advanced level certificate Principles and Practices of Agriculture syllabus shall be examined by Uganda National Examinations Board (UNEB). It will be examined with three examination papers.

## Mode of Assessment

### ***a) Continuous assessment***

This should be carried out through the following: written exercises, project reports, case study analyses and group work reports.

### ***b) Summative assessment***

This will be done at the end of a school term or year. It should follow the Uganda National Examination Board format shown below.

### **Paper 1: Theory short answer questions (2 hours 30 minutes)**

The paper will consist of multiple and short answer questions all of which will be compulsory. It will have two sections as follows:

- Section A is composed of 30 multiple-choice questions. (30 marks)

- Section B is composed of 7 structured questions. (70 marks)

### **Paper 2: Theory essay type questions (3 hours)**

This paper will consist of 5 sections (A, B, C, D and E) representing the 5 sections of the syllabus. Section A will have only one compulsory question. The other sections will have two questions each, out of which a candidate answer only one question. Therefore, the paper will consist of nine questions out of which, a candidate will attempt 5. Each question will carry a maximum score of 20 marks making a total score of 100 marks for the paper.

### **Paper 3: Practical (2 Hours)**

The paper will consist of 5 compulsory questions from different sections of the syllabus. Each question will be awarded a maximum of 10 marks. (50marks)

## **Suggested Projects**

### ***Animal Production***

1. Raising poultry from a day-old chicks to:
  - i) table stage (broilers)
  - ii) egg laying stage (layers)
2. Feed-making and testing for animals (feed trials)
3. Improving local chicken by crossing with exotics, and carrying out management
4. Raising pigs from piglet stage to slaughter stage
5. Management of a zero-grazing unit (dairy animals)
6. Rabbit keeping
7. Goat keeping

### ***Crop Production***

1. High value crops
2. Vegetables:
  - i) Pepper
  - ii) Okra
3. Annual crops:
  - i) maize
  - ii) beans
6. Medicinal crops:
  - i) Artimesia sp,
  - ii) Moringa
  - iii) Aloe vera
7. Spices:

- i) ginger
  - ii) pepper
8. Mushrooms

### ***Food Processing and Storage***

1. Processing and preserving crops/foods using local methods
2. Developing new technologies in food processing and preservation
3. Agricultural engineering and farm mechanisation
4. Designing and construction of animal structures/house (animal)
5. Designing and making solar driers and using them (crop)
6. Designing and making storage facilities e.g. granaries, etc (crop)

**Note:** Projects may also be assigned in other areas of the syllabus.

### **Time Allocation**

#### ***Time Allocation per Term***

Class	Term	Minimum total learning time/term (weeks)	Periods / week	Time/ period (minutes)	Total time/ week (hours)	Total time/ term (hours)	Periods/ term
S5	I	7	9	40	6	42	63
	II	10	9	40	6	60	90
	III	8	9	40	6	48	72
	<b>Annual</b>	<b>25</b>				<b>150</b>	<b>225</b>
S6	I	10	9	40	6	60	90
	II	9	9	40	6	44	81
	III	6	9	40	6	46	54
	<b>Annual</b>	<b>25</b>				<b>150</b>	<b>225</b>
<b>Total for the course</b>		<b>50</b>				<b>300</b>	<b>450</b>

#### ***Note***

Allocation of time was arrived at bearing the following in mind:

- Time of reporting for S5 in Term I
- School activities like sports, music, etc.
- Internal examinations and UNEB examinations
- Public holidays

## Syllabus Teaching Sequence

Class	Term	Topics	Sub-Topics	Periods
S5	I	1. Basic Science I	- Cytology - Genetics, Variation, Selection and Genetic Engineering	27
		2. Crop Production I	- Soil Composition - Soil and Water as Farming Resources - Soil Fertility I	18
		3. Animal Production I	- Status of Livestock Production in Uganda - Classification of Livestock - Livestock Improvement	18
				63
S5	II	4. Basic Science II	- Chemicals of Life - Plant Morphology and Physiology - Reproduction in Plants - Animal Anatomy and Physiology - Micro and Macro Organisms of Agricultural Importance	45
		5. Crop Production II	- Soil Fertility II - Production of High Value Crops	24
		6. Animal Production II	- Poultry Breeding - Livestock Management	21
				90
S5	III	7. Basic Science III	- Ecology I - Ecology II - Farm Chemicals	18
		8. Crop Production III	- Agro-Forestry	9
		9. Animal Production III	- Fish Farming - Beekeeping - Livestock Rearing and Environment - Animal Nutrition	45

<b>Class</b>	<b>Term</b>	<b>Topics</b>	<b>Sub-Topics</b>	<b>Periods</b>
				<b>72</b>
S6	<b>I</b>	10. Crop Production IV	- Crop Improvement	24
		11. Animal Production IV	- Investigation and Projects Guidelines - Animal Health - Dairy Production - Livestock Records - Pasture Management	45
		12. Agricultural Economics and Farm Management I	- Population and its Influence on Agriculture - Gender and Agricultural Production	21
				<b>90</b>
S6	<b>II</b>	13. Crop Production V	- Urban and Peri-Urban Farming	9
		14. Agricultural Economics and Farm Management II	- Production Theory - Factors of Production - Marketing Behaviour And Strategies - Farm Planning and Management	54
		15. Agricultural Engineering & Farm Mechanisation I	- Simple Mechanics - Management of Work Animal	27
				<b>90</b>
S6	<b>III</b>	16. Crop Production VI	- Crop Protection - Project Reports	18
		17. Agricultural Engineering and Farm Mechanisation II	- Construction Materials - Farm Equipment and Tools - Farm Structures	27
		18. Agricultural Economics and Farm Management III	- Agricultural Policies - Land Polices in Uganda - Farmers' Organisations	18
				<b>63</b>

## Competences

By the end of the course, a learner should have developed competences in the five sections of agriculture as follows:

### Basic Science

#### I. Chemicals of life

The learner should be able to:

- describe the basic structures of proteins, carbohydrates and lipids.
- explain the importance of proteins, lipids, carbohydrates, minerals, vitamins and water in organisms.

#### II. Genetics

The learner should be able to:

- describe the processes of cell division.
- explain the importance of cell division in inheritance.
- explain the processes and causes of variation in organisms.
- explain basic principles in genetic engineering.
- explain the processes of selection in populations of organisms.
- describe the metabolism of proteins, lipids, carbohydrates, minerals, vitamins and water in organisms.
- carry out tests to identify proteins and carbohydrates.

#### III. Plant morphology and physiology

The learner should be able to:

- describe the structure and functions of plant leaves, roots, flowers and vascular systems.
- describe the processes of mineral uptake, photosynthesis, transpiration, transport and reproduction in plants.
- explain nutritional requirement of plants.

#### IV. Animal anatomy and physiology

The learner should be able to:

- describe the structure and functioning of the reproductive, respiratory and digestive systems of farm animals.
- describe the signs and symptoms of nutritional deficiency diseases in farm animals.
- explain nutritional requirements of animals.

#### V. Micro and macro organisms of agricultural importance

The learner should be able to:

- explain the importance of micro organisms in agriculture.

- describe the different types of beneficial and harmful micro organisms.
- describe the life cycles of crop and livestock disease causing micro organisms.

## VI. Ecology

The learner should be able to:

- define an eco-system.
- describe the components of an ecosystem and their inter-relationships.
- describe different types of ecosystems.
- explain energy flow in an ecosystem.
- explain the effects of human interference on the environment.
- describe the methods used to preserve an ecosystem.

## VII. Farm chemicals

The learner should be able to:

- carry out tests to identify radicals in farm chemicals.
- explain the uses of farm chemicals.
- use farm chemicals correctly and safely.

## Livestock Production

The learner should be able to:

- explain the role of livestock production in improving the welfare of the individual, family, community and the nation.
- select suitable livestock breeds/species for a given production area.
- select the best animals within breeds/species for rearing and breeding.
- apply appropriate technologies to improve livestock production.
- carry out recommended livestock rearing practices.
- care for the environment while rearing and treating livestock.
- formulate suitable feeds for various categories of livestock.
- feed various categories of livestock correctly.
- recognise parasites and diseases in livestock.
- take appropriate measures to control parasites and diseases in livestock.
- produce quality products and by-products from livestock.
- market livestock products and by-products profitably.
- keep appropriate livestock production records.
- use records to ensure profitable livestock production.
- harness animal power to do farm work.

- establish and manage pastures for grazing livestock.
- establish and manage livestock projects efficiently.
- explain the importance of gender equity in livestock production.
- explain principles involved in urban and peri-urban livestock farming.
- carry out practices in urban and peri-urban livestock farming.
- adopt new technologies and innovations to improve livestock production.
- integrate tree growing into livestock production.
- practice organic livestock farming.
- use and maintain simple farm structures for livestock production.
- design and construct simple farm structures for livestock production.
- explain the role of research and research organisations in livestock production.

## Crop Production

### I. Soils

The learner should be able to:

- explain the concept of soil and water conservation.
- identify signs of soil degradation and loss of fertility.
- use appropriate methods to conserve soil and water.
- explain causes of soil fertility loss and soil degradation.
- describe the different methods of conserving soil and water.
- carry out measures to maintain and improve soil fertility.
- prepare different types of organic manures.
- analyse different inorganic fertilizers for different nutrients in them.
- apply the most appropriate fertilizers with due considerations to cost and safety of the environment.
- carry out soil analysis to determine soil composition and properties.

### II. Crops

The learner should be able to:

- explain the role of crops in the welfare of the individual, family, community and the nation.
- explain the principles of crop improvement.
- recognise crop pest and disease damage in the field and in storage.
- devise methods of minimising pest and disease damage with due regard to safety of the environment.

- adopt new technologies and innovations to improve crop production.
- raise high value crops with export potential.
- describe crop project quality requirements for both the local and export market.
- carry out appropriate post-harvest handling practices to reduce losses.
- add value to crop products using appropriate methods and technologies.
- integrate tree growing into crop production.
- practice organic crop farming.
- explain principles involved in urban and peri-urban crop farming.
- carry out practices involved in urban and peri-urban crop farming.
- explain the importance of gender equity in crop production.

## Agricultural Engineering and Farm Mechanisation

The learner should be able to:

- explain the importance of mechanisation in modernising agriculture.
- explain the effects of farm mechanisation on the environment.
- use appropriate tools, equipment and machinery in farming.
- maintain farm tools, equipment and machinery properly.
- design and construct simple farm tools and equipment.
- construct and maintain simple farm structures.
- design simple rainwater harvesting and storage systems for domestic and farm use.
- explain the role of research and research organisations in agricultural mechanisation.

## Agricultural Economics/Agribusiness

The learner should be able to:

- choose the most profitable farming enterprises.
- budget for profitable agricultural production.
- manage the factors of production efficiently.
- keep and use records to ensure profitable agricultural production.
- add value to agricultural products through proper handling, processing, packaging and storage.
- devise effective strategies for marketing agricultural products.

- plan agricultural production according to market conditions.
- participate effectively in the organisation and management of farming organisations.
- explain the importance of agricultural organisations in agricultural development and production.
- interpret agricultural and land policies and relate them to agricultural production.
- communicate effectively when marketing agricultural products.

## SENIOR FIVE TERM ONE

### Topic 1: Basic Science I

*Duration: 27 Periods*

#### Overview

The basic unit of life is the cell. This is where the basic unit structure and functions of plants and animal take place. The cell helps one to understand how life occurs in all living organisms. The cell is a self perpetuating chemical system. It maintains an internal environment which is capable of exchanging with its surrounding.

#### Learning Outcome

The learner should be able to:

- acquire basic scientific knowledge and skills needed to develop better methods of crop and livestock production.
- recognise the chemical and biological compositions of plants and animals.
- differentiate between the relationship of the biotic and abiotic factors in agriculture.

#### Sub-Topic 1: Cytology

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• distinguishes between the plant cell and animal cell.</li><li>• justifies the importance of cell physiological processes in agriculture.</li><li>• describes the processes of cell division.</li><li>• explains their importance in inheritance.</li></ul>	<ul style="list-style-type: none"><li>• Detailed structure of plant and animal cells</li><li>• Cell physiological process</li><li>• Cell division:<ul style="list-style-type: none"><li>- mitosis</li><li>- meiosis</li></ul></li><li>• Importance of cell division in inheritance</li></ul>

#### Methodology

- Using discussion method, guide the learners to:
  - identify parts of the microscope and hand lens.
  - calculate the magnification of an object using a microscope.

- use a light microscope to observe plant and animal cells.
- draw detailed labelled structures of plant and animal cells.
- study displayed charts of cell division under mitosis and meiosis.
- draw, label and emphasise the main activities of interphase, prophase, metaphase, anaphase and telophase.
- Demonstrate so that learners can carry out:
  - a diffusion experiment using potassium permanganate/ copper (II) sulphate.
  - an experiment of osmosis using fresh potatoes/paw-paws and salt/sugar then summarise the experimental steps namely: materials/apparatus, procedure, observation and conclusion.
- Lead a guided discussion on active transport in plants and animals to illustrate movement of materials.
- Brainstorm so that learners can explain the:
  - structural differences between plant and animal cells.
  - importance of each type of cell division.
  - significance of mitosis and meiosis in agriculture.
  - process of diffusion and osmosis.
  - main differences between mitosis and meiosis.
- Ask learners to make notes focusing on the experiments and the discussions above.

## Practical

- Observing prepared slides on cell division under the microscope
- Carrying out simple plant and animal breeding experiments to show inheritance

## Resources

- Prepared charts, slides and models showing cell division in plants and animals
- Microscopes and accessories
- Live farm animals
- Planting materials

## Hints to the Teacher

- A simple electronic structure of cells will be good enough to show the important inclusions of mitochondria, endoplasmic reticulum, Golgi body, lysosomes and vacuole.
- Emphasis should be put on the process of prophase, metaphase and anaphase during cell division.

- Clearly illustrate diffusion to learners and relate it to movement of materials in a cell.
- The osmosis process should be made in light of isotonic, hypotonic and hypertonic solutions.

## Assessment

- Setting up a light microscope ready for observation
- Calculation of the magnification
- Drawing and labelling plant and animal cells
- Description of the stages in cell division
- Distinguishing between diffusion and osmosis

## Sub-Topic 2: Genetics

Competences	Content
The learner: <ul style="list-style-type: none"><li>• describes genetics and its terminologies.</li><li>• explains the importance of inheritance in agriculture.</li><li>• explains the role of heredity in producing the desired varieties of plants and animals.</li><li>• illustrates the advantages of hybridisation.</li></ul>	<ul style="list-style-type: none"><li>• Meaning of genetics:<ul style="list-style-type: none"><li>- terminologies in genetics such as dominance and epistasis</li></ul></li><li>• DNA as the genetic material for inheritance:<ul style="list-style-type: none"><li>- inheritance types namely monohybrid and dihybrid</li></ul></li><li>• Advantages of hybridisation</li></ul>

## Methodology

- Lead learners in a guided discussion to define genetics and its terminologies followed by clarification of the genetics terms and ask learners to make notes on these terminologies.
- Discuss and ask learners to state Mendel's law of inheritance; define dominance, co-dominance and hybridisation.
- Carry out a demonstration on how to obtain monohybrid and dihybrid ratio so that learners can compute these two ratios.
- Ask learners to role play Mendel's laws of inheritance using beans of different colours/size with two volunteers who will be blind folded and asked to pick the two beans each time until all beans have been removed from the container. Another student should be recording the bean characteristics like size or colour. This would then be followed by

a class discussion that there is nothing to determine which bean to be carried/picked. This would then be related to genes in cells.

- Construct with the learners the Punnet square to explain phenotypes and genotypes of offspring from given crosses then ask learners to draw and use these squares in explaining genetics and inheritance in plants and animals.
- Organise learners in groups to carry out:
  - a simple plant and animal breeding experiment to show inheritance as a project.
  - and use plant breeding experiments to demonstrate dominance and hybridisation then make a group report to the class.
  - an analysis of the use of Punnet square in determining genetics and traits inheritance.
- Ask learners to brainstorm on the role of heredity and advantages of hybridisation then make notes after your clarification.
- Discuss with the learners the meaning of hybrid, hybrid vigour, heterosis and breed.
- Ask learners to explain the desirable qualities of a hybrid.
- Organise a field trip for learners to a clonal nursery for the learners to observe and summarise in their books the steps involved in carrying out cloning of crops.

## Practical

- Draw a cross between two inheritable traits using a Punnet square
- Investigate Mendel's law of inheritance using bean seeds

## Resources

- Punnet square chart
- 1000 bean seeds half of which are of one colour and the other are of a different colour
- Masks, cups and a record sheet
- Clonal garden/ florist plot

## Hints to the Teacher

- Explanation of Mendel's laws of inheritance and genetic terms should be made in light of cell division.
- Monohybrid and dihybrid ratios should be differentiated using Punnet square.
- Only examples and advantages of hybridisation should be made.

## Assessment

- Working out the monohybrid and dihybrid ratio
- Definition of genetics, heredity, gene, allele, dominance, recessive, phenotype, genotype, homozygous, heterozygous, homologous, bivalent, chiasmata, synapsis, epistasis, crossing over, back cross, selfing, polyploidy, hybridisation, hybrid vigour, heterosis and sex linked
- Calculating the results of different crosses of the filial generations by the help of the Punnet square and draw different trait combinations
- Mendel's laws of inheritance

## Sub-Topic 3: Variation

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• explains the causes and process of variation in plants and animals.</li><li>• distinguishes between continuous and discontinuous variation.</li></ul>	<ul style="list-style-type: none"><li>• Definition and importance of variations in plants and animals</li><li>• Types of variation:<ul style="list-style-type: none"><li>- continuous and discontinuous variations</li></ul></li><li>• Causes of variation</li><li>• Importance of new species, varieties, breeds</li></ul>

## Methodology

- Brainstorm the causes and types of variation and ask learners to summarise them.
- Ask learners to carry out an experiment on variation and distinguish between continuous and discontinuous variation.
- Ask learners in groups to demonstrate the concept of continuous and discontinuous variation using a plotted graph based on measurement of height, size of plant parts, sex, tongue rolling, having dimples, being left handed or right handed, weight/mass, and length of structures on living organisms or on their own body parts.

## Hints to the Teacher

- A clear difference between continuous and discontinuous variation needs to be made with examples from agriculture.

## Practical

- Observing variations in plants and animals of the same species

## Resources

- Live plants of the same species
- Animals of the same species
- Metre rule, pencils, record sheets/tables, graph papers and a mathematical set

## Assessment

- Continuous and discontinuous variation
- Causes of variation

## Sub-Topic 4: Selection

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• describes the process of selection.</li><li>• selects plants and animals based on desirable qualities.</li></ul>	<ul style="list-style-type: none"><li>• Selection (natural and artificial) in relation to desired qualities of plants and animals</li></ul>

## Methodology

- Lead a guided discussion with learners to describe the origin of natural selection and summarise the role of natural selection and mutation in agriculture production.
- Ask learners to carry out selective breeding in goats, rabbits, poultry, sheep, guinea pigs or pigs and summarise the criteria being used.
- Give instructions and guidelines to learners in groups to propagate selected plant materials for further selection.
- Ask learners to record their procedure and findings during the propagation of selected plant materials.
- Ask learners in groups to explain in a class presentation and writing the desirable qualities used when selecting good plants and animals.

## Practical

- Propagating plant materials selected on the basis of observable qualities
- Propagating selected plant materials for further selection
- Keeping and interpreting performance records of plants and animals for selection
- Selecting and breeding animals

## Resources

- Plant materials for propagation
- Record cards
- Growing plants
- Live animals like goats, rabbits, poultry, sheep, guinea pigs, rats and pigs
- Charts and markers

## Hints to the Teacher

- The gateway to improving animal and plant production known as selection, the desirable qualities used and factors that favour it should be emphasised.

## Assessment

- Qualities for selection of animals and plants
- Factors that favour selection in agriculture
- Types of selection

## Sub-Topic 5: Introduction to Genetic Engineering

Competences	Content
The learner: <ul style="list-style-type: none"><li>• explains the basic principles of genetic engineering.</li><li>• justifies the role of genetic engineering in livestock and crop production.</li></ul>	<ul style="list-style-type: none"><li>• Principles of genetic engineering</li><li>• Role of genetic engineering such as Polyploidy and Cloning</li></ul>

## Methodology

- Before the lesson, locate a website or resource centre/newspaper/journal and obtain current information on genetic engineering.

- Carry out a guided discussion on genetic engineering and its importance in agriculture and ask learners to summarise the meaning and importance.
- Present a case study of maize and cotton produced by genetic engineering then ask learners to investigate and summarise the current success made in genetic engineering.
- Organise a debate for learners on the role of genetic engineering in livestock and crop production.

## Practical

- Carrying out plant breeding experiments to demonstrate dominance and hybridisation
- Cloning crops
- Visiting clonal nurseries to observe cloned plants and the process of cloning

## Resources

- Clonal garden and clonal nursery
- Tools, equipment and materials for cloning including plant and animal hybrids
- Charts, film / videos showing gene interactions show on genetic engineering and websites of genetic engineering in agriculture
- Case study of genetic engineering in maize and cotton

## Hints to the Teacher

- Make a good research on genetic engineering to enable you get a case study then summarise the principles, role and trends of genetic engineering in plants and animal production

## Assessment

- Ask learners to explain:
  - the meaning of genetic engineering.
  - the importance of genetic engineering in agriculture.
  - the role of genetically modified foods in fighting hunger.
  - trend of genetic engineering today from the case study.

## Topic 2: Crop Production I

*Duration: 18 Periods*

### Overview

All chemical reactions that maintain life in a plant or animal take place in water while the essential minerals required for plant growth enter the plant as a component of water. In addition, the mineral salts needed by animals are carried as ions or nutrients in water. Therefore, the cells in both plants and animals are composed of over 70 percent water if they are to perform the life functions well. On the other hand, all the other elements needed by the plants come from the soil.

Soil fertility is essential for the proper growth of plants. The productivity of a farming land and animals depends on soil fertility and thus a need to maintain the fertility.

### Learning Outcome

The learner should be able to:

- appreciate why soil and water conservation measures are necessary in agriculture.
- initiate growing of high value crops for sale.
- justify the value of tree growing to the individual person, community and our environment.
- evaluate the role of crop improvement and organic farming in production of health foods.
- categorise the effects of weeds, pests and diseases in crop production.

### Sub-Topic 1: Soil and Water as Farming Resources

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• investigates the soil properties and composition.</li><li>• discovers the importance of soil components and texture.</li><li>• explains the importance of soil properties.</li><li>• demonstrates effective methods of soil and water conservation.</li><li>• categorises the major soil types</li></ul>	<ul style="list-style-type: none"><li>• Soil mineral contents that is N, P, K, and S</li><li>• Soil textural classes, structure, particle density, bulk density aeration, pH, cation exchange capacity (CEC)</li><li>• Importance of soil and water conservation in agricultural production</li><li>• Methods of soil and water conservation</li><li>• Major soil types in Uganda</li></ul>

<b>Competences</b>	<b>Content</b>
of Uganda. <ul style="list-style-type: none"> <li>• constructs simple rainwater harvesting facilities.</li> </ul>	

## Methodology

- Using a demonstration, guide learners how to determine the amount of air, water, humus/organic matter in the soil.
- Carry out a guided discussion with learners on:
  - main components of soil particles.
  - characteristics of a fertile soil.
  - soil texture and the importance of soil structure.
- Through a guided demonstration, ask learners to carry out soil sedimentation including writing of the procedure of the experiment that is the apparatus/materials, methods, observations and conclusion. The learners should put a given quantity of dry soil in a measuring cylinder and cover with about four times as much water. With one hand over the mouth of the cylinder, the mixture should be shaken vigorously then allowed to stand.
- Organise learners:
  - to watch a video show entitled “rainwater from disaster to blessing” and take notes on the need to collect rain water.
  - to carry out a survey of how water is harvested in and around the school community including the drawing of the structures used.
  - to participate in the construction of simple water harvesting facilities/tanks.
- Ask learners to:
  - design models of water harvesting facilities.
  - discover the different soil properties by:
    - moistening a spoonful of a sample with little water and rolling it into a ball
    - rubbing between the fingers a dry soil sample
    - putting a small amount of soil in a glass of water
    - heating gently a small sample of soil in a boiling tube
    - observing a wet soil sample: the soil colour and size of soil particles using a series of sieves
  - demonstrate the methods of collecting and storing rainwater in their homes.
  - draw the map of Uganda showing the major soil types.
  - draw and label the five soil structures.
  - make a chart of soil types and the crops they support and display them in the class.

- Organise a field visit for learners to:
  - see sources of water and rain water harvesting facilities in and around the school.
  - identify water harvesting methods like gutters, pots, drums, tanks, underground reservoirs and dams/ponds.
  - collect soil samples and identify them.
  - a nearby stream or swamp to consolidate their knowledge on how wetlands are being degraded by man.
  - see degraded sites so that they observe and identify the causes of degradation. A report on the causes of soil degradation in the school/community will thereafter be made.
- Guide learners to demonstrate how to prevent soil degradation.
- Ask learners to suggest measures that could be taken to rehabilitate degraded soils around their school.

## Practical

- Construction of soil and water conservation structures (ridges, bunds, silt pits, diversion channels, graded banks, wind breaks and terraces)
- Planting cover crops, mulching and manuring
- Analysis of soil to determine mineral content, textural classes, structure, bulk and particle density

## Resources

- Degraded sites and map of soil types in Uganda
- Tools (dibber, hoe, soil auger, soil bags, trowel, soil sieves, soil samples, blocky soil structure, heat source, mortar/pestle, measuring cylinders, beakers, funnels, filter paper/cotton wool, garden line, wheel barrow string, tape measure, water source and spade) plus the soil testing kit/reagents and apparatus
- Soil textural triangle chart
- Houses with water harvesting facilities
- Chart of water harvesting facilities
- Video show entitled “rainwater from disaster to blessing”

## Hints to the Teacher

- The size and shape of soil particles determines the physical nature of the resulting soil type in an area. The soil physical nature affects texture and structure which in turn determines the amount of nutrients, water and air in that soil. Therefore, emphasis must be made on the process of

reducing the rate at which soil and water is lost in degraded farming areas.

## Assessment

- The four components of a soil particle
- Soil structure and soil texture
- Drawing the results of mechanical analysis/soil sedimentation after 15 minutes, 60 minutes and one week
- Calculating the percentage composition of the different soil particle sizes in a mechanical analysis experiment
- Calculating the percentage composition of the amount of air, water and organic matter in a given soil sample
- Measures of how to prevent soil degradation

## Sub-Topic 2: Soil Fertility I

Competences	Content
The learner: <ul style="list-style-type: none"> <li>• classifies the causes of soil fertility loss.</li> <li>• designs activities that help to improve and maintain soil fertility.</li> <li>• identifies ways in which soil fertility is gained.</li> </ul>	<ul style="list-style-type: none"> <li>• Ways in which soil fertility is lost</li> <li>• Ways in which soil can gain fertility</li> <li>• Methods of improving and maintaining soil fertility</li> </ul>

## Methodology

- Carry out a guided discussion so that learners can explain the:
  - meaning of soil fertility.
  - ways soil fertility is lost.
  - observable signs on crops growing in poor soils.
- Ask learners to suggest different ways the soil can gain fertility then emphasise the soil and water conservation methods.
- Guide learners to make an exhibition of crops growing in a poor soil and good fertile soils so that they can explain and write down the characteristics of these crops.
- Organise learners in groups to carry out a project of planting of trees and grass in an eroded area.
- Lead learners in groups to design simple models of a bench terrace.

- Ask learners in groups to come up with measures of conserving soil and water resources on a farming land and present them to the class for discussion.
- Guide learners to demonstrate:
  - the methods of improving and maintaining soil fertility.
  - how to carry out mulching of flower beds in the school compound.
  - how to establish a trash/stone line, wash stops, weir and gabions to conserve soil and water in the school compound/community.
  - how to carry out a project on making and using of organic compost manure.
  - how to make farm yard manure.
- Lead a class discussion so that learners can explain the:
  - factors determining a crop rotation programme and factors considered during intercropping.
  - causes for invasions of wetlands, deforestation, overgrazing, landslides and soil erosion.
- Organise learners in groups:
  - to plant cover crops in school plots as a project and make a report.
  - to watch a video show/photographs/ chart showing the effects of soil erosion, overgrazing, deforestation, landslides, earthquakes and invasions of wetlands and record their findings.
- Ask learners to submit project reports and illustrations on mulching, making of organic manure/compost manure, model of a bench terrace, planting of cover crops, planting of trees and grass in the school compound.

## Practical

- Making of manures
- Mulching of a garden
- Designing a crop rotation on the school garden

## Resources

- Pictures/photographs, charts, video slides showing crops growing
- Sample of crop produced from both fertile and infertile soil
- Tools and equipment for soil and water conservation (mattock, mallet, claw hammer, spirit level, slashers, panga, hoes, mulching materials, pegs, nails, stones, strings, spades, mould plough, disc plough, plumb bob, trowel, tape measure, wheelbarrow, gunny bags); tree seedlings, grass species and eroded sites

- Video slides, pictures/photographs and chart showing the effects of soil erosion, overgrazing, deforestation, landslides, earth quakes and invasions of wetlands

### Hints to the Teacher

- Soil fertility is essential to the proper growth of plants. There are several factors that contribute towards the fertility of a given soil. Emphasis should be put on factors like soil depth, soil structure, drainage, ability of the soil to retain water, nutrient availability, soil reaction and farming activities going on.
- Clear explanation of the causes of soil erosion like action of human beings, action of water, and action of wind then removal of vegetation is expected. Summarising the effect of soil erosion including climate change and landslides are crucial in minimising environmental challenges.
- Get support from the school administration to provide the relevant inputs to the learners such as land, planting materials, garden tools/equipments, fertilizers, pesticides, space, funds and time.

### Assessment

- Reasons why soil suffers infertility
- Soil fertility
- Crop rotation programme
- Characteristics of crops growing in poor soils
- Soil and water conservation on a gentle slope
- Soil erosion and the effects of landslides in agriculture
- Suggestions on how deforestation can be minimised in Uganda
- Tree and grass planting in conserving soil and water on a farming land
- Environmental problems faced by wetlands in your home area/ Uganda

### Sub-Topic 3: Soil Composition

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• analyses the composition of a fertile soil.</li> <li>• demonstrates the importance of soil and water as farming resources.</li> <li>• appreciates water and soil as farming</li> </ul>	<ul style="list-style-type: none"> <li>• Soil composition</li> <li>• Characteristics of soil suitable for farming</li> <li>• Soil and water as farming resources</li> <li>• Ways in which soil and water</li> </ul>

Competences	Content
resources <ul style="list-style-type: none"><li>• describes the causes and effects of soil degradation.</li></ul>	are important to crops <ul style="list-style-type: none"><li>• Soil degradation and its effects</li></ul>

## Practical

- Identifying degraded soils
- Identifying effects of soil degradation on crop farming
- Carrying out measures to prevent soil degradation
- Carrying out measures to rehabilitate degraded soils

## Resources

- Sites with degraded soils
- Tools, equipment and materials for soil rehabilitation (such as organic manure, lime, hoes, planting materials of fallow crops)

## Topic 3: Animal Production I

*Duration: 18 Periods*

### Overview

Animals are raised mainly to provide food for the population. Some animals are kept for religious, social or economic reasons. For example, the Bahima and Karamojong regard cattle as a measure of wealth and social prestige. Some people keep animals as pets or sporting purposes. Therefore development of the livestock industry is of great importance to the Ugandan economy. This can begin with selection which is the gateway to livestock improvement.

### Learning Outcome

By the end of the topic, the learner should be able to:

- apply appropriate practices of livestock production and animal welfare in Uganda.
- demonstrate understanding of skills of handling livestock improvement in animal production.

### Sub-Topic 1: Introduction to Livestock Production

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• explains the status of livestock production and distribution in Uganda.</li> <li>• identifies the available breeds/species of livestock in Uganda.</li> <li>• examines policies in the livestock sector.</li> <li>• classifies livestock according to origin, type, breed and purpose.</li> <li>• states the recommended principles of animal welfare.</li> </ul>	<ul style="list-style-type: none"> <li>• Status of livestock population and distribution</li> <li>• Factors affecting livestock distribution and production</li> <li>• Recent developments and policies in the livestock industry</li> <li>• Classification of livestock</li> <li>• Basic principles of animal welfare</li> </ul>

**Methodology**

- Lead a guided discussion so that learners identify the importance of livestock production in Uganda and ask learners to note down its role in the economy.
- Organise the learners in groups to study the Uganda livestock distribution map using the Uganda School Atlas and identify where livestock is kept in their home district. Then ask the learners to draw a local district map of livestock distribution.
- Organise for learners:
  - a field trip to a nearby livestock farm and lead them in a guided discovery of the characteristics of different livestock kept on a farm.
  - a debate on the need to take into consideration animal welfare and summarise the recommended principles of animal welfare.
  - a role-play of the care for animals then summarise the demonstration of how to care for animals.
  - a field visit to observe and record the routine practices in caring for farm/pet animals. Before the visit, you should prepare a questionnaire on the characteristics of, reasons for keeping, housing requirement, management, feeding, health, processing of farm output, marketing of products and general welfare of pet animals.
  - a video show or a computer simulation to show the different types/breeds of livestock.
  - a display of pictures/photographs and charts showing various types of livestock kept in Uganda so that they can write down observable characteristics.
- Lead a class discussion so that learners point out the difference between type and breed of livestock.
- Guide the learners in designing and constructing of a pet animal house at school.
- Use a veterinary officer /animal extension worker to carry out a guided discussion on the Animal Welfare Act.
- Ask the learners in groups to participate on a weekly basis in grooming, feeding, cleaning animal houses, and observing signs of ill health and make a written report presentation to the class.

**Practical**

- Study visit to livestock improvement centres like DATICS and ARDC's with improvement practices and technologies
- Field study to:
  - identify the factors favouring livestock production
  - identify types of animals kept, systems and rearing practices

- investigate ways livestock farmers are solving the problems they are facing
- Observing charts/pictures/videos that show the different breed characteristics

## Resources

- Different animal breeds and species
- Statistical data on livestock population
- Uganda School Atlas and the Animal Welfare Act
- Pictures/photographs, charts and video slides showing various types of livestock in Uganda
- Computer simulation of livestock breeds and pet house model
- Expert veterinary officer/animal extension worker

## Hints to the Teacher

- Get support from the school administration to provide the relevant inputs to the learners such as land and animals to use in getting hands-on and space for these activities. In addition, acquisition of wide knowledge on livestock production in Uganda and the Animal Welfare Act will make understanding of livestock breeds and distribution better.

## Assessment

- Drawing the map of livestock distribution in Uganda
- The routine practices in caring for farm/pet animals around the school
- The characteristics of dairy and beef breeds of cattle
- Livestock distribution in Uganda
- The principles of animal welfare in Uganda
- Animal rearing practices in Uganda
- The ways to improve looking after and caring for animals at home

## Sub-Topic 2: Livestock Improvement

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• explains correctly the terms used in selection.</li> <li>• demonstrates the reasons for selecting livestock</li> <li>• establishes and explains the criteria for selecting different livestock breeds.</li> </ul>	<ul style="list-style-type: none"> <li>• Definition of livestock selection</li> <li>• Reasons for selecting livestock</li> <li>• Criteria for selecting suitable livestock breeds/species for a given area:           <ul style="list-style-type: none"> <li>- adaptability</li> </ul> </li> </ul>

Competences	Content
<ul style="list-style-type: none"> <li>• creates a selection guideline for selecting desired livestock.</li> <li>• describes the different methods of livestock selection.</li> <li>• justifies the reason for selection of livestock.</li> <li>• evaluates the selection methods used in livestock improvement.</li> <li>• describes the reasons for livestock breeding.</li> <li>• describing the components of an artificial insemination kit.</li> <li>• applies appropriate technologies to improve livestock production.</li> <li>• demonstrates the procedure of artificial insemination and embryo transfer.</li> <li>• explains the advantages and disadvantages of artificial insemination, embryo transfer and surrogacy in livestock.</li> </ul>	<ul style="list-style-type: none"> <li>- production level</li> <li>- food consumption and conversion</li> <li>- quality of products</li> <li>- farmer's managerial ability</li> <li>• Characteristics for selection of: <ul style="list-style-type: none"> <li>- beef cattle and dairy cattle</li> <li>- dual purpose cattle</li> <li>- layers and broilers</li> <li>- dual purpose birds</li> <li>- dairy goats and meat goat</li> <li>- dual purpose goats</li> <li>- breeding gilts and boars</li> </ul> </li> <li>• Methods of selection: <ul style="list-style-type: none"> <li>- individual selection</li> <li>- pedigree selection</li> <li>- progeny testing</li> <li>- tandem selection</li> <li>- selection index</li> </ul> </li> <li>• Definition of breeding</li> <li>• Reasons for breeding livestock</li> <li>• Methods of breeding and their advantages and limitations: <ul style="list-style-type: none"> <li>- inbreeding</li> <li>- cross breeding</li> <li>- out crossing</li> <li>- line breeding</li> <li>- back crossing</li> <li>- grading up</li> </ul> </li> <li>• Artificial insemination kit</li> <li>• Artificial insemination (AI) definition</li> <li>• Procedure of semen collection, dilution and storage plus embryo transfer</li> <li>• Advantages and disadvantages of artificial insemination, embryo transfer procedure and Surrogacy in livestock</li> </ul>

## Methodology

- Lead a class discussion with learners to:
  - define selection and the various terms used in selection.
  - review the advantages and disadvantages of natural mating.
  - point out the ideal conformation features and other characteristics to consider when selecting different kinds of livestock, using pictures/charts/diagrams.
  - explain the advantage and disadvantages of the different livestock breeding methods namely natural mating, in-breeding, line breeding, out breeding, cross breeding or grading up.
  - define artificial insemination and note down its advantages and disadvantages.
  - clarify the four factors of accuracy, selection pressure, phenotypic variability and heritability.
  - state the advantages and disadvantages of embryo transfer in livestock production.
- Exhibit charts/pictures or organise a video show for learners to write down the main ideal conformation and breed characteristics in dairy and beef cattle.
- Using a guided discovery with the learners, describe the parts of male and female reproductive systems of a farm animal. Then ask learners to draw, label and state the functions of the parts of reproductive systems of a male and female farm animal.
- Collect materials like models of syringe, artificial vagina, semen tubes, nitrogen cylinder and teaser gun which you can assemble in good time to demonstrate artificial insemination.
- Distribute the performance records of different kinds of livestock to learners in groups to study and identify a basis of selection.
- Prepare questionnaires for learners to use in observing and as a guide in selecting a good animal appropriate for breeding from a group of farm animal such as rabbits, pigs, goats and local birds.
- Provide guidelines to learners to start on livestock project work.
- Lead a guided discussion on the advantages and disadvantages of natural mating and artificial insemination. The learners should make clear notes.
- Carry out a demonstration so that learners can identify the artificial insemination kit components.
- Organise a computer simulation of semen collection, artificial insemination and embryo transfer for learners to see the steps taken.
- Organise a field visit to an animal improvement centre for learners to identify the criteria of selecting livestock for breeding and improvement.

- Brainstorm and ask learners to describe the procedure of embryo transfer and surrogacy in livestock.
- Using guided discussion and an invited veterinary officer or animal health extension worker, demonstrate for learners the artificial insemination practice and ask them to keenly observe the demonstration and summarise the procedures.

### Practical

- Observing animals to identify the breed selection characteristics
- Examining the pedigree and performance records of individual animals including the breeding charts
- Field visit to observe demonstration of semen collection, dilution, storage and artificial insemination procedure
- Observing signs of heat in animals
- Undertaking projects involving the use of improved technologies in livestock production
- Project work to involve:
  - breeding animals
  - keeping and analysing breeding records
  - observing the characteristics of progenies and comparing them with those of their parents and local (control) animals

### Resources

- Charts/picture/video or slides showing different kinds of livestock with ideal conformation and breeds characteristics
- Live animal of different breeds and different livestock in the school or nearby farm
- Livestock breeding charts/records illustrating breeding methods or computer simulation
- Production records of various types of livestock like milk yield, growth rate, weight gain, eggs yield and wool production
- Artificial insemination kit or kit of AI proto-type from an animal improvement centre
- Experts like veterinary officers or animal health extension workers to talk about artificial insemination

### Hints to the Teacher

- Get support from the school administration to provide the relevant inputs to the learners such as artificial insemination kit, inviting a veterinary officer, live animals for use to display the male and female

reproductive system as well as funds and time to make a field visit to observe signs of heat.

- The reproductive part should be displayed for learners and preserved in formalin for future use.
- Make a good demonstration of artificial insemination procedure but only explain the concepts of embryo transfer and surrogacy.

## Assessment

- Importance of selection in livestock breeding
- The factors to consider when selecting any livestock for breeding
- The factors one would consider when selecting a dairy cow, beef cow, a mutton sheep, and a boar, a pullet and gilt
- The signs of heat in farm animals
- Drawing and labelling the male and female reproductive systems in farm animals
- The advantages and disadvantages of natural mating, in-breeding, line breeding, out breeding, cross breeding and grading up
- Livestock improvement in Uganda
- The instruments used to transfer the embryo from the donor cow into the recipient cow
- Advantages and disadvantages of twin transfer of embryos
- Merits, limits and conditions for the success of artificial insemination in Uganda
- The main causes of failure in conception when artificial insemination is used to breed livestock

## SENIOR FIVE TERM TWO

### Topic 4: Basic Science II

*Duration: 45 Periods*

#### Overview

In most of the cell organelles are water and a group of molecules, many of which are organic compounds. These organic compounds all contain carbon, hydrogen, nitrogen, sulphur and phosphorus. However, there are three main types of organic compounds found in living cells, that is, carbohydrates, lipids and proteins. The chemicals which make up the bodies of plants, animals or other organisms are known as organic molecules, whereas molecules that form part of surroundings of organisms, such as carbon dioxide in air or water in the soil are called inorganic molecules. So you need to know about the chemical nature of these materials.

Ecology is the study of plants and animals in relation to each other and to the physical and chemical environment in which they naturally occur. But much of the agriculture and farming emphasise individual organisms as if they occur in isolation. To bring the relationship of plants and animals plus their effect on their environment is of much importance as seen in this topic.

#### Learning Outcome

By the end of the topic, the learner should be able to:

- appreciate the chemical and biological composition of plants and animals.
- appreciate the cycling of water and nutrients between soil, plants and air.
- demonstrate understanding of the main structural parts of the digestive, reproductive and respiration systems of farm animals.
- apply the need for a balance between harmful and beneficial organisms.
- display consciousness in the need for a balance between the biotic and abiotic component of the agriculture/farming environment.

## Sub-Topic 1: Chemicals of Life

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>explains the functions of lipids, protein, water, carbohydrates, vitamins and minerals.</li> <li>describes the working and characteristics of enzymes.</li> </ul>	<ul style="list-style-type: none"> <li>Functions of: <ul style="list-style-type: none"> <li>- proteins</li> <li>- lipids</li> <li>- carbohydrates</li> <li>- water</li> <li>- minerals and vitamins</li> </ul> </li> <li>Enzymes</li> </ul>

### Methodology

- Lead a guided discussion and ask learners to state the functions of carbohydrates, proteins, lipids, vitamins, minerals, enzymes and water, and ask the learners to summarise them.
- Ask learners to research on and summarise:
  - essential and non-essential proteins.
  - monosaccharide, disaccharides and polysaccharides.
  - lignification and cellulose.
- Using a demonstration method, ask learners individually or in a group to conduct an experiment:
  - to identify the properties and factors that affect enzyme activity.
  - to investigate the effect of pH and temperature on enzyme activity and ask the learners to tabulate the results and plot the graphs of the findings.
  - to investigate the effect of varying amounts of hydrogen peroxide on equal amounts of catalase made from fresh liver of a cow.
  - to determine the amount of hydrogen peroxide remaining by a titration with potassium permanganate solution.
  - to investigate the presence of carbohydrates, proteins, lipids and ascorbic acids.
  - to classify animal feeds and farm products basing on their composition.
- Use guided discovery to enable learners identify symptoms of mineral and vitamin deficiency in plants and animals.
- Brainstorm so that learners can recall and write the deficiency symptoms of vitamins and mineral salts in plants and animals.
- Display crops and animals with mineral deficiency so that learners can identify and record observable symptoms. Then ask the learners to suggest ways of rectifying the deficiency symptoms.

**Practical**

- Investigate the presence of proteins, lipids and carbohydrates in feeds and agricultural products
- Investigate the working of enzymes

**Resources**

- Reagents for food tests; fresh liver from a cow
- Sample of different seeds and ingredients of animal feeds
- Agricultural farm products
- Measuring cylinders, muslin cloth, glass rod, pipette and burette
- Beakers, test tubes and boiling tubes
- Litmus paper, hydrogen peroxide, potassium permanganate and sulphuric acid
- Heat source of paraffin stove/charcoal stove/Bunsen burner
- Bromothymol blue/universal indicator, droppers and a white tile

**Hints to the Teacher**

- Get support from the school administration to provide the relevant inputs to the learners such as liver from a cow/goat/hen, food reagent test materials, food materials and animal feeds containing sugars/lipids/proteins/ascorbic acid, plants and animal showing deficiency symptoms of vitamins and minerals.
- Carry out investigations of the mode of action, characteristics and factors influencing enzyme activities before presenting it to learners.

**Assessment**

- Practical exercise on determining the presence of reducing sugars, non reducing sugars, proteins, lipids and ascorbic acids
- Examples in each case of farm products which supply carbohydrates, reducing sugars, non-reducing sugars, proteins and lipids
- Types of carbohydrates like monosaccharide, disaccharides and polysaccharides
- Composition of sucrose, lactose, maltose and starch
- The essential amino acids
- Enzymes mode of action and its characteristics
- The factors that influence enzyme action
- Functions of carbohydrates, proteins and lipids
- Deficiency symptoms in plants and animals

## Sub-Topic 2: Plant Morphology and Physiology

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>describes the structure and functions of leaves, roots, flowers, fruits and the vascular system of plants.</li> <li>describes the processes of photosynthesis and transport (transpiration, translocation) in plants.</li> <li>demonstrates the factors influencing photosynthesis, translocation and transpiration.</li> </ul>	<ul style="list-style-type: none"> <li>External and internal structures of plant stems, leaves, roots, flowers and fruits in relation to their functions</li> <li>Modified plant parts like bulbs, root/stem tubers, corms, rhizomes or stolons</li> <li>Process of photosynthesis (light and dark <b>stages</b>)</li> <li>factors affecting photosynthesis</li> <li>absorption of water and minerals</li> <li>Translocation of materials within the plant</li> <li>Process of transpiration: <ul style="list-style-type: none"> <li>- effects of transpiration</li> <li>- factors affecting transpiration</li> </ul> </li> </ul>

### Methodology

- Lead a guided discussion for learners to identify:
  - the external and internal structures of leaves, stems and roots in plants.
  - the functions and adaptation of the observed external and internal structure.
- Discuss and ask learners to:
  - describe the plant storage organs and their importance in agriculture.
  - explain the techniques, procedures and methods of budding, layering, tissue culture, grafting and cloning in plants.
- Mount prepared slides of the internal structures of leaves, stems and roots onto a microscope and ask learners to observe, draw and label five main parts observed in each structure.
- Provide the learners with charts/ pictures/computer simulation or video showing the techniques and different methods of budding, grafting, layering, cloning and tissue culture and put emphasis on the factors to be considered for successful budding, grafting, cloning, tissue culture and layering.

- Through guided discussion, ask the learners to explain the concept of:
  - germination.
  - asexual reproduction and sexual reproduction.
  - photosynthesis in green plants.
  - transpiration and translocation.
- Guide learners to describe:
  - types and causes of seed dormancy.
  - procedure of breaking seed dormancy.
- Ask learners to demonstrate how a photometer is used to illustrate the factors that affect transpiration.
- Using guided discovery, make learners:
  - identify the leaf adaptations for photosynthesis and transpiration.
  - clarify the stages of photosynthesis like carboxylation, reduction, regeneration and product synthesis; plus the factors that influence photosynthesis (light, carbon dioxide, chlorophyll and water) and transpiration in green plants.
- Using a guided discussion, lead the learners in defining photosynthesis, translocation and transpiration in plants.
- Ask learners to carry out a demonstration to determine:
  - the light compensation points around the school using an osmometer experiment.
  - the presence of proteins, sugars and lipids in modified plant structure and ask learners to recall the procedure and carry out their own food tests on modified plant structures.
- Organise a field study for learners to practice random sampling, record a transect walk section, identify and collect different planting materials.
- Review the project methods then ask learners to carry out project work on determining the suitable length of cassava cuttings / sweet potato vines/elephant grass root stock that can give best yields under different treatments.
- Using a video camera, ask learners to make a film on the transect walk, propagation, germination, photosynthesis, transpiration and breaking of seed dormancy.

## Practical

- Identifying parts of the plant structures
- Cutting and observing sections of plant parts to study the internal structures
- Observing and describing modified plant parts
- Carrying out experiments to demonstrate the factors affecting photosynthesis, translocation and transpiration

## Resources

- Osomometer, photometer, microscopes and stop clock
- Food test reagents, test tube, boiling tubes and heat sources
- Different plant parts like leaves, stems and roots
- Microscopes and accessories; hand lenses and dyes
- Video slides, video camera, video player and power source
- Modified plant parts: tubers, stems, rhizomes, runners, bulbs, roots and leaves
- Propagation materials for plants
- Chemical for testing seed viability
- Growing medium of soil like gravel, chalk dust, sand, clay, loam, subsoil, wood ash, wood shaving and toilet tissue
- Specimen tubes that are longer with plastic cap/rubber bung
- Bicarbonate indicator/dyes that can change from colour
- Supply of more or less mature leaves of similar size
- Different plant parts like stems, roots, leaves, flowers and fruits, growing plants
- Materials and apparatus for experiments on photosynthesis, translocation and transpiration in plants

## Hints to the Teacher

- Consult the biology teachers on possible practicals on photosynthesis, transpiration, germination and seed dormancy.
- Get support from the school administration to provide the relevant inputs to the learners such as land, planting materials, working tools/equipment, fertilizers, pesticides, space, funds and time.

## Assessment

- Adaptations of plant leaves, stems and roots in order to perform their functions
- Meaning of photosynthesis, carboxylation, photo phosphorylation, transpiration, translocation, vegetative propagation, germination and seed dormancy
- The factors influencing germination, photosynthesis and transpiration
- Seed dormancy and ways of breaking seed dormancy
- Calculation of the germination percentage of a sample of seed and stating reasons whether they are suitable as planting materials

## Sub-Topic 3: Reproduction in Plants

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>describes the process of reproduction in plants.</li><li>differentiates between asexual and sexual reproduction.</li><li>demonstrates the factors that influence seed germination.</li><li>performs breaking of seed dormancy.</li></ul>	<ul style="list-style-type: none"><li>Reproduction in plants</li><li>Asexual reproduction, vegetative propagation and sexual reproduction</li><li>Seed germination<ul style="list-style-type: none"><li>- adaptation of seeds</li><li>- structure of seeds</li><li>- seed viability</li></ul></li><li>Seed dormancy</li></ul>

### Methodology

- Lead a guided discussion for learners to identify:
  - the external and internal structures of leaves, stems and roots in plants.
  - the functions and adaptation of the observed external and internal structure.
- Discuss and ask learners to:
  - describe the plant storage organs and their importance in agriculture.
  - explain the techniques, procedures and methods of budding, layering, tissue culture, grafting and cloning in plants.
- Mount prepared slides of the internal structures of leaves, stems and roots onto a microscope and ask learners to observe, draw and label five main parts observed in each structure.
- Provide the learners with charts/ pictures/computer simulation or video showing the techniques and different methods of budding, grafting, layering, cloning and tissue culture and put emphasis on the factors to be considered for successful budding, grafting, cloning, tissue culture and layering.
- Through a guided discussion, ask the learners to explain the concept of: germination, seed dormancy, asexual reproduction and sexual reproduction.
- Guide learners to describe the:
  - types and causes of seed dormancy.
  - procedure of breaking seed dormancy.
- Ask learners to brainstorm the:

- importance of using seed as a planting material with relevant examples.
- advantages and disadvantages of using seed as a planting material.
- and identify different crops planted using vegetative propagation and give the vegetative material/structure used in each crop.
- advantages and disadvantages of using vegetative materials for planting
- and select suitable materials for planting from an assortment of seeds or vegetative materials then suggest the reasons for their choice.
- Ask learners to demonstrate:
  - growing of different seed samples under suitable germination conditions from the known amount seeds provided in petri dishes/plates/tins/containers/plastic cups and make them to count and record the number of seeds which germinate after 7days out of the total planted.
  - ability to calculate seed germination percentage when using their experimental results.
- Also make them to compare with seed samples grown in sand, clay, subsoil, wood ash, wood shavings, toilet tissues and distilled water.
- Lead learners in a groups to:
  - discuss the process of reproduction in plants.
  - observe and find out the difference between sexual and asexual reproduction.
  - investigate the factors that influence germination.
- Brainstorm the causes and ways of breaking seed dormancy.

## Practical

- Investigating sexual and asexual reproduction in high value crops
- Carrying out seed viability tests
- Breaking seed dormancy using different methods

## Resources

- Modified plant parts: tubers, stems, rhizomes, runners, bulbs, roots and leaves
- Propagation materials for plants like seeds
- Chemical for testing seed viability
- Growing medium of soil like gravel, chalk dust, sand, clay, loam, subsoil, wood ash, wood shaving and toilet tissue
- Viability testing chemicals such as tetrazolium salt and potassium permanganate

## Hints to the Teacher

- Consult the teachers of biology on possible practical exercises, on photosynthesis, transpiration, germination and seed dormancy.
- Get support from the school administration to provide the relevant inputs to the learners such as land, planting materials, working tools/equipments, fertilizers, pesticides, space, funds and time.

## Assessment

- Seed dormancy and ways of breaking seed dormancy
- Calculation of the germination percentage of a sample of seed and stating reasons whether they are suitable as planting materials
- Difference between sexual and asexual reproduction

## Sub-Topic 4: Animal Anatomy and Physiology

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• describes the structure and functioning of the digestive, reproductive and respiratory systems in farm animals.</li><li>• identifies the observable structural features of the digestive, respiratory and reproductive system.</li><li>• relates the functions of the parts to the structures identified on the digestive, respiratory and reproductive systems.</li></ul>	<p><i>i) Digestive system</i></p> <ul style="list-style-type: none"><li>• Structure and functioning of the digestive system of:<ul style="list-style-type: none"><li>- poultry</li><li>- ruminants</li><li>- non-ruminants</li></ul></li></ul> <p><i>ii) Reproductive system</i></p> <ul style="list-style-type: none"><li>• Structure and functioning of the reproductive systems of birds and mammals</li></ul> <p><i>iii) Respiratory system</i></p> <ul style="list-style-type: none"><li>• Structure and functioning of the respiratory systems of birds and mammals</li></ul>

## Methodology

- Acquire small livestock like birds/poultry, goats, rabbits, pigs, sheep and other farm animals from the school administration to carry out demonstrations for the learners.
- Carry out a demonstration of dissecting a small livestock for each of the systems and ask the learners to observe, identify and draw the structural features of the digestive, reproductive and respiratory system.

- Display the parts of the digestive, respiration and reproductive system of a dissected farm animal and ask learners to relate the identified parts to their functions.
- Demonstrate how to preserve the dissected parts of the digestive, reproductive and respiratory systems in formalin. Each system should be put in its own container and given a clear label.
- Using a guided discussion, ask the learners to describe the structures identified in the systems displayed.
- Brainstorm with learners on:
  - the role of hormones during reproduction in livestock such as oestrogen, progesterone, prolactin, adrenalin, oxytocin, follicle stimulating hormone, luteinising hormone, corpus luteum, pituitary glands and thyroid glands.
  - the role of enzymes in the digestion of food such as salivary amylase/ptyalin, insulin and pepsin.
- Exhibition /display of a dissected livestock for learners to observe, manipulate the parts like gizzard, gullet, trachea, heart, lungs, liver, gall bladder and drawing of conclusions about their findings relating to structural adaptations and functions.

## Practical

- Carrying out dissections to identify parts of the digestive systems of poultry, ruminants and non-ruminants
- Carrying out dissections to identify the parts of the reproductive systems of birds and mammals
- Carrying out dissections to identify the parts of the respiratory systems of mammals and birds

## Resources

- Live birds or small livestock and other mammals
- Dissection kits, razor blade plus knife, preservatives of live materials and dressing board, and materials for dissection
- Live ruminant and non-ruminant

## Hints to the Teacher

- Light treatment covering the functions of parts of the digestive, reproductive and respiratory systems should be made.
- Get support from the school administration to provide the relevant inputs to the learners such as small ruminant and non-ruminant livestock, working tools/equipments and preservatives.

## Assessment

- The names of the parts of the digestive, reproductive and respiratory systems plus stating their functions
- Digestion in ruminants and non-ruminants
- Well labelled diagrams describing digestion in a pig, cow, rabbit, hen and goat
- The process of digestion in ruminant and non-ruminants
- Egg formation in birds
- The male and female reproductive systems in a named livestock
- How the end product of digestion are absorbed in animals

## Sub-Topic 5: Micro and Macro Organisms of Importance in Agriculture

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• identifies the different types of micro-organisms.</li><li>• categorises the different types of micro-organisms.</li><li>• explains the importance of micro-organisms.</li><li>• enumerates the harmful effects of micro-organisms.</li><li>• identifies the different types of macro-organisms that are important in agriculture.</li><li>• describes the different types of macro-organisms that are important in agriculture.</li></ul>	<p><i>Micro-organisms</i></p> <ul style="list-style-type: none"><li>• Basic structure and characteristics of micro organisms:<ul style="list-style-type: none"><li>- viruses and bacteria</li><li>- protozoa and fungi</li><li>- nematodes</li><li>- beneficial micro-organisms</li><li>- fermenters /decomposers</li><li>- nitrogen fixers</li><li>- biological control agents</li></ul></li><li>• Importance of micro organisms</li><li>• Harmful micro-organisms such as pathogens</li></ul> <p><i>Macro-organisms</i></p> <ul style="list-style-type: none"><li>• Morphology of:<ul style="list-style-type: none"><li>- earthworms</li><li>- liver flukes</li><li>- nematodes</li><li>- ticks</li><li>- tapeworm</li></ul></li><li>• Beneficial macro-organisms:<ul style="list-style-type: none"><li>- pollinators</li><li>- decomposers</li></ul></li></ul>

Competences	Content
<ul style="list-style-type: none"> <li>• explains the importance of macro-organisms.</li> <li>• enumerates the harmful effects of macro-organisms.</li> </ul>	<ul style="list-style-type: none"> <li>- soil aerators</li> <li>• Adaptations of harmful macro-organisms to their mode of life</li> <li>• Harmful macro-organisms and their effects: <ul style="list-style-type: none"> <li>- parasites like ticks, liver flukes, tapeworms, round worms, mites, lice and nematodes</li> <li>- vectors like snails, tsetse flies, ticks, insects, nematodes, pests, insects, vermin and birds</li> </ul> </li> </ul>

## Methodology

- Organise learners in groups to discuss and compare the adaptation features on the different micro- and macro-organisms selected.
- Organise a field visit to the selected sites around the school and ask learners to collect, observe and locate the homes of different micro- and macro-organisms.
- Lead learners in a guided discovery of the harmful and beneficial effects both micro- and macro-organisms on farm products like but not limited to maize, beans, wood, meat, milk, hides and skins.
- Through a guided discovery, ask learners to collect, observe and estimate the population of different parasites, vectors, earthworms, millipedes, centipedes, rhizobium on beans/soya in selected gardens of high value crops and insects.
- Lead the learners to observe and brainstorm both harmful and beneficial effects of macro- and micro-organisms.
- Ask learners to mount slides on a light microscope with different macro- and micro-organisms or provide a hand lens then observe, draw and label five structural characteristics of each.
- Through a demonstration, enable the learners to:
  - calculate the population density of macro- and micro-organisms.
  - estimate the number of earthworms (the learners should be in pairs to be able to use a quadrat and methanol procedures).
  - adhere to the procedure of capture-recapture method of estimating population size.
  - identify and classify different organisms whose densities could make up a project work using reference books or the internet.
  - culture bacteria and fungi in the laboratory

- Brainstorm so that learners can summarise the:
  - problems encountered when estimating population of terrestrial organisms such as catchability (size, speed of movement, camouflage, animal learning of the trap), migration, birth rate (fecundity, generation time, sex ratio and food security), death rate and accurate identification.
  - adaptation features of ticks, fleas, tapeworms, liver flukes, pig lice, bees, termites, wasps, millipedes, centipedes, mice, rats and pests on high value crops.

## Practical

- Observing fungal colonies under natural conditions
- Culturing bacteria and fungi and observing their growth and characteristics.
- Observing mounted slides of micro-organisms
- Observing specimens of macro-organisms
- Studying the activity of earthworms in the soil
- Collecting and observing the different types of parasites, vectors and pests
- Observing the harmful effects of macro-organisms on their hosts
- Observing adaptation features in macro-organisms
- Estimating the number of vectors, pests, earthworm/ millipedes/ centipedes/nematodes in a selected site

## Resources

- Mounted slides of micro and macro organisms
- Microscopes with accessories, hand lens and white tile
- Materials with fungal growth like cassava, bread, old walls on farm buildings
- Culturing materials for bacteria and fungi
- Undiluted 30% methanol or ethanol
- Soil samples from school farm/nearby farms
- Two jam jars, basin and bucket
- Quadrat of 0.5x0.5 metres and map extracts of the area
- Procedure of capture-recapture method, waterproof paint and brush, forceps, traps, pooters and specimen tubes
- Baermann /Tullgren funnel (wire gauze, lamp, funnel, beaker, porous bag)
- Preserved earthworms, liver flukes, ticks, lice, tapeworms, nematodes, mites, tsetse flies, vermin, rats, birds and insects

## Hints to the Teacher

- Caution should be taken when handling organisms to observe the structural characteristics of micro- and macro-organisms because some are vectors of diseases of human being.
- Only emphasis of the population changes of micro- and macro-organisms on high value crops should be made.

## Assessment

- Calculation of the estimated population of selected micro- and macro-organisms around the school and in the gardens of high value crops
- Calculating the population of earthworms in the school hedge and mulched school garden
- The beneficial and harmful effects of micro- and macro-organisms in high value crops
- The adaptations of selected micro- and macro-organisms on the farm
- The functions of any five structural features on selected micro- and macro-organisms
- The problems encountered when sampling terrestrial organisms

## Topic 5: Crop Production II

Duration: 24 Periods

### Sub-Topic 1: Soil Fertility II

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• explains the meaning of organic manure.</li><li>• identifies the different types of organic manure.</li><li>• prepares different types of organic manure and manure tea.</li><li>• describes the procedure of making compost manure.</li><li>• discusses the factors influencing the quality of farm yard manure.</li><li>• differentiates between macro- and micro-nutrients/trace elements</li><li>• describes the deficiency symptoms of each macro-nutrient.</li><li>• distinguishes between liming and fertilizer elements.</li><li>• applies inorganic fertilizers correctly on high value crops.</li><li>• assesses the choice of fertilizer for a crop.</li><li>• evaluates the effects of inorganic fertilizers on the environment.</li><li>• explains the role of nitrogen, phosphorus and potassium in crop production.</li><li>• discusses the safety precautions when handling and applying inorganic fertilizers.</li></ul>	<ul style="list-style-type: none"><li>• Organic manure</li><li>• Types of manure</li><li>• Methods of preparation of compost manure, green manure, manure tea, garden tea, night soil and farm yard manure</li><li>• Factors influencing quality of organic manure</li><li>• Role of macro- and micro-nutrients in plant growth</li><li>• Deficiency symptoms of macro-nutrients (NPK)</li><li>• Liming materials</li><li>• Effectiveness of inorganic fertilizers</li><li>• Advantages and limitations of organic and inorganic fertilizers</li><li>• Safety precautions when using fertilizers</li></ul>

## Methodology

- Using guided discussion, ask learners to:
  - suggest the different types of organic manure.
  - give the meaning of organic manure, farm yard manure, compost manure, green manure and inorganic fertilizers.
  - analyse inorganic fertilizers for their nitrate and phosphate content.
  - analyse the soil chemical properties after using fertilizers.
  - justify the factors influencing the effectiveness of fertilizers in crop plants.
  - describe the advantages and limitations of organic and inorganic fertilizers.
  - explain the main differences between organic and inorganic fertilizers.
  - explain advantages and limitations of organic and inorganic fertilizers.
- Guide learners in groups and lead a demonstration of the:
  - different activities of the compost manure-making process.
  - steps of how to carry out soil sampling of farming land to get soil samples for use in testing for soil pH.
  - procedures of how to raise seedlings in nutrient culture solutions.
  - different methods of applying the right types of fertilizers in high value crops at school.
- Through guided discovery, enable learners to:
  - prepare manure (farm yard manure, liquid/manure tea, garden tea and green manure) so that they can write down the procedure.
  - test for pH on soil samples collected and recall the procedure.
  - test the nutrient composition of fertilizers particularly for nitrate, sulphate and phosphate nutrients.
- Brainstorm with learners as they make notes on:
  - characteristics of farm yard manure.
  - factors influencing the quality of farm yard manure.
  - advantages and disadvantages of using organic manure.
  - the meaning of inorganic fertilizers.
  - classes of inorganic nitrogenous, phosphates and potassic fertilizers.
  - the role of nitrogen, phosphorous, potassium and sulphur in plants.
  - deficiency symptoms of some important micro- and macro-nutrients.
  - factors influencing the choice and effectiveness of inorganic fertilizers.
  - reasons, benefits, limitations and effects of liming soil.
  - factors influencing the effectiveness of fertilizers.

- Ask learners to role-play the:
  - safety precaution when handling and applying fertilizers.
  - effects of fertilizers on the environment.
- Ask the learners individually to collect, display and describe plants with nutrient deficiency symptoms in and around the school.
- Design with learners' ways of collecting urine and household waste/used water for use in agriculture.
- Arrange a display of different fertilizers for learners to observe, analyse, interpret, identify and draw conclusions relevant to crop production.

## Practical

- Observing plants for mineral deficiency symptoms
- Applying fertilizers and manures
- Carrying out soil erosion control measures

## Resources

- Crops showing nutrient deficiency symptoms
- Eroded sites
- Samples of different organic manure and inorganic fertilizers
- Materials for making manure
- Tools and equipment for making manure
- Pits, containers, materials for making manures (such as animal excreta, kitchen wastes, grass, leaves, crop residues), tools and equipment
- Brown ring test and phosphate test reagents including boiling tubes, 2M sulphuric acid and iron (II) sulphate
- Specimen crops, crop products like fruits/seeds/roots displaying deficiency or good supply of plant nutrients
- Land/soil bags/wooden soil boxes for projects and demonstration
- Urine manure slurry (drum, strong sack/gunny/nylon bag, strong pole, rope, small plastic sheet, comfrey, tobacco, Tithonia)
- Photographs/pictures, charts, video slides showing growing plants

## Hints to the Teacher

- Make a list of the major and trace elements that plants need from the soil.
- Emphasise the deficiency symptoms of these elements and the role of organic manure in putting back nutrients.
- The soil amendment practice and fertilizer use in Uganda is low but most of it is being done in growing of flowers.

## Assessment

- Macro- and micro-nutrients/trace elements
- The role of organic manure in maintenance of soil fertility
- Importance of maintaining soil fertility
- The safety precautions when handling and applying fertilizers and manures
- The effects of fertilizers applications on the environment
- Soil acidity and soil amendment
- Benefit of liming soils by farmers

## Sub-Topic 2: Production of High Value Crops

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• adapts practices involved in the production of high value crops with export potential.</li> <li>• integrates tree growing with crop production.</li> <li>• initiates value addition before selling of high value crops.</li> </ul>	<p>Production of high value crops</p> <ul style="list-style-type: none"> <li>• Group A: Vegetable and spices such as okra, garlic, Irish potato and pepper</li> <li>• Group B: Fruits (pineapple, mango and gooseberry)</li> <li>• Group C: Medicinal crops (such as moringa, neem, aloe vera and Artemisia sp)</li> <li>• Group D: Popular cottage crops like mushrooms, flowers and upland rice</li> <li>• Group E: Trees, mulberry, Lucerne <i>Musizi</i> and pine</li> </ul>

## Methodology

- Before the lesson:
  - acquire the different recommendations by research stations/model farm/ extension workers involved in the selected high value crops.
  - prepare a questionnaire and organise a visit to a farm in the area where the two selected high value crops are grown so that the learners can observe, inquire and record findings from these farmers.
- Lead a guided discussion for learners to:
  - explain the agronomic practices involved in production of high value crops.
  - explain the post-harvest handling practices and their requirement.
  - explain innovative ways of marketing high value crops.

- Demonstrate the agronomic practices in growing the two selected high value crops for learners to:
  - prepare a suitable seedbed for growing a high value crop.
  - select suitable materials for planting.
  - carry out a germination test of planting material.
  - carry out the agronomic activities involved in growing of crops.
  - grow successfully the selected high value crops.
  - establish a crop museum at school.
  - keep records of various high value crop production activities.
- Have different secure plots for learners in groups to use in growing the selected two high value crops.
- Prepare an instructional manual on the activities to be carried out by learners in growing the high value crops.
- Supervise the learners and assess them when carrying out:
  - establishment and managing of a nursery.
  - seedbed preparation and site selection.
  - seed/planting material selection.
  - timely planting and transplanting.
  - optimum spacing, planting depth and seed rate.
  - application of fertilizers; weed, pest and disease control.
  - harvesting and preparing produce for storage.
  - innovative storage, packaging and presentation of high value crops for the market.
- Organise a day for learners to:
  - present and discuss a written report of activities carried out.
  - observe displayed photographs/charts or video slides of successful crops.
  - visit a commercial farmer producing one high value crop for export.
- Ask learners to work out the costs of producing each crop and project incomes based on production levels obtained. From the calculations of expenditure and income, let the learners draw conclusions on the most profitable crop and where there are losses ask them to propose remedies.

## Practical

- Raising selected high value crops suitable for the area (school locality) from each group indicated
- Identifying crops in the museum
- Planting and managing trees

## Resources

- Specimen crops, crop products like fruits/seeds/roots displaying deficiency or good supply of plant nutrients and planting materials
- Land/soil bags/wooden soil boxes for projects and demonstration
- Photographs/pictures, charts, video slides showing growing plants
- Crop production manual like for Solanum macrocarpon (Nakati)
- Tools and equipment for crop growing and agrochemicals and fertilizers
- Crop museum/gene bank

## Hints to the Teacher

- Get support from the school administration to provide the relevant inputs so that learners can go into production of high value crops. These include things like land, planting materials, working tools/equipments, fertilizers, pesticides, space, funds, moral support and time.
- Supervise the learners carrying out the agronomic practices in high value crops. Ensure careful crop husbandry management in the production of high value crops to guarantee success.
- Clearly adhere to the post harvest practices which include threshing, cleaning, processing, sorting, drying, dusting, treatment, packaging and storage.
- The crop chosen should have potential to sell in the locality when students innovatively market it.
- Finally guide school administration to establish a crop museum.

## Assessment

- Reasons for increased production of the selected high value crops
- The procedure of raising the selected high value crop from seedbed preparation to harvesting
- The procedure of planting upland rice and procedure for preparing the selected high value crops
- Advantages of refrigerated stores for selected high value crops such as vegetables
- Precautions to be taken when harvesting the selected high value crops
- Factors that would affect the quality of the selected high value crops
- How processing, packaging and advertising would increase farmers' income from high value crops

## Topic 6: Animal Production II

*Duration: 21 Periods*

### Overview

Livestock management includes among other things but not limited to feeding, housing, breeding, record keeping, disease and pest control. These activities are carried out on livestock to ensure high production.

### Learning Outcome

By the end of the topic, the learner should be able to:

- apply the knowledge of good diets in livestock management.
- apply appropriate skills of recommended routine practices in livestock.
- demonstrate knowledge and proficiency in poultry production.
- justify the reasons for livestock improvement.
- demonstrate proficiency in poultry, beekeeping and fish production.
- prepare different rations for feeding livestock on the farm.
- adhere to the guidelines of providing suitable animal rearing environment.
- clarify their knowledge of handling livestock records and animal health.
- manage dairy production, poultry breeding, fish pond stocking and beekeeping on a farm.

### Sub-Topic 1: Livestock Management

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• explains the principles and practices of livestock feeding.</li><li>• classifies various livestock feeds.</li><li>• examines the nutritional requirements for various kinds and types of livestock.</li><li>• carries out appropriate livestock feeding practices.</li><li>• demonstrates the principles and practices of good livestock</li></ul>	<ul style="list-style-type: none"><li>• Principles and practices of good livestock feeding:<ul style="list-style-type: none"><li>- adequate feeding</li><li>- balanced ration</li><li>- clean water and clean feeds</li></ul></li><li>• Livestock feeds</li><li>• Nutritional requirement of different livestock</li><li>• Livestock feeding practices</li><li>• Principles and practices of good livestock housing</li></ul>

Competences	Content
<ul style="list-style-type: none"> <li>housing.</li> <li>• demonstrates appropriate livestock and housing practices.</li> <li>• describes the meaning, purpose, procedure, advantages and limitations of routine livestock management practices.</li> <li>• demonstrates the routine livestock management practices.</li> <li>• differentiates between silage and hay.</li> <li>• describes the procedure of making silage and hay.</li> <li>• demonstrates the preparation of silage and hay at school for feeding livestock.</li> <li>• justifies the factors that influence the quality of silage and hay.</li> </ul>	<ul style="list-style-type: none"> <li>• Routine livestock and housing management practices</li> <li>• Silage and hay</li> </ul>

## Methodology

- Lead learners in a discussion on the:
  - principles and practices of good livestock feeding and housing.
  - nutritional requirements of different livestock at various stages of growth.
  - meaning, purpose, procedure, advantages and limitations of routine livestock management practices.
  - factors influencing the qualities of good silage and hay.
- Using demonstration, guide learners to:
  - feed and water animals.
  - clean the feeding and watering equipment.
  - mix feed rations for different livestock.
  - clean and disinfect livestock houses.
  - maintain and repair livestock houses.
  - carry out routine management practices.
  - make silage and hay.
- Ask and have the learners in groups to:
  - identify various feed stuffs presented.

- classify various feed stuff as proteins, carbohydrates, fats, minerals, vitamins, roughages, concentrates, supplements, succulents and additives.
- feed and water livestock.
- record feeding regimes of different livestock.
- administer right dosage of drugs.
- demonstrate how to carry out appropriate livestock feeding practices.
- Demonstrate and involve learners in the procedures of carrying out:
  - de-beaking, castration, dehorning, hoof trimming, identification, livestock record keeping
  - hand spraying, dosing, drenching, branding, tattooing, docking, grooming, kindling, de-worming, tooth clipping, ear notching, culling, vaccination and ear tagging.
  - home feed mixing.
  - dipping and spraying livestock.
  - silage, hay and calf pellet making.
  - designing a feeds outlet shop (but you are expected to be fully knowledgeable about each skill so as to guide learners effectively).
- Provide learners with the proper guidance, right materials, enough time and equipment so that they can carry out the following tasks:
  - branding cattle/young calves
  - dosing/drenching of calves
  - disbudding of calves and injecting of cattle
  - hand spraying of livestock
  - taking the anal temperature of cattle
  - tattooing of goats, hoof trimming of goats and dehorning
  - caponising of male birds
  - ear tagging of goats/pigs/cattle
  - castration of young piglets
  - ear notching of pigs, tooth-clipping in pigs and creep feeding
  - de-beaking of layers and culling of birds
  - docking lambs/raddling/ crutching/tupping/serving/ringing
  - shearing of wool from sheep
  - dusting livestock houses
  - steaming-up/ drying-off/ flushing of livestock
  - designing and construction of rabbit kindling boxes

## Practical

- Feeding and watering animals
- Cleaning feeding and watering equipment, among others

## Resources

- Live poultry and farm animals such as cattle, sheep, goats, pigs, rabbits and guinea pigs
- Livestock feeds (roughages: grass, Lucerne, cereal stalk, sweet potato, moringa, hay, silage or concentrates: cotton seed cake, groundnut cake, soya bean cake, sunflower cake, fish meal, blood meal, bran, premix, additives, dairy/sow and weaner/layer mash/grower mash meal, mineral salt, calf pellets, milk booster, molasses, feed additives (terramycin)
- Equipment for routine management operations (elastrator, burdizzo, hot iron dehorner, hoof trimmer, hand spray pump, scissors, branding iron, ear notcher, neck straps/chain, electric de-beaker, knife, tooth clipper, sharp knives, razor blades, tattooing machines and thermometer)
- Feeding and watering equipment
- Livestock sanitation equipment including a hand spray pump
- Cattle dip/crush/spray race and silage pit
- Animal feed mill and feed outlet shop

## Hints to the Teacher

- Whereas there are many routine management practices to be carried out under this topic, learners at this level cannot handle all but you should be knowledgeable enough about each before going to demonstrate any one of them.
- Get support from the school administration to provide the relevant inputs to the learners such as live farm animals, livestock routine management equipment, livestock feed materials and silage making requirements. Otherwise organise with farmers or a veterinary officer where you can take learners to have practical experience of the different routine management operations.

## Assessment

- Procedures of determining anal temperature of a given livestock
- Precautions a farmer should take before using a cattle dip
- Qualities of good silage and hay
- Drawing a beef animal and labelling the parts suitable for branding
- Advantages and limitations of open/surgical castration in livestock
- Importance of identification as a routine management practice in livestock
- Importance of feeding roughages to livestock

- Importance of feed additives in the diet of livestock
- Consideration when siting a good housing of a named livestock
- Reasons for using limited amounts of protein when making feeds for livestock
- Importance of adequate supply of water in feeding of livestock
- Procedure of using a hand spray pump when treating a named livestock
- Methods of de-beaking, castration, identification, dehorning and feeding of young livestock
- Advantages and disadvantages of steaming up, flushing, creep feeding, livestock identification, drying off and closed castration
- Classification of feedstuff in terms of correct names, nutrient supplied to livestock and its group. This could be done using a table as shown below:

Specimen/Feed	Name	Class of feed	Nutrient supplied
1. Cotton seed cake			
2. Potato vine			
3. Maize bran			
4. Dairy meal			
5. Calf pellet			
6. Mineral lick/salt block			
7. Blood meal			
8. Fish Meal			
9. Hay			
10. Oyster shell			
11. Elephant grass			
12. Sodium chloride			
13. Desmodium spp			
14. Molasses			

## Sub-Topic 2: Poultry Breeding

Competences	Content
The learner: <ul style="list-style-type: none"><li>• initiates appropriate poultry breeding practices.</li><li>• develops criteria for selecting poultry breeding stock.</li><li>• describes the routine management practices of poultry breeding stock.</li></ul>	<ul style="list-style-type: none"><li>• Poultry breeding practices</li><li>• Selection of breeding stock, i.e. cocks and hens</li><li>• Management of breeding stock, mating ratios and egg collection</li></ul>

Competences	Content
<ul style="list-style-type: none"> <li>• compares the theoretical poultry breeding management practices with the farmer's actual practice.</li> <li>• describes the routine hatchery management practices.</li> </ul>	<ul style="list-style-type: none"> <li>• Hatchery and hatchery management: <ul style="list-style-type: none"> <li>- hatchery hygiene</li> <li>- conditions for a hatchery (temperature, humidity, aeration)</li> <li>- selecting/grading eggs for hatching</li> <li>- turning eggs in the incubator</li> <li>- hatching period</li> <li>- candling of eggs</li> <li>- sexing of chicks</li> <li>- brooding chicks</li> <li>- improved management of natural incubation of eggs</li> </ul> </li> </ul>

## Methodology

- Lead learners in a guided discussion on the:
  - practice of natural and artificial poultry breeding.
  - selection and management of poultry breeding stock.
  - qualities of good quality eggs for breeding.
  - breeding principles in poultry.
  - methods of raising poultry in Uganda.
- Using brainstorming with learners, identify the suitable conditions for incubating eggs.
- Organise a field visit with prepared questionnaires for learners to:
  - find out what breeds and hatchery management practices are being used.
  - compare their routine management practices with those being carried out at the farm.
  - consolidate their knowledge on the selection of poultry breeding stock.
  - explain the conditions necessary for successful incubation of eggs on this farm.
  - carry out egg candling on this farm.

- describe the care given to young chicks until maturity at the poultry farm.
- mix poultry feeds and participate in the procedure of home mixing of poultry feeds.
- Using a demonstration, prepare learners to:
  - select cocks and hens suitable for breeding stock.
  - select eggs for incubation.
  - candle eggs for fertility.
  - adhere to a vaccination schedule/regime.
  - carry out candling of eggs in the incubator.

## Practical

- Managing breeding stock including feeding, brooding chicks, rearing growers, vaccinating, de-beaking, collecting eggs, grading/packing of eggs, egg candling and selling of birds
- Selecting of cocks and hens as breeding stock
- Visiting a poultry breeder to observe management of breeding stock

## Resources

- Poultry unit of layer birds of both local and exotic poultry birds
- Incubator and brooding materials
- One day old chick/pullet/brooding equipment
- Egg tray, egg boxes, candler and light source
- Nest boxes, water trough/drinker, feed/food trough, roosting box or perches
- Spade with tarpaulin, gunny bags/sacks
- Poultry feeds for different stages including the following: fish meal, maize bran/ rice/ wheat bran, cotton seed cake, sunflower cake, bone meal, oyster shells, primix, general purpose/common /layer salt, broken maize/cassava flour/sorghum meal
- A farm with a hatchery and live birds of different categories
- Various materials like candler, de-wormers, de-beakers, vaccines and bio-safe as a disinfectant

## Hints to the Teacher

- Young chicks are valuable in successful poultry production. Therefore wide knowledge on the principles and methods of breeding would be required. Hence careful poultry breeding will be emphasised so that chicks with good breed characteristics are produced.

- Get support from the school administration to provide the relevant inputs to the learners so that factors influencing incubation and production of good quality eggs are achieved.
- Organise field trips to a hatchery farm to show learners important poultry breeding practices. But breeding in poultry will be examined in detail. Poultry include chicken, ducks, geese, turkey and guinea fowl. Currently chicken are raised in greater numbers. Chicken must be produced to meet the increasing demand for table birds.

## **Assessment**

- The limitations of natural poultry breeding today
- Production of good quality eggs for hatching on the farm
- How to care for young newly hatched chicks
- Conditions necessary for successful incubation of eggs
- Characteristics of a good quality egg for incubation
- Management practices that a poultry farmer should carry out to produce good quality eggs
- The valuable characteristics used in selecting poultry breeding stock
- Routine management practices for a poultry breeding stock
- How to improve on quality and production of local poultry in Uganda

## SENIOR FIVE TERM THREE

### Topic 7: Basic Science III

*Duration: 18 Periods*

#### Overview

Ecology is the study of plants and animals in relation to each other and to the physical and chemical environment in which they naturally occur. But much of the agriculture and farming emphasises individual organisms as if they occur in isolation.

The relationship between plants and animals and their effect on their environment is of much importance and will be seen in this topic. Among the many things that are used in the environment by man are farm chemicals. These are chemical preparations specially manufactured for agricultural use. They can be applied in farming activities in order to increase yield, improve quality of produce or protect plants and animals. So the way they are handled plus their impact on the environment is of concern in agriculture.

#### Learning Outcome

By the end of the topic, the learner should be able to:

- explore the characteristics of both the terrestrial and aquatic ecosystem.
- demonstrate the extent to which the patterns in vegetation and animals can be explained by human activity and the related biotic factors of now and the past.
- demonstrate understanding of when to use and methods of using farm chemicals.
- apply different farm chemicals with proper understanding of their effect in agriculture.

## Sub-Topic 1: Ecology I

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>describes the components of an ecosystem and their inter-relationships.</li> <li>designs and creates different sized quadrate frames to be used in sampling.</li> <li>generates energy flows, food chains and food webs around the school.</li> </ul>	<ul style="list-style-type: none"> <li>Definition of ecology/ecosystem</li> <li>Components - living things (biotic) and non-living things (abiotic)</li> <li>Interactions like: <ul style="list-style-type: none"> <li>- food chains</li> <li>- food webs</li> <li>- pyramids of biomass and numbers</li> </ul> </li> </ul>

### Methodology

- Using a guided discussion, make the learners:
  - explain the concept of an ecosystem, niche, habitat and community.
  - explain with relevant examples the concepts of food chain, food web, succession, climax and ecological pyramids then ask learners to generate simple food chains, food webs and ecological pyramids.
- Brainstorm with learners:
  - how to make a transect and random sampling in the school farm or land.
  - types of ecosystems and ask them to write them down.
  - succession and its stages on a farm, and shoot monthly picture/photos of each stage.
- Guide the learners to demonstrate how to:
  - measure the moisture content, the percentage moisture content of soils in the high value crop and organic matter content of soil in different ecological niches/habitat plus the light compensation points of selected plant species.
  - follow the procedure of determining soil pH of the five samples (acidic soil, alkaline soil, anthill soil, loam/garden soil and ash soil from recently burnt area) given.
- Lead the learners in a guided discovery of the levelling method of using ranging poles to calculate the gradient of the school or community around the school.
- Lead the learners in groups to plan and measure the slope around the school.

- Review using a guided discovery and project work with learners the construction of different sized quadrat to be used during random sampling.
- Lead the learners in a practical work on succession on a cleared piece of land or an exposed rock/concrete slab covering an underground water tank.
- Ask learners in groups to draw, display and exhibit food chains, food webs and ecological pyramids.

### Practical

- Visiting a selected habitat to identify the ecosystem components and their interactions
- Establishing a habitat and monitoring its progression or degeneration

### Resources

- Selected habitats/ecological sites like school farm, flower gardens, school lawns/hedges
- Ranging poles, measuring tape of 30-50 metres and sighting level
- Testing kit for pH with universal indicators, Munsell chart, spatula, barium sulphate, test tube, brush, small bucket/basin to carry the apparatus, towel and distilled water
- Small domestic oven/agriculture soil laboratory oven/camping stove/muffle furnace
- Evaporating dishes, tobacco tin having a rubber seal /foil which can burn
- Point quadrat (with 20 pins, 50 cm long and 20 cm high) and other quadrat of size between 0.25 x 0.25m to 2.0 x 2.0 m and a top pan /sensitive weighing balance
- Record sheets, waterproof markers/pens and random numbers
- Specimen bags/bottles, sweep nets, trowel, plastic/gunny bags/a hoe
- Test tubes as long as possible with rubber bungs to fit or using special soil testing glass tubes, heat source, whirling hygrometer/ wet and dry bulb thermometer
- Workshop tools like mallet, claw hammer, assorted nails, masking tape, hand drill, clamp and wood chisel plus dry wood/timber and still /digital camera and digital video recorder

### Hints to the Teacher

- Ecology can be the study of all factors affecting an area where plants and animals coexist. Therefore, consider the interactions between plants and animals where farming is taking place.

- Secondly only emphasise the meaning of terms in ecology and the effects of agriculture on the ecosystem.
- Finally ask learners to identify common food chains and food webs in high value crops in and around the school.

## Assessment

- Terms like ecology, species, organism, habitat, niche, population, community, biomass, carrying capacity, ecosystem, food chain, food web, prey, predator, parasitism, commensalism, mutualism, succession and climax
- Components of an ecosystem
- Distinction between the biotic and abiotic factors in an ecosystem
- The effect of agriculture on the ecosystem of an area
- Calculation of the gradient of the school land or that of the adjacent community
- Continuous assessment of projects during the construction of quadrants
- Practical exercise to determine the pH of different soil samples, organic matter, heavily manured soils and exhausted soils

## Sub-Topic 2: Ecology II

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• describes the different types of ecosystems.</li> <li>• explains the factors affecting plant and animal distribution in an ecosystem.</li> <li>• demonstrates the effects of agricultural activities on an ecosystem.</li> <li>• predicts a succession of organisms in a given habitat around the school.</li> </ul>	<ul style="list-style-type: none"> <li>• Types of ecosystems:           <ul style="list-style-type: none"> <li>- terrestrial</li> <li>- aquatic</li> </ul> </li> <li>• Factors affecting plant and animal distribution in an ecosystem</li> <li>• Adaptation of plants and animals to an ecosystem</li> <li>• Effects of agricultural activities on ecosystems</li> <li>• Succession and climax in a community</li> </ul>

## Methodology

- Before the lesson, prepare an investigation on ecological study guideline for flowering plants and animals in a given area then have learners read and use it.
- Using a guided discussion, have the learners:
  - explain the meaning of ecology.
  - define the term ecosystem.
  - identify the biotic and abiotic component of an ecosystem.
  - explain the factors affecting plant and animal distribution in an ecosystem.
- Brainstorm so that learners can predict the main issues of the:
  - investigation guide for plants and animals in an ecological study.
  - effect of agricultural activities on an ecosystem.
- Through a guided discovery, help learners to estimate the:
  - fauna and flora population like along a stream on the farm with effluent running into it.
  - weed species density in a high value crop or farming areas around the school.
- Provide guidelines for the following ecological field studies so that learners can:
  - determine the population of species in a given ecosystem.
  - compare two homogeneous ecological habitats.
  - measure environmental factors on agricultural land and water like comparing light compensation point, air humidity, slope, levelling using ranging poles, amount of soil moisture/organic content, suspended solids content in water, turbidity of water on the farm and water flow rate using a Pooh stick.
  - examine zonation along belt transect.
  - investigate the water and air content, and pH of a soil sample from a high value crop.
  - use a quadrat frame in sampling of organisms.
  - estimate the number of earthworms and soil nematodes (using Baermann/Tullgren funnel).
  - write up an ecological research project paper emphasising introduction, methods, results/observations, discussion of results, discussion of significance and references consulted.

## Practical

- Visiting both terrestrial and aquatic ecosystems to compare their components and asses the condition of the components

- Comparing two homogeneous habitat ecological characteristics in both the terrestrial and aquatic ecosystem
- Investigating the present flora and fauna of a pond, rook pool, protected spring or a dam
- Examining zonation along the belt transect

## Resources

- Sites representing terrestrial and aquatic habits
- Sites degraded by agricultural activities like swamps and wetlands
- Hand net, bucket, white tray, hand lens, record sheet, suitable key of plant and animal in the area, glass tube, plastic bags, measuring cylinder
- Appropriate equipment for measuring physical factors like quadrat frames, point quadrat, species list of the area, record sheet, tape measure
- Equipment to measure environmental factors like wooden pegs, mallet, felt tip pen, record sheet, site sketch/pond/ dam/rook pool map, graph papers
- Equipment to sample motile animals like the hand net; gumboots and an overall coat

## Hints to the Teacher

- Plants and animals are distributed according to the ecological conditions prevailing. You should clearly indicate the difference between a terrestrial and aquatic ecosystem.
- Use of simple procedures of estimating population will be needed. So get support from the school administration to provide the relevant inputs for learners to determine population of organisms in the two ecosystems.

## Assessment

- Components of an ecological research report
- Factors affecting plant and animal distribution in an ecosystem
- The effects of agriculture on a terrestrial and aquatic ecosystem
- Procedure of estimating population of a terrestrial flowering plant or animal

## Sub-Topic 3: Farm Chemicals

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• identifies the different farm chemicals.</li><li>• classifies the different farm chemicals.</li><li>• differentiates observable effects of farm chemicals.</li><li>• evaluates the contribution of farm chemicals to pollution of the environment.</li><li>• describes the dangers of improper use of farm chemicals to the environment.</li><li>• explains the precautions to take when using farm chemicals.</li></ul>	<p>Different farm chemicals</p> <ul style="list-style-type: none"><li>i) <i>Fertilizers</i><ul style="list-style-type: none"><li>- nitrogenous</li><li>- phosphatic</li><li>- potassic</li></ul></li><li>ii) <i>Pesticides</i><ul style="list-style-type: none"><li>- herbicides</li><li>- fungicides</li><li>- acaracides</li><li>- rodenticides</li></ul></li><li>iii) <i>Soil amendments</i><ul style="list-style-type: none"><li>- lime</li><li>- vermiculite</li></ul></li><li>iv) <i>Animal drugs</i><ul style="list-style-type: none"><li>- antibiotics</li><li>- analgesics</li><li>- ant-retrovirals</li><li>- antihelmintics</li></ul></li><li>v) <i>Food preservatives</i><ul style="list-style-type: none"><li>- sodium chloride</li><li>- sodium citrate</li><li>- sodium benzoate</li></ul></li></ul>

### Methodology

- Before the day of the lesson, gather the different kinds of farm chemicals like fertilizers, soil amendment materials, pesticides, herbicides, fungicides, acaracides, wormicides, auxins, food preservatives, animal drugs and rodenticides with the support from the school administration.
- Have learners read case study 1 and identify the intention of the writer.
- Have learners in a guided discovery of:
  - classifying farm chemicals presented to them and identifying farm chemicals.
  - administering drugs to animals through dosing, drenching and injection.
  - applying farm chemicals, observing the effects and recording findings.
  - applying preservatives to foods like meat and tomatoes to increase life span and easy packaging.

- comparing and determining the level of damage/infestation of pests on preserved farm products, including use of organic preservatives.
- Through a guided discussion, have learners explain the:
  - contribution of farm chemicals to pollution of the environment.
  - precautions to take when using farm chemicals.
  - dangers of improper use of farm chemicals.
  - effects of farm chemicals on high value crops, weeds and selected animals pests.
- Lead learners to demonstrate the:
  - procedures for safe use of farm chemicals.
  - mixing of chemicals following the recommendations of the manufacturer.
  - assembling of spraying equipment like hand spray pump.
  - applying of salt on a green hide/skin and ash on dry beans to preserve them.
  - identification of active ions in farm chemicals.
  - effects of auxins, fertilizers, pesticides, wormicides and fungicides, in agricultural activities.

## Practical

- Identifying farm chemicals using their characteristics
- Carrying out tests to identify active ions contained in the chemicals
- Applying the chemicals where possible and observing their effects
- Investigating the effects of lime on clay soils, anthills and organic matter
- Administering drugs to animals where possible and making a follow up of the animals
- Applying preservatives to different foods

## Resources

- Food preservatives like dryers, salt, sodium bi-carbonate, ash, red pepper, tobacco
- Petri dishes, measuring cylinders, test tubes, conical flasks, rubber bungs, beakers, test tube rack, bucket, sweep net and gloves
- Spraying equipment and farm chemicals like the hand spray pump, old engine oil, sulphur dioxide, fertilizers, pesticides (Ambush), acaracides, wormicides, herbicides (weed master, Glycophosphate, Roundup), auxins (Seradix) rodenticides, animal drugs, lime, vermiculite, food preservatives, and fungicides (Dithane M-45)
- Plants and animals where farm chemicals can be used
- Farm products like milk, hides/skins, meat, maize/bean/millet seeds

## Hints to the Teacher

- Great care must be taken when using farm chemicals. This is because some are dangerous substances which are highly toxic to plants, other animals and human beings. Strictly follow the manufacturer's instructions.
- Get support from the school administration to provide the relevant farm chemical inputs to the learners in the following categories: food preservatives, fumigants, stomach poisons, systematic poisons and contact poisons.

## Assessment

- Categories of farm chemicals studied and their uses
- Precautions a farmer should take when using farm chemicals
- Correct steps in using each farm chemical
- Dangers of the improper use of farm chemicals
- Reduction of the effects of farm chemicals to our environment

## Topic 8: Crop Production III

*Duration: 9 Periods*

### Overview

Forest is an area where vegetation consists mainly of trees, which are tall, woody plants and natural trees. Other types of plant and many animals live in the same area. Trees can be grown in plantations. However, trees can be grown together with crops.

### Learning Outcome

The learner should be able to:

- demonstrate understanding of the interaction of trees with crops for a sound environment and sustainable agriculture.
- appreciate the value of trees to the individual persons, community and the environment.
- demonstrate skills of raising trees with crops in one garden.

### Sub-Topic 1: Agro-Forestry

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• examines the meaning and principles of agro-forestry.</li> <li>• designs a suitable land use for the school which incorporates agro-forestry activities.</li> <li>• demonstrates practices of agro-forestry in the school.</li> <li>• establishes a nursery bed.</li> <li>• understands the challenges of agro-forestry.</li> <li>• describes how trees of agro-forestry are harvested and processed.</li> </ul>	<ul style="list-style-type: none"> <li>• Meaning of agro-forestry</li> <li>• Methods and procedures for establishing agro-forestry</li> <li>• Principles and practices of agro-forestry</li> <li>• Establishing a nursery bed for trees</li> <li>• Selection of trees for agro-forestry</li> <li>• Advantages of agro forestry practices in agriculture</li> <li>• Challenges of agro-forestry</li> <li>• Harvesting and processing of trees in an agro-forestry garden</li> </ul>

## Methodology

- Lead the learners into a guided discussion to explain the:
  - meaning of agro-forestry, coppicing, pollarding, lopping and silvi culture.
  - principles and practices of agro-forestry.
- Ask learner to brainstorm the:
  - challenges of agro-forestry.
  - procedure of harvesting and processing trees.
- Lead learners to demonstrate how to:
  - raise agro-forestry seedlings in a nursery bed.
  - select trees for agro-forestry.
  - establish a demonstration plot for agro-forestry, silvi-pastoral cultural and trees.
  - practise pruning of trees in agro-forestry garden.

## Practical

- Identifying suitable agro-forestry tree species
- Raising seedlings of agro-forestry trees
- Planting and raising agro-forestry trees in association with crops and animals
- Investigating the correct methods and procedures for establishing an agro-forestry garden

## Resources

- Agro-forestry tree planning materials (cutting, seeds, seedlings)
- Land/demonstration plot, pegs, hoes, dibbers, bow/power chain-saw, panga, axe and ropes
- Coffee husk/saw dust/organic manure/lake sand, single super phosphates (SSP)
- Rooting hormone like Seradix (for stem cuttings)
- Pesticides, pruning knife, and secateurs
- Charts, slides/video shows illustrating the importance of trees in agriculture
- Manila sheet, masking tape, packet of marker, thumb pins and glue
- Agro-forestry tree planting materials
- An agro-forestry farm

## Hints to the Teacher

- A forest is an area where the vegetation consists mainly of trees. Other types of plants and animals may live in the same area naturally or when scientific principles are applied for them to coexist. It is against this background that emphasis of the benefits and challenges of agro-forestry should be taught.
- Get support from the school administration to provide the relevant inputs to the learners such as land where to have the required plots.

## Assessment

- The appropriate practices in management of agro-forestry
- Economic importance of forests in Uganda
- Maintenance practices of a mature agro-forestry
- Promotion of agro-forestry, forest and tree conservation

## Topic 9: Animal Production III

*Duration: 45 Periods*

### Overview

Fish farming has not been developed as much as it should be in Uganda, considering the protein requirements of its people. Despite the fact that fish is heavily consumed in Uganda, the population still depends very much on natural waters such as lakes, streams and rivers for fish supply. However with this awareness of advantages, the importance of cultivating fish in ponds should now be emphasised. The large-scale production of fish can provide raw materials for industries. Less importantly, fish can be raised for aesthetic purposes in an aquarium and for sports, as well as for financial benefit.

Traditional methods of beekeeping are still predominant in Uganda where it remains an important seasonal activity. The introduction of modern beekeeping, including modern beehives and technological practices, has resulted in quite remarkable gains.

The quality of the livestock environment on which most farmers depend is declining. Yet livestock rearing is undergoing a complex process of technical and geographical change. Production is shifting from the traditional country sides to either urban or peri-urban areas, and towards sources of feeds or easy access to the market. It is entering a direct competition for the dwindling and scarce land, water and other natural resources. On the other hand, intensive animal production systems are producing high levels of nitrogen and phosphorus wastes and concentrated discharges of toxic material. Yet those systems are often located in areas where effective waste management is more difficult. This posses an environmental concern today.

### Learning Outcome

By end of the topic, the learner should be able to:

- demonstrate skills of modern fish farming and beekeeping practices in Uganda.
- demonstrate understanding of fish pond and apiary management.
- explore ways of fish preservation, fish products marketing and honey marketing.
- prepare different rations for fish and other livestock on the farm.
- adhere to the rules and regulations of fishing and beekeeping in Uganda.

## Sub-Topic 1: Fish Farming

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• explains the status of fish farming in Uganda and the factors that affect the industry.</li> <li>• classifies broadly the different types of fish.</li> <li>• identifies fish species and fish structural features.</li> <li>• explains the functions of fish structural features.</li> <li>• designs a model fish pond for stocking.</li> <li>• adheres to appropriate fish farming practices.</li> <li>• describes the fish pond fertilization.</li> <li>• selects desirable fish types for stocking a fish pond.</li> <li>• feeds fish in a pond for high output.</li> <li>• designs methods of controlling the aquatic weeds.</li> <li>• classifies the causes and treatment of fish mortality.</li> <li>• Post-harvest handling technologies in Uganda.</li> <li>• demonstrates proper fish harvesting from a pond.</li> </ul>	<ul style="list-style-type: none"> <li>• Importance of fish, factors affecting fish farming, farmed fish in Uganda (Nile tilapia, common tilapia, Zanzibar imported, cat fish, mirror carp)</li> <li>• Classification of fish species and their structural features</li> <li>• Fish ponds: types, siting, layout and maintenance, control of water flow and level, factors affecting fishpond like water quality: silting, pollution due to decaying organic matter, pH level and heat, agrochemicals and polluted water sources</li> <li>• Pond fertilization: why pond fertilization is done, types of pond fertilizers, making compost manure for pond fertilization</li> <li>• Stocking fishponds: selecting desirable fish types, fish combinations, and fish fry production (breeding)</li> <li>• Feeding fish: supply of fish feeds, supplementary fish feeds, and feeding characteristics of fish</li> <li>• Aquatic weeds: types, advantages and disadvantages, and aquatic weed control</li> <li>• Fish mortality and diseases: causes of fish mortality, parasites and diseases, treatment of diseases</li> <li>• Tools and materials used in fish farming: fish nets, boats, papyrus mats, water pumps, storage boxes for keeping fish, baskets, buckets, tools for constructing and maintaining ponds</li> </ul>

## Methodology

- Have learners in a guided discovery to explain the:
  - status, importance and benefits of fish farming in Uganda.
  - factors affecting fish farming in Uganda.
  - measures taken to ensure sustainable fish harvesting from ponds.
  - rules and regulations of fishing in Uganda.
- In a guided discovery, lead learners how to:
  - distil, refill and construct a fish pond.
  - protect fish against predators like snakes and birds.
  - formulate a fish feeding ration.
  - measure the suspended solid content in pond water.
- Ask the learners to carry out:
  - fish processing.
  - post harvest handling technology in fish technology.
- Ask learners to be in groups so that they can:
  - identify different fish species available in Uganda.
  - harvest fish from a pond or lake and carry out pond fertilization.
  - clear around the fish ponds and control weeds around ponds.
  - measure and determine the turbidity of pond water.
- Lead a guided discussion for learners to explain fish feeding practices, fish disease and predator management.
- Organise a study visit for learners to a nearby fish farm to observe and make notes on the management practices.

## Practical

- Drawing after observing and describing different fish types
- Dam/pond construction
- Cleaning around the pond
- Making compost manure to fertilize the pond
- Feeding fish
- Introduction of fish fry/fingerlings into the pond
- Fish harvesting
- Controlling weeds in the pond
- De-silting the pond
- Constructing models of fish boats, fish basket and fishing gears

## Resources

- Fish species specimen, fish fry, tilapia(*Oreochromis spp*), Nile perch (*Lates niloticus*), cat fish (*Clarias spp*), lung fish (*Protopterus aethiopicus*) and fingerlings

- Fish feeds, poultry manure, tobacco plants, boiled chicken eggs and Planktons
- Fish nets, guard nets, hand net, fish buckets, fish storage boxes, seine net, rods and hooks
- Pond construction tools, boats, fish specimen tube and water pumps
- Uganda Fisheries Act
- White tray, wide mouthed pipettes, tape measure, wooden pegs, mallets water proof pens, key to fresh water fauna and flora, record sheet, filter funnel, filter paper, measuring cylinder, 250 ml beakers, weighing balance, glass tubes of 2.5 cm diameter and 100 cm long, plane glass glued to the bottom which has a black cross painted on with lines of 1mm, weights, corks, hooks and spears

## Hints to the Teacher

- Classification of fish is so varied but for agricultural purposes it will be based on the type of water in which the fish lives. For example, the fresh water fish, culture/pond/special tank /aquarium fish, and marine fish.
- Get support from the school administration to provide the relevant inputs to the learners to make a field visit or establish a fish pond at school.
- A good fish pond should be able to hold water all the year round with an average depth of about two metres. The pond must have correct temperature, sufficient nutrients for the growth of plants, adequate aeration and the bottom should be free from debris.
- The stocking rate is determined by the species of fish and method of harvesting. Fish may be fed with rice/maize bran, floating and sinking pellets and poultry litter. Efforts should be made not to over feed the fish as it may lead to shortage of oxygen. Many fish diseases are caused by pollutants entering water.

## Assessment

- Improving fish farming in Uganda
- Fish feeding and pond fertilization
- Control of fish predators
- Methods of harvesting, processing, preserving and marketing fish in Uganda
- Advantages of fish cropping by seine net compared to other methods
- Fishing rules and regulations

## Sub-Topic 2: Beekeeping

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>discusses the importance of beekeeping in agriculture.</li><li>discovers the different bee species.</li><li>identifies different members of the bee colony.</li><li>understands the factors affecting beekeeping.</li><li>initiates beekeeping by managing a beehive.</li><li>designs the different models/types of beehives.</li><li>harvests and prepares bee products for sale.</li></ul>	<ul style="list-style-type: none"><li>Importance of beekeeping</li><li>Bee species<ul style="list-style-type: none"><li>- apis mellifera monticola</li><li>- apis mellifera litorea</li><li>- apis scutellata</li></ul></li><li>Members of the colony (queen, drone, worker)</li><li>Factors affecting beekeeping</li><li>Management of a beehive:<ul style="list-style-type: none"><li>- planting trees and shrubs near apiary</li><li>- provision of water (sugared) during the dry season</li><li>- location of apiary</li><li>- stocking the beehive</li></ul></li><li>types of hives: local, Kenya top bar (ktb) beehive, langstroth, etc.</li><li>honey harvesting, honey processing and bee products and their uses.</li></ul>

## Methodology

- Through a guided discussion, enable learners to:
  - explain the importance and benefits of beekeeping in agriculture.
  - explain the factors affecting beekeeping in Uganda.
  - describe the management of an apiary.
  - describe the diseases and parasites of bees.
  - explain the methods of harvesting and processing of good quality honey.
- Brainstorm so that learners can:
  - choose a suitable site and prepare a beehive.
  - hang or fixed beehive to avoid parasitic attacks.
  - trap bee colonies and clean the apiary.
  - harvest honey and extract honey.

- Organise a study visit with learners to a nearby apiary to observe and make notes on the management practices.
- Ask the learners in groups to:
  - identify different members of a colony, the bee species and different beehives.
  - select, grow and manage recommended trees and shrubs that attract bees.
  - process and package honey or wax for sale.
  - feed bees during a dry season.
  - harvest honey using appropriate methods.
  - market honey from their beehive.

## Practical

- Observing and identifying bee types and different members of the colony.
- Trapping bee colonies
- Planting flower shrubs near hives
- Cleaning the apiary
- Selecting, planting and managing recommended trees and shrubs near an apiary that is sunflower, eucalyptus
- Harvesting honey and honey extraction
- Project to compare honey production in improved hives with that in local hives

## Resources

- Bee colonies, beehives including box hives, top-bar hive, log beehive, bee wax and hanging wires
- Clothing and hive tool muslin cloth, harvesting veils, bee suits/protective gears, smokers, gloves, swarm net and hive knife

## Hints to the Teacher

- Bees are useful pollinators of flowering plants but extra care must be taken when you have to establish a beehive in the school.
- It is better to get support from the school administration to make a field visit to a modern apiary farm and observe how beehives are hanged/fixed, harvesting of honey and wax.

## Assessment

- Drawing and labelling a top-bar beehive
- Harvesting honey

- Methods of processing honey and packing of honey
- Industrial use of bee wax
- Roles of the members of a bee colony like workers, drones and queen

### Sub-Topic 3: Livestock Rearing and the Environment

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• evaluates environmental problems in routine rearing practices of livestock.</li><li>• explains the environmental problems resulting from livestock rearing.</li> <li>• initiates the care for the environment while rearing and treating animals.</li><li>• describes the practices/measures that can be taken to care for the environment while rearing livestock.</li><li>• designs innovative ways of livestock waste management.</li></ul>	<ul style="list-style-type: none"><li>• Environmental problems due to livestock rearing and treatment e.g.<ul style="list-style-type: none"><li>- over grazing</li><li>- pollution of the environment by chemicals (drugs, pesticides)</li><li>- contamination of livestock products by agrochemicals</li><li>- transmission or spread of zoonotic diseases</li></ul></li><li>• Caring for the environment using:<ul style="list-style-type: none"><li>- the correct stocking rate</li><li>- rotational (controlled) grazing</li><li>- grazing pasture at the right stage</li><li>- drugs and sprays according to manufacturer's instructions and in specified places, e.g. constructed places</li><li>- drugs and sprays safely</li><li>- safe disposal of animal waste</li><li>- medicinal plants to treat livestock</li><li>- safe disposal of diseased carcass and animal wastes</li></ul></li></ul>

## Methodology

- Demonstrate for learners to suggest the:
  - correct use of drugs and acaracides based on manufacturer's instructions.
  - ways of maintaining hygienic conditions in animal quarters.
  - methods of safe disposal of diseased carcass.
  - the correct use of drugs and livestock treatment chemicals.
  - ways of handling and using animal wastes.
- Guide learners to demonstrate the procedure of using acaracides on the farm.
- Organise a study visit for learners to a nearby animal slaughter house and an intensive livestock farm to observe and document environmental problems.
- Lead a brainstorm session for learners to suggest:
  - innovative ways to handle and use animal wastes safely.
  - practices taken to care for the environment while rearing livestock.
- Ask learners to role-play the animal care.
- Provide the environment management policy so that learners in groups can discuss the key areas that are used today.

## Practical

- Demonstrating correct use of drugs and acaracides based on manufacturer's instructions
- Maintaining hygienic conditions in animal quarters
- Handling and using animal wastes
- Demonstrating methods of safe disposal of diseased carcass

## Resources

- Charts, video tapes and computer simulations
- Overgrazed sites or charts showing/ illustrating impact of overstocking/ over grazing on the environment.
- Contaminated drugs/animal chemicals dumping site
- Video showing effects of animals and use of drugs on the environment

## Hints to the Teacher

- Before the lesson acquire, the Animal Health Care Act to understand the rules and regulations.

- Whereas there are many environmental challenges posed by rearing livestock, at this level the learners can emphasise animal waste management and how to innovatively deal with it.

## Assessment

- Impact and indicators of environmental degradation due to livestock rearing
- Designing a poster to sensitise farmers about the environmental hazards from livestock wastes
- Environmental problems due to intensive livestock rearing in Uganda

## Sub-Topic 4: Animal Nutrition

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>describes the concept of balanced diet and digestibility in farm animals.</li><li>explains the common animal nutrition terms.</li><li>explains the effects of nutrient deficiencies on farm animals.</li><li>adheres to the nutritional requirements for various kinds and types of livestock from the locally available materials.</li><li>formulates, prepares and uses suitable feeds to feed various categories of livestock.</li><li>computes animal rations from available ingredients.</li></ul>	<p><i>Animal Nutrition</i></p> <ul style="list-style-type: none"><li>Animal nutrient requirements:<ul style="list-style-type: none"><li>concept of a balanced ration and other animal nutrition terms like digestibility</li></ul></li><li>Nutrient deficiencies and their effects on farm animals</li><li>Basis for animal nutrient requirements and the factors determining the type of feed given to animals</li><li>Ration formulation:<ul style="list-style-type: none"><li>methods of ration computation (Pearson square or algebraic)</li><li>weighing ingredients</li><li>assembling ingredients</li><li>grinding and mixing</li><li>bagging and storage</li></ul></li></ul>

## Methodology

- Through brainstorming, ask learners to explain the:
  - reasons for feeding farm animal and the concept of balanced diet.
  - factors that influence digestibility of feeds in farm animals.
  - effects of nutrient deficiencies in farm animals.
- Lead a demonstration for learners to:
  - classify various livestock feed ingredients.
  - assemble and weigh ingredients when preparing to make an animal ration.
  - formulate feed rations, grinding ingredients and mixing them properly.
  - put well-mixed rations into bags, pack, and store them safely.
- Organise a field visit with prepared questionnaires for learners to:
  - compare their routine management practices with those being carried out on the farm.
  - mix poultry feeds and participate in the procedure of home mixing of poultry feeds.
  - go to a nearby animal feed mill or feed outlet shop to clarify the procedures in feed ration formulation.
- Ask learners in groups to:
  - draw up a timetable for feeding animals on the farm and participating in the animal feeding.
  - investigate the nutrient composition of different feeds particularly the presence of proteins, fats, reducing and non-reducing sugars.

## Practical

- Observing and describing nutritional deficiency symptoms in farm animals
- Computing rations (using Pearson square and algebraic methods)
- Demonstrating the procedure of safe storage of prepared animal ration on the farm
- Preparing a feed by weighing ingredients, assembling ingredients, grinding, mixing, bagging and storage

## Resources

- Live farm animals (cattle, sheep, goats, pigs, rabbits)
- Livestock feeds (roughages: grass, Lucerne, cereal stalk, sweet potato, moringa, hay, silage or concentrates: cotton seed cake, groundnut cake, soya bean cake, sunflower cake, fish meal, blood meal, bran, premix, additives, dairy/sow and weaner/layer mash/grower mash meal, mineral salt, calf pellets, milk booster, molasses, etc.)

- Photocopies of feed nutrient tables, charts of digestive systems, manila, markers
- Feeding and watering equipment, and dressing equipment (knives, razor blades)
- Animal feed mill and feed outlet shop
- Spades, wheel barrows and gunny bags, calculators, weighing scale, tarpaulins
- Feed mixtures/rations like layers mash, broiler starter, sow and weaner meal, dairy meal

### Hints to the Teacher

- Get support from the school administration to provide the relevant inputs to the learners for formulating feeds for livestock. First and foremost the feed ingredients to be used must be obtained and their composition established from the standard feed composition table. Otherwise use the expertise of the feed outlets' managers to make livestock rations but be precise and accurate with non-ruminants and poultry when they are totally confined indoors.

### Assessment

- Definition of terms used in livestock feeding: production ration, maintenance ration, starch equivalent, digestibility, crude protein, biological value, digestible crude protein
- Ways of feeding farm animals in order to get high yields
- Classification of feed ingredients
- Types of feed rations
- The common equipments used in feeding farm animals

## SENIOR SIX TERM ONE

### Topic 10: Crop Production IV

*Duration: 24 Periods*

#### Overview

Crop production, like crop improvement, has been practiced by human kind for thousands of years, since the beginning of civilisation. This has been possible through selection and breeding practices. These activities have led to changes of the genetic makeup of plants. As a result, man has developed crops with more beneficial characteristics to humans for example larger fruits or seeds, drought tolerant plants, fast growing crops, as well as pest/disease resistant and high yielding varieties. But this has generated arguments about values which are neither absolute nor universal and controversies of crop improvement integrity. Concerns about the consequences of this development in terms of risks, benefits and impacts on human remain an issue of discussion.

#### Learning Outcome

By the end of the topic, the learner should be able to:

- demonstrate understanding of crop improvement principles.
- apply appropriate new ways of increasing crop yields in agriculture.
- adapt crop improvement practices that are relevant today.

#### Sub-Topic 1: Crop Improvement

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• justifies the importance of crop improvement.</li> <li>• explains principles of crop improvement.</li> <li>• applies various crop improvement methods and technologies.</li> <li>• discovers the current issues</li> </ul>	<ul style="list-style-type: none"> <li>• Reasons and importance of crop improvement</li> <li>• Principles of crop improvement: <ul style="list-style-type: none"> <li>- selection</li> <li>- breeding</li> <li>- introduction of new varieties</li> <li>- introduction of genetically modified organisms (GMOs)</li> <li>- cloning of crops</li> <li>- grafting</li> <li>- budding</li> </ul> </li> <li>• Current issues and</li> </ul>

Competences	Content
and developments in crop improvement.	developments in crop improvement

## Methodology

- Through guided discussions, make the learners to:
  - explain the meaning, reasons and achievements of crop improvement.
  - describe the ethical issues in crop improvement.
  - explain the desirable characteristics for breeding in crops.
- Ask learners to demonstrate vegetative propagation by budding, grafting, tissue culture and the use of specialised vegetative organs.
- Lead learners in a brainstorming session to explain the:
  - techniques of crop improvement.
  - factors to consider in vegetative propagation.
  - importance, advantages and disadvantages of each technique of vegetative propagation.
- Organise the learners in groups to:
  - carry out germination percentage calculations with different propagation materials.
  - carry out grafting, budding and tissue culture.
  - prepare rooting of cuttings and carry out seed inoculation of selected legumes.
  - design innovative methods of breaking seed dormancy.
  - determine plant population and density using the quadrat methods.
  - watch video shows/charts and describe crop improvement practices.
- Organise a field visit to research stations for learners to:
  - observe crop breeding practices.
  - clarify their knowledge on crop improvement procedures and importance.

## Practical

- Raising seedlings
- Carrying out grafting and budding on the farm
- Field visits to selection and breeding centres to observe crop-breeding practices
- Preparing cuttings for rooting like coffee, tea and ornamental plants

## Resources

- Grafting tools and equipment e.g. grafting knife, seedlings, root stocks, scions, rooting hormones like welgrow and seradix, rooting media like saw dust and lake sand, polythene sheets and tapes plus budding tools or equipment
- Slides, video/camera pictures/charts showing different methods of vegetative propagation
- Availability of suitable materials for budding, grafting, tissue culture and seedling
- Rootstocks and screen nets
- Scalpels, pruning knives, grafting/budding knives, budding tapes, water buckets, metre rules, rooting media, wax and polyethene sheets/bags

## Hints to the Teacher

- Basically crop improvement is aimed at increasing food and fibre production for human beings. But propagation by use of bulbs, corms, tubers, rhizomes, tissue culture, graft or buds faces the challenge that they are food storage structures. Therefore emphasise crop improvement techniques and their importance.

## Assessment

- Defining vegetative propagation, grafting, budding, bud-grafting, tissue culture, seed dormancy
- Procedure of successful transplanting, and preparing cuttings for rooting
- Advantages and disadvantages of vegetative propagation, budding, grafting and tissue culture
- Reasons for crop improvement and seed dormancy
- Suggesting the different ways of breaking seed dormancy in agriculture
- Ethical issues that are in crop improvement

## Topic 11: Animal Production IV

*Duration: 21 Periods*

### Overview

Investigation and project work are also an important part of the agriculture course because they offer much scope for applying scientific process into practice by learners rather than simply learning about it. Each project or investigation/study is to some extent unique and the learners' observations are original. It also prepares the learners to be at the sharp end of scientific research.

Health in animals is the normal functioning of the body. If any of the bodily processes are upset, then the animal is unwell. Consequently, it will not give the expected yield. The best way of ensuring good health among livestock is to provide them with good food or pasture and to manage the animals under the best conditions.

Pasture based production offers farmers the ability to let the ruminants' environment and immune system work together so that farmers can have acceptable production levels. Ugandan milk production is largely dominated by small-scale farmers who own over 90 percent of the national cattle population (FAO 2004).

In rural areas, where 96 percent of poor Ugandans live (Okidi et al, 2004), up to about 60 percent of the households keep mostly indigenous cattle (NAADS; King 2002). By far, the majority of milk production systems in Uganda are characterised by (a) a 'low input-low output' approach, (b) livestock is not an important source of cash, but a source of food, store of wealth and status symbol, and (c) milk demand is increasing and driving more and more of these dairy farms to intensify and often to diversify as to increase household returns. For this to be successful, one needs good farm documentation.

Farm records are essential to good farm management. The exact record kept depends on the farming enterprise. Livestock owners need records of breeding and general accounts of the farm operations like inventories, farm diary, farm accounts, labour records, cash accounts and other financial records.

### Learning Outcome

By the end of the topic, the learner should be able to:

- apply scientific knowledge learned or experienced and practical skills.

- appreciate that prevention of diseases is better than control and demonstrate a caring attitude towards livestock.
- demonstrate understanding of a good plan of dairy production and marketing dairy products on the farm.
- demonstrate ability to write and keep good farm records.
- differentiate the different types and uses of farm records.
- adhere to appropriate practices in the management of pastures, fodder crops and agro-forestry fodder trees.

## Sub-Topic I: Investigation and Projects Guidelines

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• produces evidence of scientific behaviour in terms of choice of method and objectivity in interpreting data collected and drawing conclusions.</li> <li>• Selects a suitable livestock project to establish and manage in the school.</li> <li>• writes a plan for feasible livestock project.</li> </ul>	<ul style="list-style-type: none"> <li>• Importance of project method in learning agriculture</li> <li>• Selection of a project</li> <li>• Planning the project considering: <ul style="list-style-type: none"> <li>- purpose of the project (eggs, meat, breeding, feeds conversion, honey, weight gain, fish fry or high value crop)</li> <li>- site for the project</li> <li>- when to start the project (timing)</li> <li>- determining amount of the inputs/budgeting</li> <li>- length of the project/timeframe</li> <li>- activities involved in the project</li> <li>- assigning duties and schedule of activities</li> <li>- setting performance indicators (clear milestones/behaviours to</li> </ul> </li> </ul>

Competences	Content
<ul style="list-style-type: none"><li>uses the correct procedures in establishing a viable livestock project.</li><li>evaluates the project using the performance indicators.</li><li>generates a good project report with a title, aims/objective of investigation, methods employed, reasons for adoption of the methods, materials used/illustrations or results presentation, interpretation/conclusion of findings and final discussion with suggestions for the future investigation or learning points.</li></ul>	be looked for) <ul style="list-style-type: none"><li>Establishing the project</li><li>Managing the project</li><li>Evaluation of the project</li><li>Presenting a project/investigation report</li></ul>

## Methodology

- Lead a discussion and ask the learners to point out the:
  - good investigation method in an agricultural study.
  - main features/components of a good scientific report.
- Organise a day for learners to present their reports after carrying out a scientific investigation or project.

## Practical

- Carry out a selected project

## Resources

- Previous reports, specimen farm records and specimen financial records
- Project planning and scientific investigation guidelines
- Sample scientific reports

## Hints to the Teacher

- Get support from the school administration to provide the relevant inputs to the learners to carry out a project and make a report.
- Establish a procedure of assessment of the scientific principles gained by the learners.

## Assessment

- Main phases in carrying out a livestock or crop project
- Features of an investigation of an animal or crop in an ecological study
- Components of a good project report

## Sub-Topic 2: Animal Health

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• describes the life cycles of livestock disease vectors.</li> <li>• categorises transmission of livestock diseases.</li> <li>• recognises diseases in livestock and takes appropriate measures to control them.</li> <li>• understands the laws governing animal health in Uganda.</li> <li>• recognises parasites in livestock and takes appropriate control measures.</li> <li>• describes the life cycles of livestock parasites.</li> </ul>	<ul style="list-style-type: none"> <li>• Disease vectors (tsetse flies, ticks)</li> <li>• Causes of diseases and their mode of transmission</li> <li>• Diagnosis and control of common diseases of animals:             <ul style="list-style-type: none"> <li>- anthrax</li> <li>- Newcastle and swine fever</li> <li>- trypanosomiasis</li> <li>- foot and mouth</li> <li>- CBPP and ECF</li> <li>- scabies</li> </ul> </li> <li>• Laws/ regulations governing animal health and public health in Uganda</li> <li>• Parasites like external parasites (ticks, lice, mite, mange, fleas) and internal parasites (round worms, liver flukes, tape worms)</li> </ul>

## Methodology

- Ask learners to demonstrate the:
  - control of parasites and diseases in farm animals.
  - drenching, spraying, vaccinating, injecting and dipping of farm animals.
- Lead learners in a guided discussion to explain the causes of livestock diseases.
- Prepare an exhibition for learners to:
  - identify signs and symptoms of common livestock diseases.
  - identify some common parasites and their effects on livestock.

## Practical

- Observing and identifying signs of sickness in animals
- Drugs administration methods such as drenching, dosing, spraying and applying pour-on acaracides
- Identification and description of internal and external livestock parasites and disease vectors

## Resources

- Sick animals, materials and equipment used to control parasites/disease
- Diagrams, pictures/video slides showing healthy animals and diseased ones
- Thermometer, drugs, tablets, drenching gun, injection/hypodermic syringe
- Preserved collection of livestock parasites (internal and external)
- Public health and animal health acts

## Hints to the Teacher

- Health in animals is the normal functioning of the body. If any of the bodily processes are upset then the animal is unwell. Unhealthy animals do not produce well, yields are low and the qualities of products are poor. Animals with some diseases and pests have to be killed to avoid spreading infection.
- When handling causes of diseases especially those caused by viruses, inform and remind the learners about HIV/AIDS.
- Finally let learners observe and practice safe handling of animals during disease control practices and other operations.

## Assessment

- The main causes of livestock diseases on the farm
- Procedure of taking body temperature, getting a blood sample for the laboratory, injecting drugs into the body and administering tablets into the mouth of a farm animal
- Drawing and labelling the observable features of some common livestock parasites and pests
- Regulations governing livestock and public health in Uganda
- Public health and animal health act

## Sub-Topic 3: Dairy Production and Marketing

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• assesses the importance of the dairy industry.</li> <li>• explains how to establish a dairy unit.</li> <li>• explains how to obtain high quality products and by-products from dairy animals using appropriate technologies.</li> <li>• prepares, processes, packs and gives prices to animal products for marketing using appropriate technologies.</li> </ul>	<ul style="list-style-type: none"> <li>• Importance of the dairy industry: <ul style="list-style-type: none"> <li>- types of dairy animals in Uganda</li> <li>- dairy management systems</li> </ul> </li> <li>• Establishment of a dairy unit</li> <li>• Clean milk production: <ul style="list-style-type: none"> <li>- clean milk</li> <li>- clean cow</li> <li>- clean environment</li> <li>- clean utensils</li> <li>- cooling and proper storage</li> <li>- handling, processing, preservation and storage of milk and milk products</li> </ul> </li> <li>• Processing and marketing dairy products</li> </ul>

### Methodology

- Lead a guided discussion so that learners can explain:
  - the importance of the dairy industry in Uganda.
  - the importance of cooling and proper storage of milk.
  - the establishment of a dairy unit.
- Ask learners to demonstrate the:
  - process and procedure of clean milk production.
  - caring for animals to produce milk.
  - testing of dairy cattle for mastitis.
  - hand milking of livestock, filtering of milk, sieving of milk and cooling milk for storage.
  - cleaning milk utensils and clean milking.
  - steps in making of cheese, cream, butter/ghee and yoghurt.
  - grooming the milking animals.

## Practical

- Identification of characteristics of a good dairy animal
- Zero grazing unit establishment
- Milking, sieving milk, storing milk and cleaning milk utensils
- Making ghee, yoghurt and cheese

## Resources

- Lactating animals and milk
- Milking equipment like milking towel, milking salve, strip cup, soap, milking rope, milking bucket/can, milk strainer, milking jug and fridge or saucepan with a lid
- Equipment for ghee and yoghurt
- Milk storage facilities like a refrigerator

## Hints to the Teacher

- Access to a dairy animal and equipment will facilitate developing practical skills in this topic.
- Get support from the school administration to provide the relevant inputs to the learners to demonstrate the procedure of clean milk production and making of cheese/ghee/yoghurt/butter/cream.
- Make learners to develop an innovative processing and a good marketing plan of dairy products.

## Assessment

- Characteristics of dairy cattle and boran breeds
- Good quality milk from dairy farm animal
- Clean milk production and milk by-products
- Tools and equipments in milking
- Milk preservation and processing

## Sub-Topic 4: Livestock Records

Competences	Content
The learner: <ul style="list-style-type: none"><li>• explains the meaning and importance of keeping livestock records.</li><li>• prepares different types of farm</li></ul>	<ul style="list-style-type: none"><li>• Meaning and importance of keeping livestock records</li><li>• Types of livestock records</li></ul>

<b>Competences</b>	<b>Content</b>
<p>records for different enterprises in the school/farm.</p> <ul style="list-style-type: none"> <li>• describes the different types of livestock records.</li> <li>• analyses records to ensure profitable livestock production.</li> <li>• suggests the best methods of record keeping for the different farming operations.</li> </ul>	<p>(breeding, production, birth, health, death, input, sales, and expenditure records)</p> <ul style="list-style-type: none"> <li>• Collecting and keeping different types of livestock records</li> <li>• Analysing records on the farm</li> <li>• Using livestock records on the farm</li> </ul>

## Methodology

- Lead a discussion for learners to explain the:
  - meaning of farm records.
  - importance of keeping livestock records.
- Organise for learners a field visit to a commercial mixed farm so that they can:
  - identify different types of farm records.
  - study the record keeping system.
  - compare the types of records kept by famers with those learnt in class.
- Prepare a case study for learners in groups to:
  - analyse the records to ensure profitability.
  - suggest the best methods of records management on a farm.

## Practical

- Examining different records that are kept on the farm
- Collecting livestock production information
- Making inferences or conclusions based on analysis of records
- Field visits to a livestock farm to study the various records kept

## Resources

- Records kept in the school farm/ for the demonstration plot/unit
- Livestock records (farm diary, inventory, labour/breeding/production, gross margin analysis, profit and loss account, balance sheet and budget)
- Farm office/documentation centre, national research station and district farm institute

- Livestock farms with record cards and livestock record sheets

### Hints to the Teacher

- All farmers need general accounts of the operations, farm accounts, inventories and production records. However, livestock owners will in addition need mating, breeding, gestation and parturition records. These farm records are essential to good farm management and informed decision-making. Therefore, practice and reasons for keeping records must be dealt with in detail.

### Assessment

- Importance of farm records in agriculture
- Types of records kept on a poultry, fish, dairy, goat, sheep, rabbit and for different crops. Financial farm records like gross margin, profit and loss account, balance sheet and budget
- Labour records
- Production records

### Sub-Topic 5: Pasture Management

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• describes the importance of pasture and fodder in livestock feeding.</li><li>• classifies pasture grasses, legumes and forage crops.</li><li>• justifies the limitations of tropical grasslands.</li><li>• demonstrates the correct methods and procedures for establishing pasture grasses, legumes and forage crops.</li><li>• determines the correct seed rate, spacing and ecological zones for establishing different pasture grasses, legumes and forage crops.</li><li>• inoculates legume seeds with correct rhizobium bacteria.</li><li>• selects pasture species for livestock.</li></ul>	<ul style="list-style-type: none"><li>• Importance of pastures and fodder trees/shrubs for feeding livestock</li><li>• Classification of pastures and forage crops</li><li>• Limitations of tropical natural pasture grasslands</li><li>• Establishment of pastures</li></ul>

Competences	Content
<ul style="list-style-type: none"> <li>• establishes a pasture, fodder crop and agro-forestry trees for fodder.</li> <li>• demonstrates how to improve natural pastures.</li> <li>• describes the steps taken to improve natural grasslands.</li> <li>• explains different management practices in pastures, fodder crops and agro-forestry fodder trees.</li> <li>• explains the effects of poor pasture management.</li> <li>• differentiates between overstocking and under stocking of a grazing land.</li> <li>• explains the different methods of utilising fodder and pasture crops in livestock feeding.</li> <li>• compares the different grazing systems in pasture management.</li> <li>• explains the need for forage and pasture conservation.</li> <li>• preserves pastures for livestock.</li> <li>• describes the procedure of hay and silage making.</li> <li>• judges the quality of hay and silage.</li> <li>• categorises the factors that influence the quality of pastures, hay and silage.</li> </ul>	<ul style="list-style-type: none"> <li>• Ways of improving natural pastures and grasslands</li> <li>• Grazing management</li> <li>• Preservation of pastures (grasses, legumes and fodder crops)</li> <li>• Factors influencing quality of pastures, silage and hay</li> </ul>

## Methodology

- Using a guided discussion, ask learners to:
  - explain the importance of pastures in feeding livestock.
  - identify the limitations of natural grasslands.
  - point out ways of improving natural grasslands.
  - explain the factors that influence the quality of pastures, hay and silage.
- Ask learners in groups to carry out a project on pasture establishment and silage making.
- Lead a demonstration so that learners can:

- prepare a seedbed for pasture grasses and legumes then establish a pasture museum.
- establish an agro forestry plot for livestock feeding.
- carry out different silvi-culture practices like thinning, pruning, lopping, and coppicing, pollarding, shading and trimming.
- Organise a field visit with questionnaires for learners to complete on how farmers are managing pastures on their farms.

## Practical

- Identifying pasture species that is five grasses and legumes (by seeds and plants)
- Preparing a pasture seedbed
- Planting pasture grasses, legumes and fodder trees
- Fertilizing, weeding, and topping/slashing pastures
- Inoculating legume seeds with rhizobium bacteria
- Constructing and maintaining watering points in pastures
- Planting shade trees
- Using a wire strainer in fencing/ paddocking
- Preparing mineral salt blocks
- Investigating grasses and legumes that can grow together
- Making hay and silage
- Investigating the effect of moisture, drying and age of pasture materials on the quality of hay and silage

## Resources

- Pasture species, fodder and agro-forestry fodder trees then preserved pasture (hay and silage)
- Plot of land and facilities for inoculating legume seeds
- Tools, equipment and materials for making silage such as elephant grass, young maize stalks, manure, lactic acid, molasses and chopping machine/knife
- Photographs, slides showing different systems of grazing
- Equipment for weed control including slashing tools plus seedbed preparation tools
- Fertilizers and manure for top dressing of pasture areas
- Planting materials of pasture species
- Implements for seedbed preparation (hoes and rake)
- Slashers for topping
- Old pastures or natural grassland/rangelands
- Pasture grasses like elephant grass, Rhodes grass, thatching grass, guinea grass and palisade grass

- Pasture legumes like green leaf and silver leaf desmodium, stylo, centrosema, glycine, lab lab, caliandria, moringa
- Pasture grasses and legumes/fodder crops ready for preservation
- Cereals and legume crops just before flowering like maize and beans
- Additives and supplement like molasses, maize bran and maize seeds
- Fencing materials and equipment for making paddocks

### Hints to the Teacher

- Good pastures are made up of good quality grasses, a proportion of legumes and few pasture weeds. Emphasise the characteristics of a good pasture including palatability, nutritious, digestibility, and high yield, resistance to trampling, compatibility and reliable reproduction rate.
- Get support from the school administration to provide the relevant inputs to the learners to establish pasture plots of pure grass, pure legume, mixed stand and fodder crops or visit where such practices are being carried out.

### Assessment

- Importance of pastures in livestock feeding
- The procedures of making hay and silage on the farm
- Conservation of pastures on the farm
- Methods of pasture improvement
- Establishing a good sward for grazing of livestock
- Importance of legumes in a grazing area for livestock
- Grazing methods that can be employed on an established pasture
- Stocking rate, carrying capacity, over grazing, rotational grazing, strip and zero grazing
- The main causes of pasture deterioration
- Improvement of an established pasture
- Role of manure in pastures

## Topic 12: Agricultural Economics and Farm Management I

*Duration: 21 Periods*

### Overview

Population is the number of organisms of the same species or people occupying a certain area at any one time. In Uganda there is rapid population growth rate of 3.5 percent per annum. As a result, many resources are in short supply including shortage of food, space, energy and water. On the other hand, this population interacts with the environment and well above 70 percent of the working population is employed in the agricultural sector. The role of agriculture increases as population grows. Gender is widely used to refer to the socially constructed differences and distinctions between boys, girls, men and women of a given population. Gender is a tool of analysing boys, girls, men and women's lives in the population of Uganda and how they contribute to agriculture and development.

### Learning Outcome

By the end of the topic, the learners should be able to:

- appreciate the crucial role of gender in agricultural production.
- demonstrate understanding of effects of population on agriculture development in Uganda.

### Sub-Topic 1: Population and its Influence on Agricultural Production

Competence	Content
<ul style="list-style-type: none"><li>• The learner examines the effects of population characteristics on agriculture production.</li></ul>	<ul style="list-style-type: none"><li>• Meaning of population</li><li>• Population structure</li><li>• Population density</li><li>• Population distribution</li><li>• Population growth rate</li></ul>

### Methodology

- Have a guided discussion for learners to explain the:
  - meaning of population, population structure, population density, population size.
  - factors that led to Uganda's present population structure.

- factors that affect food production, food distribution and food consumption.
- effects of population size on food production and supply.
- factors contributing to population size changes in Uganda today.
- factors affecting population distribution like climate, soil, topography, political, social amenities, pests and diseases.
- causes of population changes in Uganda.
- Organise a debate for learners on the topic “population increase should be halted now or never.”
- Organise a role-play for learners to:
  - show the challenges of a large family in relation to food supply, land versus a small family.
  - depict the structure of age and sex in a community and their influence on food production.
- Ask learners in groups to:
  - draw pictograms showing the number of members in their family.
  - illustrate population distribution in Uganda using bar graphs.
- Ask learners in groups to present findings on the:
  - problems experienced by farmers in densely and sparsely populated areas of Uganda.
  - relationship of agricultural activities to population distribution in Uganda.
  - calculations and workings of population densities of some selected districts of Uganda.

## Teaching/Learning Aids

- Population pyramid charts showing Uganda's population structures of 1969, 1980, 1991, 2002 and 2012
- Population statistical tables
- 2002 Uganda Population and Housing Census: analytical report
- Slides and films showing population changes
- Map of Uganda showing population distribution and population density from Uganda Atlas: Longman series

## Practical

- Drawing the map Uganda showing population distribution
- Drawing the Uganda population pyramid

## Hints to the Teacher

- Illustrate how the population has been changing over time and show the challenge it poses to the resources available and agriculture as a sector.

## Assessment

- The meaning of population structure, population density, population distribution and population size
- Factors that led to the present population structure and size
- The effects of population structure on food production
- Factors contributing to Uganda's present population distribution
- Differences between population distribution and density
- Calculating the population density of some selected districts of Uganda
- The agricultural activities carried out in densely and sparsely populated areas
- How population increase affects agriculture production
- Problems associated with rapid rise in Uganda population
- Suggestions to meet the increased demand on agriculture by high population

## Sub-Topic 2: Gender and Agricultural Production

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• constructs own meaning of gender.</li><li>• discovers the importance of gender equity in crop and livestock production.</li><li>• mainstreams gender into crop and livestock production.</li><li>• explains the gender issues in agriculture.</li></ul>	<ul style="list-style-type: none"><li>• Meaning of gender</li><li>• Roles and rights of boys / men and girls/ women in crop and livestock production</li><li>• Gender issues like land acquisition/ ownership, choosing enterprises, mobility, education, planning the enterprises, managing enterprises and their products, sharing the proceeds from sales of products and access to financial services</li></ul>

## Methodology

- Before the lesson, organise four gift bags each containing one of the following: a toy plane or any other toy, small bag, shoes and a hat. Label the bags as A, B, C and D. Wrap these gifts in glittering materials before putting them in the bag. During the first lesson, ask four learners to volunteer to come and pick a bag of their choice. Do not allow them to open the bags but instead ask them to write on a chart reason for the choice of bag, who of either the boy or girl; the bag in their hands should be given. Which reason would support their choice of offer? Then finally allow the volunteers to open the bag to reveal the content then relate to what is on the chart and a baby in the womb of its mother (up to old age). This game is used in construction of the meaning of gender.
- Organise a drama or role play for learners to demonstrate the triple role of boys, girls, men and women in the community around the school.
- Lead a guided discussion for learners using Annex 3 to explain the meaning of gender, sex, gendering, practical gender need, strategic gender need, gender stereotyping, gender gap, gender equity, gender equality, gender disparity, gender relation, gender analysis, gender myth.
- Lead learners in a brainstorming session to explain the:
  - gendering process.
  - factors that influence the existence of a gender relation.
  - importance of gender analysis.
  - gender issues affecting agriculture development.
- Ask learners in a guided discussion to differentiate between:
  - the various gender analysis tools.
  - practical gender needs and strategic gender needs.
  - gender equality and gender equity.
  - gender mainstreaming and gender gap.
  - gender sensitive and gender responsive approach.
  - gender and development and women in development.
- Ask the learners to read and conclude by discussing the Case Study 3b.

## Practical

- Drama/role-plays depicting the roles of boys / men and women /girls in crop and livestock production
- Survey of who does what in the school (men, women, girls and boys)

## Resources

- Worksheets, markers, flip charts, stand, masking tape, hand outs
- Videos like Mr Trouble, a Nigerian movie

- Song of Mr Money by Bob Wine
- Skit of naming a child in traditional Busoga/Ankole/Masai/Karamojong/Langi/Alur
- Staff establishment and current bearers
- Facilitators and guest speakers on gender issues
- Charts, films, slides, videos depicting equity of men and women in livestock production

### Hints to the Teacher

- Gender is the way the society has assigned roles, responsibilities, attributes, opportunities and treatment to individuals (boys, girls, women and men). This creates social differences and may be influenced by age, class/caste, race/ethnicity, and disability, geographical, economic and political environment.
- When handling gender, five important questions should be asked. These include:
  - Who does what activity in a given setting/organisation? (Identify the individuals as boys, girls, men and women by stating the actual activity they are doing). Separate the productive, reproductive and community roles/activities
  - What resources/inputs do they have in order to perform the activities? (the resources/inputs to meet practical needs or strategic needs) Clarify on who owns what and who decides on what.
  - What factors politically, economically, socially, technologically and legally influence what you see (PESTLY analysis)? Learners at this level may have limited knowledge of handling this question so just have light treatment to it but show the factors influencing the existences of a gender relation.
  - Who of the boys, girls, men and women benefits or is disadvantaged/ excluded by the setting/organisation?
  - What should be done to help the disadvantaged/excluded individuals?
  - Suggest a gender responsive approach to address the gaps identified.

### Assessment

- The gendering process in their community
- Key ideas in gender analysis

- Activities in the communities: who does them; what resources they have and beneficiaries
- Factors influencing the existence of a gender relation
- The major landmarks Uganda's government has made in promoting and addressing gender balance
- The main differences between gender and development (GAD) and women in development (WID)

## SENIOR SIX TERM TWO

### Topic 13: Crop Production V

*Duration: 9 Periods*

#### Overview

Farming within many of the African cities and their neighbourhoods has become increasingly important today than ever before. It is a main source of employment, income and food for the urban population and more so for the disadvantaged lot. Surprisingly, little is understood and known about the approaches, principles, practices, benefits, constraints and forces behind urban- and peri-urban farming. This kind of farming has been known to be very intensive. It uses little amounts of external inputs but there is greater amount of wastes with no place for disposal. This challenge poses a greater hindrance to farming in our cities.

#### Learning Outcome

The learner should be able to:

- apply the principles of organic farming.
- appreciate the role of urban- and peri-urban farming in production of food.
- demonstrate understanding of the benefits of organic farming to a healthy population.

## Sub-Topic 1: Urban and Peri-Urban Farming

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• demonstrates principles involved and carries out practices in urban- and peri-urban organic farming.</li> <li>• verifies the principles involved and carries out practices in organic farming.</li> <li>• assesses the benefits and problems of organic farming.</li> </ul>	<ul style="list-style-type: none"> <li>• Principles and practices involved in urban- and peri-urban farming</li> <li>• Problems associated with urban- and peri-urban farming</li> <li>• Benefits of urban- and peri-urban farming</li> <li>• Principles and practices of organic farming</li> <li>• Benefits of organic farming</li> <li>• Problems associated with organic farming</li> </ul>

### Methodology

- Lead learners in a guided discussion so that they explain:
  - urban, peri-urban and organic farming.
  - role of organic manure in crop production.
  - factors influencing the quality of different manures.
  - benefits of urban and peri-urban farming.
  - benefits of using organic materials in growing of crops.
  - the challenges of waste management in urban- and peri-urban farming.
  - case study of marketing organic farm product.
- Provide learners in groups with guidelines so that they can prepare of organic manures with emphasis on making of manure teas, compost manure making and waste management/recycling .
- Display different types of manure for learners to identify and use in their plot.
- Ask learners to raise seedlings/vegetables in pots, sacks, basins, wooden boxes and baskets.
- Lead learners in a demonstration of:
  - marketing channel of organic products in Uganda.
  - controlling pests and diseases using organic materials; urine - manure slurry; botanical pesticides of Mexican marigold/tagetes minuta with chilli pepper, tobacco, neem/ azadirachta indica.
  - turning organic farm wastes into fuel (briquettes).

- Organise field visits for learners to compare two farms dealing in organic farming.

### Practical

- Visits to urban- and peri-urban organic farms to identify the practices involved
- Projects in urban- and peri-urban organic farming

### Resource

- Urban, peri-urban and organic farms for either crop, animal or both
- Different types of organic materials used like tithonia, gliricidia, neem tree, moringa, leucaena, calliandra, senna, cassia, mulch, urine -manure slurry, manure tea, comfrey, green manure, compost manure and farmyard manure
- Sacks, basins, buckets, soil pots, drums or jerry can
- Trowels, hoe, spade, wheel barrow and wooden boxes to make gardens on the veranda/balcony
- Seeds/seedlings of vegetables and fruits and garden tools like garden fork, rake, hand hoe
- Rabbits, sheep, goats, pigs and fish ponds
- Chicken, geese, ducks, parrots and zero grazing cattle/unit
- Urban, peri-urban organic and livestock farming units

### Hints to the Teacher

- Familiarise with organic farming practices and procedure of making organic manure.
- Get support from the school administration to provide the relevant inputs to the learners to practice organic farming at school.

### Assessment

- Benefits and challenges of organic farming in Uganda
- Suggesting ways of making organic farming work for a small scale farmer
- Organic farming on a small scale

## Topic 14: Agricultural Economics II

*Duration: 54 Periods*

### Overview

Supply and demand is perhaps one of the most fundamental concepts of economics and it is the backbone of a market economy. Demand refers to how much (quantity) of a product or service is desired by buyers. The quantity demanded is the amount of a product people are willing to buy at a certain price; the relationship between price and quantity demanded is known as the demand relationship.

Supply represents how much the market or farmer can offer. The quantity supplied refers to the amount of a certain good producers or farmers are willing to supply when receiving a certain price. The correlation between price and how much of a good or service is supplied to the market is known as the supply relationship. Price, therefore, is a reflection of supply and demand of an agriculture product in the market.

### Learning Outcome

By the end the topic, the learner should be able to:

- demonstrate an understanding of the key principles of production.
- demonstrate an understanding of the factors affecting demand, supply and elasticity.
- demonstrate an understanding of the factors that ensure good productivity on the farm.
- manage the factors of production to increase farm output.
- evaluate the costs of production in order to increase farm profit.
- adhere to the principles of production and marketing of farm products.
- explore an innovative marketing system of a farm product produced at school.
- design a marketing strategy for farm products.
- demonstrate an understanding of the essential components of a business plan.
- assess the roles of government and other players in agricultural production and development.
- examine the land policies and other government interventions towards agriculture development.

## Sub-Topic 1: Production Theory

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• explains the meaning of agricultural economics.</li><li>• explains the concept of scarcity, choice and opportunity cost.</li><li>• explains the factors of production of land, labour and capital.</li><li>• demonstrates the roles of the factors of production in agriculture.</li><li>• describes the factors influencing labour supply and labour efficiency in agriculture.</li><li>• describes the attributes of a good farm manager.</li><li>• describes the characteristics of an agricultural entrepreneur/intrapreneur.</li><li>• compares the characteristics of a farm manager with those of an entrepreneur.</li><li>• describes the procedure of acquiring a loan and managing it successfully.</li><li>• describes how to overcome the challenges associated with agricultural credit.</li><li>• designs an innovative agricultural credit financial transaction/ products.</li><li>• discriminates the factors influencing agricultural credit repayment.</li><li>• administers the different zones of a production function and relates them to agricultural production.</li></ul>	<ul style="list-style-type: none"><li>• Definition of agricultural economics</li><li>• Basic concepts of scarcity, choice, preference and opportunity cost</li><li>• Factors of production: land, labour and capital</li><li>• Labour, entrepreneurship and intrapreneurship in farming</li><li>• Capital and agricultural credit</li><li>• Production function</li><li>• Law of diminishing returns</li><li>• Costs of production such as:<ul style="list-style-type: none"><li>- average costs</li><li>- marginal costs</li><li>- fixed costs</li><li>- variable costs</li><li>- explicit costs</li><li>- implicit costs</li><li>- total costs</li></ul></li></ul>

## Methodology

- Lead a discussion for learners to explain the:
  - meaning of agriculture economics, demand, supply, elasticity and production function.
  - relationship between inputs and outputs (production functions) on the farm.
  - law of diminishing returns as it applies to agricultural production.
  - law of demand and supply in agricultural production.
  - price elasticity in relation to agricultural production.
- Lead a guided discovery for learners to identify the ways of reducing costs of production.
- Ask learners to demonstrate:
  - curves showing relationships between inputs and outputs in agricultural production.
  - the factors affecting demand, supply and elasticity of agricultural products.
  - production function curves, demand curves and supply curves using available data.
  - elasticity of demand and supply to agricultural production.
  - the various types of production costs.
  - different type/zones of the production functions.
  - how to gather data about farm product price and quantities in the neighbouring market over a period of 4 months.
  - the causes and effects of price fluctuation and measures to stabilise prices.
  - the factors affecting demand and supply of a high value crop or animal product.

## Practical

- Drawing and interpreting the supply and demand curve
- Investigating the factors influencing choice of an agricultural enterprise
- Field visit to a land office, micro credit office and labour office
- Completing a land registration form
- Identifying sources of agricultural finance in Uganda
- Visiting an agricultural credit service provider to study the procedure of obtaining a loan
- Investigating innovative and alternative forms of collateral including warehouse receipt, accounts receivable, equipment, standing crops, livestock
- Completing a loan application form
- Plotting production function curves using available data

## Resources

- Farm production records
- Charts illustrating production functions, production costs, supply and demand
- Graph papers and calculators
- Data for selling and buying of goods and services
- A case study of a successful agricultural entrepreneur
- A farm unit and existing farm records on factors of production
- Local market with interview schedule and a selected family intended expenses
- Report format for the survey to the land office (land title) and title deed
- Banks, SACCOs, micro credit facilities and agricultural traders

## Hints to the Teacher

- Illustrate that if prices of farm products fall, demand will increase and many people will have ability to buy more of that product. However, if prices are too high more will be offered for sale but the demand for farm product will decrease. Thus a need to stabilise prices of agricultural products should be emphasised by mentioning the causes and effects of price fluctuation.
- The least combination of the land, labour and capital to produce increased output should be emphasised. Furthermore, farmers' entrepreneurial characteristics like ability to cope with change, creativity, innovation, motivation, risk taking, negotiation, personal branding, good listening and communication skills must be brought out. The idea of zipping finance with farming should be lightly handled.

## Assessment

- Land tenure systems in Uganda
- Labour supply to agricultural farms in Uganda
- Agricultural credit and micro finance
- Challenges associated with agricultural credit in Uganda
- The factors influencing choice of an agricultural enterprise by a farmer in Uganda
- The law of demand, law of supply and law of diminishing returns
- Factors affecting supply and demand of agricultural product
- Differentiating between constant, increasing and diminishing returns
- Price fluctuation and measures to stabilise prices
- Differentiating between production costs
- How production costs can be minimised by farmers on the farm

- Different types of demand, supply and elasticity
- How the forces of demand and supply can be exploited by a farmer

## Sub-Topic 2: Factors of Production

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• explains the concept of scarcity, choice and opportunity cost.</li> <li>• explains the factors of production: land, labour and capital.</li> <li>• justifies the need for land tenure and land reform.</li> <li>• describes the procedure of acquiring a loan and managing it successfully</li> <li>• demonstrates the roles of the factors of production in agriculture.</li> <li>• describes the attributes of a good farm manager.</li> <li>• describes the characteristics of an agricultural entrepreneur/intrapreneur.</li> <li>• compares the characteristics of a farm manager with those of an entrepreneur.</li> <li>• describes the factors influencing labour supply and labour efficiency in agriculture.</li> <li>• describes how to overcome the challenges associated with agricultural credit.</li> <li>• designs an innovative agricultural credit financial transaction/products.</li> <li>• discriminates the factors influencing agricultural credit repayment.</li> </ul>	<ul style="list-style-type: none"> <li>• Basic concepts of scarcity, choice, preference and opportunity cost</li> <li>• Land, land tenure and land reform</li> <li>• Labour, entrepreneurship and intrapreneurship in farming</li> <li>• Capital and agricultural credit</li> </ul>

## Methodology

- Through guided discussions, make learners to explain the:
  - meaning of land tenure, land reform, agricultural credit, entrepreneurship and intrapreneurship in farming.
  - basic concepts of scarcity, choice and opportunity cost.
  - factors of production of land, labour and capital.

- Organise a field visit to a nearby market and ask the learners using a prepared interview schedule to:
  - interview traders and consumers on farm goods and services in relation to scarcity, choice and opportunity cost.
  - record the types, prices, amount available and number of buyers expected for goods and services on a market.
- Guide learners to have a role play on the functions of a good farm manager and the underachieving farm manager
- Lead learners to discuss in groups and share in plenary the:
  - factors influencing labour supply and labour efficiency in agriculture.
  - roles of factors of production in agricultural production.
  - factors influencing agricultural credit repayment.
- Organise learners to summarise the outcome of their brainstorming on the:
  - procedure of acquiring a loan and managing it successfully.
  - characteristics of an agricultural entrepreneur/intrapreneur as in Case Study 5.
  - factors influencing labour supply and labour efficiency in agriculture.
  - challenges associated with agricultural credit and how to overcome them.

## Practical

- Examine a loan application form and land lease title
- Design a questionnaire for gathering information about the market of agricultural products, labour market in agriculture and agricultural traders

## Resources

- A farm unit and existing farm records on factors of production
- Local market with interview schedule and a selected family intended expenses
- Report format for the survey to the land office (land title)
- Banks, SACCOs and agricultural traders

## Hints to the Teacher

- The least combination of the land, labour and capital to produce increased output should be emphasised. Furthermore, farmers' entrepreneurial characteristics like ability to cope with change,

creativity, innovation, motivation, risk taking, negotiation, personal branding, good listening and communication skills must be brought out. The idea of zipping finance with farming should be lightly handled.

## Assessment

- Land tenure systems in Uganda
- Labour supply to agricultural farms in Uganda
- Agricultural credit
- Challenges associated with agricultural credit in Uganda
- The factors influencing choice of an agricultural enterprise by a farmer in Uganda

## Sub-Topic 3: Marketing of Agricultural Products

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• defines the concept of a market and its related terms.</li> <li>• explains the functions of marketing.</li> <li>• describes types of markets of agricultural products.</li> <li>• recalls the problems of marketing agriculture products.</li> <li>• creates an effective marketing strategy for a farm product.</li> <li>• communicates effectively for marketing agricultural products.</li> <li>• brands, blends and packages</li> </ul>	<ul style="list-style-type: none"> <li>• Define market and marketing</li> <li>• Functions of marketing</li> <li>• Types of markets: <ul style="list-style-type: none"> <li>- perfect competition</li> <li>- imperfect competition</li> <li>- monopoly</li> <li>- oligopoly</li> <li>- oligopsony</li> <li>- cartels</li> <li>- introduction to warehouse receipt and e-marketing of agriculture products</li> </ul> </li> <li>• Marketing strategies</li> <li>• Effective branding with emphasis on choice of a brand name, labelling, packaging, display and sealing</li> <li>• Business plan</li> </ul>

Competences	Content
agricultural produce properly to enhance marketing. • describes the agricultural business plan structure.	

## Methodology

- Make learners to discuss the:
  - meaning of market, monopoly, oligopoly, cartel, country buyer, wholesaler, retailer, speculators, broker and agent.
  - functions of marketing, characteristics of agricultural products and problems affecting marketing of agricultural products.
- Organise a field visit to a nearby market for the learners to:
  - observe and record, display on charts the observations and discuss the various activities involved in marketing.
  - conduct a market survey using a prepared guide.
  - role-play in manageable groups the major players/actors in marketing on return.
- Ask learners in groups to read Case Study 2 and 6 then:
  - make innovative advertising posters, branding, packaging, brand name and exhibition for selected high value crops or animal products.
  - design innovative marketing strategies for selected, high value crops and animal products.
  - analyse the role of middlemen in marketing of agricultural products.
  - design appropriate marketing practices, for agricultural products.
  - develop a simple business plan.

## Practical

- Develop a simple business plan for an agricultural product
- Brand and pack an agricultural product

## Resources

- Market for agriculture products
- Advertisements
- Branded products and branding departments in marketing institutions
- Packaging materials
- Creative artist, marketing officers and brand development managers as facilitators

## Hints to the Teacher

- Agriculture marketing means that farmers' produce has to undergo a series of transfer or exchanges from one hand to another before it finally reaches the consumers. It is a process that starts with a decision made by a farmer to produce a saleable farm commodity/service and involves all aspects of the market structure which are both functional and institutional, basing on technical and economic considerations. This may include pre and post-harvest operations, assembling, grading, processing, packaging, branding, storage, risk-taking, advertising, transportation and distribution. Agriculture marketing, therefore, means a link between the farm and the non-farm sectors. This points to the fact that it includes marketing functions, agencies, channels, efficiency and costs, price spread and market integration, farmer surplus and post harvest handling.
- While the objectives of efficient agriculture marketing should be emphasised as:
  - enabling the farmers to get the best possible returns/rewards for the efforts involved to produce.
  - providing farmers the lifting of all farm output, he or she is willing to sell at an incentive/motivating price.
  - reducing the price difference between the farm gate price and the ultimate consumers.
  - making available all products and services of farm origin to consumers at reasonable price without impairing quality.

## Assessment

- Functions of marketing
- The role of marketing in agriculture
- Differentiating between a cartel and wholesaler
- Reasons for processing, packaging and branding of farm products
- Warehouse receipt and e-marketing in agriculture
- Challenges in marketing agricultural products

## Sub-Topic 4: Farm Planning and Management

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• adapts good plans for a farm.</li><li>• develops a business plan for a farm enterprise.</li><li>• adheres to the main components of a business plan.</li><li>• justifies a good plan for efficient farm management.</li><li>• describes the stages in the process of farm management.</li><li>• examines the tools for managerial decisions on the farm.</li><li>• explains management functions and relates them to farm production.</li><li>• explains the factors that promote farm efficiency.</li><li>• compares two farms for their efficiency standards.</li></ul>	<ul style="list-style-type: none"><li>• Farm planning and factors affecting planning decisions</li><li>• Farm business plan</li><li>• Farming efficiency</li><li>• Farm management</li><li>• Farming efficiency</li></ul>

## Topic 15: Agricultural Engineering and Farm Mechanisation I

*Duration: 27 Periods*

### Overview

As more and more food production is required to feed the ever increasing population, the means and amount of power used definitely increases beyond what human hands can do. Alternative ways must be found to do work to meet the increasing demand for food hence the use of machines. These machines have a better speed at which they do work which is known as power. Power is used to produce food, fibre and energy. This power can be got from animals or machines.

### Learning Outcome

By the end of the topic, the learner should be able to:

- appreciate the principles in the working of machines.
- demonstrate understanding of the factors influencing the level of mechanisation on the farm.
- demonstrate skills of designing common farm tools to improve production in crops and animals.
- demonstrate understanding of the working of a mould board plough.
- verify the factors influencing the level of mechanisation on the farm.
- design farm tools to improve production in crops and animals.

### Sub-Topic 1: Simple Mechanics

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• describes the working of simple machines.</li> <li>• explains the basic principles of working of simple machines.</li> </ul>	<ul style="list-style-type: none"> <li>• Principles of the working of simple machines</li> <li>• Definition of a machine and related terms</li> <li>• Types of machines (lever, inclined plane, wheel and axle, wedge) and their working principles. (Relate machines to farm work)</li> <li>• Simple calculations in mechanics (load, effort, work, force, energy,</li> </ul>

Competences	Content
<ul style="list-style-type: none"><li>Designs and constructs models of simple machines.</li></ul>	<p>friction, mechanical advantage, efficiency and velocity ratio)</p> <ul style="list-style-type: none"><li>Models of simple machines</li></ul>

## Methodology

- Before the lesson, prepare charts, pictures, photographs, models or proto type of different machines to be provided to learners to:
  - study, draw, label, operate, assemble and demonstrate the working of machines.
  - illustrate the use, repair and maintenance.
- Ask learners to demonstrate how to:
  - measure different parameters like length, volume, weight/mass and time taken during movement involving farm implements, tools, equipment and simple machines.
  - define terms like speed, velocity, force, mass, pressure, work, energy, power, lever, mechanical advantage, velocity ratio and efficiency.
- Have the learners read Case Study 4 and demonstrate:
  - the working of simple mechanics like levers, pulleys and see-saw.
  - how to measure perimeter/circumference, area and volume of various objects on the farm like bricks, timber boards, milk buckets, milk cans, plots of land and gardens.
- Organise learners in groups to design and make models of simple farm machines.
- Ask learners to make simple calculations in machine operations with emphasis on mass, length, time, perimeter, circumference, volume, area, work, force, energy, mechanical advantage, velocity ratio, efficiency and power.

## Practical

- Making models to demonstrate the working of simple machines
- Carrying out laboratory experiments using simple machines to measure various parameters (like distance, weight and volume) to use in mechanics calculations

## Resources

- Simple machines like pulleys, levers, wheel axle, inclined plane, wedge and see-saw

- Calculators, rulers, mathematical set, tape measure, weighing scale, stop clocks
- Wood/timber, boxes, manila papers, razor blades, glue, hand saw, claw hammer

## Hints to the Teacher

- Simple machines make work easier by allowing us to push or pull over an increased distance. Simple machines are the elementary building blocks of which all more complicated machine are built. For example, inclined plane, wheels, levers, wedges and pulleys are used in the mechanisms of a bicycle, farm store or tractor.
- A simple machine can be a device that changes the direction or magnitude of force. Force, on the other hand, is any influence that causes an object to undergo a change in speed, and a change in direction. Force is a push or pull that cause an object with a mass to change its velocity (which include starting from natural state or state of rest) to acceleration.
- Machines use mechanical advantage/leverage to multiply force. Thus it uses simple applied force to do work against a single load of force. Then the ratio of the output force to the input force is mechanical advantage.
- Finally, machine components that are designed to manage forces and movements are called mechanisms. An ideal mechanism in a machine transmits power without adding to or subtracting from it.

## Assessment

- Definition of energy, force, work, mechanical advantage, velocity ratio, efficiency and power
- Calculation of area, perimeter, volume, speed, work, efficiency, power and pressure in farm machines, tools, equipment and structures/models
- Conversion of measures to standard units.

## Sub-Topic 2: Management of Work Animals

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• understands the importance of animal as source of farm power.</li> <li>• describes the training of traction animals.</li> <li>• harnesses animal power to do</li> </ul>	<ul style="list-style-type: none"> <li>• Importance of animals as a source of farm power</li> <li>• Training of traction animals, selection of good animals for traction and feeding traction animals</li> </ul>

Competences	Content
farm work.	<ul style="list-style-type: none"><li>Handling or care of traction animal and using animals for traction</li></ul>

## Methodology

- Ask learners to discuss the:
  - different sources of farm power in Uganda.
  - factors considered by the farmer before mechanising agriculture activities.
  - factors influencing the choice of animals to be used in traction.
  - handling and care given to traction animals.
- Ask learners in groups to:
  - debate reasons that can lead to successful implementation of traction technology.
  - assemble the mould board plough ready for use.
  - identify the characteristics of animals suitable for traction.
  - identify the components of a mould board plough.

## Practical

- Training animals for traction
- Feeding the traction animals
- Handling of traction animals
- Identifying component parts of traction equipment like the mould board plough

## Resources

- Slides or video shows, photographs and charts showing sources of farm power, training of animals to provide power and traction equipment
- Traction animals like bull/oxen, camels, donkey and horses
- Traction equipment such as but not limited to mould board plough
- Animal traction training manual
- Facilitator in traction technology
- Mould board plough components

## Hints to the Teacher

- Farm power embraces all forms of power inputs into agricultural production. It includes among others animal power. The use of animals, particularly cattle and donkeys, as a source of farm power, is still not

extensive. Yet over 25% of cultivated land in Africa is worked with animal traction. Furthermore, the common mould board plough is the implement used in animal traction. It is an important primary tillage machine that completely inverts and pulverises the soil, uproots all weeds, trash crop residues and bury them. It is designed to cut down the soil and invert it to the right side, completely burying the undesired growth which is subsequently turned into manure. Its coulter cuts vertically into the ground just ahead of the share or frog. The other parts like the frame, mould board, main beam, depth rod, furrow wheel, landside and plough chain are for supporting. Therefore, get support from the school administration to provide this equipment for the learners to use during demonstration.

## Assessment

- The advantages and disadvantages of the main sources of power on the farm
- Animal power
- Characteristics of areas suitable for the use of animal traction/draft technology
- Factors to consider for the success of traction technology in Uganda
- Mould board plough and its components

## SENIOR SIX TERM THREE

### Topic 16: Crop Production VI

*Duration: 18 Periods*

#### Overview

Pests are the organisms that cause damage to our crops. Diseases may be physiological or as a result of disease agents like fungi, bacteria or viruses that grow and survive by feeding on plant material. On the other hand, weeds are any plants that grow where they are unwanted. All these things cause serious loss for the farmers and call for the protection of crops.

#### Learning Outcome

By the end of the topic, the learner should be able to:

- appreciate the harmful effects of pests, diseases and weeds in agricultural production.
- explore the effects of common pests, diseases and weeds.
- demonstrate understanding of the effects of pests, symptoms of diseases that attack garden crops and economic importance of weeds.

#### Sub-Topic 1: Crop Protection (General Principles of Crop Protection)

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>• demonstrates crop protection measures for different crops.</li><li>• differentiates the effects of weeds, pests and diseases in crop production.</li><li>• administers the methods of managing weed, pests and diseases on crops.</li></ul>	<ul style="list-style-type: none"><li>• Crop protection measures</li><li>• Effects of weeds, pests and diseases in crop production.</li><li>• Methods of managing weeds, pests and diseases on crops:<ul style="list-style-type: none"><li>- cultural practices</li><li>- physical</li><li>- mechanical</li><li>- biological</li></ul></li></ul>

<b>Competences</b>	<b>Content</b>
<ul style="list-style-type: none"> <li>• explains the effects of crop protection measures on the environment.</li> <li>• demonstrates ways of minimising the effects of crop protection measures on the environment.</li> </ul>	<ul style="list-style-type: none"> <li>- chemical pest management</li> <li>- integrated pest management</li> <li>- legal methods</li> <li>- plant resistance</li> <li>- genetic manipulation</li> <li>• Effects of crop protection measures on the environment</li> <li>• How to minimise crop protection effect on the environment</li> </ul>

## Methodology

- Ask learners in groups to:
  - collect, identify and record ten common diseases, ten common pests and ten common weeds of the high value crop plants.
  - classify and identify the different pests, weeds and diseases of the high value crop plants.
  - preserve the common diseases, pests and weed specimens.
- Guide learners to individually demonstrate how to collect, observe, label and preserve samples of common weeds, pests and plant parts infected by diseases.
- Through a guided discussion, ask learners to explain the:
  - appropriate methods of controlling diseases, pests and weeds.
  - effects of diseases, pests and weeds on crop production.
  - botanical features of pests and weeds that make them successful in farmers' crops.
  - symptoms of common diseases in crops.
- Lead learners to brainstorm the effects of crop protection measures on the environment and suggest ways of reducing these effects.
- Organise a debate for learners on the merits and demerits of using chemicals in crop protection.
- Ask the learners to demonstrate weed, pest and disease control on their school plots with high value crops.
- Put learners in groups to:
  - explain the effects of crop protection measures on the environment.
  - classify and identify agrochemicals, weeds, pests, and diseases.
  - describe the factors that make weeds more competitive than crops.
  - explain the harmful effects of weeds, pests and diseases on crops.

- describe the methods of managing weeds, pests and diseases in the environment.
- demonstrate weed, pest and disease control in the school plots using different methods: cultural, mechanical, biological and chemical means.
- suggest the most appropriate methods of pest, disease and weed control in crops.
- suggest ways of minimising the effects of crop protection measures on the environment.
- identify the botanical features of diseased plants, weeds and pests.
- compare different methods of weed, pest and disease control in terms of effectiveness, costs and safety.
- identify pests and pathogens on mounted slides.
- investigate and compare the effects of biological and chemical control of diseases, pests and weeds in a high value crop.

## Practical

- Investigate the effects of weeds, pests and diseases on crops
- Identification of common weeds, pests and diseases
- Designing suitable control measures for the common weeds, pests and diseases

## Resources

- Chemicals for crop protection
- Sweep nets, traps and bags, specimen preservatives and specimen bottles
- Damaged crops, common weeds, pests, and diseased plants, a field with weed infestation
- Photographs, slides and videos showing pests, diseased plants and common weeds
- Equipment and materials for chemical, biological, mechanical and cultural control measures
- Microscopes and their accessories
- Crop protection equipment including overalls, gumboots, gloves and first aid box
- Charts/slides, video – illustrating effects of agrochemicals on the environment

## Hints to the Teacher

- In farming, a large part of the farmer's time, income and labour is taken up by controlling weeds and reducing heavy losses that may arise from pests and diseases. When weeds, pests and diseases are not controlled, they interfere with growth of crops, development of products and crop yields. This in turn will affect crop and animal production both in quality and quantity. This is why learners need to recognise the effects of weeds, pests and diseases. Innovative solutions of crop protection methods can make an important contribution towards improving the health of the crops used to produce food, animal feeds, fibres and bio fuels.
- Crop protection can help crops reach their potential yield. Some agrochemicals help plants in their critical growth stages to develop strong roots, which are the basis for healthy crops and promote high yields. Insecticides and fungicides protect crops from pests and diseases, improve plant vigour and lead to efficient use of soil nutrients, while herbicides control weeds which are known to reduce yields through competition for water, light and nutrients. Therefore, get support from the school administration to provide the relevant inputs to enable you demonstrate the use of crop protection measures as a way of controlling the weeds, pests and diseases in crops.

## Assessment

- Economic importance of weeds
- Factors that make weeds more competitive than farmers' crops
- Harmful effects of weeds
- Classification of weeds as perennial and annual or broad and narrow leaved weeds
- Methods of controlling weeds, pests and diseases
- Insects as crop pests
- Predators and prey in crop pests
- Fungal diseases in crops
- Ways of minimising the effects of chemical control of diseases, pests and weeds on the environment
- Considerations that may reduce the effects of diseases, pests and weeds in crops
- Measures that can be taken to prevent plant diseases

## Topic 17: Agricultural Engineering and Farm Mechanisation II

*Duration: 27 Periods*

### Overview

Mechanisation can make farming less tedious and more profitable. This can begin with construction of farm structures. The materials used must be of good quality, reasonable price and suitable for the farming activity. Advance planning can ensure that constructed structures are exactly right for their functions.

Using good quality tools designed for a particular job can save money. Remember that a job done with poor tools takes longer and is less effective.

### Learning Outcome

By the end of the topic, the learner should be able to:

- compute accurately the cost of construction materials.
- demonstrate understanding of designing, interpreting and using construction drawing for buildings on the farm.
- demonstrate skills of handling, repairing, using and maintenance of tools and equipment.
- demonstrate skills of making models/proto types.

## Sub-Topic 1: Construction Materials

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• describes the properties of construction materials.</li> <li>• develops a criteria for selecting appropriate materials for constructing farm structures.</li> <li>• estimates the amount and costs of different types of construction materials needed for a given construction job.</li> <li>• costs the materials required in the construction of farm structures (buildings, fences, roads, irrigation and drainage systems, crushes, dips, water storage facilities).</li> </ul>	<ul style="list-style-type: none"> <li>• Types of construction materials and their properties</li> <li>• Selection of materials for different construction jobs basing on their properties</li> <li>• Basic principles of quantity surveying</li> </ul>

## Methodology

- Arrange for a visit with a prepared interview guide to a place where learners will be able to observe and participate in:
  - preparation of bricks, blocks, stones, concrete mixture, mortar, plaster, rough cast, tiles, roofing materials, timber, poles, grass thatch, sand, earth, mud and wattle.
  - selecting, estimating the amount and costing of materials for building and construction.
  - laying of bricks/blocks with mortar and roofing of the truss.
- Organise an exhibition for learners to identify the different building and construction materials on the farm.
- Lead a guided discussion for learners to explain the:
  - Properties/characteristics of the different building and construction materials.
  - advantages and disadvantages of different building and construction materials.
  - factors to consider when choosing building and farm structure construction materials.
  - estimation of bills of quantities in building and constructing of farm structures.
  - costing of building and construction materials.
- Ask learners in groups to:

- identify different construction materials.
- describe the properties of different construction materials.
- select suitable materials for construction and make models of simple farm structures.
- estimate the quantities and costs of construction materials.
- prepare a budget of construction materials for a simple farm structure model.
- construct models or prototypes of some common building and farm structures.

## Practical

- Identifying different materials for construction
- Subjecting materials to compression forces, tensional forces, heat and moisture to test their strength
- Carrying out tests to determine material strength.
- Determining the quantities of materials required to put up a given farm structure and costing them
- Using appropriate materials in construction/ modelling of simple farm structures

## Resources

- Building and construction tools
- Timber of different specification' timber boards and poles
- Corrugated iron sheets, tiles, thatching grass, plastic sheets
- Nails, wire mesh, woven wire mesh, tidal netting and gauze wire/sisal balls
- Building and construction materials like cement, paint, vanish, terrazzo, lime, lake sand, river sand, bricks, blocks, stone, mud and wattle
- Ropes/chains, measuring tapes, spirit level and pegs
- Farm structure models

## Hints to the Teacher

- Construction material is anything used for building farm structures.
- Get support from the school administration to provide the relevant construction materials that may include metals and non metals.
- Emphasise the properties of these construction materials and how to make them more durable.

## Assessment

- The reasons for painting metals and timber to be used in farm structures
- Procedure of curing concrete, bricks and blocks as building materials
- Computing the number of bricks for a small calf pen of 2m by 1m by 1.5m with a joining mortar, door and open space area of 1.2 square metres
- Computing the number of iron sheet needed to roof a house which is 6m long by 4m wide when each sheet covers 3m by 0.8m.

## Sub-Topic 2: Farm Equipment and Tools

Competence	Content
<ul style="list-style-type: none"> <li>• The learner constructs simple models of livestock rearing equipment.</li> </ul>	<ul style="list-style-type: none"> <li>• Designing and construction of livestock rearing equipment: beehives, bailing boxes, forage harvesters, forage choppers, feeders, waterers/drinkers, nesting boxes and feed mixers</li> </ul>

## Methodology

- Organise an exhibition so that learners can identify the use of:
  - livestock production tools, protection tools and equipment.
  - carpentry workshop and builders' tools.
  - dismantled component parts of tools and equipments on the farm.
- Put learners in groups to demonstrate how to:
  - dress appropriately when using tools and equipment.
  - handle properly and safely all tools and equipment.
  - repair and maintain the livestock tools and equipment.
  - apply correctly workshop safety procedures.
  - demonstrate the proper storage of the livestock tools and equipment.
  - design and construct simple farm tools and equipment.
  - construct livestock production equipment like feeders, nest boxes, canders, rabbit hutch/pen and mobile pet houses.
  - maintain the workshop, builders', livestock tools and equipment.
  - properly and safely handle the workshop, builders', livestock tools and equipments.
- Ask learners to brainstorm the:
  - safety procedures when using workshop, builders' and livestock tools and equipment.

- procedure of making feeding equipments on the farm.
- Ask learners to:
  - draw, identify and label parts of workshop, builders' and livestock tools and equipments.
  - repair damaged parts, tighten loose bolts/nuts, replace worn out parts and sharpen cutting edges.
  - assemble common workshop, builders' and livestock tools and equipments.

## Practical

- Constructing simple livestock rearing equipment

## Resources

- Overall coat used when handling the livestock tools and equipment such as a hand spray pump
- Slides, photographs or charts illustrating how to use, handle, repair, maintain and store different livestock tools and equipment
- Knapsack sprayer, hand spray pump, syringe, drenching gun, hand brace, ear tags, burdizzo, elastrator, hot iron dehorner, candler, spoke shave, slot screw driver, hand saw, claw hammer, chisel, mallet, grease/oil, water, soap, towel, strip cup, milk strainer, milking pail, wooden feeder trough, nest box, fodder preparation tools, milking tools and equipment, tools for measuring length, rasps, nuts and bolts
- Materials and tools for constructing simple equipment and tools like beehives, bailers, forage choppers, feeders, feed mixers, waterers/drinkers, nesting boxes

## Hints to the Teacher

- Farm equipment can be divided into garden tools, workshop tools, animal equipment and building tools. The material used in making these tools, the design and function of tools so as to be useful to the farmer need to come out properly.
- Light treatment should be made on the component parts but clear description of how it is used to perform its function is vital.
- Get support from the school administration to provide the relevant farm equipment for learners to have hands-on experience.
- Proper storage with a well documented inventory of the farm equipment will save the school.

## Assessment

- Livestock tools, garden tools and workshop tools
- Maintenance practices of tools, equipment and machines
- Use of farm tools, equipment and machines
- Identification of common tools as shown below

No.	Specimen	Name	Function	Maintenance
1.	Knapsack sprayer			
2.	Syringe			
3.	Drenching gun			
4.	Ear tag			
5.	Burdizzo			
6.	Hand brace			
7.	Dehorner			
8.	Candler			
9.	Spoke shave			
10.	Milk strainer			
11.	Feeder trough			
12.	Chisel			
13.	Rasps			
14.	Tenon saw			

## Sub-Topic 3: Farm Structures

Competence	Content
The learner:	<ul style="list-style-type: none"> <li>• understands basic principles of technical drawing.</li> <li>• designs simple building plans for farm structures.</li> <li>• constructs / models a simple farm structures.</li> </ul> <ul style="list-style-type: none"> <li>• Basic principles of technical drawing in farm structures</li> <li>• Building and construction drawing of farm structures</li> <li>• Constructions/modelling a simple farm structures</li> </ul>

## Methodology

- Ask learners in small groups to:
  - draw building plans of basic farm structures.
  - study and interpret building and construction drawings/plans.
  - construct models of simple farm structures.
  - identify materials used in construction of farm structures.

- prepare a budget for a simple farm structure.
- Organise learners in a group to:
  - relate the use of farm structures to their design.
  - interpret simple building and construction drawings correctly.
  - identify the suitable construction materials for simple farm structures.
  - explain the factors to consider when planning any farm structure construction like a dairy unit, calf pen, rabbit hutch, fish pond, pigsty, deep litter house, milking parlour, farm store and machinery shed.
  - outline the procedure for constructing a fish pond, beehive, rabbit hutch, cattle crush, nest boxes/feeders, pets house, dairy shed, goat house and pigsty.
  - describe the procedures of maintaining farm structures.
  - prepare and justify a budget for construction of a simple farm structure like a beehive, rabbit hutch, pet house, poultry cage/deep litter house, goat or turkey house and pigsty.
  - visit a farm with cattle dips, crushes, spray races to identify siting of the structures and construction features.
  - construct a crush starting with a drawing plan, estimating the materials, costs and actual construction.
  - repair a crush, cattle dip, crop store/crib.
- Lead learners to demonstrate the procedure of constructing a fish pond, beehive, rabbit hutch, cattle crush, nest boxes/feeders, pets house, dairy shed, goat house and pigsty.
- Through brainstorming, ask learners to:
  - justify a budget for construction of a simple farm structure like a beehive, rabbit hutch, pet house, poultry cage/deep litter house, goat or turkey house and pigsty.
  - explain the procedures of maintaining farm structures.

## Practical

- Taking the measurements of different farm structure in and around the school
- Designing simple plans for farm structures

## Resources

- Mathematical set
- Drawing boards, paper, T-squares, set squares, rulers and pencils
- Building and construction plans, sketches and drawings of farm structures

- Artistic photos/pictures of completed farm structures
- Different construction materials and tools used
- Actual housing structures constructed from building plans, sketches and drawings
- Project plan and diagrammatic representation of ground/floor plan, left/right or side and front/back elevations

### Hints to the Teacher

- Farm structures are anything that is constructed on the farm. Farm structures include fences, buildings, roads, canals and stores.
- In order to improve the living standards of farmers, structures and buildings should have a comfortable and a healthy living environment which includes clean water and sanitation facilities.
- Handling and management operations on the farm require different structures to ensure safety of livestock, crops and the operator, as well as efficiency of the operation. For instance, a cow being milked should conveniently be restrained with enough space in a milking crush. Good enough these are provided for in a building plan.
- Review of basic farm structures like animal crush, dip tank, spray race, barn, calf pen, pigsty, deep litter house, fish pond and rabbit hutch is a good introduction here. These farm structures are an investment made by the farmer so should be developed from a well designed plan and bill of quantities specified. These should be used when assessing the net worth of the farm.
- Get support from the school administration to provide the relevant building plans for the learners to use.

### Assessment

- The main components of a budget for a simple farm structure
- Construction materials and tools used in simple farm structures

## Topic 18: Agricultural Economics III

*Duration: 18 Periods*

### Overview

Without government involvement, one doubts whether there will an abundant food supply, increased agricultural export to get foreign exchange and efficient land use. Most important, Uganda needs to be self-sufficient in food. Government involvement in agriculture is fundamentally to ensure food availability to its people and moving financial resources to rural areas.

Land is taken as a resource in terms of the space it provides, the environment it covers, the resources it contains and supports as well as the capital it represents and generates. It is therefore important that all issues surrounding land are not only addressed but are transformed into a robust engine for social and economic development in Uganda. This can be done by enacting a good land policy, increasing land rights awareness and the related agricultural policies plus mapping out the implications for each stakeholder.

### Learning Outcome

By the end of the topic, the learner should be able to:

- explain the role of government in agricultural development.
- state the current agricultural policies in Uganda.
- explain the recent agricultural initiatives and programmes in Uganda.
- explain the roles of research institutions and organisations in agricultural development.
- explain the role of extension service in agricultural development in Uganda.
- state the role of other players in agricultural development.
- describe the impact of socio-economic policies on agriculture development in Uganda.
- relate the issues in agriculture extension with all the players.
- demonstrate an understanding of the role of government and policies in agricultural development.
- explore how to create and manage a farming organisation.
- appreciate the need for land reforms and increased awareness of land rights in Uganda.

## Sub-Topic 1: Agricultural Policies and Government Role in Agricultural Development

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"> <li>• identifies the role of government in agricultural development.</li> <li>• interprets agricultural policies and relates them to agricultural production.</li> <li>• describes the importance of research, research organisations, extension services and other partners in agricultural production and development.</li> <li>• classifies the roles of various players in agricultural production.</li> </ul>	<ul style="list-style-type: none"> <li>• Role of government in agricultural development</li> <li>• Current agricultural policies and programmes in Uganda</li> <li>• Plan for Modernisation of Agriculture (PMA)</li> <li>• National Agricultural Advisory Services (NAADS)</li> <li>• Programme for Elimination and Alleviation of Poverty (PEAP)</li> <li>• Agricultural Sector Programme Support (ASPS)</li> <li>• Research organisations in Uganda and their roles in agricultural sector development.</li> <li>• Extension services and their role in agricultural production and development</li> <li>• Research – extension – farmer linkages in relation to agricultural production and development</li> <li>• Roles of various players in agricultural production and development in areas like: extension/ education/ advisory, financing, marketing and research</li> <li>• Other players in the agricultural sector development such as:</li> <li>• international organisations like the FAO, IFRI, WFP, NGOs</li> <li>• donor organisations like IMF, ADB, World Bank, MDI, micro</li> </ul>

Competences	Content
<ul style="list-style-type: none"><li>evaluates the effects of the different socio-economic policies on agriculture.</li></ul>	<p>finance institutions, insurance and private firms</p> <ul style="list-style-type: none"><li>Socio-economic and other policies that affect agriculture like PAF, WTO, DISP, NEPAD, AGOA, structural adjustment programmes, fair trade, privatisation, liberalisation, import and export policy</li></ul>

## Methodology

- Before the lesson:
  - acquire the different current agriculture policies and related socio-economic policies of Uganda.
  - study the FAO report on Uganda agricultural development to identify policy issues.
- Organise learners in groups to:
  - identify agricultural service providers/stakeholders according to the level of importance to the farmer using the Venn diagram analysis. Also identify the key actors in this area.
  - identify the current sources of support and state the type of service to farming the people in this area are getting.
  - read NAADS and PMA documents then summarise their roles in agricultural development so that learners recognise the need for government involvement in agriculture.
- Organise for learners a field visit with a prepared questionnaire to:
  - observe new technologies at one research organisations in Uganda.
  - watch films/video shows on the works of FAO, WFP, ILO, USAID and IFFRI.
  - listen to a guest speaker/resource person.
- Through a discussion, allow learners to:
  - analyse available policy documents, brochures and agricultural development organisations'/institutions' information.
  - explain the role of government in agricultural development.
  - justify the place of extension in agricultural development.
  - examine the recent agricultural development programmes and initiatives.
  - assess the effects of the socio-economic policies on agriculture.
  - debate the role of NGOs and NAADS in agricultural extension service delivery.

- Organise a drama skit using a group of learners to show a sick person who sought help from traditional healer, church minister, a medical officer and a personal close friend. The sick person got treatment from all of them. Brainstorm on who helped the sick person to heal or die quickly. Relate this to the farmers who interact with all sorts of service providers in agriculture.

## Practical

- Visiting research stations to observe new agricultural technologies
- Case study of PMA, NAADS and PMA working papers
- Visiting NGOs, NAADS and district agricultural offices
- Visiting Bank of Uganda and rural commercial banks branch offices

## Resources

- Uganda Government Agriculture Policy documents
- Guest speaker from the Ministry of Agriculture, Animal Industry and Fisheries, agricultural research stations
- Charts, posters, video tapes depicting new agricultural technologies and research activities and brochures
- Resource persons from MAAIF, NGOs (CARE-Uganda, Heifer International, CIDA, UNDP, DFID, GIZ, FINCA, CARITAS, IFFRI, FAO, World Vision, Concern)
- Video/films on research programmes
- Brochures on research organisation mandates
- Agricultural research stations
- Agricultural trade show/national exhibitions
- Development Strategy and Investment Plan (DSIP)
- Players in the agriculture sectors and agri-value chains

## Hints to the Teacher

- Government in most of the developing countries is in charge of setting the agenda for development have a big presence in agriculture.

## Assessment

- Current agricultural policies in Uganda
- The role of NAADS in agricultural development
- The main areas of focus for PMA
- The role of donor organisations in agricultural development
- Challenges of NAADS in delivering extension services to farmers

- Recent agricultural programmes that are supporting the development of agriculture in Uganda

## Sub-Topic 2: Land Policies of Uganda

Competences	Content
<p>The learner:</p> <ul style="list-style-type: none"><li>justifies knowledge of the current land use policies and constitutional provisions.</li><li>describes the land tenure systems in Uganda.</li><li>explains the effects of land use policies and land tenure systems on agricultural production.</li><li>interprets current land use policies and relates them to agricultural production.</li><li>demonstrates knowledge of the land rights of individuals.</li></ul>	<ul style="list-style-type: none"><li>Current land use policies and constitutional provisions</li><li>Land tenure systems<ul style="list-style-type: none"><li>- Lease land</li><li>- Mailo land</li><li>- Communal land</li><li>- Free hold</li></ul></li><li>Effects of land use policies on agricultural production including the land rights</li></ul>

## Methodology

- Ask learners to read the land constitutional provision in article 173 extracted from the 1995 Uganda Constitution to identify the different land tenure systems provided.
- Using Case Study 5, ask learners to discuss the effects of land use policies and land tenure systems in agricultural development.
- Organise debate sessions for learners to explain the current land use forms and rights.
- Lead a brainstorming session for learners to explain the effects, merits and demerits of the land tenure system of Uganda.
- Organise learners in groups to read the Case Study on land use and land ownership so that they can suggest how to overcome the challenges.
- Guide learners to demonstrate land mapping principles, procedures, requirements and benefits of land registrations.

## Hints to the Teacher

- You are aware that in the current era, our country is facing challenges of a rapidly growing population on the same size of land as was the case in Berlin conference of 1884. Besides, there is need to devise ways or means to relieve pressure and competition over the scarce land resource. Furthermore, there is global warming, climate change, land degradation, landslides, rapid urbanisation and poor land use planning, all of which have adverse effects on land. There is thus a need to regulate, reform and transform the land rights and land tenure in Uganda. This should be through a harmonised land tenure framework, land right administration and land use management that are spelt out in the Uganda land policy.

## Assessment

- Land reform in Uganda
- Challenges of communal, estate and free hold land tenure in Uganda
- Identifying the main features of correct/right land lease title deed
- Procedures of obtaining a land title deed and certificate of land tenancy
- Main challenges of land reforms in Uganda
- Causes of land disputes in Uganda
- Benefits of land registration in Uganda

## Practical

- Study Annex 3b on land use conflict in Uganda

## Resources

- Land policy documents
- Land titles/title deeds
- Resource persons on land issues, policies and law

## Sub-Topic 3: Farmers' Organisations

Competences	Content
The learner: <ul style="list-style-type: none"> <li>describes the principles that govern operations of farming organisations.</li> <li>explains the roles of farming organisations in agricultural</li> </ul>	<ul style="list-style-type: none"> <li>Principles and operation of farming organisations</li> <li>Roles of farming organisations in agricultural development</li> </ul>

Competences	Content
<p>development.</p> <ul style="list-style-type: none"><li>• examines and appreciates the role of farming organisations in agricultural production and development.</li></ul>	<p>such as:</p> <ul style="list-style-type: none"><li>- farmers associations</li><li>- farming organisations</li><li>- co-operatives</li></ul>

## Methodology

- Organise a field visit for learners to a farming organisation with guiding questions to investigate its functions, operation and structure.
- Ask learners to point out the names of farming organisations in their home area so that you can clarify the definition.
- Lead a guided discussion for learners to explain the role of farming organisations in agricultural development.
- Invite a resource person to facilitate in explaining the principle and status of farming organisations in Uganda.

## Hints to the Teacher

- Farmer organisations are in form of cooperatives and commodity organisations intended to provide various inputs, marketing, educational and other social services. They are the farmers' mouthpiece. You should know that the farmers' voice cannot be obtained without the farmers' organisations.

## Assessment

- Farming organisations' benefits to farmers
- Main principles of farming organisations like the cooperative society or agricultural credit and saving association/ farmer business school/farm field school/out growers scheme/beekeepers' association

## Practical

- Visiting farming organisations to study their functions and the way they are organised

## Resources

- Policy on farming organisations in Uganda
- Brochure of the farming organisations
- Documents belonging to farming organisations
- Resource persons from farming organisations

## Appendices

### Case Study 1: Poem

I am dead  
Man and woman you have done it  
Done it to me  
Why, what wrong did I do to you?  
You have dumped all household, farmers' and industrial refuse  
Not spared plastic bottles, polyethene, agrochemicals  
and rubbish of all kinds onto me  
My only blanket  
You have taken away

I can no longer hold water  
My colour is mosaic  
You drain and drain  
You poison and poison  
You sip and sip me dry  
You have cut all my plants  
You have made mats for yourself to sit  
Murrum and heaps of murrum  
What a mess you have done to me  
No cover

I am dead  
Fish has died  
Frogs have run away  
Cows have collapsed  
Toads have done the same  
Where will they go?  
So do not shed crocodile tears.

#### Questions

1. What is the writer talking about?
2. Whose blanket has been taken away?
3. What is being described in stanza 2?
4. What actions are affecting wetlands today?
5. What suggestions can be made to save the wetlands?

## Annex 2: Analyse the Case Study made by S6 Students

Rahel was born in Kilimanjaro Region some 40 years ago in a family of 4 boys and 3 girls. She was brought up by her step-mother because her mother had divorced. Her upbringing was rather rough; she experienced a lot of mistreatment. She was able to attain standard IV primary school education after which she emigrated to the urban centres of Moshi and Arusha where she served as a house girl for several years.

At the age of 22, she met a police officer named Kingo who made her pregnant and later, decided to take her as his wife. When they first met, Rahel had been employed by a Chagga woman selling *mbege* (a Chagga beverage). With time she acquired a lot of experience in the production and sale of the brew. By the time she met Kingo, some new customers were mistakenly referring to Rahel as the owner of the *mbege* brewing centre.

Immediately after she joined Mr Kingo, she requested permission from her husband to start brewing *mbege* at police staff quarters. Within a very short period, she became very famous around the police quarters and neighbouring streets, and was nicknamed "Mama Mbege". Her success was envied by some police officers and she was ordered to stop brewing *mbege*. She immediately convinced her husband to rent a small house outside the premises of the quarters to retain most of her customers. She was aware of the limitations one was likely to face with rented premises and she was just about to ask her husband to look for a plot in the shanty town so that they could start erecting their premises. She hesitated because of two reasons: first, her marriage with Kingo (who was from a different tribe) had not been formalised either in the tribal circles, church or government. Secondly, she thought that her success could be interpreted as a sign of exercising a dominant role in the family affairs.

After four years, the police officer was transferred to Mbeya, a region that neighbours his home. Rahel alias Mama Mbege, was then a mother of three children, and she was really doing well in business. In Mbeya, *mbege* was unavailable though there were other local brews. The start-up was tough because it took time for people to get accustomed to that new brew. As more Chagga people in Mbeya discovered Mama Mbege's business, more came for a drink and during holidays (Easter/Christmas/public holidays); she would receive several orders for Mbege to be taken to people's homes. She started making good money and this time, she decided to implement her earlier idea of having a home of her own. She secured the plot and set a day to pay the money and sign the agreement. On the day the agreement was to be signed, her husband disappeared from home and the agreement was not finalised. This was the beginning of difficult times for her. He

started rebuking her in statements such as: "It is normal for you Chagga women to control men but you will not control me" and things of the like.

Mama Mbege sought the advice of others, including the relatives of her husband. She managed to influence one of them to volunteer to face her husband over the matter. He co-operated, so the agreement was written and the plot was secured. Immediately, she started making clay bricks and within a short time there were enough bricks to construct a house. She had requested her husband to design the new house but again, he did not support the idea. She made a contract with a "fundi" and the work was soon completed. Most commodities in the market were in short supply, so she had a problem of securing corrugated iron sheets. But, fortune was on her side; the R.T.C Manager was her husband's tribesman, so she approached him and she immediately got allocated the sheets.

As she brought the corrugated iron sheets home, she almost could not differentiate her husband's behaviour from that of a lunatic. While she expected appreciation and praise from him, she was again ridiculed, insulted and called names. She ignored all the setbacks she was encountering. She roofed her house and started with the finishing up work. The finishing needed a lot of money, so she decided to do it piece meal. In those rooms she could not work on, she started a poultry project of 200 layers and 200 broilers. The sales from broilers were used to feed the layers until she started getting eggs.

Eggs were not selling in that locality, but she discovered that she could use the "Kijiweni" or "Jua Kali" boys to take her eggs to Chunya, a place where there are gold mines. She made good money; while other poultry proprietors were selling a tray for Shs 6,000, she was almost getting double the price. She got good money, finished up the house and now settled for a new "going". By then, things domestically were almost getting out of control and she decided to leap forward. This time she established a retail shop and employed a young boy who was assured of a share if he managed the shop well. She then started to travel to Arusha and sometimes as far as Namanga, where she could get Kenya-made products, which besides being relatively cheaper, were selling like hot cakes in the southern region markets. The boy performed well and the profits increased.

She prospered further and this time, established a bar of her own. The woman tried to support her husband and the whole family, but she admitted that the husband's behaviour retarded her development to a large extent. She also revealed that her husband's behaviour was a reflection of some form of inferiority complex because of his inability to fully support the family. She appreciated the necessity and important role of contacts and connections with different people; such contacts are necessary if the

business is to prosper. In the case of problems associated with running a bar, the proprietor has to attract customers, talk to them and even at times extend free offers to regular customers or even give limited credit. This close relationship with customers in the bar is giving her husband a headache. Sometimes he becomes quite hostile for no apparent reason at all. She admits that further trouble from her husband might make it necessary for them to separate temporarily, because the children still need parental care and education.

Regarding her future plans, Rahel anticipates a smooth going when her children complete their schooling and join her in the business. She admires the transport industry, but she dreams of it only if the boys will show the initiatives and abilities to manage a transport business.

### Questions

1. Having read this story, analyse the motives which have driven "Mama Mbege" to become a successful entrepreneur.
2. What main characteristics have driven her to fulfil her ambitions?
3. What would you have done if you were in "Mama Mbege's situation of having a very inactive partner?

## Annex 3a: Gender

This word comes from three languages as recorded or where it is believed that civilization begun. These words are:

**Genus** (Latin), which means one kind/sort/ type or the other

**Genre** (French), which means one kind or type

**Gen** (Greek), which means to produce

All these languages point to one thing that our society/immediate surroundings goes very far to nurture or prepare and produce us as a one kind or one type from birth until we die. This is from the fact that each one of us tries to define the objects we interact with as one kind or the other basing on characteristics observed.

Unfortunately in everyday life, gender is understood to refer to women and girls only. This school of thought only wants to down play the underlying fundamental issues.

Muylwyk and Smetsers (1996) refers to gender as the different social roles of men and women as observed and held by a given group of people, which roles are not physically/biologically denoted by their sex. For instance, sex has more than one meaning. In terms of gender, it means whether the person is male or female. It is also used to describe sexual intercourse.

The sex that children are born with influences their chances in life, along with a number of other important variables such as socio-economic class or caste, race, ethnicity and disability. These biological differences become important primarily when children reach puberty, but the social roles are assigned from the moment of their birth. All societies assign different roles, attributes and opportunities to girls and boys. They are socialised to perform the roles expected from women and men in their society and are based on the ideas in each society on how women and men should or should not behave.

While a **gender role** refers to the different things men, boys, girls and women do in their society, some of these things are based on the fact or physiological make up, others on attributes but the majority on what society believes about what men, boys, girls and women can or cannot do. For example:

- Women can give birth to babies, breastfeed and are more caring therefore women are more suitable for nursing than men
- Men are very aggressive therefore are more suitable for military work than women.

Certainly society beliefs and influence play a big part in determining the males and female roles. The good thing this is changing a lot today. On the other hand, gender simply means the way a society has defined/assigned the roles, attitudes, responsibilities and behaviours of men, women, boys and girls. Gender has played a great role in shaping men, boys, girls and women's position in life for many years. This has been due to gender stereotypes or strong beliefs not based on facts or what others think about one group/individual.

Therefore, these differences between men, women, boys and girls are just acquired and learnt from the group of people they live with. So from birth, the person is made to learn from the adults and his/her immediate surroundings a number of things which leads them to have different potentials, roles, responsibilities, needs, opportunities, constraints and interest. This means your surroundings give you opportunities and limitations.

**Gender role** means the different things that boys, girls, men and women are considered capable of doing in a given social setting. It is the set of social and behavioural norms that are considered to be socially appropriate for an individual. Take this example. Women and girls prepare meals or Sere has been offered a place at a polytechnic to study engineering. Sere is the only girl in the class. Sere came first at the end of first year. The boys stopped talking to her. Sere is feeling miserable because she has no friend in the class. What should Sere do? Another example is that a woman in Karomoja is capable of constructing a house right from clearing the site to thatching the house. This, however, is not expected among the Baganda. Gender roles influence the division of labour.

**Gender identity** is the way an individual feels about being either a boy, girl, man or woman. It is usually formed by age three and is extremely difficult to change after that.

**Gender stereotype** are beliefs that have no factual truth but usually stories that have been around for so long that people start to believe that they are true and treat them as such. There are a lot of beliefs around us that are not based on any fact. Unfortunately when you believe in them or that you are limited in what you can do with your life, you will probably set different goals to what you really would like to achieve for yourself. Gender stereotype also affects the assessment people make of their own competences.

Because gender roles can severely limit our plans and how we look at the future, it is important that an individual becomes aware of them and overcome the stereotype expectations that are put onto us by our society.

**Gender equality** is when boys, girls, men and women are given the same or equal opportunities, rights, treatment, responsibilities and resources. For instance, when women have the same qualifications as men, then their pay should be the same. Also when a girl comes first in the class, the rewards and accompanying statements should be similar to those given to a boy who comes first in class who comes first in class. The division of labour which is based on gender discrimination and unequal sharing of resources should be reversed.

**Gender equity** is when boys, girls, men and women are given fair, just and similar treatment. Find out if teachers depict girls and boys being engaged in similar activities. Do teachers choose the right words to use? For instance saying that “boys will be boys” or “girls will be girls” is harmful phrase in a class of girls and boys.

**Disability** is loss or reduction of functioning of body parts due to impairment.

**Gender gap** is different treatment of individuals or groups of people on the basis of social expectations and attributes of boys, girls, men and women. It may be a result of customary practices, religious biases, social assumptions or myths and taboos which prevent one group/individual from getting their fair share of resources.

**Gender discrimination** involves excluding or restricting members of one group or an individual from opportunities that are available to others. Otherwise it is being treated worse than others for some arbitrary reasons. It includes one sex being disadvantaged because the other is favoured.

**Gender oppression** is where one individual/gender dominates the other unjustly or even cruelly through the use of power (the resources/skills/knowledge one has to influence action) and domination.

**Gender analysis** is the systematic examination of the roles, relations and processes focusing on the imbalance in power of women, girls, men and boys in all societies.

**Gender responsive** is creating an environment that reflects an understanding of the realities that boys, girls, men and women live in and then addressing them.

***Differences between gender and sex***

SEX	GENDER
1. Natural	1. Man-made
2. Biological	2. Socio-cultural
3. Visible differences in the genitalia or genital organs	3. Invisible but exhibited as masculine or feminine qualities/ behaviours patterns, values
4. Relates to differences in procreative or reproductive functions	4. Relates to responsibilities, functions or roles performed
5. Difficult to change	5. Can easily be changed
6. Remains the same everywhere thus constant	6. Changes from time to time, with the place, culture, race, generation and even family
7. Is in-born in an individual/ organism	7. Is just learnt from the surroundings of the individual

**Question for reflection**

1. Why should having different bodies and different functions lead to inequality in society?
2. Outline the main differences between sex and gender.

## Annex 3b: The Case Study made by Gender Students

In some rural parts of Mayuge district of eastern Uganda, land is communally owned by the clan. Individuals only “own” it as long as they are putting it to use. This right must be endorsed by the group of elders overseeing the clan land. If the land lies under rest for an extended period of time, then others in that family or clan are free to cultivate it.

An NGO called ‘Send a Cow’ chose Mayuge as its project area. This NGO has a livestock development programme as one of its core activity. In this activity, heifers are donated to women only. In addition, a borehole is sunk to alleviate the water needs in the area. Surprisingly, the women continue to fetch water from the valley leaving the modern facility for men to get water for sale. Twenty one women were mobilised and formed into a women group by the male project officer. The project officer is a graduate called Waira. He has worked so hard to change the life of the people in Mayuge. The following rules are followed by the group members:

1. Group meeting every Thursday at 10 am
2. Payment of membership of Shs 10000
3. Fencing off one acre of land to grow improved pasture
4. At the age of 9 months, a female calf is to be donated to another member
5. Members to open an account with a micro credit facility started by the NGO.

Bida, a senior four leaver negotiated with her husband to receive the heifer. Bida fenced off land and planted it with improved pasture. The animal calved a male calf and started giving 15 litres of milk per day. The husband in turn of events decided to marry a second wife after one year. The second wife, a senior two leaver named Midda, asked the husband that she should be allocated the land with pastures since her co-wife was not using it. Besides, everybody in the village grazed their animals in the communal lot on the hill. Midda could not understand why Bida’s cows could not graze there as well.

This caused a stir in the family. The husband sought the help of the clan leaders. The head of this clan quickly called for a meeting to resolve the conflict. After listening to both sides, the elders resolved that Bida removes the fence immediately and refrain from being selfish when using land on which all ancestors had happily coexisted for the past hundred years!

### Questions

1. Suggest the four reasons that made the women to abandon the borehole
2. What four gender issues can you identify in this case?

3. What are implications do these issues have for agricultural development
4. What interventions would you recommend to address the identified gender issues?

## Annex 3c: Gender Relations

Gender relations refer to when two or more individuals have to live together and share common resources around them in a workable arrangement. For this to be possible, some relationship must exist between them. It is the magnitude of power between men, women, boys and girls as it is revealed in the practices exhibited, ideas coming from them, the resources they are using and the roles they are playing.

These relations ascribe to them different abilities, attitudes, desires, personal traits and behavioural patterns.

In other words, it refers to any workable arrangement between two or more individuals who are living together and using the same resources to achieve a better life.

This workable arrangement of living together is possible because:

- ❖ Fall-back position: These are the options/opportunities an individual has outside the arrangement. These options will determine how well off the individual would be without being in the relationship. This may determine whether an individual will keep and maintain a relationship or not. If the options out there are bad; the individual may stay on but if better opportunities exist out there then the individual will quit and give up.
- ❖ Legitimate claim: This is what an individual deserves in the eyes/heart/hands of others around him or her. It is the degree to which your request, negotiation, bargains, effort, price, brand name or share is regarded and seen as what you deserve or a right by others you live with.
- ❖ Perceived interest response: This is how an individual looks at his/her well being relative to that of others. Many times the women, men, boys and girls are socialised to take care of the interest of others to be above their own. For instance, in some societies, women, even though they too are hungry, are seen eating last after serving all others at the table. This makes some people to think that women/girls or boys/men are kind/tolerant or have less sharp perception of their own individual interest. Yet the truth is that women, like men, are more future focused and forward looking in their interest but just decide to be accommodating and intelligent to situations/things which are hurting to them to achieve something better in future.
- ❖ Perceived contribution response: This is ones feeling about what one brings in the relations for the well being of the members in the arrangement. Each individual judges what he/she does for a workable

relationship. This determines how they behave towards others like most women see that they contribute a lot in producing a new individual. This feeling makes the women to bargain more or to strike a hard bargain for their biological children and next of kin. They go far in explaining how much contribution they have made.

- ❖ Doxa: These are the issues or areas not open to discussion or question. They must occur as one finds them. They include women eating last in some households, kneeling down by women in Buganda, religious issues, and the strategic marriage alliances. For example in Asia, an old daughter in law who has a son can be allowed to participate in a household decision. Yet a new bride/wife or an old woman with daughters only has to find a distant place to hide and work from at the time of decision-making in the household.

The point here is that doxa is in the interest of the dominating and powerful group members of a given setting. They have the resources to use for influencing action. And when the women or men have resources then their societies allow them to participate in decision-making

- ❖ Endowment: This is what an individual owns by birth or circumstance of living/interaction which makes him or her to own a productive and scarce resource.
- ❖ Cooperative conflict: These are concerns raised and cannot be answered by an individual who is outside a gender relation or workable arrangement of living or working with others. It is knowing and being aware of the correct things but accepting to do what the majority thinks and feels is right for that time/ situation in order to save your head.
- ❖ Transaction costs: This is the arrangement that institutions or individuals come into a workable arrangement of living together or existence in order to lower the expense. It is very true when markets do not exist or do not work well. For a family, it can be assisted by transaction costs to achieve the goals of livelihood, security, reproduction, child upbringing, and care for the elderly, etc.
- ❖ Entitlement: These are the resources an individual has as his or her own which he/she can exchange with others.

## Case Study 4: Introduction to Machines

A simple machine is a mechanical device that changes the direction or magnitude of force. It is the simplest functioning structure that can use mechanical advantage/leverage to multiply force. A simple machine uses a single applied force to do work. It falls into two classes namely those with vector resolution like a wedge, inclined plane or screw and those with equilibrium such as the lever, pulley and wheels. The machine transforms lateral force and movement to do work for man.

Mechanisms of machines are the components designed to manage force and movements of objects. An ideal mechanism transmits power without adding to or subtracting from it. In the mechanism, there is no opposition to force/movement (frictionless). It does not include the power source and is made from rigid bodies that do not deflect or wear out.

### Common terms

**Mass** is the quantity of material a body contains.

**Force** is anything which changes or tends to change the state of rest or uniform motion of a body. Under the SI (system international) system, the unit of force is Newton. When a force of one Newton is applied to a mass of one kilogramme, it will give it an acceleration of one metre per second per second.

**Pressure** is the force applied to a given area.

**Work** is the force applied to a body causing it to move through a given distance.

**Vector** is what is needed to move an object from one point to another. The magnitude of a vector is the distance between the two points in a given direction.

**Wedge** is a triangular shaped tool and is used to lift heavy objects when a small force is applied at one end.

**Lever** is a rigid object that is used with an appropriate pivot to either multiply the mechanical force. It is a stiff bar that rests on a support called fulcrum which lifts or moves loads. It is a rigid object that is used with an appropriate fulcrum/pivot to both multiply mechanical force/effort that can be applied to another object or multiply the distance and speed at which the opposite end of the object will travel.

**Pulley** is a simple machine that uses grooved wheels and a rope to raise, lower or move a load from one point to another. Pulleys are used to change the direction of applied force, transmit rotational motion or realise a mechanical advantage in either a linear or rotational system of motion.

There are three kinds of pulley systems namely: fixed pulley which has a mechanical advantage of 1. This means that the force applied is equal on both sides of the pulley and there is no multiplication of force. A movable pulley is used to multiply force and has a mechanical advantage of 2. This is to say that if one end of the rope is anchored, pulling the other end of the rope will apply a double force to the object attached to the pulley. Finally, there is the compound pulley which is a combination of both the fixed and movable pulley.

**Mechanical advantage** is the ratio of the output force to the input force.

**Equilibrium** is a system of particles at rest and whose total force is zero.

**Velocity ratio** is measured by dividing the speed at which the effort moves by the speed at which the load moves.

**Power** is the rate of doing work

**Density** is the mass of a body divided by its volume

**Newton's 1<sup>st</sup> law of motion:** A body at rest or uniform motion will continue in its state unless an external force acts on it. This means that there is a natural tendency of objects to keep doing what they are doing.

**Newton's 3<sup>rd</sup> law of motion:** For every action, there is an equal and opposite reaction. This means that when you push an object, it pushes back with an equal force in your direction.

## Case Study 5: Uganda Land Policy

The goal of the National Land Policy is "to ensure sustainable utilisation and management of Uganda's land resources for wealth creation, poverty reduction and overall socio-economic development".

The objectives of the National Land Policy are to:

- stimulate the contribution of the land sector to overall socio-economic development, wealth creation and poverty eradication in Uganda.
- harmonise and streamline the complex tenure regimes in Uganda for equitable access to land and security of tenure.
- clarify the complex and ambiguous legal and constitutional framework for sustainable management and stewardship of land resources.
- resolve historical injustices to achieve balanced growth and social equity.
- reform and streamline land rights administration to ensure efficient, effective and equitable delivery of land services.
- ensure sustainable utilisation and management of environmental, natural and cultural resources on land for national socio-economic development.
- ensure planned, environmentally-friendly, affordable and well-distributed human settlements for both rural and urban areas; including infrastructure development.
- harmonise all land-related policies and laws, and strengthen institutional capacity at all levels of Government for sustainable management of land resources.

### Guiding Principles

The following principles have guided the development of the National Land Policy:

- Land policy must guarantee the right to own land either individually or in association with others.
- Land policy must address all the multiple social, cultural, economic, ecological and political functions of land.

- Land must be productively used and sustainably managed for increased contribution to economic productivity and commercial competitiveness.
- Use and development of land must contribute to poverty reduction, as land is a basic resource central to the overall development agenda of Uganda.
- Access to land by all Ugandans must reflect concern with equity and justice irrespective of gender; whether through the market or through any system of inheritance, customary or statutory.
- Management of land resources must contribute to democratic governance, peace-making and security, by nurturing institutions and procedures for resolution of land disputes and conflicts.
- Management of land resources must mitigate environmental effects, reverse decline in soil quality and land quality.
- Land policy must guide the development of policies in other productive sectors; it is an important determinant of the health and vitality of all sectors and sub-sectors which depend on land for productivity.
- Land sector operations must be fully costed, financed and provided with adequate support services infrastructure.
- Civil society organisations and the private sector must work hand in hand with government actors to achieve the vision, goal and objectives of the land sector.
- Ugandans must understand that the value (monetary and intangible) of land is irreversibly and rapidly changing/

### Case Study 6: Important Farmer Entrepreneurial Characteristics

1. **Hard working:** running a farm business requires a lot of energy and drive. This involves the ability to work for long hours when necessary, to work intensely in spurts and to cope with less than a normal amount of sleep.
2. **Self-confident:** to succeed, farmer entrepreneurs have to believe in themselves and in their ability to achieve the goals they have set for themselves. This is often shown by a belief that “if you want something badly enough and are prepared to work at it, you will usually get it”.

3. **Builds for the future:** the goal for most successful farmers is to build a secure job and income for themselves and improved livelihood and wealth for their families, which is based on their own abilities. This means farmer entrepreneurs understand that it may take several years to build up farm business income to a reasonable standard.
4. **Profit-oriented:** interest in generating money is a clear indicator of a farmer entrepreneur's suitability for being a farm business owner. This means recognising that the farm business comes first and competing family care roles might need to be reorganised. Once profits are generated, the farmer entrepreneur can make decisions about how the profits can be used, to expand the farm enterprise or for personal or family use.
5. **Goal-oriented:** success in farm business depends upon being able to set realistic goals or targets and to work with determination to achieve them. This ability to set goals (for things the person thinks are worthwhile) and to work to achieve them is fundamental to being a farmer entrepreneur.
6. **Persistent:** all businesses have their problems and disappointments. Being persistent in solving a problem is one of the keys to being a successful entrepreneur.
7. **Copes with failure:** all farm business ventures inevitably contain disappointments and failures as well as successes. Coping with failures involves recognising these failures, learning from them and seeking new opportunities. Without this characteristic, early failures may end a person's attempt at self-employment.
8. **Responds to feedback:** Farmer entrepreneurs are concerned to know how well they are doing and to keep track of their performance. Obtaining useful feedback and advice from others is another important characteristic of farmer entrepreneurs.
9. **Demonstrates initiative:** research shows that successful farmer entrepreneurs take the initiative and put themselves in positions where they are personally responsible for success or failure.
10. **Willing to listen:** the successful entrepreneur is not an inward looking person that never uses outside resources. Self-reliance does not exclude the ability to ask for help when needed from such people as agro input suppliers, bank officials, accountants and successful farmer advisers. Being able to listen to the advice of others is a key characteristic of an entrepreneur.
11. **Sets own standards:** setting standards of performance and then working to achieve them is another indicator of a successful farmer entrepreneur. These standards can be income, quality, sales or product

turnover. Most entrepreneur farmers want to do better each year, to set and achieve higher standards from year to year.

12. **Copes with uncertainty:** being a farmer is much more uncertain than employment. This uncertainty is about yields, climate, sales, seasons and turnover, but it often also exists in other areas such as input delivery and prices, and bank support. An ability to cope with this uncertainty without becoming too stressed is a necessary trait of being an entrepreneur.

13. **Committed:** starting and running a farm enterprise demands total commitment by the farmer in terms of time, money and lifestyle. It has to be a major priority in the farmer's life. Committed individuals find it easier to gain the support of others to their business project.

14. **Builds on strengths:** successful farmers base their work upon the strength(s) they have, such as manual skills, interpersonal skills, selling skills, organisational skills, writing skills, knowledge of a particular product or service, knowledge of people in a trade and ability to make and use a network of contacts.

15. **Reliable and has integrity:** the qualities of honesty, fair dealing and reliability in terms of doing what one has promised to do are essential traits of an entrepreneur.

16. **Risk-taker:** being an entrepreneur involves some risks. Entrepreneurs have the ability to take measured or calculated risks. Such risks involve working out the likely costs and gains both on the farm business and on the private life, the chance of success and the belief in oneself to make the risk pay off. Entrepreneurs may be considered risk avoiders when they reduce their risks by having others assume part of the risk. Those who assume the entrepreneur's risk may be bankers, suppliers and customers.

## PRINCIPLES AND PRACTICES OF AGRICULTURE

### PAPER 1 THEORY P515/1

#### TABLE OF EXAMINATION SPECIFICATION

Syllabus Content	Section /	Know.	Comp.	App.	Anal.	Synsth.	Eval.	Items
<b>Section A</b>								<b>30</b>
<b>A. Basic Science</b>								
1. Genetics								
2. Plant anatomy and physiology								
3. Animal anatomy								

and physiology 4. Micro and macro organisms 5. Ecology 6. Chemicals of life 7. Farm Chemicals							
<b>B. Crop Production</b> 1. Crop 2. Soil	2 1	2 1					
<b>C. Animal Production</b> 1. Cattle 2. Piggery 3. Poultry 4. Beekeeping 5. Fish farming	1 1 1 1 1	1 1 1					
<b>D. Agricultural Engineering and Farm Mechanisation</b> 1. Machines 2. Construction materials	1	1 1					
<b>E. Agricultural Economics and Farm Management</b> 1. Factors of production 2. Production theory 3. Price theory 4. Market behaviour 5. Choosing enterprises 6. Farm planning and management	1 1 1 1 1 1	1 1 1					
<b>Section B (7 Questions)</b>							
<b>A. Basic Science</b> 1. Genetics 2. Plant Anatomy			1				

and physiology 3. Animal anatomy and physiology 4. Micro and macro organisms 5. Ecology 6. Chemicals of life 7. Farm Chemicals							
<b>B. Crop Production</b> 1. Crop 2. Soil			1				
<b>C. Animal Production</b> 1. Cattle 2. Piggery 3. Poultry 4. Beekeeping 5. Fish farming			1				
<b>D. Agricultural Engineering and Mechanisation</b> 1. Machines 2. Construction materials			1				
<b>F. Agricultural Economics and Farm Management</b> 1. Factors of production 2. Production theory 3. Price theory 4. Market behaviour 5. Selecting enterprises 6. Farm planning & management			1				
<b>Paper 515/1</b>	17	13	7				37

## PRINCIPLES AND PRACTICES OF AGRICULTURE

### P515/2 ESSAY

#### TABLE OF EXAMINATION SPECIFICATION

Syllabus Section	Know.	Com.	App.	Ana.	Synth.	Eval.	Items
A. Basic Science			1				<b>1</b>
B. Agricultural Economics and Farm Management			1			1	<b>2</b>
C. Crop Production			1	1			<b>2</b>
D. Animal Production				1	1		<b>2</b>
E. Agricultural Engineering and Farm Mechanisation				1	1		<b>2</b>
<b>Examination Paper</b>			<b>03</b>	<b>03</b>	<b>02</b>	<b>01</b>	<b>09</b>

**PRINCIPLES AND PRACTICES OF AGRICULTURE****P515/3 WRITTEN PRACTICAL****TEST SPECIFICATION GRID**

Syllabus Section	Know	Comp	App	Anal.	Synth.	Eval.	Items
<b>Qn 1. Basic Science</b>	a		1				1
	b			1			1
	c	1					1
	d				1		1
	e		1				1
<b>Qn 2. Soil Science</b>	a			1			1
	b				1		1
	c	1					1
	d		1				1
	e					1	1
<b>Qn 3. Crop Production</b>	a			1			1
	b				1		1
	c	1					1
	d		1				1
	e					1	1
<b>Qn 4. Animal Production</b>	a		1				1
	b			1			1
	c	1					1
	d				1		1
	e					1	1
<b>Qn 5. Agricultural Engineering and Farm Mechanisation</b>	a	1					1
	b		1				1
	c	1					1
	d			1			1
	e			1			1
<b>P515/3</b>	<b>5</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>3</b>	<b>24</b>	

**Note:**

1. Each question should reflect a balanced coverage of scientific skills e.g. observation, recording information, interpreting and application.
2. Each paper shall be marked out of 100 marks.

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