COURSE GUIDE

SED305
PRACTICUM IN SCIENCE TEACHING

Course Team

Dr. Moses m. Atadoga & F.K. Falalu (Course Writers/ Developer)
Email: atadoga2008@yahoo.com
Phone: 08035048267
Prof Z. C. Njoku[1] , Dr Emmanuel Ifeanyi, Orji [1] &
Cliff Okebalama[1] , Dr. Nonye Odionye[1]
, Dr. Bianca U. Mbonu-Adigwe[1] (Course Reviewers (2021)
,Dr. Florence Ifeanyieze[2] and Dr. Chijioke Jonathan Olelewe [3]
[1]Department of Science Education, University of Nigeria,Nsukka.
Email: zephrinus.njoku@unn.edu.ng
, +234(0)8035811170.
[2]Department of Agricultural Education, University of Nigeria, Nsukka ,
[3]Department of Computer & Robotics Education,
Faculty of Vocational &Technical Education, University of Nigeria, Nsukka

Instructional Designer:
Learning Technologists:
Copy Editor

NATIONAL OPEN UNIVERSITY OF NIGERIA

2022 by NOUN Press
National Open University of Nigeria
Headquarters
University Village
Plot 91, Cadastral Zone
Nnamdi Azikiwe Expressway
Jabi, Abuja

Lagos Office
14/16 Ahmadu Bello Way
Victoria Island, Lagos

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

Printed 2022

ISBN: 978-978-058-518-1

Contents

INTRODUCTION

SED305 – PRACTICUM IN SCIENCE TEACHING is meant to acquaint you with basic skills on practical aspects and pedagogy of science teaching.

WHAT YOU WILL LEARN FROM THIS COURSE

You will learn of the methods of teaching chemistry subject.

COURSE AIMS

The aim of this course is to acquaint you with skills in handling practical issues and methods in the teaching of various science subjects, namely Agricultural science education, Biology education, Chemistry education, Computer education, Integrated science, Mathematics education and Physics education.as a school subject.

COURSE OBJECTIVES

By the end of this course, you should be able to:

(i) Demonstrate skills in handling basic tools, apparati, equipments etc, used in teaching science subjects
(ii) discuss the uses and management of those tools and equipments;
(iii) Demonstrate skills in improvising basic instructional materials needed in practical science teaching;
(iv) Discuss precautionary steps required in handling basic science tools and equipments

WORKING THROUGH THE COURSE

To complete this course, you are expected to read the study units, and other relevant books and materials provided by the National Open University of Nigeria at the end of each unit of work.

Each unit contains self assessment exercises and at certain points in the course, you are required to submit assignments for assessment purpose. At the end of the course, there is a final examination. This course is expected to last for a period of one semester. Below, you will find listed, all the components of the course, what you have to do, and how you should allocate your time to each unit in order that you may complete the course successfully and on time.

THE COURSE MATERIALS

National Open University of Nigeria will provide you with the following:

The Course Guide: This consists of seven Modules, each having a number of units.

Also at the end of each unit are lists of books – References and For Further Reading. While you may not procure or read all of them; they are essential supplements to the course materials.

Modules and Study Units

MODULE 1: AGRICULTURAL SCIENCE EDUCATION

MODULE 2: BIOLOGY EDUCATION

MODULE 6: MATHEMATICS EDUCATION

UNIT 1: INTRODUCTION TO SED305 MATHEMATICS OPTION
UNIT 2: CONSTRUCTION OF LINES
UNIT 3: CONSTRUCTION OF ANGLES
UNIT 4: CONSTRUCTION OF TRIANGLES
UNIT 5: CONSTRUCTION OF QUADRILATERALS

MODULE 7 PHYSICS EDUCATION

UNIT 1: BASIC RULES AND OPERATIONS IN CONDUCTING PHYSICS PRACTICAL ACTIVITIES
UNIT 2: PRECAUTIONS IN THE CONDUCT OF PHYSICS PRACTICAL ACTIVITIES
UNIT 3: ATTITUDES TOWARDS PHYSICS PRACTICAL WORK/ACTIVITIES
UNIT 4: PRACTICAL SKILLS OR PROCESS SKILLS IN CONDUCTING PHYSICS PRACTICAL ACTIVITIES/EXPERIMENTS
UNIT 5: PRACTICAL ACTIVITIES ON VARIOUS BRANCHES IN PHYSICS

ASSESSMENTS

SED305 is a non- examinable. There are two aspects of the assessments. First are Self Assessment Exercises (SAEs), which provides continuous feedback as the candidate progresses with the course, second is the Final Examination which is usually administered through written exercises following online instructional videos.

Log in to elearn.nouedu2.net with your matric number in lower case as username and password. Click on SED305 and click on Practical Class to watch the videos in your programme of choice
Candidates are required to attend to these exercise in any discipline of their offering, forward them to the programme Coordinator concerned for assessment and similarly submit to the education desk officer in their respective study centres for upload in the PAS **to enable the**

Department credit scores to the affected candidate for the semester the course was registered. The contact details of the Programme Coordinators are provided provided on the course page.

SELF ASSESSMENT EXERCISES

You are advised to be sincere in attending to the exercise.You are expected to apply knowledge, information and skills that you have acquired during the course. At the end of the units you will be provided with probable answers to the SAEs.

Aside from your course material provided, you are advised to read and research widely using other references which will give you a broader viewpoint and may provide a deeper understanding of the subject.

Ensure all completed assignments are submitted on schedule before set deadlines. If for any reasons, you cannot complete your work on time, contact your tutor before the assignment is due to discuss the possibility of an extension. Except in exceptional circumstances, extensions may not be granted after the due date.

How to get the most from this Course

In distance learning, the study materials are specially developed and designed to replace the lecturer. Hence, you can work through these materials at your pace, and at a time and place that suits you best.

Visualise it as reading the lecture instead of listening to a lecturer.

Each of the study unit follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. Use these objectives to guide your study.

On finishing a unit, go back and check whether you have achieved the objectives. If made a habit, this will further enhance your chances of completing the course successfully.

The following is a practical strategy for working through the course:

- Read this course guide thoroughly.
- Organise a study schedule, which you must adhere to religiously. The major reason students fail is that they get behind in their course work. If you encounter difficulties with your schedule, please let your tutor know promptly.
- Turn to each unit and read the introduction and the objectives for the unit.
- Work through the unit.The content of the unit itself has been arranged to provide a sequence for you to follow.
- Review the objectives of each study unit to confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult with your tutor.
- When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.
- After submitting an assignment to your tutor for grading, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments.
- After completing the last unit, review the course and prepare yourself for final examination. Check that you have achieved the units objectives (listed at the beginning of each unit) and the course objectives listed in this course guide.

FACILITATORS/TUTOR AND TUTORIALS

There will be specific time made available for tutorial sessions, in support of this course. You will be notified of the dates, time and location of these tutorials, together with the name and phone number of your tutor, as soon as you are allocated a tutorial group.

Your tutor will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter and provide assistance to you during the course. You must mail your tutor marked assignments to your tutor well before the due date. They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by telephone, e-mail or your discussion group (board) if you need help.

The following might be circumstances in which you would find help necessary. Contact your tutor if:
You do not understand any part of the study unit or the assigned readings.

You have difficulty with the self – tests or exercises.

You have a question or problem with an assignment, with your tutor's comments on an assignment or with the grading of an assignment.

You should try your best to attend the tutorials. This is the only chance to have face-to-face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating in discussions actively.

SUMMARY

This course is designed to expose you to some practical skills that would help you improve your science teaching and stimulate students' interest and achievement in the study of various science programmes

We, sincerely wish you the best, as you study the course.

MODULE 1: AGRICULTURAL SCIENCE EDUCATION

Reviewed and Reprocessed by
Ifeanyieze, Florence Obiageli
Department of Agricultural Education
University of Nigeria, Nsukka

UNIT 1: SIMPLE FARM TOOLS

Module Introduction

In many parts of developing countries of the world, ost agricultural activities ae carried out with simple farm tools. Simple farm tools are handle-held devices that are used to carry out uncomplicated farm operations. Simple farm tools are mostly used in developing countries due to small farm holdings and inability of farmers to afford machines and associated implements that make work easier. Many of the farmers are poor and so find it very difficult to purchase sophisticated machines and implements.

Manipulation of simple farm tools requires skills which the user must possess to be able to handle each without injury to oneself, others and the tool itself. Ability to make use of these tools properly results in accomplishment of activities faster and better quality of works performed. The use of simple farm tools perfectly by a farmer makes the product cleaner and attractive to buyers. The use of simple farm tools for large scale production makes work tedious and discourages many youth from taking agriculture as a profession. The use of simple farm tools should not frighten the youth because of the good quality products coupled with the fact that some farm operations are not suited to the use of farm machines. Furthermore, it is necessary to start at low level and increase at higher later.

Some of simple the farm tools are explained in units one to ten of this book. A student is expected to study it carefully to be able to identify appropriate tools for a particular farm operation, indicate the uses and how to maintain such tool in addition to capability to answer questions posed under ‘test yourself or self’.assessment sections in each unit. The sub units in module one are

Sub-Unit 1: SICKLE
SUB-Unit 2: MACHETE/CUTLASS
SUB-Unit 3: HOE
SUB-Unit 4: HAND TROWEL
SUB-Unit 5: SECATEURS
SUB-Unit 6: SHEAR
SUB-Unit 7: GARDEN FORK
SUB-Unit 8: SPADE
SUB-Unit 9: WATERING CAN
SUB-Unit 10: KNAPSACK SPRAYER

SUB-UNIT 1 SICKLE

1.1 Introduction

A sickle is a necessary farm tools that is required by a farmer in carrying out farm operations. Certain positions are required while using a sickle and the maintenance of appropriate position helps to avoid injury on the farmer, others and the tool during farm operation.

1.2. Intended Learning Outcomes (ILOs)

By the end of this lesson on sickle, the students should be able to

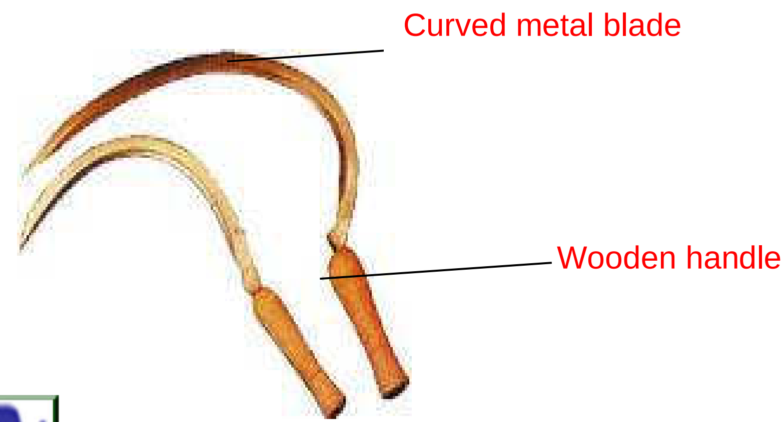
- Define sickle
- Draw and label a sickle
- Describe a sickle
- State the uses of sickle
- State the maintenance practices for sickle

1. 3. Main Content

Meaning and Description of a Sickle

A sickle is a special knife with a curved metal blade made of scraps and a short wooden or metal handle. The convex part of the curved metal is sharp while the other side is blunt. The wooden handle is for holding the sickle during farm operation

1.3.1. Diagram of a Sickle



1.3.2. Uses of Sickle

1. It is used for harvesting cereal crops
2. It is used for cutting of grasses

1.3.3. Maintenance practices for Sickle

1. Clean and dry after use.
2. Sharpen blade when blunt
3. Oil or grease the metal part before storage to prevent rusting
4. Store away from moisture

1.4. Self-Assessment Exercise(s) 1

1. define a sickle
2. Describe a sickle
3. Draw and label a sickle
4. State two uses of a sickle
5. Outline four ways of maintaining a sickle

---

1. 5. Conclusion

A sicle is a necessary tool with a curved metal blade and a short wooden handle used for harvesting cereals and grasses.

1.6. Summary

A student should be instructed to use a sickle in the field to carry out appropriate farm operation while the teacher rtaes him/her.

1.7. References/Further Readings

Steps on how to use a sickle

SUB-UNIT 2 MACHETE/CUTLASS

2.1. Introduction

Machete can also be called cutlass. It is one of the necessary hand-held tools used by a farmer for different farm operations.

2.2. Intended Learning Outcomes (ILOs)

By the end of this lesson on cutlass, the students should be able to

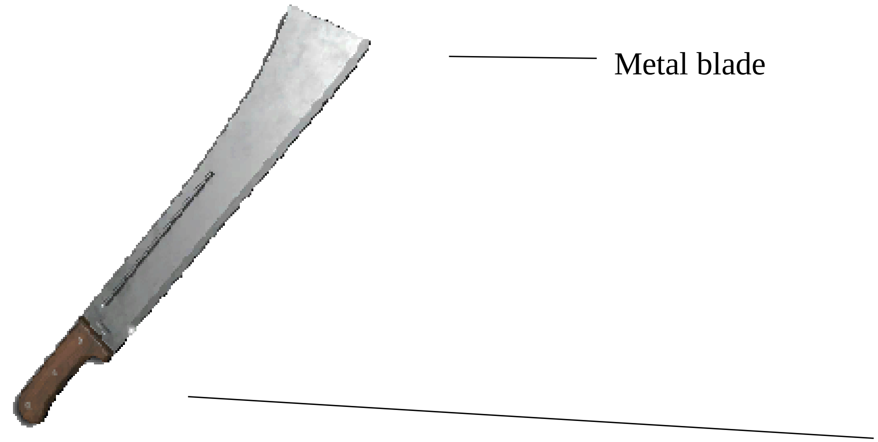
- Define Machete/Cutlass
- Draw and label a Machete/Cutlass
- Describe a Machete/Cutlass
- State the uses of Machete/Cutlass
- State the maintenance practices for Machete/Cutlass

2. 3. Main Content

Meaning of cutlass

A cutlass consists of a long metal blade and a short handle. The metal is broad and the tip can either be curved, flat or pointed

2.3.1. Diagram of a Cutlass



2.3.2. Uses of cutlass

1. It is used for cutting and clearing grasses
2. It is also used for planting of seeds
3. It can be used for harvesting of crops such as sugarcane

2.3.3. Maintenanceof Cutlass

The following are ways of maintaining cutlass

1. Clean and dry after use.
2. Sharpen blade when blunt
3. Oil or grease the metal part before storage to prevent rusting
4. Store away from moisture.

Self-Assessment Exercise(s)

Test Yourself With a labeled diagram, describe a cutlass State the uses of a cutlass List four ways of how to maintain a cutlass Practice the use of a cutlass in slashing grasses in the field

2.3.4. Conclusion

A cutlass is a necessary tool with a metal blade and a short wooden handle used for slashing grasses among other activities. .

2.4. Summary

A cutlass is a hand-held tool that has a long metal blade and short handle. Cutlass is used for slashing grasses, planting and harvesting crops. It is preserved by sharpening, washing, oiling metal parts among other..

2. 5. References/Further Readings

Meaning of sickle, Importance of sickle, Steps on how to use a sickle

SUB-UNIT 3 HOE

3.1. Introduction

A hoe is one of the simple farm tools used by farmers in carrying out certain specific farm operations

3.2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

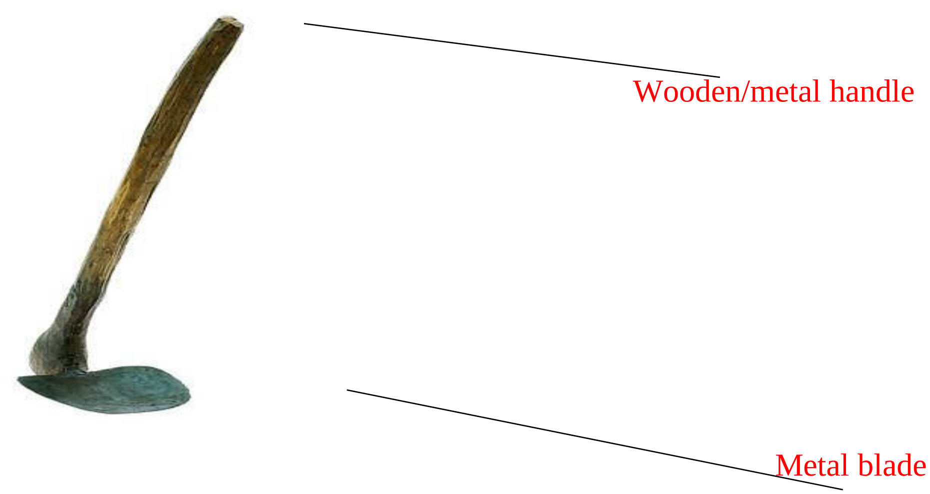
- define a hoe
- draw and label two major parts of a hoe
- use hoe to carry out farm operation
- state the uses of a hoe
- maintain hoe

3.3. Main Content

Meaning of Hoe

A hoe is digging tool with a short broad metal blade and a wooden or metal handle. The metal handle tappers at its end with a tip that is inserted into the hole in the handle.

3.4. Diagram of a hoe



3.5. Uses of a hoe

1. It is used for making mounds and ridges
2. It is also used for weeding
3. It can also be used for digging holes

3.6. Maintenance of a Hoe

1. Clean and dry after use.
2. Sharpen blade when blunt
3. Oil or grease the metal part before storage to prevent rusting
4. Store away from moisture

3.7. Self-Assessment Exercise(s)

Test yourself

1. With a labeled diagram, describe a hoe
2. State the uses of a hoe
3. List four ways of how to maintain a hoe

3.8. Conclusion

A student should be instructed to use a hoe in the field to carry out appropriate farm operation while the teacher assesses the performance..

3. 9. Summary

A hoe is a hand-held tool that has a short broad metal blade and short wooden handle. A. hoe is used for digging hole, weeding and making mounds or ridges It can be maintained by washing, oiling metal parts and keeping it in moisture free environment.

SUB-UNIT 4 HAND TROWEL

4.1. Introduction

A hand trowel is one of the simple farm tools used by farmers in carrying out certain specific farm operations. It is used by farmers that are mostly in developing countries where are agriculture is not yet fully mechanized.

4.2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

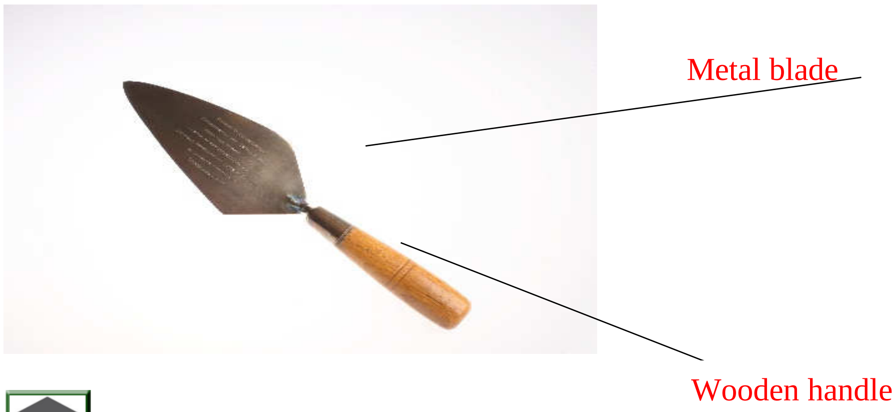
- define a hand trowel
- draw and label two major parts of a hand trowel
- use hand trowel to transplant seedlings from nursery to permanent site
- state the uses of a hand trowel
- maintain hand trowel

4.3. Main Content

4.3.1.Meaning of a hand trowel

A hand trowel is small tool with a short wooden handle and a short metal blade.

4.3. 2. Diagram of a hand trowel



4.3.3. Uses of Hand Trowel

1. A hand trowel is used for transplanting seedlings
2. It is used for digging small holes
3. it is also useful when scrapping soil lump clogged in the metal blade of hoe or cutlass.

4.3.4.Maintenance Hand Trowel

1. Clean and dry after use.
2. Oil or grease the metal part before storage to prevent rusting
3. Store away from moisture

Self-Assessment Exercise(s)

Test yourself

1. *With a labeled diagram, describe a hand trowel*
2. *State the uses of a hand trowel*
3. *How will you maintain a hand trowel*

4. 5. Conclusion

A student should be instructed to use a hand trowel in the field to carry out appropriate farm operation while the teacher assesses the performance..

4. 6.0 Summary

A hand trowel is a hand-held to that has a long metal blade and short wooden handle. A. hand trowel is used for digging hole transplanting seedlings and scraping soil. Itit is maintained by sharpening, washing, oiling metal parts and keeping it in moisture free environment.

4.7. References/Further Readings

Study Stepwise process in using a hand trowel

SUB-UNIT 5 SECATEURS

5.1. Introduction

A secateur is a necessary farm tools that is required by a Gardner/farmer in carrying out horticultural operations. Certain positions are required while using a secateur and the maintenance of appropriate position helps to avoid injury on the farm and the tool during farm operation

5. 2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

- define a secateur
- draw and label two major parts of a secateur
- use secateur to trim flowers
- mention uses of a secateurs
- maintain secateur

5. 3. Main Content

5.3.1 Meaning of A secateurs

A secateurs is a sharp strung scissors-like tool or pruning clippers that has a pair of metal blade and handle with a security lock located between

5.3.2 Diagram of Secatur

5.3.3. Uses of secateurs

1. It is used for cutting young branches of shrubs and tress
2. It is used for cutting large vegetables with thick stalk like pumpkins or fruits such as grape

5.3.4. Maintenance practices for secateurs

1. Clean and dry after use.
2. Sharpen blade when blunt
3. Oil or grease the metal part before storage to prevent rusting
4. Store away from moisture

5 4. Self-Assessment Exercise(s)

Test yourself

1. Draw and label a secateurs
2. State two uses of a secateurs
3. Outline four ways of maintaining a secateurs

5.5. Conclusion

A *secateurs* is a hand-held to that has a pair of metal blade and handle. A. *a secateurs* is used for cutting young branches of shrubs, trees and large vegetables with thick stalk like pumpkins. It is maintained by sharpening, washing, oiling metal parts and keeping it in moisture free environment.

A student should be instructed to use a secateurs in the field to carry out appropriate farm operation while the teacher assesses the performance..

5. 6. Summary

Secateurs is a hand-held tool that is used for trimming hedges and flowers. It is maintained by washing, oiling metal parts and keeping it in moisture free environment.

5. 7. References/Further Readings

Study

1. Importance of *secateurs*
2. Step by step procedure on how to use *secateurs*

SUB-UNIT 6 SHEAR

6.1. Introduction

A shear is a necessary farm tools that is required by a gardners and farmer in carrying out horticultural operations. Certain positions are required while using a shear and the maintenance of appropriate position helps to avoid injury on the farm and the tool during farm operation.

6.2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

1. define a shear
2. draw and label two major parts of a shear
3. use shear to trim flowers
4. mention uses of a shears
5. maintain shear

6.3. Main Content

6.3. Meaning of Shear

A shear is a scissors-like cutting tool that has two blades which moves past each other during operation. It has a pair of metal blade and wooden handle.

6.3.1. Diagram of Shear

6.3.2. Uses of Shear

- It is used for pruning ornamental plants

6.3.3 Maintenance of Shear

1. Clean and dry after use.
2. Sharpen blade when blunt
3. Oil or grease the metal part before storage to prevent rusting
4. Store away from moisture

6. 4. Self-Assessment Exercise(s)

Test yourself

1. Describe a shear
2. What is a shear used for in the farm
3. **Outline four ways of maintaining a shear**

6. 5. Conclusion

A *shear* is a hand-held tool that has a pair of metal blade and handle. It is used for pruning ornamental plants. It is maintained by sharpening, washing, oiling metal parts and keeping it in moisture free environment.

A student should be instructed to use a shear in the field to carry out appropriate farm operation while the teacher observes the performance and makes corrections where necessary.

6. 6. Summary

A shear is a hand-held tool that is used for for pruning ornamental plants. It is maintained by washing, oiling metal parts and keeping it in moisture free environment

6.7. References/Further Readings

Find out other uses of shear

Study and practice the stepwise process of using a shear for pruning plants.

SUB-UNIT 7 GARDEN FORK

7.0 Introduction

A garden fork is a necessary farm tools that is required by a gardeners and farmer in carrying out horticultural and other farm operations. Certain positions are required while using a garden fork. It is necessary to use the for appropriately and carry out maintenance practices effectively to ensure safety of the operator and the tool. Effectivel maintenance also helps the tool to last longer thereby helping the farmer save money..

7.2. Learning Outcomes (LOs)

By the end of the lesson, the students should be able to

1. define a garden fork
2. draw and label two major parts of a garden fork
3. make use of garden fork
4. maintain garden fork

7.3. Main Content

Meaning of Garden Fork

A garden fork is long tool with groove wooden handle and metal blade with four tines/prongs. The blade has a hollow provision for insertion of the wooden handle head where they are fastened with either nails or other fastening devices. The grove in the wooden handle helps the user to hold it firmly during operation.

7.3.1.Diagram of Garden Fork

7.3.2. Uses of Garden Fork

1. It is used for loosening soil
2. Moving or spreading compost manure
3. Moving mulch materials

7.3.3. Maintenance of Garden Fork

1. Clean and dry after use.
2. Oil or grease the metal part before storage to prevent rusting
3. Store away from moisture

7.4. Self-Assessment Exercise(s)

Test yourself

1. *Describe a garden fork*
2. *What are the uses of garden fork*
3. *Mention three ways of maintaining a shear*

7.5.0 Conclusion

A *garden fork* is long tool with groove wooden handle and metal blade that has tines or prongs. The blade has a hollow provision for insertion of the wooden handle head where they are fastened with either nails or other fastening devices. The grove in the wooden handle helps the user to hold it firmly during operation. This tool is used mainly to loosen soil, move or spread compost manure or mulch materials on the farm land. To ensure that this tool last long and perform required operation, it must be effectively maintained by cleaning, drying after use, greasing the metal parts and prongs before storage in a moisture free environment to prevent rusting

7. 6.0 Summary

A student should be guided to use a garden fork in the field to carry out appropriate farm operation while the teacher observes the performance and makes corrections where necessary.

7.7. References/Further Readings

Find out other uses of garden fork

Study and practice the stepwise process of using a garden fork for farm operation. Identify another farm tool that has the same features with garden fork..

SUB-UNIT 8 SPADE

8.1. Introduction

A spade is a necessary farm tools that is required by a gardener and farmer in carrying out horticultural and other farm operations. Certain postures are required while using a spade. It is necessary to hold spade appropriately while using it for farm activities and carry out maintenance practices effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool to last longer thereby helping the farmer save money.

8.2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

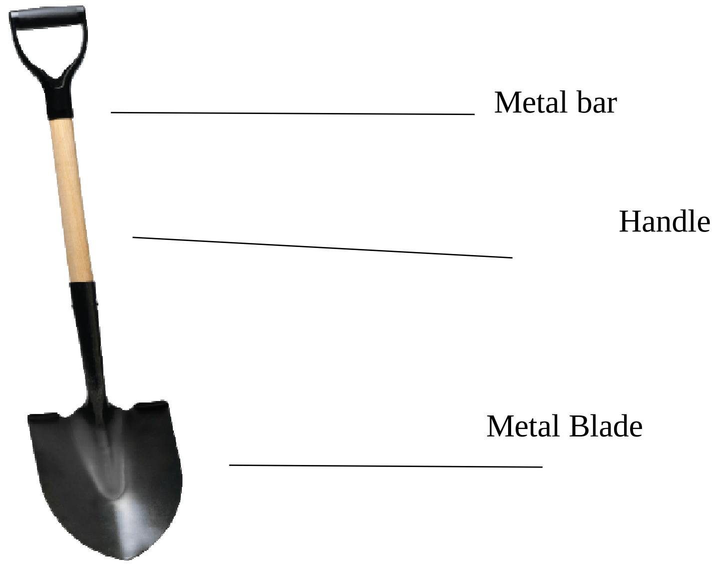
1. define a spade
2. draw and label two major parts of a spade
3. make use of spade in farm operations
4. carry out maintenance practice for spade.

8. 3. Main Content

8.3.1. Meaning of Spade

A spade is a simple farm tool with a rectangular shape short metal blade and long metal handle. The long metal handle at one edge is in the form of Y-shape with a short metal bar that crosses the Y-shape at the top. The cross bar and the Y-shaped edge are fastened together by nails or screw.

8.3.2. Diagram of Spade



8.3,3 Uses of Spade

1. It is used for digging
2. It is used for mixing things such as soil and manure
3. It is used for moving materials such e.g. moving soil into a head pan

8.3,4 Maintenance of Spade

- Clean and dry after use.
- Oil or grease the metal part before storage to prevent rusting
- Store away from moisture

8. 5. Conclusion

A spade is long rectangular Y shaped tool with short metal blade and long metal handle. It also has a cross bar at the Y-shaped edge of the handle which is fastened together by nails or screw. The Y shaped grove in the handle helps the user to hold it firmly during operation. This tool is used mainly for digging, mixing things such as soil and manure and moving materials such as soil or manure into a head pan

To ensure that spade last long and perform required operation, it must be effectively maintained by cleaning, drying after use, greasign the metal parts and prongs before storage in a moisture free environment to prevent rusting

8.6.0 Summary

A student should be guided to identify a spade among other farm tools. The should also be guided in the farm to use a spade to carry out appropriate farm operation while the teacher observes the performance and makes corrections where necessary.

8.7. References/Further Readings

Study and practice the stepwise process of using a spade to carry sand.. Identify another farm tool that has the same features and functions with spade...

SUB-UNIT 9
WATERING CAN

9.1. Introduction

A watering can is a necessary farm tools that is required by a gardeners and farmer in carrying out horticultural and other farm operations to ensure presence of moisture for healthy growth of crops. Certain postures are required while using a watering can. It is necessary to hold a watering can appropriately while using it for farm activities. A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool to last longer thereby helping the farmer save money.

9. 2. Learning Outcomes (LOs)

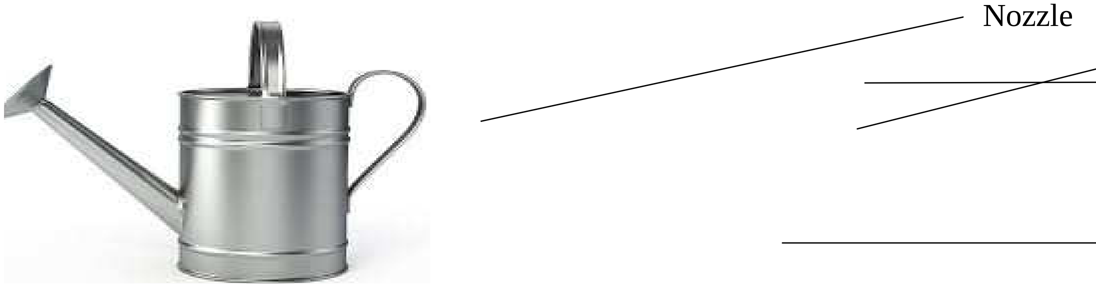
By the end of the lesson, the students should be able to

1. define a watering can
2. draw and label two major parts of a watering can.
3. make use of watering can in farm operations
4. carry out maintenance practice for watering can.
5. State two reasons for maintain watering can

9.3. Main Content : Meaning of Watering Can

A watering can is a receptacle tool made of metal scraps which can be conveniently carried by the operator. It is shaped in form of a bucket with the top half covered while the other half is open. At the front near the bottom of the can is fixed a long metal pipe with a bulb shaped head, perforated at the head. The perforation is called nozzle.

9.3.1 Diagram of Watering Can



9.3.2 Uses of watering can

A watering can is used for:

1. carrying and supplying water to seedling in the nursery, vegetables on beds and flowers in the garden.
2. storing water for domestic and other uses especially in farming household with few containers.

9.3.3. Maintenance of watering can

The maintenance activities needed of a watering can include the following:

1. Use sharp brush to remove mud or dirt in the rose.
2. Paint the can to avoid rusting.
3. Wash the can regularly after use.
4. Always use clean water for watering to prevent blockage of the rose.
5. Store in a cool dry place.

9.4. Self-Assessment Exercise(s)

Test yourself

1. *Draw and label a watering can*
2. *Describe watering can*
3. *State four uses of watering can*
4. *Mention tfive maintenance practices for watering can*

9.3. 5. Conclusion

A watering can is a necessary farm tools that is required by a in farm for providing water or moisture for healthy growth of crops. A farmer is expected to maintain the can effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool to last longer thereby helping the farmer save money

To ensure that watering can last long and perform required operation, it must be effectively maintained by washing, drying after use, greasing and painting and storage in a moisture free environment.

9.6. Summary

A student should be guided to identify a watering can among other farm tools. They should also be guided in the farm to use a watering can to supply water in to crops during dry periods. while the teacher observes the performance and makes corrections where necessary.

9.7. References/Further Readings

Study and practice the stepwise process of using a watering can for irrigation.

SUB-UNIT 10 KNAPSACK SPRAYER

10.1. Introduction

A knapsack sprayer is a necessary farm tools that is required for carrying out certain farm operations like spraying of herbicides or fertilizers to ensure proper and healthy growth of crops. Certain postures and competencies are required while using a knapsack sprayer. An operator of this tool requires certain outfits to protect the body from the content being sprayed. A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool to last longer thereby helping the farmer save money.

10.2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

1. Describe knapsack sprayer
2. draw and label two major parts of a knapsack sprayer.
3. make use of knapsack sprayer in farm operations
4. carry out maintenance practice for knapsack sprayer.
5. State two outfits to wear to protect the body when suing knapsack sprayer

10. 3. Main Content

10.3.1 Meaning of Knapsack Sprayer

Knapsack sprayer is a carrying tool made of tank or reservoiur, pump, and handle among others. The tank houses or holds/stores the liquid which flows through the nozzle as pressure is applied to the pump. Ithe spayer disperses liquid through a hand-held nozzle that is attached to the presurised tank . the tank is usally mounted on the operator’s back

10.3.2 Diagram of Knapsack Sprayer

10.3.3 Uses of Knapsack Sprayer

- It is used for applying herbicides
- It is used for applying pesticides
- It is also used in the application of liquid fertilizer

10. 3.4 Maintenance of Knapsack Spayer

- Empty the tank of any liquid after use
- Wash with clean water after use
- Replace damaged parts as soon as possible

10.4. Self-Assessment Exercise(s)

1. *With a well labeled diagram, describe a knapsack sprayer*
2. *What are the uses of garden knapsack sprayer*
3. *Mention three ways of maintaining a knapsack sprayer*

10. 5. Conclusion

Knapsack sprayer is a necessary farm tools that is required in the farm for sparying liquid fertilizers and herbicides to ensure growth of crops. A farmer is expected to maintain and protect self while using the spryer effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool to last longer thereby helping the farmer save money

To ensure that knapsack sprayer last long and perform required operation, it must be effectively maintained by washing, drying after use, and storage in a moisture free environment.

10. 6. Summary

They should be guided in the farm to use a knapsack sprayer to apply chemical or inorganic manure in liquid form to crops while the teacher observes the performance and makes corrections where necessary.

10.7. References/Further Readings

Study and practice the stepwise process of using a skapsack sprayer

Find out necessary apparels to wear when spraying chemicals on the farm..

Unit 2 FARM MACHINERY

1.1. Introduction

In most parts of the developing countries of the world, most farm operations are carried out by the use of simple farm tools. These tools make operations very tedious and uninteresting; thus forcing youth or young people out of agriculture. This means that the use of simple farm tools makes agriculture activities scary for youths. Most farming families making use of simple farm tools pray that their children do not suffer in the course of crop or animal production. Youth also seeing their parents using simple farm tools in all the agricultural activities seek for none existing white-collar jobs resulting to increase in unemployment in most developing countries.

In the history of Agriculture, man has been striving to improve quality of products by exploring better and more efficient ways of raising crops and animals to satisfy industrial demands of the ever increasing human population. The man's efforts resulted to the use farm machines in agricultural production, processing and marketing. Farm machinery is an enhance technology for use in the farm operation which has the following advantages

1. Reduces and fatigue associated with farming
2. Quickens farm operation and improves timeliness of operation
3. Increase in yield as a result of large hectare of land
4. Increase in farmer's income and so richer with enhance standard of living
5. Better quality products
6. Saves labour by replacing human labour and releasing them for other services.

Despite these advantages there are some disadvantages associated with the use of farm machines which are:

1. Farm machines are very expensive beyong the reach of most farmers.

2. The consistent use of farm machines leads to soil compaction/destroy soil texture
3. Increase unemployment due to less or redundancy of farm labour
4. Farm machine if not properly handle, could be very hazardous or risky to the operator.
5. It causes environmental degradation such as soil erosion, pollution among others.

The following units were discussed in module B
SUB-Unit 1: **TRACTOR**
SUB-Unit 2: **BULLDOZER**
SUB-Unit 3: **PLOUGH**
SUB-Unit 4: **HARROW**
SUB-Unit 5: **MAIZE SHELLER**
SUB-**Unit 6 BURDIZZO**

SUB-**UNIT 1 TRACTOR**

1.1 Introduction

A tractor is a very machine that forms the energizer of other farm implements. It is used pulling and pushing other implements like plough, harrow, cultivator, rigder among others.

1. 2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

1. define a tractor.
2. draw a tractor and indicate the point of attachment.
3. State the used of tractor.
4. Outline maintenance measures for tractor

1. **3.** Main Content

3.1 Parts of a Tractor

1.3.1 Uses

Tractor is used for the following farm operations

1. It can be used for ploughing, harrowing, mowing, harvesting and planting depending on the attachment mounted on the tractor.
2. It can be used as a means of transporting agricultural inputs, produce and workers.

1.3.2 **Maintenance of Tractor**

The following are maintenance operations for tractor

1. Check the tire pressure before use
2. Fill the tank with fuel before use
3. Check the oil level daily and change the oil regularly

4. Take the tractor to a professional for servicing regularly
5. Check battery before use
6. Clean regularly

Self-Assessment Exercise(s)

1. *Mention five ways of maintaining a tractor]*
2. *Name four implements that can be attached to a tractor*

1.4. Conclusion

Tractor is an important farm machine as it is used in manipulating other farm implements to carry out farm operations with ease. It has to be utilized based on specifications, the maintenance practices has to be appropriately carried to ensure that it lasts longer...

1. 5. Summary

They should be guided on how to couple an implement to a tractor.

1.6. References/Further Readings

Study and practice the stepwise process of coupling a tractor.

SUB-UNIT 2 BULLDOZER

2.1. Introduction

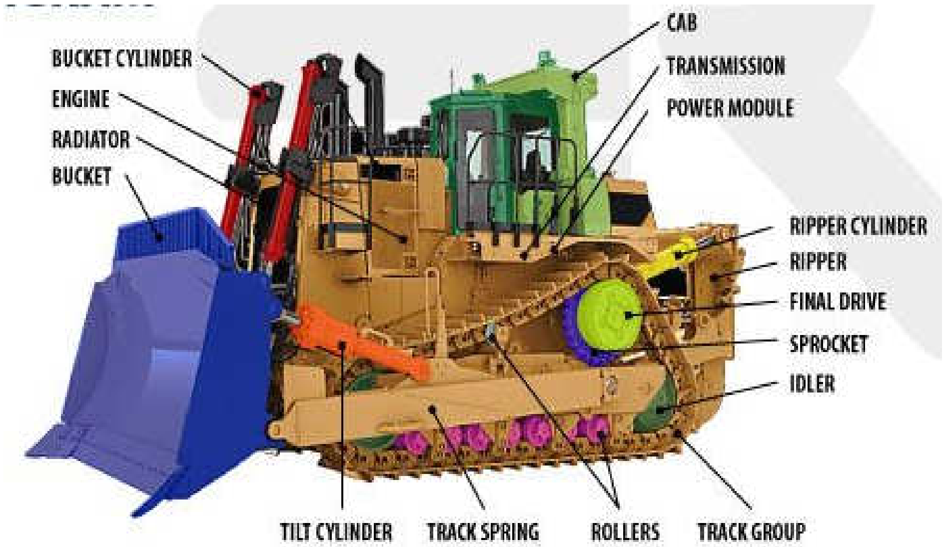
A bulldozer is a heavy farm machine rarely used in farm. It is usually used in virgin lands or where buildings are to be erected or land need to be leveled

2.2 Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

1. define a tractor.
2. draw a tractor and indicate the point of attachment.
3. State the used of tractor.
4. Outline maintenance measures for tractor

2.3. Main Content



2.3.1 Uses

- It is used for excavating the soil
- It is used for pulling down trees
- It is used for removing heavy obstacles

2.3.2. Maintenance

- Check the tire pressure before use
- Fill the tank with fuel before use
- Check the oil level daily and change the oil regularly
- Take the tractor to a professional for servicing regularly
- Check battery before use
- Clean regularly

2.4.Self-Assessment Exercise(s)

1. *Where is a bulldozer mostly needed.*
2. *Mention five ways of maintaining a bulldozer*
3. *Name four implements that can be attached to a bulldozer*

2.5. Conclusion

Bulldozer is important in farm operations. It must be maintained as indicated to help it last longer

2. 6. Summary

A bulldozer is a heavy farm machine rarely used in farm. It is usually used in virgin lands or where buildings are to be erected or land that needs to be leveled. It is mainly used in building roads and clearing heavy virgitation.

2.7. References/Further Readings

1. Identify importance of bulldozer
2. How to draw a bulldozer
3. Parts of a bulldozer

SUB-**UNIT 3 PLOUGH**

3.1

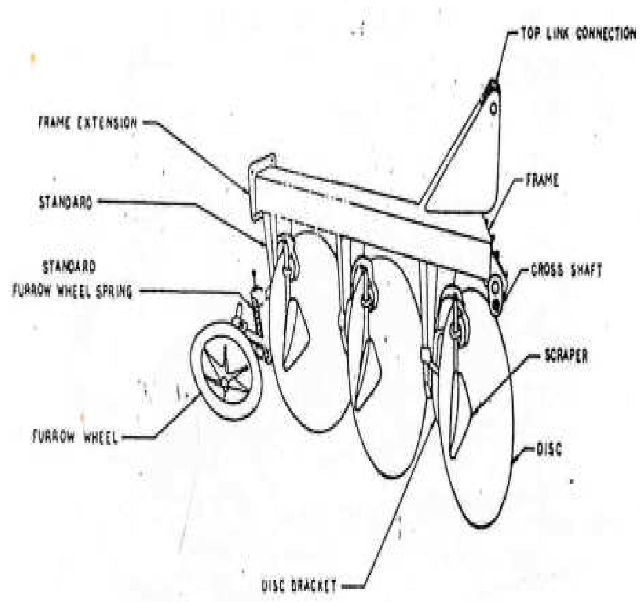
3. 2. Intended Learning Outcomes (ILOs)

By the end of the lesson, the students should be able to

1. define a plough
2. draw a plough
3. identify parts of a plough
4. carry out maintenance practices for a plough.
5. State two uses of a plough

3.3.1 Main Content

Plough is a farm implement used for primary tillage operation in the farm with aim of providing a conducive environment for optimum plant growth.



3.3.2 Uses of Plough

1. Breaking up hard-dry and sticky soil into large lumps
2. Burying legume crop and as manure.

3. Turning soil to bury weeds.

3.3.3. Maintenance

The following maintenance activities are required of a disc plough:

1. Clean after use.
2. Replace worn-out bolts and nuts.
3. Tighten loosed bolts and nuts properly.
4. Grease especially all threaded parts used for adjustment.
5. Straighten a tear or bend disc.
6. Paint the frames.
7. Oil the disc and joints when not in use.
8. Store in a cool and dry place after use.

Self-Assessment Exercise(s)

1. *What are the uses of plough*
2. *How do you maintain a plough*

3.4. Conclusion

plough is important in farm operations. It is used for primary tillage and must be maintained as indicated to help it last longer

3. 5. Summary

A plough is a farm implement used in the farm when coupled with the tractor to carry out primary tillage of breaking the soil into large lumps.

3.6.0 References/Further Readings

Types of plough, their differences and suitable areas to use each.

SUB-**UNIT 4 HARROW**

4.1. Introduction

A harrow is an implement coupled to a tractor ro carry out secondary tillage.

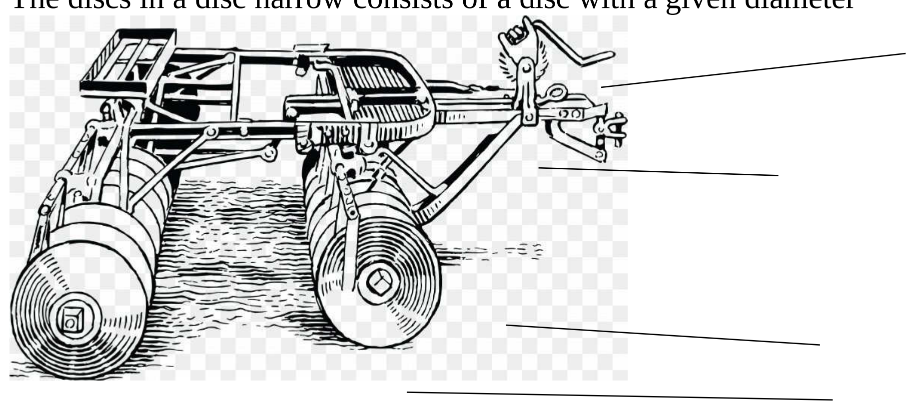
4.2. Learning Outcomes (LOs)

By the end of the lesson, the students should be able to

1. define a harrow
2. draw a harrow
3. identify parts of a harrow
4. carry out maintenance practices for a harrow.
5. State two uses of a harrow

4.3.0 Main Content

Harrow is an implement coupled to a tractor to carry out secondary tillage operation. There are two types of tractor but disc harrw is mostly used in the tropics due to the presence of stumps and stones. The discs in a disc harrow consists of a disc with a given diameter



4. 3.1 **Uses**

- It is used for breaking down soil clods
- It is also used for covering seeds after they have been broadcasted

4.3.1 **Maintenance**

1. Paint the frame and outer surface to prevent rusting.
2. Regularly apply grease to the bearings
3. Replace worn-out bearings
4. Tighten loose nuts and bolts

4. 4. Self-Assessment Exercise(s)

1. *With a well labeled diagram, describe a harrow*
2. *What are the uses of harrow*
3. *Mention three ways of maintaining a harrow*

4.5 Conclusion

Harrow is an implement coupled to a tractor to carry out secondary tillage operation. There are two types of tractor but disc harrow is mostly used in the tropics due to the presence of stumps and stones.

4.6. Summary

Harrow is an implement coupled to a tractor to carry out secondary tillage operation. There are two types of tractor but disc harrow is mostly used in the tropics due to the presence of stumps and stones

4.7. References/Further Readings

Differences between two types of harrow

SUB-**UNIT 5 MAIZE SHELLER**

5.1. Introduction

Shells or cobs of certain grain crops like maize have to be pre-processed to make them suitable for eating. Sheller is used in removing the shells of these crops..

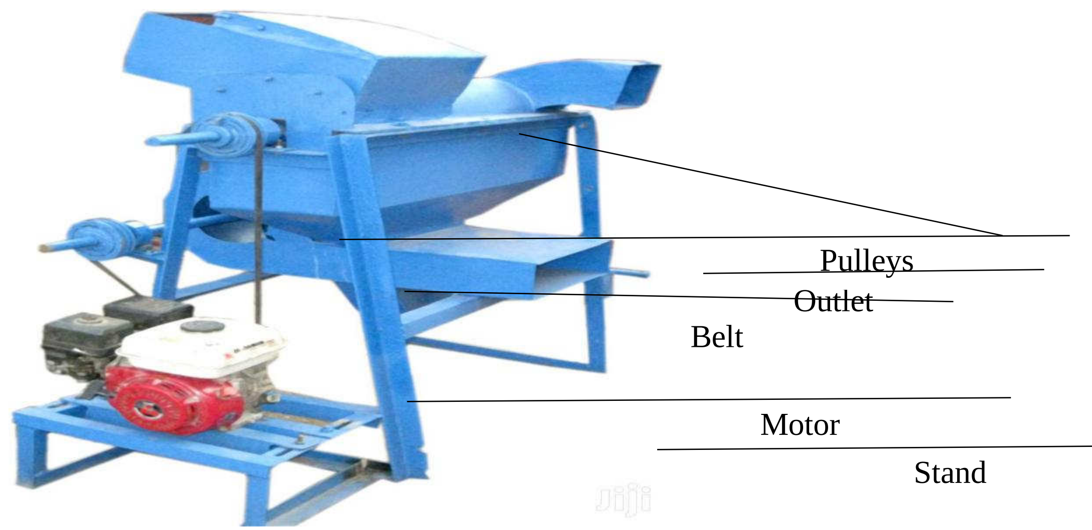
5.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the students should be able to

1. Draw a simple Sheller
2. Name two other crops that can be shelled
3. Name uses of a Sheller
4. state ways of maintaining a Sheller.

5. 3.0 Main Content

A maize sheller is a cutting-edge tool that helps thresh maize. It is a new type of machine designed for shelling maize resulting to faster maize processing.



5. 3.1 **Uses**

- It is used for separating maize from the cobs. That is shelling of maize.

5. 3.2 Maintenance

1. Paint the outer surface to prevent rusting.
2. Regularly apply grease to the bearings
3. Replace worn-out bearings
4. Tighten loose nuts and bolts
5. Fill the tank with fuel before use
6. Check the oil level daily and change the oil regularly
7. Clean regularly after use

5.4. Self-Assessment Exercise(s)

1. Name three farm produce that require a Sheller for processing
2. How would you maintain a Sheller to avoid accumulation of dirt

5.5. Conclusion

A Sheller is machine used in removing the shells of these crops..like maize.

5.6. Summary

A maize sheller is a cutting-edge tool that helps remove maize from the cob.

5.7. References/Further Readings

Find out other crops that can be shelled with the sheller

SUB-UNIT 6
BURDIZZO

6.1. Introduction

A burdizzor is a castrating instrument which achieves a humane castration of livestock by severing the testicular cord without injury to the scrotum.

6.2. Intended Learning Outcomes (ILOs)

By the end of this chapter, the students should be able to

1. define burdizzo
2. use burdizzo to castrate a ruminant animal
3. state how to maintain a burdizzo

6. 3.0 Main Content

6.3.1. Sub-Section

A burdizzor is a castrating instrument which achieves a humane castration of livestock by severing the testicular cord without injury to the scrotum. It is used in castrating ruminant animals like goat. The aim of castration is to mke the animal dosile or fatten the animal for higher income.

6.3.2 **How to carry out bloodless castration:**

1. Restrain the calf of about 4-10weeks old to be castrated down in preferred position .
2. Feel the scrotum with hand to identify the two rope-like testicular cords inside
3. Hold the scrotum in one hand, work the spermatic cord within the scrotal sac to the side of the scrotum
4. Clean the skin arouns the scrotum and disinfect
5. Clamp the instrument for castration (Burdizzo) about 1 inch above the testicle.
6. Take the Burdizzo in the right hand and using the left hand push the cord to the side between the jaws of the Burdizzo and squeeze hard.
7. take the Burdizzo in the left hand and crush the other cord
8. Hold the instrument for about 3-5 seconds.
9. Repeat the same procedure for the other cord ensuring that the instrument is clamped about one inch below the first point.

6. 3.3 **Uses**

- It is used for castrating livestock like goat, cattle and others

6.3.3 Maintenance of a burdizzor

1. Wash and dry after use
2. Disinfect before use
3. Store in a cool dry place

6.4. Self-Assessment Exercise(s)

1. *State major use of a burdizzor*
2. *What are the maintenance practices for a burdizor*

6.5. Conclusion

Burdizzor is a necessary farm tools in animal section that is required by farmers for castrating ruminants for healthy growth and fattening. A farmer is expected to maintain the tool effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool to last longer thereby helping the farmer save money

To ensure that burdizzo last long and perform required operation, it must be effectively maintained by washing, drying after use, greasing and storage in a moisture free environment in its packet.

6.6 Summary

A student should be guided to identify a burdizzo among other similar farm tools. They should also be guided in the farm to use a burdizzo while the teacher observes the performance and makes corrections where necessary.

6.7. References/Further Readings

Study Burdizzo critically

UNIT 3: FARM SURVEYING AND PLANNING OF FARMSTEAD

1.1. Module Introduction

Farm survey is the process by which measurements of land are made on the farm. It is also the process of measuring and mapping out of the position, height, size and boundaries of farmland. These measurements are presented in the form of tables, plans or layouts for specific purposes

Importance of farm surveying and planning

- It helps the farmer to know the area of the farmland
- Farm survey helps in producing a farm map
- Farm survey is important in the registration of farmland and the issuance of certificate of occupancy (C of O)
- Farm survey plan can be used as collateral for loans
- Farm surveying reveals the gradient of the farmland
- It helps the farmer to properly locate the positions of the intended farm buildings and structures
- It helps the farmer to determine the amount of seed/planting materials, fertilizers and other agrochemicals to be used in the farm.
- It also helps to determine the boundaries of the farmland.

This UNIT has ten Sub-unit which were the following

Sub-UNIT 1
RANGING POLE

1.1 Introduction

A ranging pole is a necessary farm tools that is required in farm surveying. The operation requires unique postures while using the tool. It is necessary to hold the tool appropriately while using it for farm activities. A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and the tool.

1.2. Learning Outcomes (LOs)

By the end of this chapter, the students should be able to

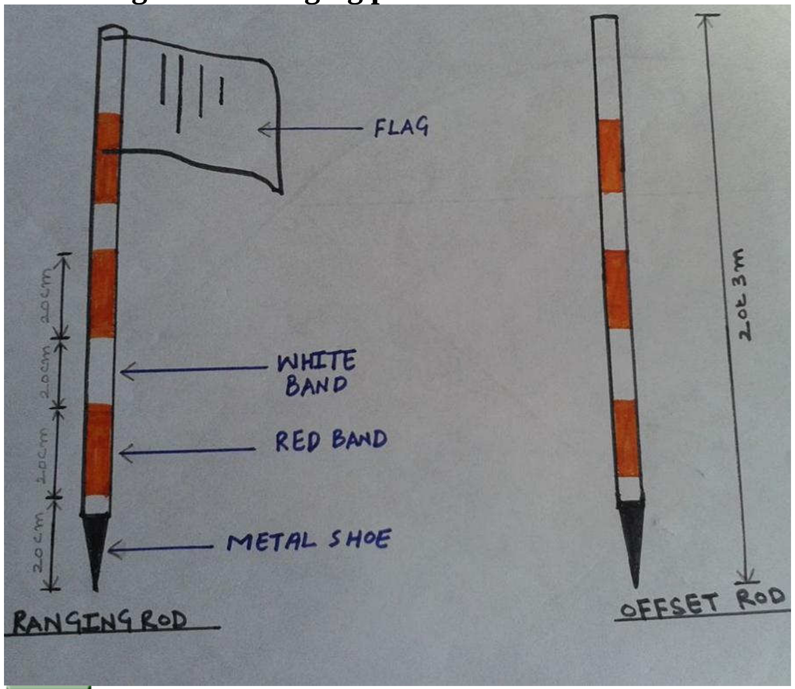
1. draw an label a ranging pole
2. state how to use a ranging pole
3. indicate how to maintain a ranging pole

1. 3.0 Main Content

Meaning of Ranging Pole

A ranging pole is made of wood, steel or bamboo material of 2m to 3m long with steel point at the bottom (if made of wood or bamboo) and is painted alternatively black and white or red and white.

1.3.1. Diagram of Ranging pole



1. 3.2. **Uses Ranging Pole**

- It is used for marking areas
- It is also used to set out straight lines
- Ranging poles are used to mark points which must be seen from a distance

1. 3.3. **Maintenance Practices for Ranging Pole**

- Clean after use
- Store in a cool dry place

1.4. Self-Assessment Exercise(s)

1. What the steps in using ranging pole
2. What is the measurement value of ranging pole

1.5. Conclusion

Ranging pole is an important tool in surveying. The pole hs different colours.

1.7. References/Further Readings

How can a farmer use ranging pole.

Sub-**UNIT 2**

ARROWS OR PINS

2.1 Introduction

Arrows and Pins are necessary farm tools that is required when surveying farmland/stead. Certain postures and competencies are required while surveying and it is only competent user that can manipulate them effectively A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and these tools. Effective maintenance also helps the tool to last longer thereby helping the farmer save money.

2.2. Intended Learning Outcomes (ILOs)

By the end of this chapter, the students should be able to

1. Describe arrow or pins
2. draw arrows and pins noting the major difference between them
3. State uses of arrows or pins
4. Outline reasons for maintain arrows and pins

1.3.0 Main Content

1.3.1.Meaning of arrow

An arrow or pin is a stout wire pointed at one end for penetrating into the ground, and with a loop at the other end. An arrow is usually 30cm to 40cm long or more.

1.3.2. Diagram of Arrows

1. 3.2 **Uses of Arrows and Pins**

- They are used to mark the end of the chain length
- They are also used to mark points during surveying or building farmhouses

1. 3.3 **Maintenance**

- Clean after use
- Store in a cool dry place

1. 4. Self-Assessment Exercise(s)

1. *Draw an arrow used in farm surveying*
2. *Describe farm surveying arrows or pin*
3. *What are the uses off survey pins*
4. *Outlines two ways of maintain arrows*

1. 5. Conclusion

Arrows are is important tool in surveying.

1.6. References/Further Readings

How does a surveyor utilize Arrows?.

Sub-**UNIT 3**
GUNTER'S CHAIN

3.1. Introduction

Gunter's Chain is a very necessary farm tools that is required when surveying farmland/stead. Certain postures and competencies are required while surveying and it is only a competent user that can manipulate the tool effectively A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and these tools. Effective maintenance also helps the tool to last longer thereby helping the farmer save money.

3.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the students should be able to

1. define a chain used in surveying
2. State the uses and how to maintain a Günter's chain

3.3. Main Content

3.3.1 Meaning of Gunter's Chain

Gunter's chain is a dumb-bell in shaped steel wires links. The links of Gunter's chain are normally joined together by three metal rings. The handle at each end is made of brass. It is 20.12 meters long and is divided into 100 links, and each link is 0.2012m Iong.

3.3.2. Günter's chain

3.3.2 Uses of Chains

1. Chains are used to achieve the following operations:
2. Measuring horizontal distance especially in swampy areas.
3. Determining straight line(s) of a farm.

3.3 .3 Maintenance

The following maintenance activities should be given to chains:

1. Remove soil that may clod on the links during use.
2. Rub oil lightly on the links to avoid wearing as the rings move on each other.
3. Wash and dry after use.
4. Fold up the links and bind properly before storing.

5. Apply oil if it is to be stored for a long period and store in a dry and airy place.

3. 4. Self-Assessment Exercise(s)

1. *Define Gunter's chain*
2. *What is the length of a Gunter's chain?*
3. *How many links has a standard Gunter's chain?*
4. *What is the measure of each link?*
5. *Mention two uses of Gunter's chain*
6. *Outline five ways of maintaining a Gunter's chain*
7. What are the stepwise process in use Günter's chain in determining the size of a farmland.

3.5. Conclusion

Gunter's Chain is an important tool in surveying. The pole hs different colours.

3.6. References/Further Readings

Steps on how to use gunter's chain in determining the size of a farmland.

Sub-**UNIT 4**
MEASURING TAPES

4.1. Introduction

Measuring Tape is a very necessary farm tools that is required when surveying or measuring the size of a farmland/stead. Certain postures and competencies are required while using tape rule and it is only a competent user that can manipulate the tool effectively for accurate measurement A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and tape rule. Effective maintenance also helps the rate rule or measuring tape to last longer thereby helping the farmer spend les in purchasing new ones.

4.2. Learning Outcomes (LOs)

By the end of this unit, the students are expected to define tape

1. State uses of tape
2. Outline ways of maintain tape rule
3. Make use of tape rule in taking measurement

4.3. Main Content

4.3.1 Meaning of a Tape

Tapes are graduated in centimeters and meters. They are commonly available in lengths of 5, 10, 15, 25, 30, 50 and 100 meters. Metallic cloth and steel tapes are commonly in available in agriculture. Metallic cloth tape is enclosed in a circular leather case with a screw roller for winding it up after use while steel tape is made of flat ribbons enclosed in a circular leather box

4.3.2 Picture of measuring Tapes

Metallic cloth tape
Steel tape

4.3.2. Uses

- It is used for measuring distances
- It is also used in determining straight angles

4. 3,3 Maintenance

- When wet, the tape should be dried before winding back into its case
- Roll back the tape into the case when not in use
- Wind back smoothly or gently into casing after use.
- Oil the roller brass handle if it stiffen.

4.4. Self-Assessment Exercise(s)

1. *What can tape be used for?*
2. *How can a farmer ensure that his measuring tappe last longer?*

Sub-**UNIT 5**
CROSS STAFF

5.1. Introduction

Cross Staff is one of surveying tools required when surveying or measuring a farmland/stead. Certain postures and competencies are required while using Cross Staff and it is only a competent user that can manipulate Cross Staff effectively for accurate measurement A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and Cross Staff. Effective maintenance also helps the Cross Staff to last longer thereby helping the farmer spend less in purchasing new ones.

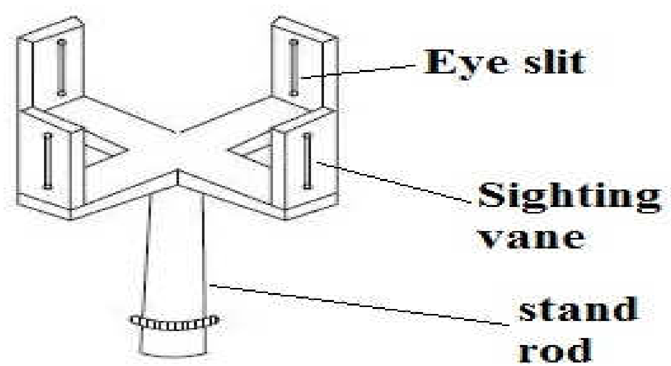
5. 2. Learning Outcomes (LOs)

1. State uses of cross staff
2. Outline ways of maintain cross staff

5.3.0 Main Content

5.3.1 Meaning of Cross Staff

A cross staff consists of a head, leg and four metal arms with vertical slits for sighting through



Cross Staff

5.3.2 Uses of cross staff:

Cross staff is used for

1. Setting out a right angle at a given point on a base line.
2. Determining the foot of a perpendicular from a given point to a given baseline.
3. Setting long offsets to important objects.

5. 3.3 Maintenance

The following maintenance activities should be carried out on cross staff:

1. Clean properly after use.
2. Oil the metal part to avoid rusting.
3. Keep away from fire and termite.
4. Store in cool and dry place.

5.4. Self-Assessment Exercise(s)

1. state uses of a cross staff

2. what are the maintenance measures of a cross staff

5.5 Conclusion

Cross Staff is a necessary farm surveying tool required by farmers for accurate determination of farm details. It has to be used and maintained based on specifications

5.6. Summary

A student should be guided to identify cross staff among other similar farm tools. They should also be guided in the farm to use a cross staff while the teacher observes the performance and makes corrections where necessary.

Sub-**UNIT 6**
PRISMATIC COMPASS

6.1 Introduction

Prismatic compass is a very necessary farm tools that is required when surveying or measuring the size of a farmland/stead. Certain postures and competencies are required while using prismatic compass and it is only a competent user that can manipulate the tool effectively for accurate measurement A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool last longer

6.2. Learning Outcomes (LOs)

By the end of this unit, the students are expected to define tape

1. describe Prismatic compass
2. State uses of Prismatic compass
3. Outline ways of maintaining Prismatic compass
4. Make use of Prismatic compass in taking farm measurement

6.3 Main Content

6.3.1 Meaning of Prismatic

Prismatic compass is a surveying equipment that has a glass top case of diameter approximately equal to 115 mm fixed on tripod. It is an important tool for surveying and requires expertise in its manipulation to help obtain accurate measures.

6.3.2: picture of a Prismatic Compass

6.3.3: Uses of Prismatic Compass

- It is used for taking bearings
- It is used for measuring angular distance

6.3.4. Maintenance

- It should be stored in a dry place after use
- Clean with a soft duster after use.
- Apply machine oil on the hinges and tripod.
- Keep away from the reach of children.

6. 4.0 Self-Assessment Exercise(s)

Test yourself

1. Define a prismatic compass
2. What are the uses of a prismatic compass
3. Advice a farmer on how to maintain a prismatic compass

6. 5. Conclusion

Prismatic compass is a necessary farm surveying tool required by farmers for accurate measurement. It can only be used by experts and need to be used and maintained based on specifications.

6.6. Summary

A student should be guided to identify prismatic compass among other surveying equipment or instrument for determining size of farm

6.7. References/Further Readings

Practice the use of Prismatic compass study precautionary measures in using the tool for effectiveness

Sub-UNIT 7
THEODOLITE

7.1. Introduction

Theodolite is a basic surveying instrument that is required when surveying or measuring the size of a farmland/stead. Certain postures and competencies are required while using Theodolite and it is only a competent user that can make use of this tool effectively for accurate measurement A surveyor is expected to carry out maintenance practices effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool last longer thereby saving the farmer from unnecessary expenditure.

7.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the students are expected to define tape

1. describe Theodolite
2. State uses of Theodolite
3. Outline ways of maintaining Theodolite
4. Make use of Theodolite in taking farm measurement

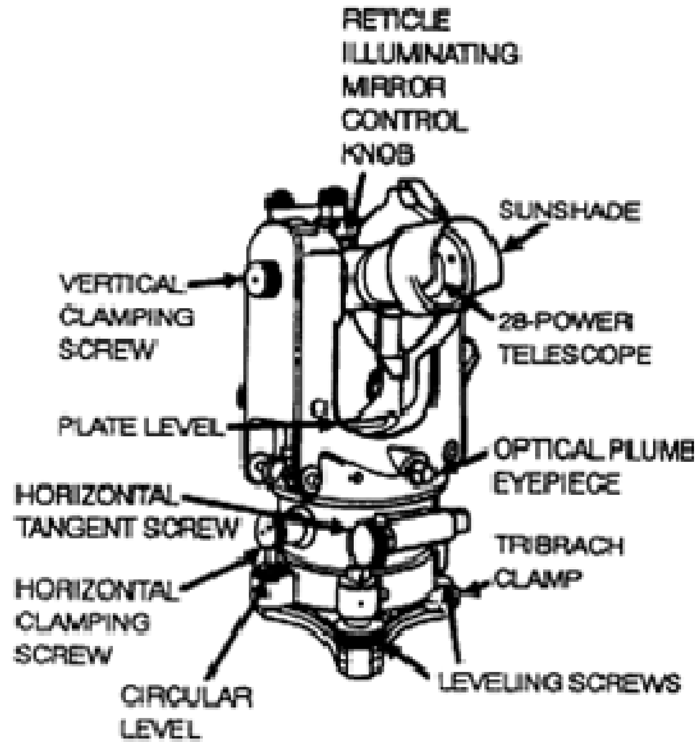
7.3. Main Content

7.3.1 Meaning of Theodolite

A theodolite is a basic survey ing equipment used in taking horinzontal and vertical lines during surveying. It consists of a telescope, horizontal and vertical plates, levels, screws erecting eye-piece. The telescope is usually mounted and can rotated to directed positions when taking measurement on horizontal or vertical planes.

7.3.2 Picture of a Theodolite


V 875911
H 1681707
POWER



7.3.3 Uses of Theodolite

- It is used for measuring horizontal and vertical angles
- It is also used for locating points on a line

7.3.4 **Maintenance of Theodolite**

- It is should be cleaned and stored in a dry place
- The metallic stands should be oiled before storing to prevent rusting

7.4. Self-Assessment Exercise(s)

Test yourself

1. *Draw and label a theodoloite*
2. *What are the uses of a theodolite*
3. *In what ways can you maintain a theodolite*

7. 5. Conclusion

Theodolite is a necessary farm surveying tool required by farmers for accurate determination of farm horizontal and vertical measurement. It can only be used by experts and need has to be used and maintained based on specifications.

7. 6. Summary

A student should be guided to identify theodolite among other surveying equipment the instrument for determining horizontal or vertical planes

7.7. References/Further Readings

Practice the use of Theodolite and study precautionary measures in using the tool for effectiveness

Sub-UNIT 8

PEGS AND BEACON

8.1. Introduction

Pegs and Beacons are basic surveying instrument required when surveying or measuring the size of a farmland/stead. Certain postures and competencies are required while using pegs and Beacons to indicate boundaries of farmlands. A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool last longer thereby saving the farmer from unnecessary expenditure.

8.2. Learning Outcomes (LOs)

By the end of this unit, the students are expected to define tape

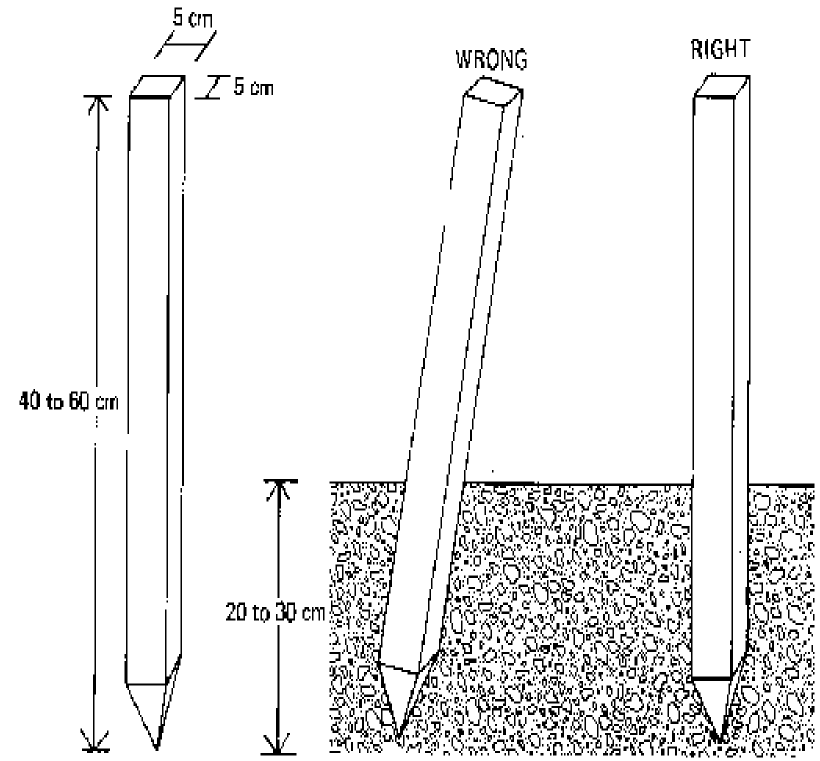
1. describe Pegs and Beacons
2. State uses of Pegs and Beacons
3. Outline ways of maintaining Pegs and Beacons
4. Describe stepwise process in using Pegs and Beacons

8.3. Main Content

8.3.1 Meaning of Pegs and Beacons

Pegs are short stick or rod used in fastening things together. It is usally driven on the ground to mark the boundary of a farmland. Beacons refer to survey tool positioned at determined boundary of a farmland. The objective of using beacon is to serve as a magor interface links between plan and the land area that represented in the survey plan.. the beacon can be made of stone, concret or other natural features that helps in indicating boundaries in individual farmer’s lanf. In some case a signal light may be attached to the beacon to give a sign of warning of danger. Either pegs or beacons can be used for the same purpose..

8.3.2 Picture of Pegs



8.3.3 Picture of Beacon or pillar

8.3.4 Uses of Pegs and Beacons

1. Both Pegs and |Beacons are used for marking points on a land during measurements
2. Beacons are used for indicating boundaries
3. Beacons are also used for identifying measured or surveyed areas.

8.3.5 Maintenance of Pegs and Beacons

- Pegs or beacons should be cleaned after use
- Each should be used appropriately
- Pegs and Becaons should be stores in a dry place when not ready for use

8. 4. Self-Assessment Exercise(s)

5.0 Conclusion

Pegs and Bacons are very important in farm surveying. They can be used effectively by experts and they need to be used and maintained based on specifications.

8.5. Summary

A student should be guided to identify pegs and beacons among other surveying equipment the instrument.

8.6. References/Further Readings

Practice the use of pegs and Beacons. Also study precautionary measures taken while using

a) Pegs

b) Beacons

Sub-**UNIT 9**
SPIRIT LEVEL

9.1. Introduction

Spirit Level is one of the basic surveying instrument required for surveying or measuring the size of a farmland/stead. Certain postures and competencies are required while using pegs and Beacons to indicate boundaries of farmlands. A farmer is expected to carry out maintenance practices effectively to ensure safety of the user and the tool. Effective maintenance also helps the tool last longer thereby saving the farmer from unnecessary expenditure.

9.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the students are expected to define tape

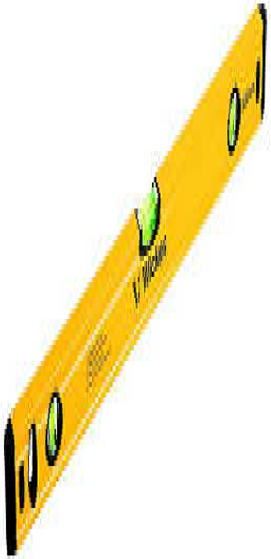
1. describe Spirit Level
2. State uses of Spirit Level
3. Outline ways of maintaining Spirit Level
4. Describe stepwise process in using Spirit Level

9.3. Main Content

9.3.1 Meaning of Spirit Level

A Spirit Level is surveying equipment deliberate designed to show the horizontal or vertical areas of a farmland. It can also be described as a tool used for determining the parallel nature of a farmland.

9.3.2 Picture of a |Spirit Level



9. 3.3. Uses of Spirit Level

- It is used for measuring the height of distant points in relation to a bench mark

9.3.4 Maintenance of Spirit Level

- It is should be cleaned and stored in a dry place
- The metallic stands should be oiled before storing to prevent rusting

9.3 **5.0 Conclusion**

Spirit level is very important in farm surveying. Its effective use depends on the level of expertise of the user. The tool must be effectively used and maintained based on specifications.

9.6. Summary

A student should be guided to identify a spirit level and practice its use forr surveying.

9.7. References/Further Readings

Watch a video on how to use Spirit leve in U-Tube

Sub-**UNIT 10**
PLANNING OF FARMSTEAD

10.1. Introduction

A Farmstead refers to all the different types of buildings and structures that are found in the farm. Examples of farmstead include greenhouses, cribs, barns, shed, pens and farm dwellings among others. Many activities in the farm are carried out in the farmstead, hence the need for farmstead planning.

Farmstead planning is a drawing or diagrammatic representation or arrangements for the layout of the farm buildings, structures and various enterprises. The farmstead must be planned by considering certain factors.

10.2. Learning Outcomes (LOs)

By the end of this unit, the students are expected to define tape

1. describe a farmstead
2. State reasons for planning a farnstead
3. Outline factors to consider when planning a farmstead

10.3. Main Content Planning of farmstead by adopting 3-4-5 Method of Farm Surveying

10. 3.1 Factors considered in planning a farmstead

- Topography: farm buildings should be sited on elevation to create room for good drainage
- Market: the nearness of the market where the produce will be sold should be considered in farmstead planning. This makes the transportation and other

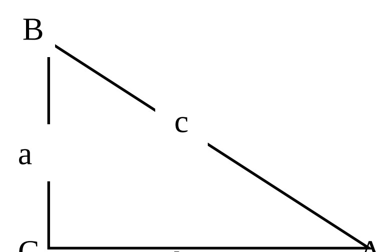
logistics needed to convey the produce to the market easier

- Water source: agricultural activities require water either as drinking source for livestock, irrigation, processing or for cleaning purposes. Water should be readily available for use in the farm.
- Soil type: the soil around farmstead should be well drained to avoid problems associated with water-logging while the fertile soils should be utilized in crop cultivation and the less fertile ones used for pasture.
- Accessibility: the farm should be easily accessible to enable easy movement of inputs and outputs.
- Drainage: in planning a farmstead, it should be ensured that the farm is well drained to avoid flooding.
- Manure management: in farmstead planning involving livestock production, considerations should be made on how to effectively manage the manure produced from the farm without causing environmental problems or breaking prevailing laws.
- Expansion: considerations for future expansions of the farmstead should also be considered while planning.

It is necessary to survey a farmstead to know the size and determine areas where each build and structures are to be located. The common method adopted in farm surveying is the 3 4 5 method

10.3.2 Meaning of 3-4-5 Method in Farm Surveying

This is a method of mapping out a right angle triangle in the farmland using the Pythagoras theorem



$a^2 + b^2 = c^2$

10.3.3. How to Use THE 3-4-5 METHOD

1. Attach two ropes of lengths 3m and 4m respectively to a ranging pole erected at the centre of the farmland.
2. Stretch the ropes and set one of them as a baseline.
3. Extend the two free ends of the ropes, while maintaining one as a baseline, until the distance between them is 5m.
4. Mark out the two arms, any of which can be extended to a desired length through sighting.

To extend the line **CA** to point **X** by sighting, another ranging pole is erected on point **A** and, a third one is held around point **X**. Somebody then stands behind the pole on point **C**, closes one of his eyes and sights the pole on point **A.** He then directs the person holding the third pole to move behind the pole on point **A** until he can no longer see the pole on points **A** and **X** while still holding one eye closed**.** The third pole is then erected on this point**.** This indicates that points **C**, **A** and**X**are on the same straight line. You would not be able to see the poles on points A and X because pole **C** is perfectly covering pole **A** and pole **A** is perfectly covering pole **X.** Arm CB can also be extended this way. A square or rectangular layout can therefore be construct day this way.

10.4. Self-Assessment Exercise(s)

Test yourself

1. *Outline surveying tools and equipment you know*
2. *Draw a ranging pole*
3. *Explain how you can survey a land making use of necessary tools and equipments.*

10. 6.0 Summary

A student should be guided to iexplain the 345 method of planning a farmstead.

10.7.0 References/Further Readings

Watch a video on how to plan a farmstead adopting 345 method in U-Tube

UNIT 4: MANAGEMENT OF FARM ANIMALS

Module Introduction

Farm animals refer to a group of living things that are taken care of by man. Some of these animals depend on grasses while others prey on others in order to survive. In the world, different kinds of animals are found both in the temperate and tropical climates.

Some animals live on land examples cattle, goat, sheep, donkey, camel, cat, dogs among others; while others live in water such as fish, crab, prawn, crocodile and hipopothamus. Land animals may be wild (lives in the forest) or domesticated (kept in residential houses of man). The domesticated animals are generally called livestock. Examples include cattle, goat, pig poutry, rabbit. The livestock are divided into Ruminants and Non Ruminants.
Classification of Farm

SUB-UNIT 1:
MILKING AN ANIMAL

1.1. Introduction

Milk of animals is only associated with cattle production especially the dairy type. The diary sector requires much carefulness to care for the cow and the calf. When cow is raised specifically for milk production special care is taken to ensure that the animals are feed adequately on complete production ration. Furthermore the calf, is fed artificially after taking the 4-5 days colostrums to help it develop strong immunity.

1.2. Learning Outcomes (LOs)

By the end of this unit, the students should be able to

1. *Define milking*
2. *Discuss the steps in milking a cow*
3. *state precautionary measures to take while milking a cow*

1.3. Main Content

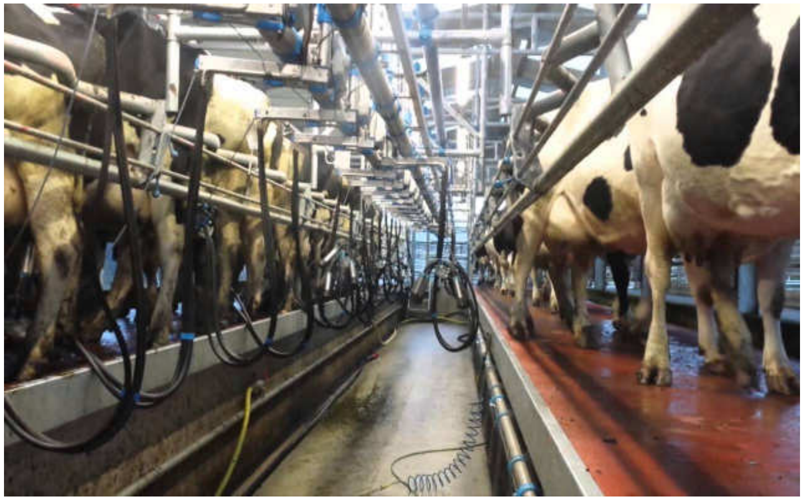
1.3.1 Meaning of milking

Milking is the process by which milk is collected from a lactating animal. This involves the removal of milk from the alveolar cells to the gland and teat cisterns and then let out through the teat duct. Milking can be done manually by hand or automatically by the use of milking machine.

1.3.2 Process of milking

Milking involves the following processes:

1. **Moving cow to the milking parlor or stall.**
   The cow to be milked should be moved calmly to the milking parlor. Forcing a cow into the parlor may scare or upset it leading to the production of adrenalin which in turn inhibits milk let down.



Milking palour

2. **Inspect the cow.**
   The cow should be inspected for signs of sickness. This includes inspecting the udder and teats for signs of discoloration and swelling or any other sign of illness. Any cow that is sick should not be milked.

3. **Disinfect the teats.**
   Each teat of the udder should be disinfected using approved disinfectants such as iodine solution. The disinfectants should be left on the teats for a few minutes before wiping out with clean towels and subsequent milking.

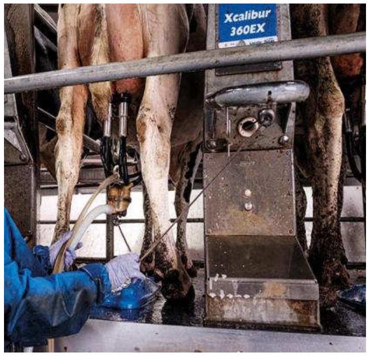
4. **Feed cow with concentrates at the point of milking**
   The concentrate feed is very palatable, the cow enjoys it. During milking the cow is fed with concentrate to help reduce restlessness or enhance milk let down s a result of keeping the cow happy.

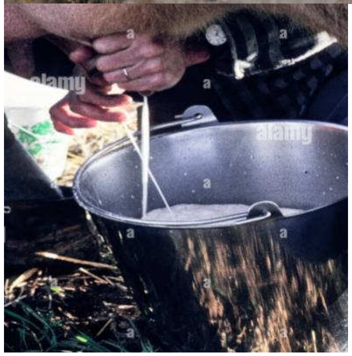
Cow feeding on concentrates while milking

5. Forestrip.
   This is the process of collecting the first two or three streams of milk in a different container for inspection. This enables the farmer to inspect the milk for clots, flakes, blood or any other abnormality which are some signs of mastitis. In case of signs of mastitis, the cow is un-milked and treated with appropriate drugs before reuming minlking. Testing the milk during forestrip also helps to arouse the udder to stimulates production of oxytocin which is a hormone that triggers milk let down.

6. Milking the cows.
   If there is no abnormality in the milk collected during forestripping, gently milk the cows using milking machine or by hand. If milking is to be done by hand, gently grab a single teat with the thumb and pointed finger at the top of the teat (near the base of the udder) and slowly work the milk down

the teat canal. Repeat the process for the other teats until all the milk is collected.





7. End of milking. Once all the milk are collected, the teats should be disinfected again using an approved disinfectant. Then store milk appropriately to avoid spoilage; as microorganisms build up in milk easily.

Disinfecting the teat of a cow with iodine after milking

1. 4.0 Self-Assessment Exercise(s)

1. *Define milking*
2. *What are the steps in milking a cow*
3. *What are the precautionary measures to take while milking a cow*

1. 5.0 Summary

Milking of cows is an important activity that are carried out every day on the lactating animals. When regularly carried out it enances the quality and quantity of milk produced especially if the cow is adequately fed with complete diet. It is necessary that cows are made happy during milking to reduce annoyance and enhance milk let dowm. Steps in milking should be strictly adhered to to ensure success. .

1.6. References/Further Readings

a. Classification of livestock
b. Difference between ruminants and non-ruminants with reference to the structures and functions of the stomach
c. Precautionary measuring to take while milking a cow
d. Watch video on milking of a cow.

SUB-UNIT 2

LIVESTOCK MANAGEMENT SYSTEMS

2.1. Introduction

Livestock Management

Livestock management system refers to the general methods adopted by farmers in livestock production. The management system employed by a farmer is generally dependent on the extent of involvement of the farmer in providing the animals with conducive housing and feed.

2.2. Learning Outcomes (LOs)

By the end of this unit, the students should be able to

1. Define thextensive system of livestock management
2. List the three types of livestock management
3. Choose the best management system adopted by commercial poultry farmer in your locality and gadduce reaon for such choice

2. 3.0 Main Content

2.3.1 **Systems of Livestock Management**

There are three major systems of Livestock management which are:

a) Extensive system
b) Semi-intensive system
c) Intensive system

2.3.2. Extensive system

In extensive of livestock management, the farmer allows the animal to roam around the environment in search for food. The farmer contributes little or nothing towards what the animals consumes. This system is mostly practiced by subsistent farmers and leads to the livestock having slow growth rate and takes long time to attain market. However, this system is less expensive in terms of cost of production. Nomadic herding of livestock and free rang poultry production are examples of extensive system.

2.3.3 Semi-intensive system

The semi-intensive system is the intermediate of extensive and intensive systems. In this system, the livestock are housed, provided with some feed and also given access to graze within a confined location during the day. This system ensures the welfare of the livestock through natural grazing while also encouraging fast growth by through the provision of formulated feed.

2.3.4 Intensive

In this system, livestock are continuously kept in confinement while all their nutritional needs are met by the farmer through the feed they are provided. Example of is method is the battery cage method of poultry production. This is the most expensive system of livestock production but guarantees fast growth rate and the attainment of market weight at the fastest possible time when compared with the other systems.

3. 4.0 Self-Assessment Exercise(s)

Test Yourself

4. *Define farm animals*
5. *What is livestock*
6. *List four groups of livestock*

3. 5. Summary

There are three major systems of livestock management which extensive, semi-intensive and intensive. The choice of any of the three depends of the choice of the farmer and subsequently on the scale of production and capital outlay. Each had advantages and disadvantages.

3.6. References/Further Readings

Ruminants and Non-ruminants
Advantages and disadvantages of each of the livestock management systems

SUB-UNIT 3

PROCESS OF EGG PRODUCTION

3.1. Introduction

Egg is produced by poultry bird. Egg is formed through certain process that is discussed in this unit

3.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the students should be able to

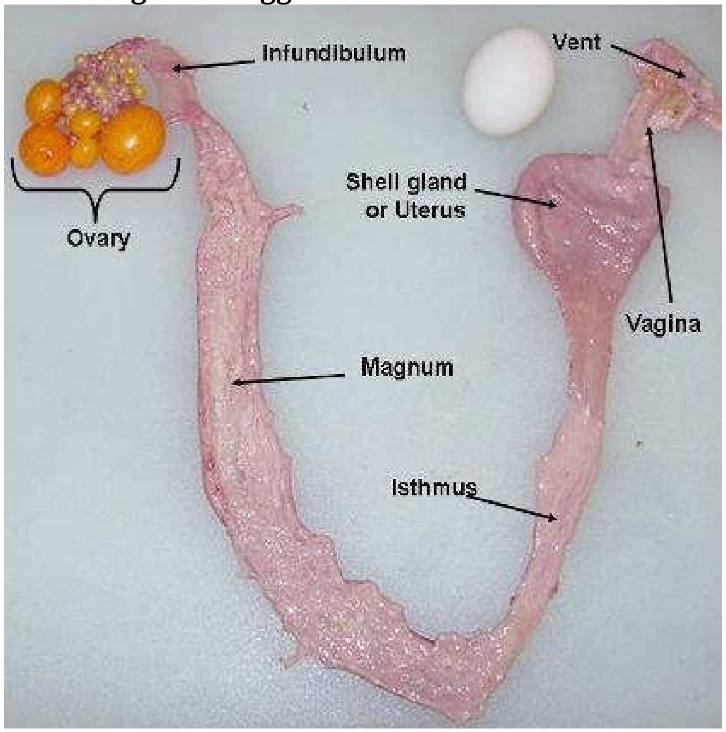
1. Identify animals that lay egg
2. Draw egg formationprocess

3.3.0 Main Content

3.3.1 Egg

Egg is laid by female animals like birds. Egg is formed in the reproductive tract of a hen and weighs about 44g. The reproductive tract of a hen is composed of different components which contribute to the final form of a mature egg. The reproductive tract of a hen can be divided into two main parts which are the ovary and the oviduct.

3.3.2 Diagram of egg Formation Process



3.3.3. Process of egg formation

The process of egg formation begins at the ovary. The ovary is where the yolk of the egg is contained. It usually contains many yolks at the same time. The yolk is known as ovum or ova (plural). When the yolk matures, the sac holding it ruptures and it is received by the infundibulum.

Fertilization takes place in the infundibulum if there is sperm. The yolk spends about 15 minutes in the infundibulum. The yolk then proceeds to the magnum where the albumen is added. The egg spends about 3 hours at the magnum from where it proceeds to the isthmus.

In the isthmus, the shell membranes, mineral salts and water are added. The outer and inner shell membranes are added. The eggs spends about one hour in the isthmus from where it moves to the uterus (shell gland). The egg shell and pigment are added in the uterus. The egg spends the longest time at the uterus. The egg spends about 21 hours in the uterus. After the egg shells has been formed and ready to be laid, the egg is released through the vagina. This takes about 1 minute to complete.

3. 4. Self-Assessment Exercise(s)

1. *Visit a poultry farm operating an extensive system of management,*
2. *list the tools and equipment being used under extensive farming system.*
3. *List major stages of*
   - *a. egg formation*
   - *b. Ovulation*
   - *c. Fertilization*

b. Formation and depositing of albumen

c. Formation and depositing of shell membranes

d. Formation and depositing of shell

e. *Oviposition*

4. *draw the reproductive system of a hen and indicate the stages of egg formation*

5. *How long does it take an egg to be formed and released?*

SUB-UNIT 4
CANDLING

4.2. Learning Outcomes (ILOs)

By the end of this unit, the students should be able to

1. Define candling
2. *Identify materials needed for construction of a candler*
3. *Construct a candling box*
4. *Using a candling box, determine if an egg is fertilized*.
5. Identify a ferlile egg
6. Differentiate between fertile and infertile egg after candling

4.3.0 Main Content

4.3.1 Meaning of Egg Candling

Candling is a method of studying the growth and development taking place inside an egg. This is done using light. Candling is done by placing an egg in from of a penetrating light in a dark room. This enables the person performing the candling to identify defects and abnormalities such as double yolk, and blood spots among others.

3.2 How to Build a Candler

a. Make six square cuts of plywood of equal dimensions (20cm)

b. Drill a hole big enough for a cable to pass through in one.

c. Fix a lamp holder with a bulb to the plywood.

d. Take a second plywood and cut a round hole in it slightly less than the size of an egg.

e. Fix the six cuts together to form a box.

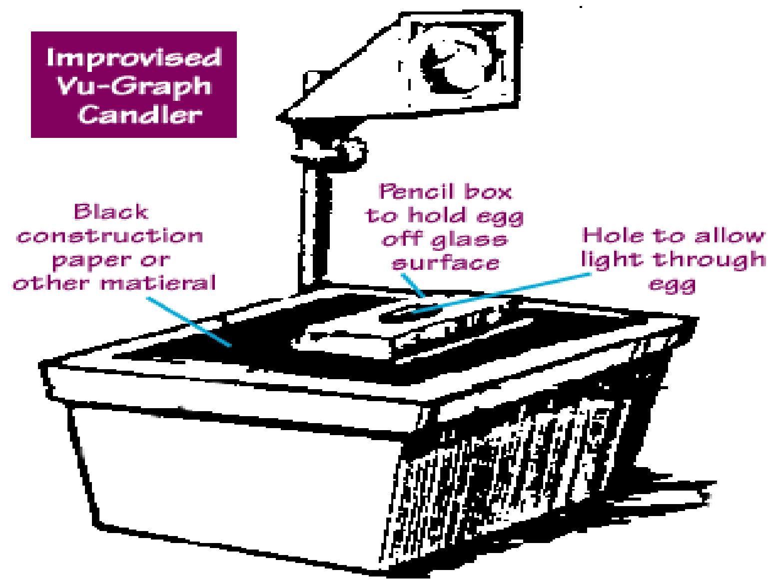
f. Link the cable to a source of power.

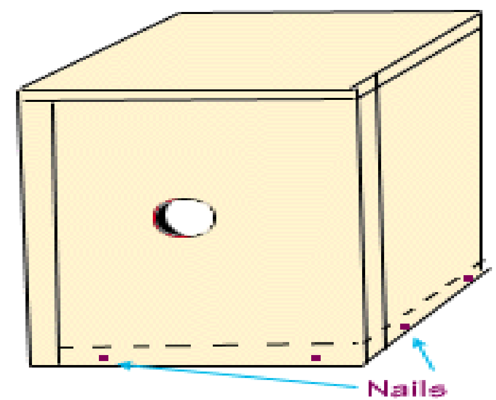
g. Place a freshly laid egg on the round hole in the candler in a dark room and put on the light in the Candler.

h. If the egg is clear (translucent), it is not fertilized and will serve as table egg not to hatching.

i. If it shows a dark spot, it is most likely fertilized and should be put in an incubator.

4.3.2 Pictures of different types of candlers


Improvised Vu-Graph Candler
Black construction paper or other matieral
Pencil box to hold egg off glass surface
Hole to allow light through egg


Nails

4. 4. Self-Assessment Exercise(s)

1. Define candling
2. *Identify materials needed for construction of a candler*
3. *Construct a candling box*
4. *Using a candling box, determine if an egg is fertilized.*
5. Identify a ferlile egg
6. Differentiate between fertile and infertile egg after candling

4.5. References/Further Readings

Difference between fertile and infertile eggs

SUB-**UNIT 5**
INCUBATION

5.1. Introduction

Incubation is keeping eggs warm for proper development of chick from the egg to ensure continuity of generations in birds. This means that when eggs are laid, they are incubated to ensure conduceive environment for the development of chicks

5.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the students should be able to

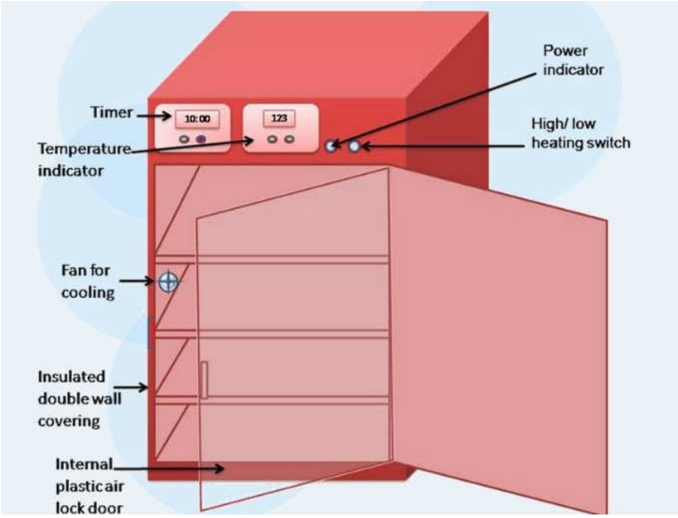
1. Define incubation
2. Draw an incubator
3. Explain precautionary Measures in Incubating Eggs
4. Maintain an Incubator

5.3.0 Main Content

5.3.1 Meaning of incubation

Incubation is the process eggs hatch into young ones after being exposed to certain conditions. Egg incubation starts from the selection of fertile eggs. Eggs that should be incubated are those ones that were laid a few days after the hen was crossed. This is to ensure that the eggs are fertile. Eggs can be stored from between 7°C to 16°C for about 7 days before incubation. The incubator should be cleaned and disinfected prior to the arrival of fertile eggs. The incubator temperature should be kept at about 38°C while the humidity in the first seventeen days before hatching should be between 50 to 55 %. The humidity in the last three days should be about 70%.

5. 3.2 Picture of an Incubator



5.3.3 Precautionary Measures in Incubating Eggs

1. Eggs should be placed in the incubator with the larger end pointing up while the narrow end should be facing down.
2. The eggs should be turned from time to time to prevent them from sticking to the shell.
3. The eggs should be candled after 10 days to find out how the chick is developing. If visible signs of blood vessels are seen, that shows that the embryo is alive but any contrary observation should be of concern.
4. Check hatching as from 21 days loading the eggs in the incubator. This is because, fertile chicks will hatch after 21 days of incubation.

5. 3.4 Maintenance of Incubator

1. Change incubator water at least every two weeks. It is necessary to change the water by emptying, washing and

adding fresh, sterilized and distilled water. Do not just refill the water.

2. Check the incubator every week to detect and discard un-used cultures
3. Clean the incubator each month through the following steps
   a) Remove all loose shells or any dry matter in the incubator
   b) Clean egg tray and water pans. It is advisable to soak them in warm water with mild disinfectant occasionally.
   c) Clean the bottom of the incubator
   d) Clean the heating elements and other electrical units
   e) Every plastic in the incubator should be wiped with cloth/glass cleaner.

5.4. Self-Assessment Exercise(s)

1. **Define incubation**
2. **Draw an incubator**
3. **What are precautionary Measures in Incubating Eggs**
4. **Maintain an Incubator**

5.5. Conclusion

Incubator is a necessary machine and the essence of it is to provide warmth

5.6. Summary

The unit discussed the meaning of incubator. It also highlighted the

1. **Drawing of an incubator**
2. **What are precautionary Measures in Incubating Eggs**
3. **Maintenance of Incubator**

5.7. References/Further Readings

Incubation process

UNIT 5: FISH FARMING

Introduction to the module

Fish is an aquatic animal which is demanded by many individual in the worl. It has good taste and supplies protein in addition to different vitamins and mineral. Many indivuals are interested in fish farming due to associated benefits. Fish farming covers the benefits or importantce, construction and management of artificial enclosure in addition the use of appropriate tools and equipments. This module covers the following units

SUB-UNIT 1: **MEANING AND IMPORTANCE OF FISH**
SUB-UNIT 2: **CONSTRUCTION OF A FISH POND**
SUB-UNIT 3: **FISHING TOOLS AND EQUIPMENT**
SUB-UNIT 4: **METHODS OF FISHING AND PRESERVATION OF FISH**

SUB-**UNIT 1**
MEANING AND IMPORTANCE OF FISH

1.1 Introduction

Fish is an aquatic animal that is in need worldwide due to its excellent, nutritious flesh. It has features that make it adaptable in water. Its product is important to man. Before now, fish was only made available from natural water bodies until recently. Man in his quest to increase its availability has modified the environment for enhanced production. Students are then drilled on fish production process to enable hem engage in its production.

1.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the studnts should be able to

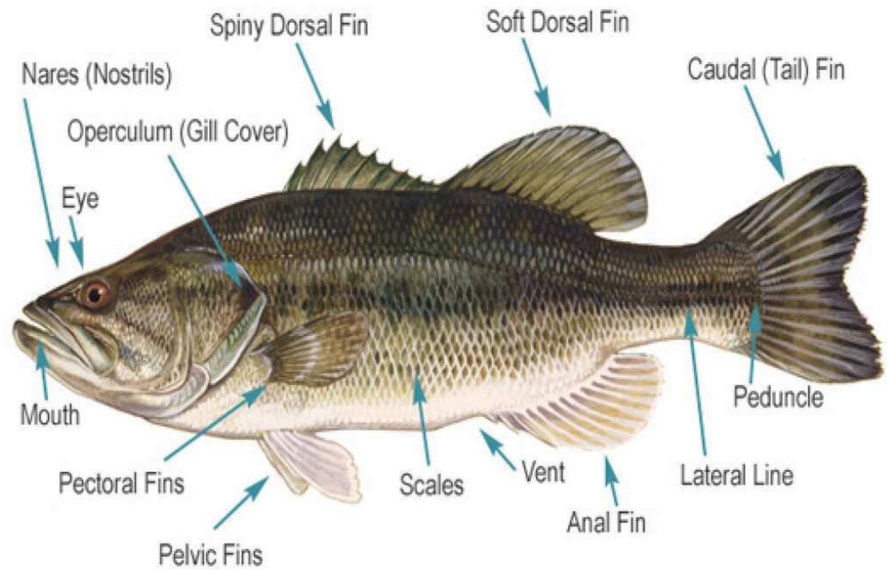
1. Explain the meaning of Fish
2. State the importance of Fish
3. Draw and label a fish
4. Define fish farming
5. State reasons for a farmer to engage in fish farming

1.3.0 Main Content

1. 3.1 Meaning of Fish

Fish is a cold-blooded aquatic organism. Most fishes have scales on the body, gills for respiration, fins/tails for movement. Fish is one of the poikilo-thematic species of cold-blooded aquatic organism with scales in the body, fins for swimming, gills for breathing (respiration) and lateral lines for balancing in water bodies. Generally, fish is defined as a limbless cold-blooded vertebrate aquatic organism with scaly-body, that swims with the help of fins/tails; balances in water with the help of lateral lines and found in natural water bodies or raised in artificial enclosure as fish farming

.1.3.2 Diagram of Fish



1. 3.3. Importance of Fish

The following are some of the importance of fish:

1. **Source of Food**
   As a source of food, fish when consumed provides the body with protein, fat and other nutrients.
2. **Source of Income**
   Fish provides income to many individuals. It is a source of income to fishermen, fish marketers and canoe builders.
3. **As a Source of Employment**
   Economically, the fishery industry is an important employer of labour both for youth and elderly. The industry offers different good job opportunities in the areas of fish capture, breeding, harvesting, marketing and building of equipment and tools needed in fish business/activities.
4. **As a Source of Industrial Raw Material**

Fish serve as raw material to industries. The skin of fish like shark is used in producing shoes, bags and wallets while the skin of cartilaginous fishes can be used for producing leather and polishing materials.

5. **As a Source of Foreign Exchange**
   Frozen fish, point and kill and other fish and its products are most often exported to other countries to earn foreign currencies. These currencies could be used to purchase items not produced in the home country which enhance development.
6. **Aesthetic Value**
   Fish is raised as pet in aquarium for private or public exhibition due its beauty and graceful movement.
7. **Religious Symbol**
   In some places, fish serves as deities and religious symbols. Some people in certain areas worship some species of fish in their locality such as practiced in Hinduism and Buddhism.
8. **Recreation**
   Fish is caught and returned to the water just for fun of it. Many people go for site seeing to observe fish behaviour as they are exhibited in public aquarium.
9. **Educational Purposes**
   Educationally, fish research has become increasingly important study due to decline in fish population and cost of feeding them.

1.3.4 Meaning of Fish Farming

Fish farming is the act of rearing of fish in man-made structures such as ponds, tanks and other enclosures for man's use.

1.3.5. Importance of fish farming

- Fish farming provides food. Fish serves as a good source of protein when consumed.
- Fish farming provides employment to those involved in fish production value chain.
- It provides income to fish farmers.
- Fish farming provides the opportunity to put into productive use lands that are unfit for other agricultural activities.
- Fish farming is a source of foreign exchange.

1. 4. Self-Assessment Exercise(s)

1. Explain the term Fish
2. State the importance of Fish
3. Draw and label a fish
4. Define fish farming
5. State reasons for a farmer to engage in fish farming

1.5. Conclusion

Students are expected to differenctiate importance of fish and fish farming

1. 6. Summary

The unit focused on the meaning of Fish; importance of Fish. Fish features, meaning of fish farming and importance of fish farming

1.7. References/Further Readings

Attributes of fish farming and why a farmer should engage in the activity

SUB-**UNIT 2**
CONSTRUCTION OF A FISH POND

2.1. Introduction

Fish is raised in an enclosure with a body of water. The enclosure is called fish pond. Fish pond is artificially constructed to provide a habitat which resembles natural fish environment. Fish pond is constructed by experts to serve farmers expected purpose of raising fish in artificial water bodies. There are different types of fsih ponds shown in this unit

2.2 Learning Outcomes (LOs)

By the end of this unit, the readers should be able to

1. Define fish pond
2. State features of fish pond
3. Chose appropriate fish pond for raising fingerlings to adult fish
4. Construct a fish pond
5. State ways of maintaining fish pond

2.3.0 Main Content

2. 3.1 Factors to Consider in sitting Fish Farm

The following considerations should be made in the construction of a fish pond;

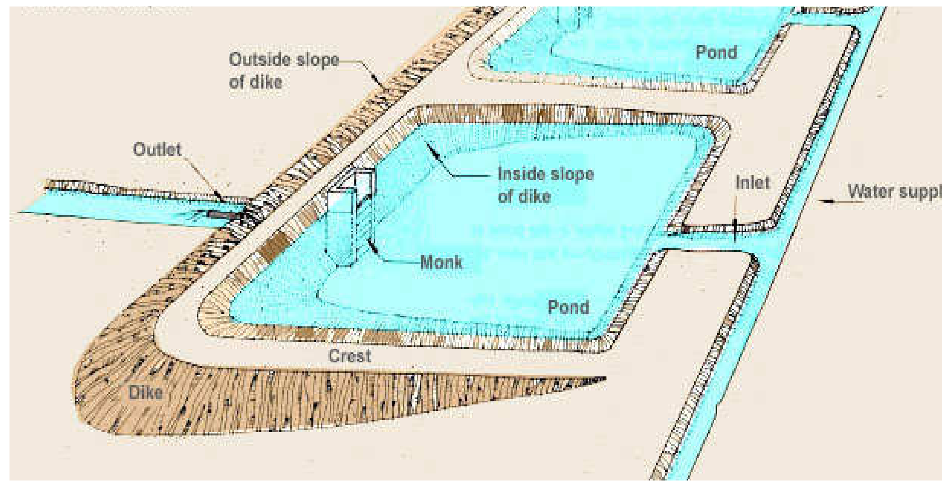
- Soil type: before a pond is constructed, the type of soil should be considered. Any piece of land that will be used for fish farming should have the ability to retain water. Therefore the best soil for fish pond should contain clay.
- Water availability and quality: good quality water source should be readily available in any location that should be used for fish farming.
- Topography of the area: the site for fish farming should be easy to drain when needed while lands that are prone to flooding should be avoided.
- Type of fish to be cultured: the species of fish to be cultured should also be considered. It should be ensured that the fish to be cultured can survive in such a location as well as have good acceptance rate among intended consumers.
- Availability of feed: before a fish pond is constructed the farmer should ensure that the feed the fish will consume is readily available and accessible.

2. 3.2 Meaning of Fish pond

A fish pond is an enclosure with a body of water for rearing any kind of aquatic animal especially fish. Fish pond can be constructed on the ground as mud pond or concrete pond. It can also be built with plastics, galvanized metals among others

2.3.3 diagram of Fish pond with its features

Features or Parts of Fish Pond



2. 3.5 .1 Types of fish Pond

There are different types of fish pond some them are

3.3.5.1 Earthen Pond.

This refers to a type of fish pond constructed on the ground. The pounding of water is on sunken earth made in such a way to accommodate water with minimal leakage. This type of pond is usally constructed in areas with clay soil.

2.3.5.2. Concrete Pond.

Concrete pond is constructed with concrete. Concrete is a mixture of gravel, sand, cement and water. It could also be made with cement blocks and fortified with concrete

2.3.5.3 Tarpaulin Pond.

2.3.5.4. Plastic or Rubber Pond.

2.3.5.5. Fiberglass Tanks.

2.3.5.6. Cage Or Pen Ponds.

2. 3.6. Maintenance of Fish Pond

- Check the water level daily to ensure there is sufficient water for the fish
- Check the screens every day to make sure that the fish do not swim away
- Keep water weeds under control

- Cut the grass on the banks regularly as this might be a hiding place for some pests
- Repair any water leaks immediately
- Get rid of fish-eating animals such as snake, rats, birds, etc.
- Keep cattle and other heavy animals away from the banks as the can destroy the pond
- Do not bathe or wash in your ponds.

2.4. Self-Assessment Exercise(s)

1. Define fish pond
2. State features of fish pond
3. Chose appropriate fish pond for raising fingerlings to adult fish
4. Construct a fish pond
5. State ways of maintaining fish pond

2.5. Conclusion

For effective fish farming in artificial water bosy, the pond must be constructed by an expert who is familiar with features of fish pond especially the basic ones like inlet, outlet, spillway and deepest part of the pond. Furthermore the farmer must be an expert to rear fish in the chosen pond, the farmer must be able to maintain the pond for higher fish yield

2. 6. Summary

Pond is an enclosure constructed to hold water for rearing fish artificially. There are different types of pond and can be noted based on the material used for the construction. A farmer is not experted to construct the pond him/herself as there are experts specialized in any type of fish pond construct. These expert provides ready made ponds in open markets for sale.

2.7. References/Further Readings

Read features of each type of fish pond

SUB-UNIT 3
FISHING TOOLS AND EQUIPMENT

3.1. Introduction

Fish is raised in an enclosure with a body of water. There are different types fishing tools that can be used for rearing or harvesting of fish either from natural or artificial water bodies. These fishing tools and equipment are discussed in this unit

3.2. Intended Learning Outcomes (ILOs)

By the end of this unit, the readers should be able to

1. Define fishing tools
2. Define fishing equipment
3. Describe each tool or equipment
4. State what each tool or equipment is used for in fish rearing
5. State ways of maintaining fishing tools and equipment pond

3.3.0 Main Content

3.3.1 Meaning of Fishing tools and Equipment

These are instrument and hand held tools that are needed for success in fish capture, harvesting or cropping. Some of these tools and equipment are:

1. Pumping machine: this is used for filling with water or draining the pond water

2. Aerator: this is used to improve the quantity of dissolved oxygen in the pond by mechanically moving the water.

3. Seine reels: this is a type of large net that is used for harvesting fish

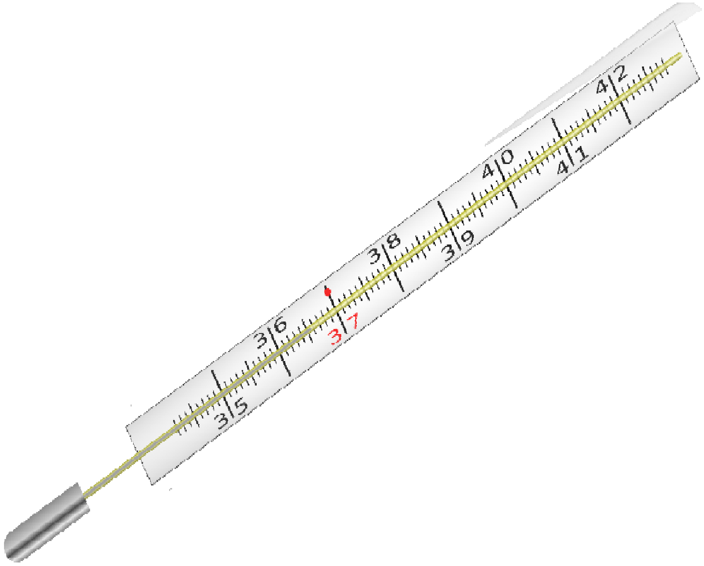
4. Dip net: this is used for catching single or small amount of fish at a time.

5. Weighing scale: this is used for weighing fish to find out how well they are growing.

6. Fish pond fountain: it is also used for aerating the pond

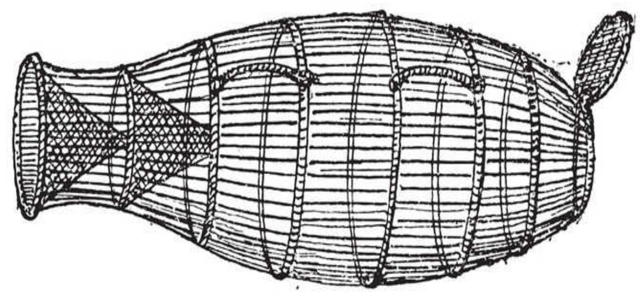
7. Automatic fish feeding machine: used for providing feed for fish instead of using hand

8. Thermometer: it is used for measuring the temperature of the water



9. Hook: this is used for catching fish with the help of bait

10. Fishing trap: used for catching fish



SUB-UNIT 4

METHODS OF FISHING

4.1. Introduction

Fish is raised in an enclosure with a body of water. These fish are harvested when they mature. The maturity of fish can take 7 -9 months although some farmers that use growth hormone produce big fish in less than four months. There are different methods of harvesting fish from the pond some of these methods were discussed in this unit. Furthermore, harvested fish need to be preserved to ensure good quality fish for sale. This unit also discussed some preservation methods t

4.2. Learning Outcomes (LOs)

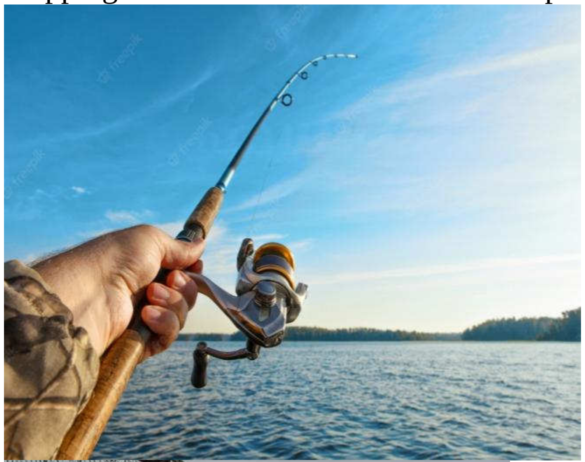
It is expected that at the end of this unit, students should be able to

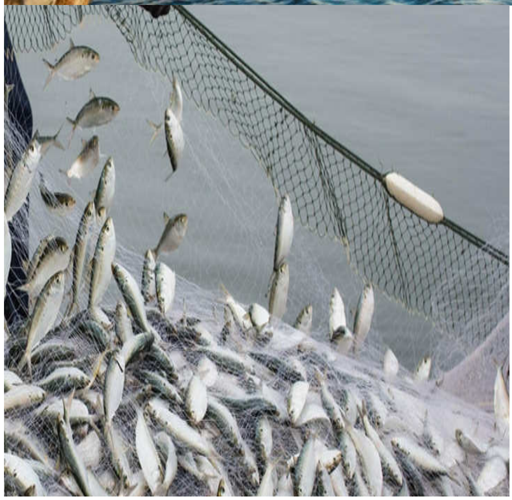
1. Define Fishing
2. Explain methods of cropping matured fish
3. Define Preservation
4. Discuss fish preservation methods

4.3.0.Main contents of the unit

4.3.1. meaning of Fishing

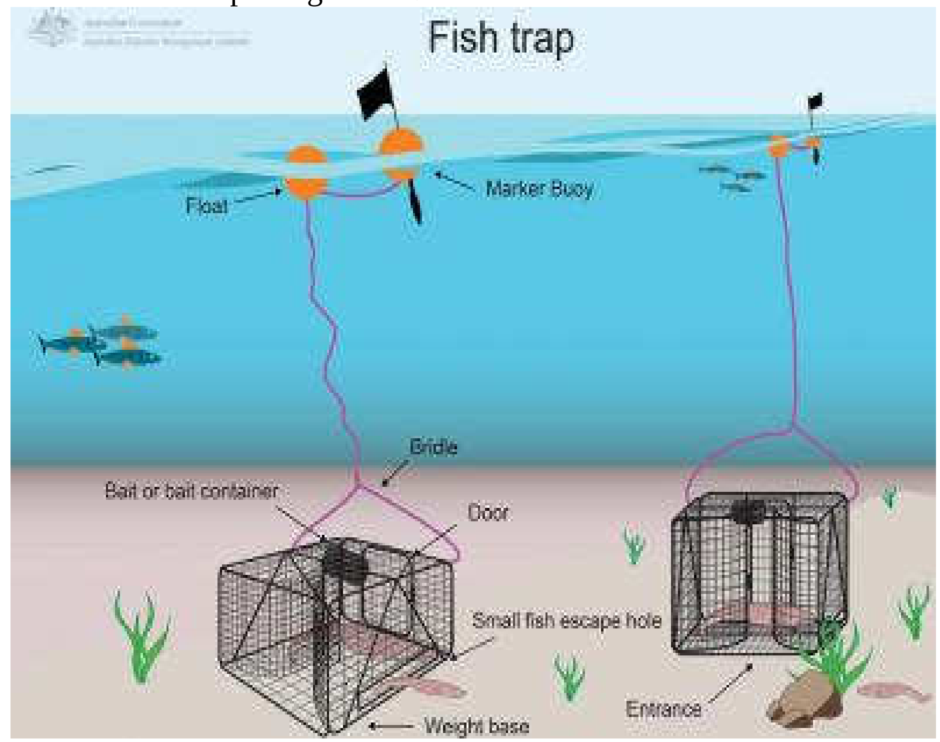
Fishing is the act of catching fish from natural or artificial water body. Fishing can also be called fish harvesting or cropping. There are different methods adopted when fishing





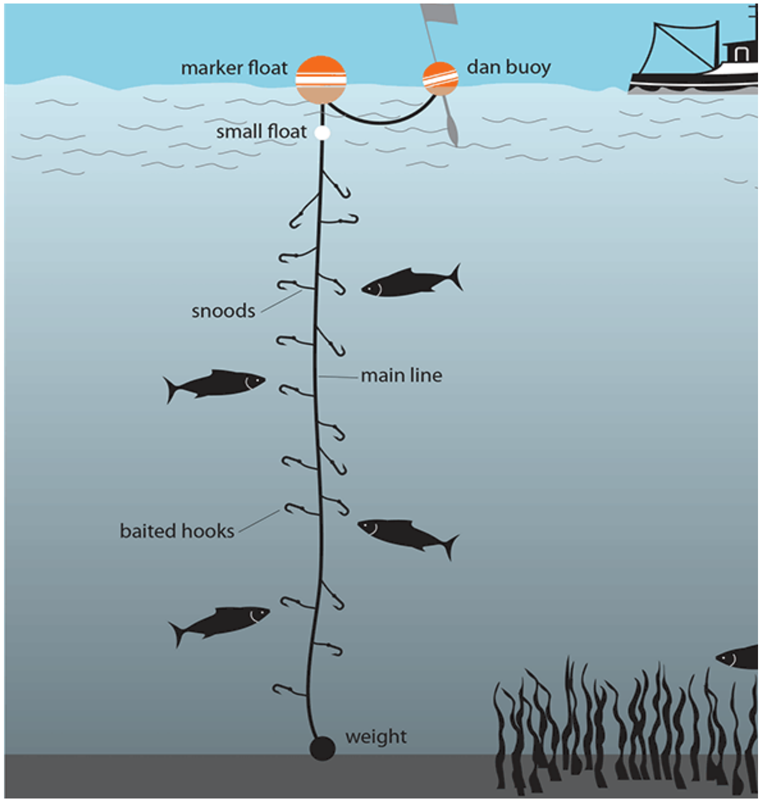
4.3.2 Methods of Fishing

1. Trapping: method utilizes traps usually made from raffia or bamboo for capturing of fish.

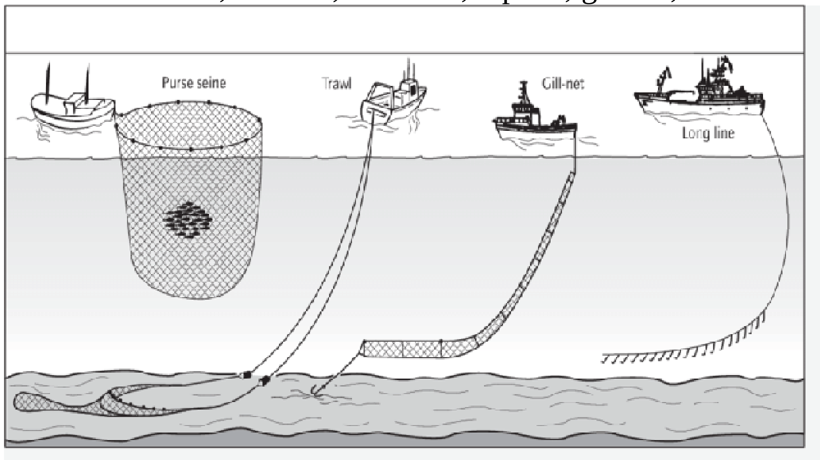


2. Spearing: a spear/harpoon with sharp pointed end is used for stabbing fish in other to capture it.

3. Hook and line/angling: a hook attached to a rod with a line is used for catching fish after the fish is lured by a bait.



4. Netting: this method involves the use of different types of fishing nets to capture fish. The different types of net include seine net, cast net, trawl net, dip net, gill net, etc.



5. Trawling: this is a commercial fishing method which involves using a large vessel (trawler) to drag along a large net in a water body in order to capture fish.

6. Electro-fishing: this involves using electric current to stun fish in a freshwater so that they can be captured.

7. Water draining: this method involves emptying the water in a fish pond in other to harvest fish. The fish is then picked with hands

SUB-**UNIT 5**
FISH PRESERVATION

5.1. Introduction

Fish is raised in an enclosure with a body of water. When fish is caught, it requires immediate preservation to help it last longer. If caught fish is delay before preservation it will spoil due to its perishability nature. There are different typesmethods of preserving fish. Some of these methods were discussed in this unit

5. 2. Learning Outcomes (LOs)

By the end of this unit, the readers should be able to

1. Define fish preservation
2. State ways fish can be preserved
3. State stepwise process in preserving fish during
   a) Smoking
   b) Salting
   c) Freezing
   d) Chilling

e) Brining

5.3.0 Main Content

5.3.1 Meaning of Fish preservation

Preservation is the act of ….many fishermen do not think of preserving caught fish. This result to planty of fish during the harvesting period but very scarce at the lean periods or off season some fishermen eat large quantity of harvested fish instead of preserving them. There are different ways of preserving fish and a farmer may experiment to find out what is desired. Some of the preservation methods are;

1. **Smoking**

   Heat from either firewood, charcoal or oven is used to cook and reduce the moisture content of fish in order to extend its shelf life. Smoking is can be stopped once the fish is well cooked (wet smoking) or can be continued until it is completely dry.

2. Salting: common salt is used to preserve fish. In this method the salt is applied all over the body of the fish.

3. Boiling: this involves cooking fish in water after it has been seasoned.

4. Frying: this involves preserving fish by frying it in oil.

Freezing

Freezing involves keeping fish in temperatures below 0°C. At this temperature, microbial and enzymatic activities are limited which helps to preserve fish. There could also be Freeze drying of fish Freeze drying is a process whereby completely frozen fish is placed under a vacuum in order to remove moisture content of fish through the process of sublimation.

5. Canning: fish are stored in air-tight cans after the addition of preservatives.

Another method is pickling which involves storing fish in air-tight containers with vinegar and salt..

5.4. Self-Assessment Exercise(s)

1. Define fish preservation
2. State ways fish can be preserved
3. State stepwise process in preserving fish during

f) Smoking
g) Salting
h) Freezing
i) Chilling
j) Brining

5.5 Conclusion

For effective fish preserving fish, there are certain methods adopted . These methods were discussed in this unit
It is necessary to be familiar with these methods and identify steps in carrying out each of the methods.

5.6. Summary

Fish preservation methods have been discussed in this unit. Any of these methods must be utilized to preserve fish and ensure quality

5. 7. References/Further Readings

Read each of the stepwise process in adopting each of the methods

UNIT 6: SOIL AND SOIL EXPERIMENTS

1.1. Module Introduction

Soil is an important medium for crop production other agricultural activities are carried out in the soil it is necessary that the soil soil is cared for in order to ensure continuity of agricultural activities

Learners are therefore require to be drilled practically on the soil contents and functions. Some practical activities were discussed. The experiments were discussed intermittently in units without specific introduction of each unit. General learning out come was stated

By the end of these experiments, the students should be able to state the aims, materials required for each experiments, procedures adopted in each each, what were observed and concluded. The units discussed were the following

SUB-**UNIT 1**	**Sedimentation Experiment**
SUB-**UNIT 2**	**Experiment to Demonstrate the Presence of Water in Soil**
SUB-**UNIT 3**	**Experiment to Demonstrate the Presence of Organic Matter in Soil**
SUB-**UNIT 4**	**Experiment to Demonstrate the Presence of Air in Soil (Soil porosity)**
SUB-**UNIT 5**	**Experiment to Demonstrate the Presence Living Organisms in Soil**
SUB-**UNIT 6**	**Experiment to Demonstrate Water**
Retention	**Capacity of Soils**
SUB-**UNIT 7**	**Experiment to Determine Soil Reaction or Soil Acidity or Alkalinity (P^H).**

SUB-**UNIT 1**
Soil Experiments

SEDIMENTATION EXPERIMENTS ON SOIL PARTICLES

3.1 Sedimentation Experiment

Aim: To demonstrate that soil is made of particles of different sizes.
Materials Used: Measuring cylinder (500 ml), soil sample, water, Beakers, stirrer, and Sodium Hydroxide or Hydrogen Peroxide.

Procedure:

- **a.** Half fill the measuring cylinder with soil.
- **b.** Pour water into the cylinder up to the top level.
- **c.** Stir the content properly.
- **d.** Add a few drops of Sodium Hydroxide or Hydrogen Peroxide
- **e.** Allow the content to settle undisturbed for bout 12-24 hours

Observation:
The particles separated into different soil particles. With the bigger particles at the bottom.in this order:
Gravel, Coarse Sand, Fine Sand, Silt and Clay with clear water and floating Organic Materials.

Conclusion:
Soil is made up of particles of different sizes.

Note: Sodium Hydroxide or Hydrogen Peroxide hastens the separation and settling down of soil.

SUB-**UNIT 2**

EXPERIMENT TO DEMONSTRATE THE PRESENCE OF WATER IN SOIL

Experiment to Demonstrate the Presence of Water in Soil

AIM: To show that water is present in soils
MATERIALS USED: Fresh soil sample (Collected from 10cm -15cm below the soil surface), a weighing machine, an oven, an evaporating dish and a stirrer.

PROCEDURE:

a. Put 100g or any other convenient known quantity of the soil sample into an evaporating dish of known weight
b. Place the dish in the oven maintained at 100^0C for about 5 minutes
c. Remove the dish, stir it gently and allow it to cool down for about 5 minutes and reweigh.
d. Return the dish back into the oven and repeat the same previous process until a constant weight is achieved.

OBSERVATION:

A gradual reduction in weight will be observed initially followed by a constant weight.

CONCLUSION:

Since the oven was maintained at 100^0C which is the boiling point of water and a point at which liquid water becomes vapour, the reduction in weight can be explained by the loss of the water content in form of vapour at the maintained temperature.

To calculate the percent (%) water content in the soil sample, use the following formula:

$$\frac{\text{Initial weight of soil sample} - \text{Final weight of soil sample}}{\text{Initial weight of soil sample}} \times 100$$

SUB-**UNIT 3**

EXPERIMENT TO DEMONSTRATE THE PRESENCE OF ORGANIC MATTER IN SOIL

Experiment to Demonstrate the Presence of Organic Matter in Soil:

AIM: To show that organic matter is present in soils

MATERIALS USED: Dry soil sample (the type produced from the previous experiment on water content), a weighing machine, bursen burner, a crucible and a stirrer.

PROCEDURE:

a. Put 100g or any other convenient known quantity of the dry soil sample into an a crucible of known weight
b. Place the crucible over a hot flame from the burner for about 5 minutes
c. Remove the crucible, stir it gently and allow it to cool down for about 5 minutes and reweigh.
d. Return the crucible back to the hot flame and repeat the same previous process until a constant weight is achieved.

OBSERVATION:

A gradual reduction in weight will be observed initially followed by a constant weight.

CONCLUSION:

Since dry soil sample was used and the content of the crucible was placed on hot flame until it became red hot, the reduction in weight can be explained by the loss of the organic matter content by oxidization and loss of gases (mainly Carbon Dioxide).
To calculate the percent (%) organic matter content in the soil sample, use the following formula:

<u>Initial weight of soil sample – Final weight of soil sample</u> X
100 Initial weight of soil sample

SUB-**UNIT 4**
EXPERIMENT TO DEMONSTRATE THE PRESENCE OF AIR IN SOIL (SOIL POROSITY)

Experiment to Demonstrate the Presence of Air in Soil (Soil porosity):

AIM: To show that air is present in soils

MATERIALS USED: A dry soil sample, two measuring cylinders ($100cm^3$), water and a stirrer.

PROCEDURE:

a. Put $50cm^3$ of water in one measuring cylinder and $50cm^3$ in the other measuring cylinder
b. Pour the soil from the first cylinder into the second cylinder and stir gentle.
c. Note the final total volume

OBSERVATION:

The expected total volume is higher than the actual final volume and bubbles were seen coming out of the cylinder when soil was been poured into it.

CONCLUSION:

The difference in weight between the expected total volume and the actual total volume can be explained by the loss of air content of the soil sample to the atmosphere as it mixed with water and evidenced by bubbles released.

To calculate the percent porosity(% porosity) of soil sample, use the following formula:

$$\frac{\text{Expected total vol. of water and soil sample} - \text{Actual total vol. of water and soil sample}}{\text{Initial weight of soil sample}} \times 100$$

SUB-**UNIT 5**
EXPERIMENT TO DEMONSTRATE THE PRESENCE LIVING ORGANISMS IN SOIL

Experiment to Demonstrate the Presence Living Organisms in Soil

AIM: To show that there are living organisms in soils

MATERIALS USED: Fresh soil sample, two test tubes, two rubber bungs, glass wool or cotton wool andCalcium Hydroxide [$Ca(OH)_2$] or Bromothymol blue

PROCEDURE:

a. Fill one third of each of the test tubes labelled **A** and **B** respectively with Calcium Hydroxide or Bromothymol blue.
b. Gently put glass wool into the test tube just above the level of the chemical.
c. Put a small quantity of the soil sample into test tube **A** only and cover each of the two test tubes with a rubber bung.
d. Keep the test tubes in place for twenty four hours or more. (A week if Bromothymol blue is used)

OBSERVATION:

The Calcium Hydroxide in test tube **A** will change from colourless to white (orBromothymol blue from blue-green to green, light green or yellow depending on the volume of gas released). There will be no change in colour in test tube **B** which serves as the control.

CONCLUSION:

When living organisms breathe, they release carbon dioxide gas as a waste product while taking in oxygen. Carbon dioxide gas can be detected using a carbon dioxide indicator solutions such as Calcium

Hydroxide or Bromothymol blue. The colour change confirms the presence of living organisms in soil.

SUB-**UNIT 6**

EXPERIMENT TO DEMONSTRATE WATER RETENTION CAPACITY OF SOILS

Experiment to Demonstrate Water Retention Capacity of Soils:

AIM: To demonstrate and compare the capacity of different soils to retain water.

MATERIALS USED: Sandy soil, loamy soil, clayey soil, three measuring cylinders, three funnels andthree filter papers or cotton wool.

PROCEDURE:

a. Fold one filter paper each to fill each of the funnels labelled **A**, **B**, and **C**.
b. Place each of the funnels on a measuring cylinder.
c. Fill funnels **A, B** and **C** with equal quantities of sandy, loamy and clayey soils respectively.
d. Slowly and simultaneously pour equal volumes of water into the three funnels.
e. Note the volume of water that finally drains into each of the measuring cylinders after about one hour.

OBSERVATION:

Experimental set-up with funnel **A** which contains sandy soil will have the highest volume of drained water followed by the one with funnel **B** which contains loamy soil and lastly the one with funnel **C** which contains clayey soil.

CONCLUSION:

Since the highest amount of water that drains is observed in experimental set-up with funnel **A** which contains sandy soil, it implies that sandy soils have lowest degree of water retention capacity while experimental set-up with funnel **C** which contains clayey soil has the highest volume of water retained. Experimental set-up with funnel **B** which contains loamy soil retains an average volume of water.

NOTE: A filter paper is folded by holding two opposite edges and folding them smoothly to form a half cycle. The two edges of the base of the half cycle are then folded to form a cone. Three of the folds are pressed together neatly before being put in the funnel.

SUB-UNIT 7

EXPERIMENT TO DETERMINE SOIL REACTION OR SOIL ACIDITY OR ALKALINITY (P^H).

Experiment to Determine Soil Reaction or Level of Soil Acidity or Alkalinity (P^H).

AIM: To determine acidity and alkalinity of soils.

MATERIALS USED: Soil samples, water, white dishes and a universal indicator

PROCEDURE:

a. Collect samples of soil from different parts of your area.
b. Moisten a sample with water and then pour few drops of the soil water into a white dish.
c. Use a universal soil indicator to produce a colour reaction in the sample of soil water.
d. March the colour produced against a colour key card to determine the p^H of the soil.
e. Repeat the procedure for other samples.

The following colour change may apply:

Red – An acid soil with p^H less than 6.5 (p^H< 6.5)
Blue / Purple - An alkaline soil with p^H more than 6.5 (p^H>6.5)
Green - A neutral soil with a p^H around 6.5.

Note: Most soils are slightly acidic to neutral in nature. A universal indicator is typically composed ofwater, propan-1-ol, phenolphthalein sodium salt, sodium hydroxide, methyl red, bromothymol blue monosodium salt, and thymol blue monosodium salt.

A roll of universal soil indicator

OBSERVATION:

Soils show different colour change in the experiment.

CONCLUSION:

Soils have different levels of soil reaction or soil acidity and alkalinity.

NOTE: Using common litmus papers may not be very accurate. Acids turn blue litmus red, and bases turn red litmus blue

SUB-**UNIT 8**
ROCKS AND ROCK FORMATION

Rock is defined as a natural aggregate of minerals which constitute the basic unit of the earth's crust.

Identification and classification of rock samples and examples.

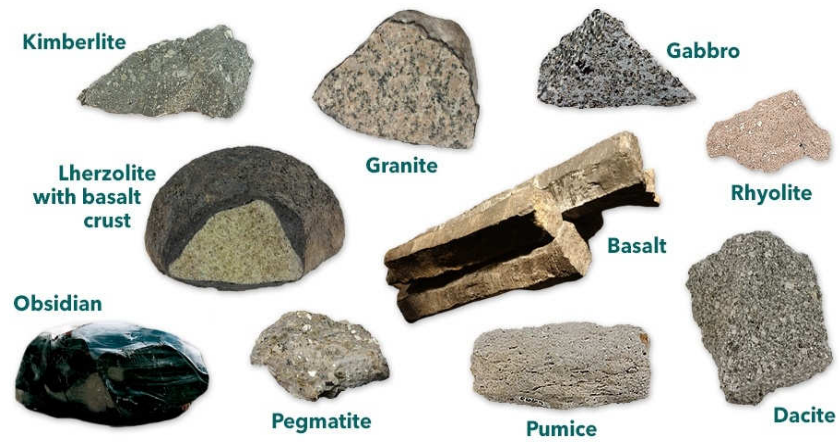
Rocks are classified into:

- Igneous rock
- Sedimentary rock and
- Metamorphic rock

Igneous rock

Igneous is a rock formed as a result of the solidification of molten magma. They are crystalline in nature and have shinny appearance. Examples of igneous rock include granite, basalt, gabbro, pegmatite, rhyolite, etc.

Samples of igneous rock



Sedimentary rock

Sedimentary rocks are rocks formed from fragments of pre-existing rocks and dead plant and materials which have been cemented together by cementing agents. Sedimentary rocks are usually stratified and have coarse texture. Examples of sedimentary rocks include sandstone, shale, limestone (chalk)

Samples of sedimentary rock

Metamorphic rock

Metamorphic rock is a rock formed as a result of changes in the nature of a pre-existing rock due to heat and pressure. Examples of metamorphic rock are marble, quartzite, gneiss, slate, etc.

Samples of metamorphic rock

4.0 Self-Assessment Exercise(s)

PRACTICAL ACTIVITIES 14

a. Collect different types of rock samples
b. Examine each of the specimens carefully noting the following:
i. Texture
ii. Colour
iii. Presence or absence of crystals (You may use hand lens)
c. Scratch the samples to find out if an expression is made.
d. Examine the samples for fossils (If any).
e. Add drops of Hydrochloric acid to see effervescence occurs or not.

UNIT 7: FLORICULTURE COMMON AND BOTANICAL NAMES OF ORNAMENTAL PLANTS

Meaning of Floriculture

Floriculture is a branch of horticulture concerned with the growing and marketing of flowers and ornamental plants.

Importance of floriculture

- It is important for the beautification of the environment.
- Floriculture helps in employment creation
- It serves as a source of income.
- It is a means of earning foreign exchange
- Floricultural plants such as lawns are important in the production of atmospheric oxygen while eliminating carbon (iv) oxide.
- Extracts from flowers are used in the production of perfumes
- Colour pigments such as carotenoid are extracted from flowers
- Ornamental plants such as lawns help in checking soil erosion
- Some horticultural plants possess medicinal value

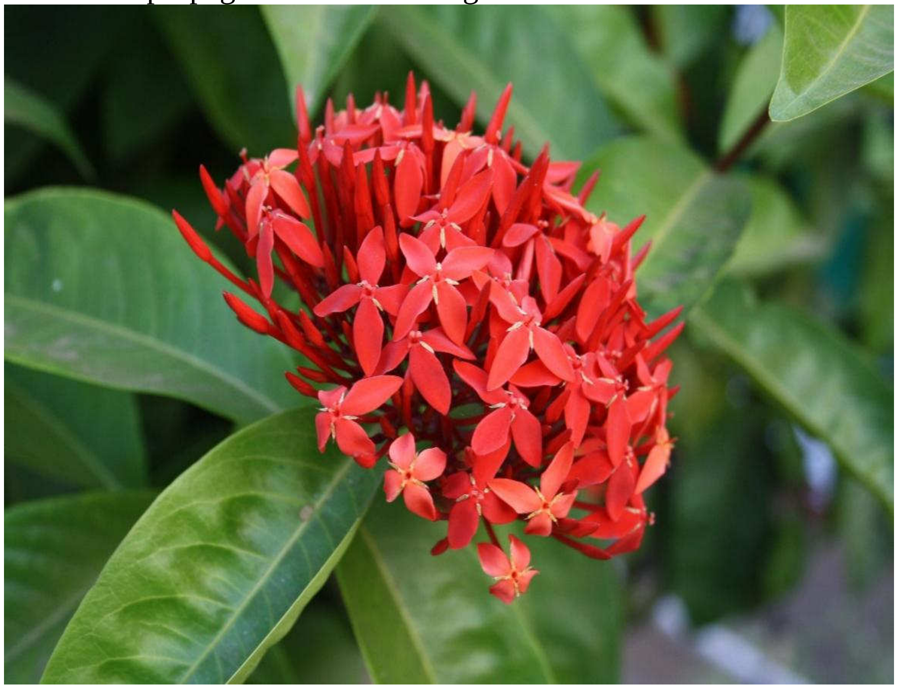
Common examples and methods of propagation.

Common name: Red bird of paradise
Botanical name: *Caesalpiniapulcherrima*

Method of propagation is by Seeds

Common name:Ixora
Botanical name:*Ixoracoccinea*

Method of propagation: Stem cuttings



Common name:Hibiscus flower

Botanical name:*Hibiscus rosa-sinensis*
Method of propagation: stem cutting

Common name: Masquerade tree
Botanical name:*Polyalthialongifolia*

Method of propagation:Seeds and soft wood cuttings

Common name: Yellow bush, golden dewdrops
Botanical name:*Durantaerecta*

Method of propagation: Stem cuttings

Common name: Mother-in-law plant, snake plant
Botanical name:*Sansevieriatrifasciata*

Method of propagation: Leaf cutting

Common name: Carpet grass

Botanical name:*Axonopuscompressus*
Method of propagation: Runners, Seeds

Common name:Triangle palm
Botanical name:*Dypsisdecaryi*

Method of propagation: Seed

Common name:Rose
Botanical name:*Rosa spp*

Method of propagation: Stem cuttings

Common name: Sunflower
Botanical name: *Helianthus annuus*

Method of propagation: Seeds

Common name: Morning glory
Botanical name: *Ipomoea purpurea*

Method of propagation: Seeds

Common name: Butterfly pea
Botanical name: *Clitoriaternatea*

Method of propagation: Seeds and cuttings

4.0 Self-Assessment Exercise(s)

Test Yourself

a. *Collect different types of ornamental plants such as Hibiscus, Wild rose, Cauliflower, Zinna, Sunflower, Morning glory, Clitoria etc.*
b. *Find out the planting materials for each of the ornamental plant.*
c. *State what makes each of the plants attractive?*

UNIT 8: DISEASES AND PESTS OF CROPS

SUB-UNIT 1:
DISEASES

Meaning of Disease

Disease can be defined as a deviation of the state of normal health in plants. Diseases are manifested through signs and symptoms such as stunted growth, discoloration of leaves, wilting, low yield, rotting parts and death among others.

Classification of diseases based on causal organisms

Based on causal organisms, plant diseases can be classified into;

- Viral diseases: these type diseases are caused by viruses such as groundnut rosette, maize streak, cassava mosaic, cocoa swollen shoot disease, etc.
- Bacterial diseases: these are the diseases that are caused by bacteria such as bacteria blight of rice, sorghum and soybean, leaf blight of cassava, tomato wilt, etc.
- Fungal diseases: these are diseases caused by fungi such as rice blast, maize smut, leaf spot in yam, powdery mildew, oil palm freckle, etc
- Nematode diseases: these diseases are caused by nematodes. Examples include root knot, root lesion, cyst, etc

Diseases in plants can also be as result of nutritional deficiency.

Control of Diseases

- Plant resistant varieties
- Treat seed/planting materials before planting.
- Practice crop rotation

- Destroy vectors by spraying appropriate chemicals
- Spray chemicals such as fungicides against fungal diseases
- Ensure proper weed manage to avoid pest and disease build up
- Uproot and burn plants infected with viral disease

UB-**UNIT 2**
PESTS

Meaning of Pest

A pest is any animal or insect that is harmful to man or his crops. Pests damage farmers' crops either in the farm or store. There are four major types or groups of pests which are

1. Vertebrate pests examples are rodents, birds, reptiles, and mammals aomong others
2. Invertebrate pests examples are insects, spiders, ticks, slugs
3. Disease causing organisms like bacteria, fungi, viruses, nematodes among others

Classification of pests

Despite the types or groups, pests can be generally classified into

- Insects: examples include weevil, beetle, aphids, locust, grasshoppers, caterpillars, thrips, whiteflies, etc.
- Rodents: examples include rat, squirrel, mice, beaver, grasscutter, etc
- Birds: weaver bird, sparrow, pigeon, etc
- Mammals: monkeys, man, pigs, cattle, goat, etc.

Effects crop pest

- Reduction in the quality of farm produce
- Destruction of crops
- Pests help to spread plant diseases
- Reduce crop yield
- Increase the cost of production
- Death of crops

Control of pests

- Hand-pick insects
- Use scarecrows
- Set traps
- Introduce natural enemies of such pests
- Practice crop rotation
- Weed the farm regularly
- Remove plant residue after harvesting or weeding
- Timely harvesting
- Use recommended pesticide

4.0 Self-Assessment Exercise(s)

Test Yourself

a. Collect diseased plants from the environment.
b. Note the parts that are affected by the disease
c. Identify the observable symptoms on the plant noting whether they are:
   - **i.** **Necrosis** (The death of cell or of tissues)
   - **ii.** **Chlorosis**(Yellowing of green tissues due to chlorophyll destruction)
   - **iii.** **Rosette** (Short, bunchy habit of plant growth)
   - **iv.** **Rot** (Softening, discoloration and disintegration of tissues)
   - **v.** **Wilt** (Loss of rigidity and dropping of plant parts, wholly or partially)
   - **vi.** **Gall/tumor** (Unusual development or transformation)
   - **vii.** **Gummosis** (Excessive gum formation)
d. Determine the causal organism such as Viruses, Bacteria, Fungi or Nematodes

SUB-**UNIT 3**
WEEDS

Meaning of Weeds

Weed is a plant growing where it is not wanted or plant growing out of place. A weed could also be defined as plant not intentionally planted by man.

Economic importance of weed

- Weeds compete with crops for nutrients, sunlight, water and space
- Some weeds harbor crop pests and diseases
- Weeds lower crop yield
- Weeds also decrease the quality of crop yield
- Weeds increase the cost of production

Methods of weed control

- Hand pulling: this involves using hands to uproot weeds.
- Hoeing: this involves using a hoe to remove weeds
- Slashing: this involves cutting down weeds with cutlass, mower or tractor mounted slasher
- Planting cover crops: cover crops help to smoother weeds thereby preventing them from growing
- Mulching: mulching covers the soil surface and prevents the emergence of weed
- Bush burning: bush burning helps to kill weeds
- Use of herbicides

4.0 Self-Assessment Exercise(s)

Assignment

Preparation of Weed Album

Stages of preparing a weed album:

a. Collect a weed from its natural site
b. Mount it on a newsprint or plain sheet showing as much many parts as possible and as you want it mounted on the weed album.
c. Place another sheet on it and mount another weed on it
d. Repeat the procedure above.
e. Place a weight covering the sheets on the last sheet.
f. Leave it in a dry condition for about a week.
g. Remove the weeds one by one and mount each of them on a sheet of a big drawing book with glue or transparent cellotape.
h. Provide the following information on each of the sheets. – Common and botanical names of the weed, and date and place of collection

SUB-**UNIT 4**
CROP HUSBANDRY

Preparing planting materials and planting yam:

i. Obtain warehouse yam or seed yam or yam sett or minisett which are all planting materials for yam.
ii. Dust the setts with wood ash or a fungicide such as TectodustTM (thiabendazole) to minimize damage in the soil and plant a day after treatment.
iii. Plant the sett by burying it in the ridge or heap the setts 15–20 cm deep with the cut surface facing up with a spacing of 1.0m x 1.0m for setts weighing 250g-300g.
iv. Provide one stake for two stands of yam or one long strong bamboo stake for 4 adjacent stands. Other staking materials include palm fronds, branches of trees etc.

SUB-UNIT 5 FARM RECORDS AND ACCOUNT

Meaning of Farm Records

Farm records are documents that show details of all the activities that take place in the farm while farm account is a type of farm record that shows details of all money received and spent.

Types of farm record/account

- Farm diary
- Farm inventory
- Production record
- Sales record
- Cash book
- Income statement
- Profit and loss account

Importance of farm records and account

- Farm records help the farmer keep track of the activities that take place in the farm.
- It helps the farmer to determine whether he is making profit or loss
- Farm records are important for calculating tax
- Farm records are important for planning and budgeting
- They are needed for obtaining loans
- Farm records help the farmer ascertain the financial position of the farm.

4.0 Self-Assessment Exercise(s)

Steps in preparing Profit and Loss Account:

a. Identify all business monetary business transactions carried out by the farm during the year under consideration with the date.

b. Post each of the transactions into Debit and Credit columns in the in the Profit and Loss account based on whether money comes into the business or goes out of the business. Sales and receipts are recorded on the right hand side (Credit side) while purchases and expenses are recorded on the left hand side (Debit side). If the total in the credit side is higher, net profit is made but if the debit side is higher, net loss is made.

References

Africa Innovations Institute (AfrII) (2016). *Piggery Production Manual: How to rear pigs*

African Union Interafrican Bureau for African Resources (2015). *Local African pig.*Retrieved October 24, 2021 from http://www.au-ibar.org/component/jdownloads/finish/129-kya/2423-local-african-pig

American Museum of Natural History (n. d.). If rocks could talk: Three types of rock. Retrieved November 7, 2021 from https://www.amnh.org/explore/ology/earth/if-rocks-could-talk2/three-types-of-rock

Bayly, J. (2019). How to milk a cow by hand.Retrieved October 26, 2021 from https://hellohomestead.com/how-to-milk-a-cow-by-hand/

Britannica (2019). Floriculture. Encyclopedia Britannica. Retrieved November 7, 2021 from https://www.britannica.com/science/floriculture

Britannica, T. Editors of Encyclopaedia (2011). Candling. Encyclopedia Britannica. https://www.britannica.com/technology/candling

Dawn, M. (2017). Ornamental plants in Nigeria. Retrieved November 8, 2021 fromhttps://www.gardenguides.com/127670-ornamental-plants-nigeria.html

Dhia, A. A. (2015). *Farmstead planning (farm building design)* (1 – 10).
events: floriculture. Retrieved November 7, 2021 from https://alec.unl.edu/agedcde/floriculture

FAO (1985). Elementary surveying equipment. Retrieved October 24, 2021 from https://www.fao.org/3/r7021e/r7021e02.htm

FAO (2003). Training manual series: simple methods for aquaculture. Retrieved November 4, 2021 from https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO/

FAO (2005). Fish pond construction and management (a field guide and extension manual. Retrieved October 26, 2021 from https://www.fao.org/3/ak506e/ak506e.pdf

Fermented Bed Technology (*FBT) or the deep litter system (DLS)*. Africa Innovations Institute,
Kampala. Retrieved October 24, 2021 from https://www.afrii.org/wp-content/uploads/2016/11/final-piggery-manual-sent-rf.pdf

Fisheries New Zealand (2009). Fishing methods. Retrieved November 7, 2021 from https://fs.fish.govt.nz/Page.aspx?pk=63

Fisheries New Zealand (2009). Fishing methods. Retrieved November 7, 2021 from https://fs.fish.govt.nz/Page.aspx?pk=63
I

feanyieze, F.O; Dada; Amusa, T. and Olaitan, S.O. (2021). Technolohy in agriculture in the topics. Nigeria. Nsukka University of Nigeria press

Iwena, O. A. (2012). *Essential agricultural science for senior secondary schools* (6th ed.). Nigeria: Tonad publishers

Jacquie, J. (n. d.). How does a hen make an egg? Retrieved October 26, 2021 from https://4hlnet.extension.org/how-does-a-hen-make-an-egg/

Klein, C. & Carmichael, R. S. (2021). Rock. Encyclopedia Britannica. Retrieved November 7, 2021 from https://www.britannica.com/science/rock-geology

National Geographic (n. d.). Rocks. Retrieved November 7, 2021 from https://www.nationalgeographic.com/science/article/rocks

Omoruyi, S. A., Orhue, U. X., Akerobo, A. A. &Aghimien, C. I. (1999). *Prescribed agricultural science for secondary schools* (2nd ed.). Nigeria: IdodoUmeh publisher

Roeder, M. (n. d.). Hatching eggs at home: a 21 day guide for baby chicks. Retrieved October 26, 2021 fromhttps://www.purinamills.com/chicken-feed/education/detail/hatching-eggs-at-home-a-21-day-guide-for-baby-chicks

Sani, Y. A., Isah, A. S., Babaji, B. A., Barnabas, S., Yahaya, R. A.& Hassan, M. B. (2016). Identification and description of some common ornamental plant species at Ahmadu Bello University Zaria, Nigeria. *Advances in Nutrition and Food Science 1*(1)

The West African Examination Council (n. d.) Agriculture paper 2, WASSCE (PC), 2018. Retrieved October 24, 2021 from https://waeconline.org.ng/e-learning/Agtfriculture/Agric227jq1.html

University of Nebraska – Lincoln (n. d.). Nebraska agricultural education career development events: floriculture. Retrieved November 7, 2021 from https://alec.unl.edu/agedcde/floricultur

Vikaspedia (n. d.). Housing management. Retrieved October 24, 2021 from https://vikaspedia.in/agriculture/livestock/sheep-and-goat-farming/housing-management

MODULE 3: CHEMISTRY EDUCATION

Reviewed and Reprocessed by:

Prof Z. C, Njoku and Cliff Okebalama
Department of Science Education,
University of Nigeria, Nsukka
Zephrinus.njoku@unn.edu.ng
08035811170

U
NIT 1: SEPARATION OF MIXTURES

1.1. General Introduction

Chemistry may be defined as the study of matter, its structure, properties, transformations, interactions processes, and the energy implications of the changes matter undergoes. Chemistry as a science discipline is an activity based subject which strongly affects our daily lives, our environment and our local and national economies. The material world is made of matter. Therefore, all forms of the material world are chemical substances. Through chemical interactions among various substances new substances are made. The process of chemical interactions or chemical reactions can lead to production of new useful or good substances, or bad and dangerous substances that are capable of destroying our environment. Therefore, the nature of Chemistry is such that it is handled with care so as to produce useful things for our benefits and wellbeing while discouraging the production of substances that can destroy us and our environment. This is why the study of Chemistry at all levels of education involves plenty practical work or laboratory activities aimed to make the subject matter contents (Theories, Laws, concepts, Principles and Hypotheses and methodologies) clearer and to develop practical or manual skills necessary for handling chemical substances and challenges that chemical substances may pose to our life and our environment. Thus, as much as possible the teaching of Chemistry should be practical based to enable learners concretize the abstract concepts they have learnt, as well as verify the theories, laws and principles of Chemistry.

By the end of your reading and carrying out the activities in this Chemistry manual, you should be able to achieve the following objectives

1.2 Learning Outcomes

1. Plan Chemistry experiments and practical activities
2. Set up equipment and materials for conducting Chemistry practical activities
3. Develop practical skills or process skills in conducting Chemistry practical activities, including some experiments
4. Learn to control variables during Chemistry experiments
5. Develop positive attitudes to Chemistry practical work/activities
6. Carry out practical activities on various topics in Chemistry
7. Take appropriate precautions in the conduct of Chemistry practical activities, and handling of chemical substances
8. Establish basic rules for students' use of Chemistry laboratory and the equipment and resources therein.

1.3.1 SEPARATION OF MIXTURES OF CHEMICAL SUBSTANCES

In nature, many chemical substances occur as mixtures, while production of substances often involve separation of mixtures of different products to obtain pure substances that are very useful in the industry and home. There are several methods of separation of mixtures, each of which depends on the physical and chemical properties of the components of the mixture. Some of the physical methods of separation of mixtures into their different components include filtration, Evaporation, Centrifuging, Chromatography, Distillation, Fractional Distillation, Magnetization, Crystallization, Sublimation and Decantation. In this section, we shall carry out activities leading to separation of different types of mixtures using some of the methods/techniques listed above. For some mixtures, more than one separation methods/techniques can be used. You will always be required to take special note of the properties of the components of the mixtures that make it possible to the use the separation techniques involved. Let us carry out the separation of some mixtures using the activities below:

Activity 1.3.1. Separation of Insoluble solid particles from liquid/solution

Aim: To separate an insoluble solid from solution/liquid.

Theory: One of the components of the mixture is insoluble solid while the other component is a liquid. The two substances can be separated by filtration or decantation using appropriate apparatuses.

Apparatus: 250cm^3 beaker, funnel, large test tube or boiling tube, filter paper, test tube rack and stirrer.

Reagents: 50cm^3 tap water and 5 grams soil.

Procedure for Decantation: Mix thoroughly 50cm^3 of water and sand. Stir the mixture completely until it is cloudy brown. Allow the mixture to settle for 20 minutes. What is your observation? Using an empty beaker as the collector, without shaking, slowly decant the liquid part of the mixture into the clean beaker. The liquid in the clean beaker is called decantate while the sand remaining at the bottom of the first beaker is called the residue. What is the colour of the decantate?

Procedure for Filtration: Mix 50cm^3 tap water with 5 grams soil and stir until a cloudy mixture appears. Fold a filter paper into cone-shape and fit it into the filter funnel. Pour the mixture slowly into the funnel and record your observations. Describe the separated substances. The liquid is called the filtrate while the solid on the filter paper is called the residue. Compare the separated substances when decantation is used and when filtration is used. What are the differences?

Activity 1.3. 2: Separation of dissolved solid from solution by Evaporation method.

Aim: To separate dissolved solid from its solution

1.3.2.1. Introduction: A mixture of two substances where one is a solid which dissolved in the other which is a liquid. The mixture is called solution. In this case the properties of the mixture are that one is volatile and can be converted into vapour by heating. When the volatile component is evaporated we obtain the dissolved substance as a solid residue.

Apparatus: Evaporating dish, two 250cm^3 beakers, Bunsen burner, wire gauze, Tripod Stand, Glass stirrer and desiccator, clock glass.

Procedure: Add 3g of common salt (NaCl) or one cube of sugar into a beaker. Add 5cm^3 of distilled water and stir until the solid dissolves completely in water. Transfer the resulting solution into an evaporating dish. Using the Bunsen burner flame, heat the solution in the evaporating dish to dryness. Describe your observation during course of evaporation and at the point of heating to complete dryness. Keep the evaporating dish and its contents in a desiccator to cool. Describe the residue.

Activity 1.3.3: Separation of mixture of two or more liquids with widely varying boiling points

Aim: To separate two or more miscible liquids with large differences in their boiling points.

1.3.2.2 Introduction: All liquids have boiling points. Some boil over a short range of temperature while others boil at a sharp temperature. The boiling point of a liquid is the temperature at which the liquid is converted to vapour /gas. If liquids of different boiling points are mixed, separating the mixture would involve boiling the liquid mixture so that each of the components of the mixture boils over at its specific boiling point. The vapour can be cooled to condensation if it is desired to collect it again as a separate liquid. This is what happens in the Liebig condenser in which running cold water is used to condense the vapour boiling over from the mixture into a liquid that can be collected in a container. This process is called distillation. Example of liquid mixture with large differences in their boiling points is a mixture of water (BP = 100^oC) and ethanol (BP =78^oC). If the liquid mixture has several components that are separated by distillation, the process is called Fractional Distillation.

Apparatus: Conical flask, large test tube, 250cm^3 beaker, Bunsen burner, Wire gauze, Tripod stand, Delivery tube, Thermometer, Distillation flask, running cold water tap, Liebig Condenser and corks.

Reagents: 50cm^3 tap water, blue ink and cold water.

Procedure: Pour 50cm^3 tap water into a conical flask and add few drops of blue ink. Heat the conical flask containing mixture of ink and water until when the solution boils, water vapour rises and condenses

in the cold test tube. Take a reading of the temperature at which the solution boils. Note the colour of the liquid collected in the test tube and the colour of the liquid remaining in the conical flask. Explain why the colour of the liquid in the conical flask has become deeper than before distillation.

Activity 1.3.4: Separation of mixture of liquids with more than two components

Aim: To separate two or more miscible liquids with close boiling points.

1.3.2.3. Introduction: When there is need to separate a mixture of several liquids with various boiling points, simple distillation apparatus will not be adequate to collect the various fractions of the liquids as pure substances after separation. Fractional distillation is the method adopted. In this case the Liebig Condenser used in simple distillation is replaced by fractional fractionating column which will help to separate the various fractions of the mixture at their different boiling points. The fractional distillation condenser has a coil of fractionating column made of glass running through the inside of the condenser. It is on this coil of glass that each component of the mixture condenses at the appropriate boiling point and the flows out for collection. See Figure 1

Apparatus: Round bottomed flask, Fractionating column, thermometer, corks, Liebig condenser, flowing tap, conical flask, Bunsen burner, Wire gauze, Tripod stand and Anti Bump (broken glass or porcelain).

Reagents: Ethanol and Water.

Safety Precaution: Ethanol is flammable; it should not be taken near naked flame.

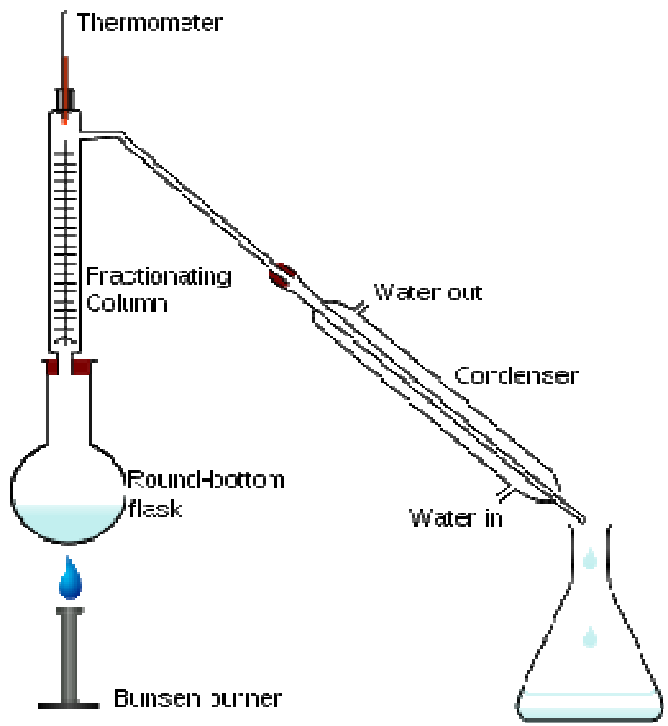


Figure 1: Apparatus set up for Fractional Distillation

{(New Diagram/ Picture brought in by the Reviewer}

Procedure: Mix equal volumes of ethanol and water in a round-bottomed flask. Assemble the fractionating column as in figure 1 above, and heat the solution while the tap is allowed to run through the Liebig condenser. Record your observations and conclusion.

Activity 1.3.5: Separation of Mixture by Process of Sublimation

Aim: To separate a mixture of solid Sodium Chloride and Ammonium Chloride.

1.3.2.4. Introduction: The nature of some chemical substances is such that when they are heated, instead of the solid melting to form liquid, the solid goes direct into gaseous state without going through the liquid phase. Such solid substance is said to have sublimed. The ability of some solids to sublime into gaseous state can be used to separate them from solid substance which do not sublime. This process is called separation by the process of sublimation. Iodine, some chlorides and camphor can sublime.

Apparatus: Glass funnel, Evaporating dish, Bunsen burner, Tripod Stand, wire gauze and beaker

Reagents: Solid Ammonium Chloride (NH_4Cl) and solid Sodium Chloride (NaCl).

Safety Precaution: Separation should be done in a fume chamber if the mixtures involve iodine which causes irritation (if vapour is inhaled) and a large dose is poisonous.

Procedure: Mix 4g of common salt (NaCl) with 2g of Ammonium Chloride (NH_4Cl) in an evaporating dish. Place a glass funnel inverted over the dish. Heat the dish and observe what happens. Record your observations and conclusion. Confirm by chemical test, which of the chemical substances (Sodium chloride – NaCl, or Ammonium chloride -NH_4Cl, sublimed and condensed on the inverted funnel.

Activity 1.3.6: Separation of immiscible liquids

Aim: To separate two immiscible liquids (Kerosene and Water) using a separating funnel.

1.3.2.5. Introduction: Separation of a mixture of two or more immiscible liquids is possible using separating funnel. The property of the liquids which is used for this separation is the differences in their densities. When the densities of the different liquids vary the arrangement of the layers of the liquid mixture would be according to the magnitude of their densities, with the one which has the highest density lowest, followed by the one with higher density and lastly by the one with the lowest density. In other words, the heaviest component of the mixture flows out first followed the next heaviest and so on.

Apparatus: Separating funnel, two $25cm^3$ beakers, Tripod stand and conical flask

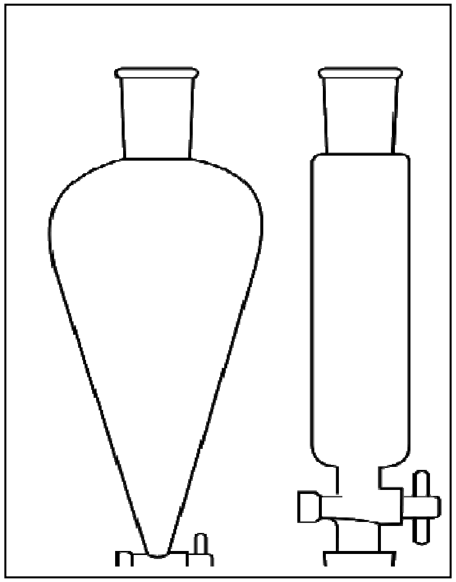


Figure 3: Using Separatory Funnels to separate Liquids in two layers

(Figures brought in by the reviewer}

Reagents: Kerosene and Water

Procedure: Carefully mix kerosene and water in a beaker and transfer the resulting mixture into a separating funnel. Let the funnel stand clamped to the retort stand, until two distinct layers of the mixture emerge. Place an empty conical flask or beaker under the tap of the separating funnel. Open the tap gradually to drain off completely the lower layer. Thereafter, run out the upper layer into another beaker. Record your observations.

1.When two immiscible form a mixture, what apparatus would you use to separate them?
2.What difference in the two liquids would make possible for you to separate them?
3. A mixture contains two liquids of different boiling points,

Self-Assessment Questions 1

UNIT 2 STANDARD SOLUTIONS

1.4.1: Preparation of Standard Solutions of Solid substances

1.4.1: Introduction

A standard solution is a solution whose concentration is accurately known. This means that the amount of solute dissolved in a given volume of solvent is accurately known. The amount of substances is measured in moles or grams, while the volumes of liquid substances is measured in cubic meters (m^3) or its lower scale equivalents such as cubic centimeters (cm^3), cubic decimeters (dm^3). The IUPAC Unit for a standard solution is moles per dm^3 ($Mol./dm^3$ or $Mol.\ dm^{-3}$). The concentration of solutions or the molarity of solutions is expressed in moles per dm^3, that is, the number of moles of the solute dissolved in one dm^3 of the solvent. Standard solutions are used to determine the concentrations of other substances, such as solutions in titration. Using standard solutions and stoichiometric equations, it is possible to predict the amount of any product from a chemical reaction. Thus the idea of standard solution is used in industrial production of substances such as fine chemical like drugs and perfumes or heavy chemicals like cement or fertilizers.

Activity 1.4.1. Steps in preparing standard solution of solid substance

Aim: Develop skills and acquire knowledge in weighing chemical substances accurately

i). Weighing of chemical substances

The instrument for weighing chemical substances is the weighing balance also called chemical balance. The chemical balance may be mechanical balance such the beam balance or top-loading Ohaus balance. The beam double pan balance is more or less out dated and hardly used again in school laboratories. In weighing with the mechanical balances, standard weights are used to balance for the weight you are trying weigh out. Top-loading balances like the Ohaus balance has notches indicating the various weight one may want to weigh out. There a venieer scale for measuring small masses. It may give accuracy to the nearest hundredth (100^{th}).

Apparatuses: Weighing balances, specimen bottles, beakers, funnels, standard flasks, Stirring rods,

Fig 5: Ohaus Chemical or Scale Balance (Meanical Open Electronic chemical balance

Fig 6: Shielded Electronic Chemical Balance

Fig 7 : Top loader electronic Balance

{Figures brought in by Reviewer}

Electronic Balance is easier to use than mechanical beam balance. Some electronic chemical balances can be accurate to the nearest ten thousandth ($10,000^{th}$). The electronic balances are very accurate.

ii). In using electronic chemical balance, the mass of the substance required to prepare a given concentration of a solution is determined from the molecular mass of the substance. The electronic balance is set at zero reading. An empty weighing bottle or any other suitable container for the substance is weighed by placing the container on the pan of the balancing and reading off the mass. Then the material/substance which is required for preparing the standard solution is gradually added to the empty container while watching the digital scale reading the mass added. This gradual addition of the substance is continued until the accurate mass of the substance is read off on the scale of the balance. The weighed substance is removed from the pan of the balance.

Note the following precautions:

a). The electronic chemical balance is very sensitive hence the cover of the weighing chamber must be closed before the reading is taken on the electronic digital scale for purposes of accuracy. If the cover is not in place, the balance would give wrong reading because even the moving air outside of the chamber affects the reading.

b). Substances being weighed must not be splashed on the pan of the balance during weighing. Certain kinds of chemical substances can react with pan thereby destroying it over time. The pan of the balance should be cleaned properly before weighing to ensure accuracy.

iii). Dissolving the weighed substance to make standard solution

Put the accurately weighed substance whose standard solution you want to prepare into a beaker that has been washed very clean with soap solution and water, (See figure 8). Add little distilled water that is much less than the volume of solution you want to prepare into the beaker. Ensure that all the weighed substances are collected into the flask.

Figure 8: Beakers with stirring Rods

Figure 9: Filter Funnels

{Figures Brought in by Reviewer}

Using the stirring rod, gently stir the mixture in the beaker until all the solid substance has dissolved completely to give a clear solution. Using a clean filter funnel (See Figure 9) gently transfer the solution completely from the beaker into a standard flask which is the volume of the solution you want to prepare (Figure 10).
Rinse the beakers thoroughly with small amount of distilled water to ensure that all the dissolved substance is collected. Pour the solution in the beaker into the standard flask. Rinse again with small amount of distilled water and again pour into the solution in the standard flask. Using distilled water from wash bottle or beaker, make up the volume of the solution in the standard flask to the standard mark such that the bottom of the meniscus of the solution stands on the standard mark of the flask. Cock the standard flask properly and shake the solution briskly to ensure uniformity.

Figure 10: Standard Flasks of different sizes

In preparing standard solutions, you should note the following:

1. A molar solution is one containing one mole or the molecular mass of the solute dissolved in one dm^3 (or $1000cm^3$) of the solution.
2. If your available standard flask is $500cm^3$, it means that you will weigh out and dissolve (0.5Moles) half of the molar mass of the solute in the available standard flask of 500 cm^3 to make the Molar solution.
3. If you want prepare 0.5 molar solution, you will weigh out half of the molar mass of the solute and dissolve in one dm^3 ($1000cm^3$) of solution.
4. If you want to prepare 0.1M solution, you should weigh out the malar mass divided by 10 to give 0.1 moles of the solute and dissolve in $1dm^3$ or $1000cm^3$ of the solution.

Let us give example with preparation of standard sodium hydroxide solutions of different concentrations using different sizes of standard flasks, as follows:

- The Formula of sodium hydroxide is NaOH
- Molar mass of NaOH = (23 +16 +1) = 40g/mole.
- 1M NaOH contains 40g of NaOH in $1dm^3$ or $1000cm^3$ of solution. So 40g is weighed out and dissolved in $1dm^3$ or $1000cm^3$ of distilled water.
- 0.5M NaOH contains 40g x 0.5 ie 20g to be weighed out and dissolved in 1 dm^3 or $1000cm^3$ of water

- 0.25M NaOH contains 40g x .0.25M ie 10g to be weighed out and dissolved in 1 dm^3 or $1000cm^3$
- 0.1M NaOH contains 40g x 0.1M ie 4g to be weighed out and dissolved in 1 dm^3 or 1000 cm^3 of water.

- 1M in 1000cm3 or 1dm3 flask contains Molar mass or 40g of NaOH dissolved in 1000cm3 of water in standard flask.
- 0.5M in 500cm3 flask = 40g x $500cm^3$ ÷ $1000cm^3$ x 0.5M ÷ 1M = 10g to be weighed out and dissolved in 500cm3 of water in standard flask.
- 0.25 M in 250 cm^3 flask = 40g x0.25M ÷ 1M x$250cm^3$ ÷ $1000cm^3$ = 2.5g to be weighed out and dissolved in 250 cm^3 of water in 250 flask.
- 0.1M in 100cm3 flask = 40g x 100cm3 ÷ 1000cm3 x0.1M ÷ 1M = 0.4g to be weighed out and dissolved in 100cm3 of water in 100 cm3 flask.

1.4.2. Preparation of Standard Solution of Liquid substance using dilution method.

1.4.2. Introduction

Dilute acid solutions such as the one used in titration experiments are made from concentrated acid solution bought from dealers in laboratory chemicals and other resources. On the container of concentrated acids are labels indicating density/specific gravity, formula, and molar mass of concentrated acid. The commercial acids do not often come with their concentrations written on their containers. It is therefore the teacher that prepares dilute acids from the concentrated ones using dilution equation, during which he/she must determine the concentration of the conc. commercial acid.

($M_1V_1 = M_2V_2$) where M = Molarity, V = Volume

Concentrated acids are very dangerous and should be handled with absolute care. They are corrosive to the body and can damage human body, clothing materials and furniture or even the floor of the laboratory. Concentrated acids release fumes and therefore should be stored proper corked in the fume chamber of the laboratory. Only trained and knowledgeable technicians should handle concentrated acids. On no account should students in primary or secondary schools be allowed to handle concentrated acids such as Hydrochloric acid, Nitric acid and sulphuric acid. These are the common concentrated acids found in the teaching laboratory.

UNIT 3 DILUTE SOLUTIONS

Activity 1. 4.1. Preparing Dilute Acid solution from concentrated acid solution

The teacher should wear laboratory coat, eye goggle, gloves for protection.

If the molarity of the concentrated acid not given on the label of the container, the teacher should work it out from the information available of the label. If the label on the Winchester Bottle of Conc. Sulphuric acid has the following information:
Density /specific gravity = 1.8g/cm3 or 1.8g/L
Percentage purity = 98%

A general formula for calculating the Molarity of the conc. acid from the information given is as follows:

$$\text{Molarity } M = \frac{10 \times D \times \%}{\text{Molar Mass}}$$

Where:
D = Density or Specific gravity;
% = Percentage purity of the acid
10 = constant dilution factor
M = Molarity of the Conc. acid

Based on the label information on the above Concentrated Sulphuric acid we can calculate Molarity using the above formula and thereafter prepare dilute solution of the acid using dilution equation.
Molecular Formula of Sulphuric Acid = H_2SO_4 [H =1, S = 32, O =16]
Molar Mass = 1x2 +32x1 +16 x4 = 2+32 + 64 = 98g/Mol.
Density/specific gravity = 1.8g/cm^3
% purity of the acid = 98%

$$M = \frac{10 \times 1.8gcm^{-3} \times 98}{98g} = 18 \text{ Mol. } dm^{-3}$$

This is 18 moles per dm^{-3} of the conc. acid. When we dilute to prepare standard dilute acid solution we must remember that Molarity is expressed in number of moles per dm^3

Dilution equation is given as: $M_1V_1 = M_2V_2$; $V_2 = \underline{M_1V_1}$ Where M1 = Molarity of conc. Acid, M2 = Molarity of Dilute Acid, V1 = Volume of conc. Acid, V2 = Volume of Dilute Acid. If we intend to prepare 0.5M bench Sulphuric Acid, we need to find the volume of the conc. acid that we would dissolve in $1dm^3$ flaks to get 0.05M solution
$M_1 = 18$, $M_2 = 0.05$, V_1 $1dm^3$, $V_2 = ?$

$$V_1 = \frac{M_2V_2}{M_1} = \frac{0.05\text{mole } dm^{-3} \times 1000cm^3}{18\text{molesdm}^{-3}} = \frac{50\ cm^3}{18} = 2.78cm^3$$

$2.78\ cm^3$ of concentrated acid will be diluted to 1 dm^3 or 1000 cm^3 to prepare 0.05M solution of dilute Tetraoxosulphate (VI) Acid (Sulphuric acid).

Use measuring cylinder to measure out $2.78cm^3$ of conc. H_2SO_4 in a fume chamber to avoid inhaling acid fumes. Put about $200cm^3$ of distilled water into the $1000cm^3$ standard flask. Using the funnel gradually add the measured conc. acid into the standard flask while stirring continuously with magnetic stirrer. Use water from the wash bottle to wash down the funnel into the flask to ensure none of the acid is lost. Remove the stirrer and wash it into the standard flask using wash bottle. Note that the standard flask and its content become hot because the reaction of the acid and water releases heat. Using distilled water carefully make up the volume of the solution to the standard mark of the flask. Cork it properly and shake to ensure complete mixing. Leave the standard flask in the fume chamber overnight for the solution to cool to room temperature. The volume of the solution would be short of the standard mark the following day due to cooling and contraction. Use wash bottle to carefully make up the solution to the standard mark. Your solution is 0.5 M Tetraoxosulphate(VI) Acid (sulphuric acid).

(Note: You do not add water to conc. acid because the reaction to form solution may become very violent and dangerous. You can acid gradually into water and there would be no violent reaction)
If the conc. acid available to be diluted is 6M hydrochloric acid to produce 0.2M bench solution, the dilution equation would be used directly to find the volume of the conc. acid that would be diluted to $1000cm_3$ of solution.
$M_1V_1 = M_2V_2$, $6 \times V_1 = 0.2 \times 1000cm3$, $V_1 = 0.2x1000/6 = 33.33 Cm^3$.

This means that 33.3 cm^3 of the conc. acid would be measured out in a measuring cylinder, added gradually into distilled water in a standard flask, and then the solution is made up to $1000cm^3$.

If a solution of 0.3M is to be prepared in 250 cm^3 standard flask, the volume of conc. HCl that would be made up to the mark is: $M1V1 = M_2V_2$, $6xV_1 = 0.3m \times 250$
$V1 = M_2V_2/ 6 = 0.3x250/6.$, = $12.5cm^3$. This means that **12.**5 cm^3 of the conc. Acid will be added to the standard flask and the volume is made up to 250 cm^3 using wash bottle.

Self – Assessment Questions 2.

1. State and identify the variables in formula for calculation of the molarity of concentrated acid before using it to prepare dilute standards solution.
2. What is standard solution?
3. Why should you avoid adding water to concentrated acid but

Figure 11: Measuring Cylinders of different sizes. Figure 12: Stock Winchester bottle of Conc. Acid

{Figures Brought in by Reviewer}

Figure 13: Pipettes of different sizes
{Fig Brought in by Reviewer}

Activity 1.4.2: Practising to draw given volumes of Liquids using the Pipette and Burette

Accurately measuring the volume of a dilute solution is one of the essential skills in volumetric analysis. For purposes of titration, the volume of a solution can be measured using a pipette of desired size. Figure 13 shows an array of pipettes which are standard measure of volumes of solution for analysis purposes. The measurement is called pipetting and is carried out as follows:

(A). **The Pipette:** Wash the pipette thoroughly using water and soap solution

Suck up clean water with the pipette and using your fore finger to close the mouth of the pipette, discharge the water gradually and exercise control of the rate of discharge of the water.

ii. Dip the end of the pipette inside the chemical solution. With the upper end of the pipette inside your mouth, carefully suck up a little of the solution and use this to rinse the pipette thoroughly. Then empty the pipette

iii. Then suck the solution and fill the pipette beyond the standard mark. Place your right forefinger across the mouth to seal the upper end of the pipette immediately you remove the pipette from your mouth.

iv. Gradually and carefully release the solution into its container by opening the sealed end and watch the solution in the pipette drain smoothly and gradually. Bring your observing eyes at parallax with the standard mark of the pipette and stopper the draining of the solution when the meniscus of solution stands on the standard mark. When this done properly, the solution in the pipette is exactly the volume indicated on the standard mark. The volume of solution measured using the pipette is very accurate. The sizes of pipettes vary so that you can select the size you want depending on the nature your laboratory activity you are carrying out.

(B) **The Burette:** A **burette** is a graduated glass tube with a tap at one end. It is standard and used for delivering known volumes of liquid, especially in titrations. It is a long, graduated glass usually mounted on retort stand during titration. Using the burette, even one drop of liquid can be delivered during titration experiments. Figure 14 shows a 50cm^3 – burette.

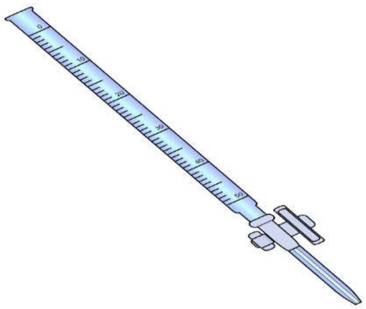


Figure 14: 50cm^3 – Burette for Titration

UNIT 4 TITRATION EXPERIMENTS

1.4.3: Volumetric Analysis (Carrying out Titration Experiment)

1.4.3.1. Introduction

Volumetric analysis is a basic operation chemical process of determining the amount reacting species that are involved during chemical reactions. It is an accurate quantitative approach, whereby a standard chemical quantity is used to standardize an unknown chemical quantity by allowing the two substances to react quantitatively, and using the stoichiometric equation to find out the quantity of the unknown substance that has been consumed by a known quantity of the standard solution. In this way the chemical substance of unknown quantity is standardized and its concentration in grams or moles per dm^3 becomes known through calculations.

In the case of acid base titration which is often carried out by secondary school chemistry students, a standard solution of acid is used to titrate a given volume of base of unknown concentration to determine the molarity (number of moles per dm^3) of the base. The base thus becomes standard solution. In the same way a standard base solution can be used to standardize an acid solution. Other chemical substance than acids and bases can be involved in volumetric analysis as long as the reaction of the substances is quantitative, and it is possible to observe the end point when one reacting species is completely used up. In acid – base titration, substances like methyl orange, phenolphthalein, screened methyl orange, methyl red, ortho cresol, etc can be used as indicators because their colours change at different pH of the solution. Thus they have different colours in acid and basic mediums.

Activity 1.4.3.1: Titration

1. Pipette out 20 cm^3 or 25 cm^3 (depending on which type of pipette is available) of the solution provided (usually a base) into a conical flask. Note that this should follow the procedure described under the use of a pipette.

2. Add about 2 or 3 drops of the indicator to the base and shake the flask. Usually, Methyl Orange is provided but occasionally, Phenolphthalein may be used. Methyl Orange is yellowish in a base and pinkish in an acid solution, while Phenolphthalein is red in a base and colourless in an acid solution.
3. Fill the burette with the titrant (acid solution) following the procedure described under the use of a burette

4. Adjust the level of the solution in the burette as appropriate. Take the reading of the burette and record it as “initial reading” ensuring there is no leakage in the burette.

5. Now place the conical flask on the white tile at the base of the retort stand. Use white paper if there is no white tile.

6. In order to prevent careless spilling of the acid solution while titrating, adjust the height of the burette so that the jet just lies slightly within the mouth of the conical flask

7. Open the burette tap to allow the solution to run into the conical flask but this should be at a controlled rate. The thumb, index finger and second finger of your hand (preferably left hand) are used for the control

8. Use the other hand (right hand) to swirl the conical flask continuously as the acid solution is being added from the burette. The agitation will ensure a proper mixture of the acid and base solutions.

9. Since you are expecting a colour change at the end point, add the acid solution drop by drop towards the end point. You should end the titration by turning off the burette tap immediately you observe that addition of a single drop of the acid solution causes a permanent colour change (yellow to faint or pink in the case of Methyl Orange indicator).

10. Read and record the burette reading. The titre value is obtained by subtracting the initial reading from the final reading. The titre value is the volume of the acid solution required to react completely with the volume of the base in the conical flask.

Activity 1.4.3.2: Recording data obtained from Volumetric Analysis Rules Guiding the Writing of Burette Readings and Calculation of Average Titre Value

1. Usually the first titration is regarded as rough/trial, so have to repeat the titration two or three more times, ensuring that two titre values do not vary by more than ± 2.0 cm^3

2. Record burette reading to two decimal places.

$$\frac{19.50 + 19.55}{2} = 19.53\ cm^3$$

3. The burette readings are conveniently tabulated as shown below:

Burette Readings	**Titrations (cm^3)**		
	Trial	**First**	**Second**
Final Burette Reading	21.10	41.60	21.55
Initial Burette Reading	0.00	21.10	1.00
Volume of Acid Used	21.10	20.50	20.55

Average volume of acid used to neutralize 25 cm^3 of the base:

$$\frac{20.50 + 20.55}{2} = 20.53cm^3$$

4. You should use for averaging only titre values that are concordant to the level of not more ± 2.0 cm^3
5. Make sure you record the calculated value of concentrations in moles per dm^3 (molarities) to three decimal places e.g. 0.560M
6. Concentration in grams per dm^3 and any other calculation should be expressed in three significant figures e.g. 2.68g/dm^3

Self-Assessment and Practice Questions

Question 1

A is a solution of Tetraoxosulphate (VI) acid containing 5.8g per dm^3. Solution B contains 9.3g of an impure potassium hydroxide per dm^3.

Put the acid solution A into the burette and titrate with 25 cm^3 or (20 cm^3) portion of B, using methyl orange or screened methyl orange as indicator.

From your result, calculate;

a. The concentration in moles/dm^3 of the Tetraoxosulphate (VI) acid in solution A

b. The concentration in moles/dm^3 of the potassium hydroxide in solution B

c. The concentration in grams/dm^3 of potassium hydroxide in solution B

d. The percentage purity of potassium hydroxide in solution B

The equation for the reaction is:

$$H_2SO_4 + KOH \longrightarrow K_2SO_4.2H_2O$$

(H = 1.0; S = 32.0; O = 16.0; K = 39.0)

Question 2

X g of anhydrous sodium trioxocarbonate (IV) was treated with 1000cm^3 or (1 dm^3) of 0.300M hydrochloric acid to obtain a solution A, which contains excess hydrochloric acid after the treatment. B is a 0.09M solution of sodium hydroxide.

Put the acid solution A into the burette and titrate against 25 cm^3 or (20 cm^3) portion of B. Use methyl orange or screened methyl orange as indicator.

Record the volume of your pipette. Tabulate your burette readings and calculate the average volume of acid required to neutralize the stated volume B.

From your result calculate:

(a) The concentration of acid in solution A in mole per litre (dm^3)

(b) The mass, X, of the sodium trioxocarbonate (IV)

Question 3

Solution A is a solution of sodium hydroxide containing 0.025 mole of the alkali in 250 cm^3 of solution. B is a solution of a dibasic acid, H_2Y.

Put solution B into burette. Pipette 25 cm^3 or (20 cm^3) portion of solution A into a conical flask and titrate with solution B using phenolphthalein as indicator.

Record the volume of your pipette. Tabulate your burette reading and calculate the average volume of acid used.

(a) Calculate the concentration in moles/dm^3 of solution B from your results

(b) if the concentration of the acid in solution B is 4.90g/dm^3, what is the molar mass of the acid to the nearest whole number?

(c) Calculate the percentage by mass of Y in H_2Y

Question 4

P is a solution of either hydrochloric acid or trioxonitrate (V) acid containing 4.6gdm^3. Q is a solution of potassium hydroxide. The concentration of solution Q is 5.75gdm^3.

Put solution P into the burette and titrate against 25 cm^3 or (20 cm^3) portion of Q. Use methyl orange or screened methyl orange as indicator.

Record the volume of your pipette. Tabulate your burette readings and calculate the average volume of acid required to neutralize the stated volume Q.

From your results, calculate:

(a) The concentration in moles/dm^3 of the base solution Q.

(b) The concentration in moles/dm^3 of the acid solution P.

(c) The molar mass of the acid

(d) From your result in (c) above identify the acid. Explain clearly how you arrived at your conclusion.

(H = 1.0; O = 16.0; Na = 23.0; Cl = 35.5; K = 39.0).

Question 5

E is a solution containing 15.7g/dm^3 of hydrated sodium trioxocarbonate (IV). F is a solution of Tetraoxosulphate (VI) acid. The concentration of solution F in mole per dm^3 is 0.065M.

Put F into the burette and titrate with 25 cm^3 or (20 cm^3) portion of solution E. Use methyl orange or screened methyl orange as indicator.

Record the volume of your pipette. Tabulate your burette readings and calculate the average volume of acid required to neutralize the stated volume of E.

From your result, calculate:

(a) The concentration in moles/dm^3 of solution E
(b) The molar mass of hydrated sodium trioxocarbonate (IV).
(c) The value of X.

The equation of the reaction is;

$$Na_2CO_3XH_2O + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + (X + 1)H_2O.$$

UNIT 5: QUALITATIVE ANALYSIS

1.5.1: Qualitative Analysis

1.5.1. Introduction: Chemical substances are made up of particles. The particles may be atoms, molecules or ions. The ions carrying charges which may be negative charge (negatively charge ions are called anions), or positive charge (positively charged ions are called cations). Qualitative analysis is an effort to identify the compositions or constituents of a chemical substance. It involves the identification of the individual atom or ion - anions and cations - present in a sample of the chemical substance. The chemical substance to be analyzed may be a salt or a mixture of salts, metallic oxides or bases or organic molecule. Chemical substances are grouped according to their characteristics. It is these characteristics that are used to identify their presence in a given sample that is being analyzed. For instance, acids turn blue litmus paper red; therefore, if a chemical substance causes litmus to turn red then the sample is an acid or it is acidic. In the same way, all chemical substances have their characteristic chemical reactions that give away their presence in a sample.

Chemical analysis of a given sample for identification of the composition of the substance follows some procedure for achieving the aim of the analysis. This procedure is the scientific methods of analysis that will surely lead to the achievement of the objectives of the analysis. Analysis of a simple salt involves:

a. Physical observation/examination of physical looks of the sample to note whether it is a liquid or solution or solid; whether it crystalline, or powdery, its colour, and general structure.
b. The action of heat on a salt: does it melt, burn, decompose, deprecate, the colour of the flame when burnt etc.
c. Does it dissolve in water, colour of the solution formed, is the solution of the sample acidic, or basic or neutral to litmus?
d. Does it dissolve in acid, or base, or organic solvent like ethanol or acetone?

e. The reactions of a salt or solution of it with dilute acids and alkalis
f. The reactions of solutions of salt with other reagents, and
g. Flame test.

1.5.2: Techniques and Procedures for Qualitative Analysis

In qualitative analysis, salts or a mixture of salts are usually supplied. At times, a solution of a salt may be given. This is an unknown compound as far as the students are concerned, the containers are appropriately labelled like specimen A, B, C etc.

When you are given an unknown salt, you are expected to carry out specified tests on it or the solution of it, observe the changes and carefully record them and finally arrive at inferences or conclusions about the nature of the unknown substance tested. For good performance, since this is part of the practical, the following guidelines should be carefully employed.

1. Bench Solutions

Bench Solutions are solutions prepared and left on the laboratory benches or racks. They are used for qualitative chemical analysis. They are usually 2 Molar solutions. Some bench solutions in the Chemistry laboratory include:

HCl, HNO_3, H_2SO_4, $KMnO_4$, NH_4OH, $NaOH$, KOH, $Ca(OH)_2$, $K_2Cr_2O_7$, Na_2CO_3, $Cu(NO_3)_2$, KI, KIO_3, $BaCl_2$, $AgNO_3$ $Pb(CH_3COO)_2$, $Pb(NO_3)_2$, CH_3CH_2OH, CH_3COOH, etc.

2. Heating of Dry Salt in a Test Tube

When a given substance is to be tested in a dry state, heat is gently applied at the initial state, while observing any change taking place and then heat is strongly applied until no further change is observed. You will be expected to describe the residue, its appearance when hot and when it has been allowed to cool to room temperature. When heating, the test tube must be held with a test tube holder in a slanting position, with its mouth pointing away from you or your fellow worker in the laboratory. Observe whether the sample decomposes on heating and whether any gases are released on decomposition.

a. The amount of substance required here for heating or preparing solutions is always a small quantity
b. Describe any gas evolved giving its colour, odour and a chemical test for confirmation of the gas.

2. Preparing Solution of Salt

When you are not given the solvent for preparing the solution of an unknown substance, use a suitable solvent to prepare the solution of the substance. The following solvents should be tried in that order: water, dilute hydrochloric acid and dilute trioxonitrate (V) acid, ensuring that the solid added dissolves completely.

If dissolution is slow, you can warm the solution gently ensuring that the solution is cooled under a tap or left to cool on its own, before carrying out chemical tests on the solution of the salt. The solution must be clear and during filtration, the solution must be carefully poured into the middle of the cone of the filter paper.

3. Adding a Reagent to Solution in a Test Tube

a. Any reagent to be added to the prepared solution must be a little at a time or (few drops at a time) while observing any changes that take place, shake after addition, until there is no further change. Use only about 2 – 3 cm^3 of the prepared solution. A dropping pipette is usually useful for adding reagents to solutions.

b. If you observe any precipitate after the addition of the reagent, describe its colour and/or appearance such as crystalline or gelatinous or powdery.

c. If it happens that no change is observed after adding the necessary reagents to the solution, then record ‘there is no visible change’.

1.5.3: Common Gases, their characteristics and sources

GASES	PROPERTIES	SOURCES OF GASES
Hydrogen (H_2)	Colourless, odourless, explodes with a slight pop sound when flame is applied	Evolves when metals react with dilute acids e.g. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
Oxygen (O_2)	Colourless, odourless, re-lights or rekindles a glowing splint	Evolves when oxides (peroxides, salts or oxy-acids, trioxonitrate (V), trioxochlorate (VII), trioxoiodates (VII) are heated, e.g. $2KClO_3 \rightarrow 2KCl + 3O_2$
Carbon(IV)oxide (CO_2)	Colourless, odourless, slightly acidic, turns calcium hydroxide solutions (lime water) milky.	Evolves when Trioxocarbonate (IV) or some metals are heated Dilute acids react with Trioxocarbonate (IV) e.g.
		$CaCO_3 \rightarrow CaO + CO_2$ $Na_2CO_3 + 2HCl \rightarrow CO_2 + H_2O + 2NaCl$
Chlorine (Cl_2)	Yellowish green colour, choking smell, turns moist blue litmus paper red and then bleaches	Evolves when certain chlorides react with oxidizing agents. $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

	it.	
Hydrogen Chloride ($HCl_{(g)}$)	Colourless, irritating smell, turns blue litmus paper red, white fumes with ammonia, fuming in moist air.	Evolves when a chloride reacts with concentrated Tetraoxosulphate (VI) acid (H_2SO_4), e.g. $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

What is a preliminary Test?

Confirmatory Test of Some common gases

Gas	**Confirmatory Test**	**Sources of the gas**
Hydrogen Sulphide (H_2S)	Colourless, smells like bad (rotten) egg, burns with light blue flame and deposits Sulphur, turns Lead Ethanoate paper black.	Evolves when a dilute acid reacts with a Sulphide e.g. $FeS + 2HCl \rightarrow FeCl_2 + H_2S$
Nitrogen (IV) Oxide (NO_2)	Brown gas with choking smell, turns moist blue litmus paper red, turns starch iodide paper blue black.	NO_2 Evolves when Trioxonitrate (V) or dioxonitrite (III) salts of some metals below Na in the Electrochemical Series are heated. Egs. $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

		Conc. HNO_3 reacts with metals e.g. $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2$ $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
Sulphur (IV) Oxide (SO_2)	SO_2 turns litmus paper red, It has colourless, irritating smell or (smell of burning Sulphur), It turns Potassium tetraoxomanganate (VII) solution colourless and turns litmus paper dipped in acidified potassium heptaoxodichromate (VI) solution green.	Trioxosulphate (IV) salts (SO_3^-). SO_2 evolves when dilute acid reacts with some tetraoxosulphate (VI), trioxosulphates (IV) or thiosulphates e.g. $Na_2SO_3 + 2HCl \longrightarrow 2NaCl + NH_3 + H_2O + SO_2$
Ammonia (NH_3)	NH_3 turns moist red litmus blue, Colourless gas with characteristic choking smell, forms white fumes with concentrated hydrochloric acid, condenses on the side or around the mouth of	Salts of Ammonium ion (NH_4^+) when reacted with Alkali with warming. NH_3 gas evolves when sodium hydroxide is

	the test tube containing conc. HCl.	added to an ammonium salt, e.g. $NH_4Cl + NaOH \longrightarrow NaCl + NH_3 + H_2O$
Water Vapour (H_2O)	Turns anhydrous copper tetraoxosuphate (VI) salt blue.	It evolves when hydrated salts are heated and converted to anhydrous salt. $NaCO_3 . 10 H_2O$

What is confirmatory Test?

1.5.4: Recording of Experiment Results

1.5.4.Introduction

Experiment results should be recorded in a clear and unambiguous language that states what action that is done the unknown sample, the observation of the effects of the action on the sample and the inference or conclusion drawn from the observations. The recording of results experiments intended to find out what the make of unknown samples are is recorded in a tabular format with three columns entitled: Test/action on sample, observation and inference/conclusion. These columns are completed as soon as the test and observation are completed. Identifying an unknown sample usually starts with describing the physical characteristics of the sample to identify its colour, whether it is liquid or solid, whether it is crystalline or powdery, deliquescent or hygroscopic etc. These initial observations and descriptions of the physical nature of the sample is the right point to start qualitative chemical analysis of an unknown sample. Further tests are carried out on the sample to identify the constituents of the sample and then mention what the sample is. The Table below shows how to record observations during qualitative chemical analysis.

Test	Observation	Inference/Conclusion
Physical observation	Describe the sample accurately	What conclusion can you reach due to the physical nature of the sample
Pick small quantity of the sample on platinum spatula and heat it gently on the Bunsen burner flame and then strongly to observe the colour of the flame and nature of the burning of the substance	Organic substances often burn with luminous flames, heavy carbon hydrocarbons burn with smoky flames, Metal ions burn with characteristic flames	Brilliant yellow for Na^{+}, Blue-Green flame for Cu^{2+}, Lilac for K^{+} ,Orange red for Ca^{2+},
To small portion of the given sample of unknown substance, add dilute HCl or dilute H_2SO_4	There is a quick effervescence of a colourless odourless gas which turns Calcium hydroxide solution (lime water) milky.	The gas given off is Carbon (IV) Oxide (CO_2) and the anion is CO_3^{2-} or HCO_3.
To original sample add concentrated Tetraoxosulphate (VI) acid	There is an effervescence of a colourless gas with a rotten egg smell and turns Lead Ethanoate paper black	The gas evolved is Hydrogen Sulphide (H_2S) and the anion involved is S^{2-}
To original sample add concentrated Tetraoxosulphate (VI) acid	There is an effervescence of brown gas with choking smell,	The gas evolved is Nitrogen (IV) Oxide (NO_2) and the anion

	which turns moist blue litmus paper red and starch iodide paper blue black.	NO_2^- (dioxonitrite (III)), are present in the sample.
To original sample add concentrated Tetraoxosulphate (VI) acid then heat in the flame	There is an effervescence of a colourless gas with irritating smell which turns both potassium tetraoxomanganate (VII) paper and acidified Potassium heptaoxodichromate (VI) paper colourless and green respectively.	The gas given off is Sulphur (IV) oxide (SO_2) and the anion is SO_3^{2-} (trioxosulphate (IV))
In the same manner if the test (b) indicates the presence of Cl^-, mix the unknown salt with MnO_2 and add concentrated Tetraoxosulphate (VI) acid to the mixture.	1.There is an effervescence of a colourless gas with irritating smell which turns moist blue litmus red and forms white fumes with ammonia.	The gas given of is HCl_g hydrogen chloride gas from the anion Cl^- (chloride).
	2.There is an effervescence of a brown gas (on strong heating) with choking smell, turns moist blue litmus paper red	The gas is nitrogen (IV) oxide and the anion is NO_3^- trioxonitrate (V).

Confirmatory Tests anions

Tetraoxosulphate	1. White precipitate	$SO4^{2-}$ is confirmed.

(VI) ion ($SO4^{2-}$) 1. To the original sample solution, add solution of Lead ethanoate solution ($Pb(CH3COO^{-})_2$ or Lead Nitrate solution ($Pb(NO_3^{-})_2$ insoluble in excess Ethanoic acid or Trioxonitrate (V) acid respectively 2. Add aqueous solution of $BaCl_2$ to the original solution of the given sample.	(PPT) of Lead Tetraoxosulphate (VI) is formed. It is insoluble in excess dilute acid. 2. A white precipitate of $BaSO_4$ indicates the presence of SO_4^{2-} ion	
Chloride ion (Cl^-): To the aqueous solution of the original sample add Silver Nitrate solution in drops until excess	Cuddy white precipitate which darkens on exposure to light.	Cl^- is confirmed
NO_3^- ion. This is the Brown Ring Test. Add to original solution of the sample freshly prepared solution of iron (II) sulphate. Then gently add concentrated	A brown coloured ring forms at the interface between the aqueous layer and the acid layer.	NO_3^- is confirmed

H_2SO_4 solution gradually along the wall of the test tube. The conc. acid forms a layer below the aqueous solution.

Preliminary Testing of samples with NaOH and NH_4OH solutions for identification of Cations

Cation	Sodium hydroxide (NaOH) Solution	Ammonia (NH_4OH) Solution
	Observations	**Observations**
Ca^{2+}	A white precipitate is formed which is insoluble in excess of sodium hydroxide	There is no precipitate formed with ammonia solution
	Solution	
Cu^{2+}	A blue precipitate is formed which is insoluble in excess of sodium hydroxide Solution	A blue precipitate is formed which is soluble in excess of ammonia solution to give a deep blue solution
Fe^{2+}	A green precipitate is formed which is insoluble in excess of sodium hydroxide Solution	A green precipitate is formed which is insoluble in excess of ammonia solution
Fe^{3+}	A reddish brown precipitate is formed which is insoluble in excess of sodium hydroxide solution	A white precipitate is formed which is soluble in excess of ammonia solution to give a clear colourless solution
Pb^{2+}	A white precipitate is formed	A white precipitate is formed

	which is soluble in excess of sodium hydroxide solution giving a clear colourless solution	which is soluble in excess of ammonia solution to give a clear colourless solution
Zn^{2+}	A white precipitate is formed which dissolves in excess sodium hydroxide solution giving a clear colourless solution	A white precipitate is formed which is insoluble in excess of ammonia solution

Confirmatory Tests for Cations

Test	Observation	Inference
Ca^{2+} Ammonium oxalate is added to the aqueous solution of the salt	A white precipitate is formed which is soluble in dilute hydrochloric acid but insoluble in dilute ethanoic acid	Ca^{2+} confirmed
Cu^{2+} Potassium hexacyanoferrate (II) solution is added to the aqueous solution of the salt	A brown precipitate is formed which is insoluble in excess of Potassium hexacyanoferrate (II) Solution	Cu^{2+} confirmed
Fe^{2+} i. Add dilute H_2SO_4 to the aqueous solution of the salt,	The solution of $KMnO_4$ is decolorized, turning slightly yellow because it has been	Fe^{2+} is confirmed

followed by a few drops of $KMnO_4$ solution.	reduced by Fe^{2+} to Mn^{2+}	
ii. Add Potassium hexacyanoferrate (III) solution to the aqueous solution of the Salt	A deep blue precipitate is formed	Fe^{2+} is confirmed
Fe^{3+} i. Add Potassium hexacyanoferrate (III) solution to the aqueous solution of the salt.	A deep blue precipitate is formed	Fe^{3+} is confirmed
ii. Add ammonium hexacyanoferrate (II) thiocyanate solution to the	A blue-red solution results.	Fe^{3+} is confirmed
aqueous solution of the salt		
Pb^{2+} i. Add dilute HCl to a cold aqueous solution of the salt	A white precipitate is formed which is insoluble in excess of dilute HCl	The precipitate is $PbCl_{2(s)}$ Pb^{2+} $+2Cl^{-}$ $PbCl_{2(s)}$
ii. The mixture in (i) above is Heated	A precipitate dissolves to give a clear colourless solution	Pb^{2+} is confirmed (PbCl$_2$ is also confirmed)
iii. The resulting solution is	The precipitate reappears as white	

Cooled	Crystals.	
Zn^{2+}: Add ammonium Sulphide solution to the aqueous solution of the salt or pass H_2S gas into the solution if it is neutral (not acidic)	A white precipitate is formed	Zn^{2+} is confirmed

Note

1. $BaCl_2$ can form white precipitates with CO_3^{2-} and SO_3^{2-} as $BaCO_3$ and $BaSO_3$ respectively, but soluble in dilute HCl.

2. $AgNO_3$ can give white precipitate with CO_3^{2-} and SO_4^{2-} but not soluble in excess ammonia.

UNIT 6: SOLUBILITY OF SALTS

Solubility of Salts

A good knowledge of the solubility of salts is essential since it enables a you to narrow the choice of possible salts. It further helps you to suspect the identity of a salt. Information given below on solubility of salts will serve as a good guide.

a. All ammonium salts are soluble in water

b. All trioxonitrate (V) salts are soluble in cold or warm water

c. All common salts of sodium and potassium are soluble in water

d. All Tetraoxosulphate (VI) salts, except those of calcium, Lead (II) and barium are soluble in water

e. All chlorides, except those of Lead (II), copper (I), mercury (II) and silver are soluble in water but more soluble in hot water.

f. All trioxocarbonate (IV) are insoluble in water except those of sodium, potassium and ammonium.

Colour of Some Common Salts and Appearances of Residues

colour	**Possible Compound**
White	Probably in Alkali Metal compounds or halogen compounds of Mg, Ca or Ba
Yellow Hot	Zinc (II) Oxide, Zinc Salts
White Cold	

Yellow	Lead (II) Oxide, hydrated iron (II) salts, AgI, AgBr
Black	CuO, FeO, Fe_3O_4, FeS, CuS, PbS, MnO_2
Black Hot	Iron (II) Oxide, many Iron (II) and Iron (III) compounds
Brown Cold	
Brown	PbO_2, Iron (III) salts, e.g. $CuCrO_4$, $CuBr_2$
Blue	Hydrated copper (II) salts e.g. $CuSO_4H_2O$
Green	Hydrated Iron (II) salts, $CuCO_3$, hydrated $CuCl_2$
Red	Fe_2O_3, Cu_2O, Pb_3O_4, HgO
Orange	$K_2Cr_2O_7$
Purple	Potassium tetraoxomanganate (VII), ($KMnO_4$), Iodine (I_2)

Self-Assessment Questions 3

1.What is the formula for determining Molar Concentration of Concentrated Acid
2. State Dilution equation and name the variable
3. What is a standard solution?
4. What is preliminary test?

Sample Practical Examination Questions

1. X is a solution of a simple salt. Carry out the following test on 20 cm^3 portions of it. Do not perform any other test. State your observation and conclusions.

   a. Add 2 drops of dilute sodium hydroxide solution, and then in excess, warm gently.

   b. Add 2 or 3 drops of dilute ammonia solution and then in excess, warm slightly

   c. Add 2 drops of hydrochloric acid and then a few drops of

6: Summary

In this unit we have gone great lengths discussing practicum in Chemistry education. Various practical activities carried in secondary school Chemistry have been discussed, starting with separation techniques of different kinds of chemical substances, methods of preparation of chemical solutions, quantitative chemical analysis and qualitative chemical analysis. The various practical activities described and meant to be hands-on. You are therefor expected to approach a school with well-equipped Chemistry laboratory to carry out most of the described Chemistry practical activities. Check the section on further reading to discover the resources you need for more discoveries in practicum in Chemistry education.

1.7: Possible Answers to Self-Assessment Question

Self – Assessment 1:

1. When two immiscible form a mixture, what apparatus would you use to separate them?

Separatory Funnel

2. What difference in the two liquids would make it possible for you to separate them?

The density the two liquids are different. One is denser than the other and the less dense one will float on the denser one, showing different columns.

3. A mixture contains two liquids of different boiling points. Name the method you can use to separate them.

Distillation apparatus can be used to separate them

4. A solid dissolved in a liquid to form a solution, what method would you use to separate the solid from the liquid?

Evaporation method can be used to separate the liquid or solvent from the solute or the dissolved substance

Self – Assessment Questions 2

1. What is standard solution?

A standard solution is a solution whose concentration is accurately known

2. Why should you avoid adding water to concentrated acid but you can add concentrated acid gradually to water?

When water is added to concentrated acid, the reaction is very rapid and it generates much heat which make the mixture blow out spilling the acid. It is dangerous. But concentrated acid can be added to water gradually without explosion the water gradually dilutes the conc. Acid with over-boiling and spilling. It is safe.

Self-Assessment 3:

The formula for determining the molar concentration of concentrated acid from the manufacturers is the following:

1. Molarity $M = \dfrac{10 \times D \times \%}{M \text{ (Molar Mass)}}$

Where:

D = Density or Specific gravity of the conc. acid;

% = Percentage purity of the acid
10 = constant factor of dilution
M = Molarity of the Conc. Acid

2. State Dilution equation and the variables
   $M_1V_1 = M_2 V_2$
   M_1 = Molarity of the original solution; M_2 = Molarity of Dilute Solution
   V_1 = Volume of Original solution; V_2 = Volume of Dilute solution

3. What is a standard solution?
   A standard solution is a solution whose concentration is accurately known per Known volume of solvent.

4. What is preliminary test?

   A preliminary test is a test carried out on a chemical substance to find direct in the determination of the contents of the substance. It gives the analyst clue for further test to find out the constituents of the substance.

   What is confirmatory test in the Chemistry Laboratory?
   A confirmatory test is a test targeted to find out whether a particular species (ion, molecule, bond type etc. is present in a sample. A confirmatory chemical test is specifically sensitive to confirm the presence or absence of a targeted species in a sample under given conditions.

1.8: **References/Further Reading:**

1. Google search on the preparation and characterization of any named chemical substance
2. Achimugu Lawrence. (2017). Senior Secondary School Practical Chemistry.
3. Osei Yaw Ababio. (2016). New School Chemistry for Senior Secondary School.

MODULE 3: CHEMISTRY EDUCATION

Reviewed and Reprocessed by:

Prof Z. C, Njoku and Cliff Okebalama
Department of Science Education,
University of Nigeria, Nsukka
Zephrinus.njoku@unn.edu.ng
08035811170

U

NIT 1: SEPARATION OF MIXTURES

1.1. General Introduction

Chemistry may be defined as the study of matter, its structure, properties, transformations, interactions processes, and the energy implications of the changes matter undergoes. Chemistry as a science discipline is an activity based subject which strongly affects our daily lives, our environment and our local and national economies. The material world is made of matter. Therefore, all forms of the material world are chemical substances. Through chemical interactions among various substances new substances are made. The process of chemical interactions or chemical reactions can lead to production of new useful or good substances, or bad and dangerous substances that are capable of destroying our environment. Therefore, the nature of Chemistry is such that it is handled with care so as to produce useful things for our benefits and wellbeing while discouraging the production of substances that can destroy us and our environment. This is why the study of Chemistry at all levels of education involves plenty practical work or laboratory activities aimed to make the subject matter contents (Theories, Laws, concepts, Principles and Hypotheses and methodologies) clearer and to develop practical or manual skills necessary for handling chemical substances and challenges that chemical substances may pose to our life and our environment. Thus, as much as possible the teaching of Chemistry should be practical based to enable learners concretize the abstract concepts they have learnt, as well as verify the theories, laws and principles of Chemistry.

By the end of your reading and carrying out the activities in this Chemistry manual, you should be able to achieve the following objectives

1.2 Learning Outcomes

1. Plan Chemistry experiments and practical activities
2. Set up equipment and materials for conducting Chemistry practical activities
3. Develop practical skills or process skills in conducting Chemistry practical activities, including some experiments
4. Learn to control variables during Chemistry experiments
5. Develop positive attitudes to Chemistry practical work/activities
6. Carry out practical activities on various topics in Chemistry
7. Take appropriate precautions in the conduct of Chemistry practical activities, and handling of chemical substances
8. Establish basic rules for students' use of Chemistry laboratory and the equipment and resources therein.

1.3.1 SEPARATION OF MIXTURES OF CHEMICAL SUBSTANCES

In nature, many chemical substances occur as mixtures, while production of substances often involve separation of mixtures of different products to obtain pure substances that are very useful in the industry and home. There are several methods of separation of mixtures, each of which depends on the physical and chemical properties of the components of the mixture. Some of the physical methods of separation of mixtures into their different components include filtration, Evaporation, Centrifuging, Chromatography, Distillation, Fractional Distillation, Magnetization, Crystallization, Sublimation and Decantation. In this section, we shall carry out activities leading to separation of different types of mixtures using some of the methods/techniques listed above. For some mixtures, more than one separation methods/techniques can be used. You will always be required to take special note of the properties of the components of the mixtures that make it possible to the use the separation techniques involved. Let us carry out the separation of some mixtures using the activities below:

Activity 1.3.1. Separation of Insoluble solid particles from liquid/solution

Aim: To separate an insoluble solid from solution/liquid.

Theory: One of the components of the mixture is insoluble solid while the other component is a liquid. The two substances can be separated by filtration or decantation using appropriate apparatuses.

Apparatus: $250cm^3$ beaker, funnel, large test tube or boiling tube, filter paper, test tube rack and stirrer.

Reagents: $50cm^3$ tap water and 5 grams soil.

Procedure for Decantation: Mix thoroughly $50cm^3$ of water and sand. Stir the mixture completely until it is cloudy brown. Allow the mixture to settle for 20 minutes. What is your observation? Using an empty beaker as the collector, without shaking, slowly decant the liquid part of the mixture into the clean beaker. The liquid in the clean beaker is called decantate while the sand remaining at the bottom of the first beaker is called the residue. What is the colour of the decantate?

Procedure for Filtration: Mix $50cm^3$ tap water with 5 grams soil and stir until a cloudy mixture appears. Fold a filter paper into cone-shape and fit it into the filter funnel. Pour the mixture slowly into the funnel and record your observations. Describe the separated substances. The liquid is called the filtrate while the solid on the filter paper is called the residue. Compare the separated substances when decantation is used and when filtration is used. What are the differences?

Activity 1.3. 2: Separation of dissolved solid from solution by Evaporation method.

Aim: To separate dissolved solid from its solution

1.3.2.1. Introduction: A mixture of two substances where one is a solid which dissolved in the other which is a liquid. The mixture is called solution. In this case the properties of the mixture are that one is volatile and can be converted into vapour by heating. When the volatile component is evaporated we obtain the dissolved substance as a solid residue.

Apparatus: Evaporating dish, two 250cm^3 beakers, Bunsen burner, wire gauze, Tripod Stand, Glass stirrer and desiccator, clock glass.

Procedure: Add 3g of common salt (NaCl) or one cube of sugar into a beaker. Add 5cm^3 of distilled water and stir until the solid dissolves completely in water. Transfer the resulting solution into an evaporating dish. Using the Bunsen burner flame, heat the solution in the evaporating dish to dryness. Describe your observation during course of evaporation and at the point of heating to complete dryness. Keep the evaporating dish and its contents in a desiccator to cool. Describe the residue.

Activity 1.3.3: Separation of mixture of two or more liquids with widely varying boiling points

Aim: To separate two or more miscible liquids with large differences in their boiling points.

1.3.2.2 Introduction: All liquids have boiling points. Some boil over a short range of temperature while others boil at a sharp temperature. The boiling point of a liquid is the temperature at which the liquid is converted to vapour /gas. If liquids of different boiling points are mixed, separating the mixture would involve boiling the liquid mixture so that each of the components of the mixture boils over at its specific boiling point. The vapour can be cooled to condensation if it is desired to collect it again as a separate liquid. This is what happens in the Liebig condenser in which running cold water is used to condense the vapour boiling over from the mixture into a liquid that can be collected in a container. This process is called distillation. Example of liquid mixture with large differences in their boiling points is a mixture of water (BP = 100^oC) and ethanol (BP =78^oC). If the liquid mixture has several components that are separated by distillation, the process is called Fractional Distillation.

Apparatus: Conical flask, large test tube, 250cm^3 beaker, Bunsen burner, Wire gauze, Tripod stand, Delivery tube, Thermometer, Distillation flask, running cold water tap, Liebig Condenser and corks.

Reagents: 50cm^3 tap water, blue ink and cold water.

Procedure: Pour 50cm^3 tap water into a conical flask and add few drops of blue ink. Heat the conical flask containing mixture of ink and water until when the solution boils, water vapour rises and condenses
in the cold test tube. Take a reading of the temperature at which the solution boils. Note the colour of the liquid collected in the test tube and the colour of the liquid remaining in the conical flask. Explain why the colour of the liquid in the conical flask has become deeper than before distillation.

Activity 1.3.4:Separation of mixture of liquids with more than two components

Aim: To separate two or more miscible liquids with close boiling points.

1.3.2.3. Introduction: When there is need to separate a mixture of several liquids with various boiling points, simple distillation apparatus will not be adequate to collect the various fractions of the liquids as pure substances after separation. Fractional distillation is the method adopted. In this case the Liebig Condenser used in simple distillation is replaced by fractional fractionating column which will help to separate the various fractions of the mixture at their different boiling points. The fractional distillation condenser has a coil of fractionating column made of glass running through the inside of the condenser. It is on this coil of glass that each component of the mixture condenses at the appropriate boiling point and the flows out for collection. See Figure 1

Apparatus: Round bottomed flask, Fractionating column, thermometer, corks, Liebig condenser, flowing tap, conical flask, Bunsen burner, Wire gauze, Tripod stand and Anti Bump (broken glass or porcelain).

Reagents: Ethanol and Water.

Safety Precaution: Ethanol is flammable; it should not be taken near naked flame.

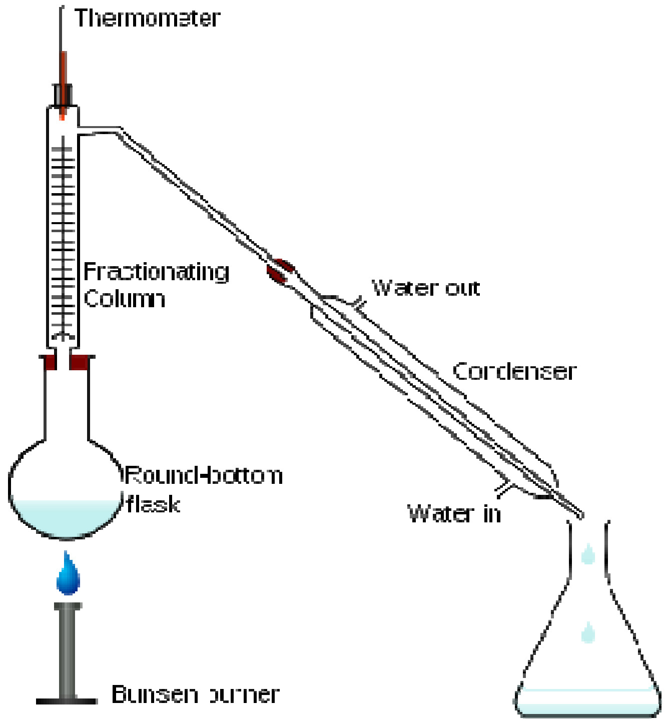


Figure 1: Apparatus set up for Fractional Distillation

{(New Diagram/ Picture brought in by the Reviewer}

Procedure: Mix equal volumes of ethanol and water in a round-bottomed flask. Assemble the fractionating column as in figure 1 above, and heat the solution while the tap is allowed to run through the Liebig condenser. Record your observations and conclusion.

Activity 1.3.5: Separation of Mixture by Process of Sublimation

Aim: To separate a mixture of solid Sodium Chloride and Ammonium Chloride.

**1.3.2.4. Introduction:** The nature of some chemical substances is such that when they are heated, instead of the solid melting to form liquid, the solid goes direct into gaseous state without going through the liquid phase. Such solid substance is said to have sublimed. The ability of some solids to sublime into gaseous state can be used to separate them from solid substance which do not sublime. This process is called separation by the process of sublimation. Iodine, some chlorides and camphor can sublime.

Apparatus: Glass funnel, Evaporating dish, Bunsen burner, Tripod Stand, wire gauze and beaker

Reagents: Solid Ammonium Chloride (NH_4Cl) and solid Sodium Chloride (NaCl).

Safety Precaution: Separation should be done in a fume chamber if the mixtures involve iodine which causes irritation (if vapour is inhaled) and a large dose is poisonous.

Procedure: Mix 4g of common salt (NaCl) with 2g of Ammonium Chloride (NH_4Cl) in an evaporating dish. Place a glass funnel inverted over the dish. Heat the dish and observe what happens. Record your observations and conclusion. Confirm by chemical test, which of the chemical substances (Sodium chloride – NaCl, or Ammonium chloride -NH_4Cl, sublimed and condensed on the inverted funnel.

Activity 1.3.6: Separation of immiscible liquids

Aim: To separate two immiscible liquids (Kerosene and Water) using a separating funnel.

1.3.2.5. Introduction: Separation of a mixture of two or more immiscible liquids is possible using separating funnel. The property of the liquids which is used for this separation is the differences in their densities. When the densities of the different liquids vary the arrangement of the layers of the liquid mixture would be according to the magnitude of their densities, with the one which has the highest density lowest, followed by the one with higher density and lastly by the one with the lowest density. In other words, the heaviest component of the mixture flows out first followed the next heaviest and so on.

Apparatus: Separating funnel, two 25cm^3 beakers, Tripod stand and conical flask

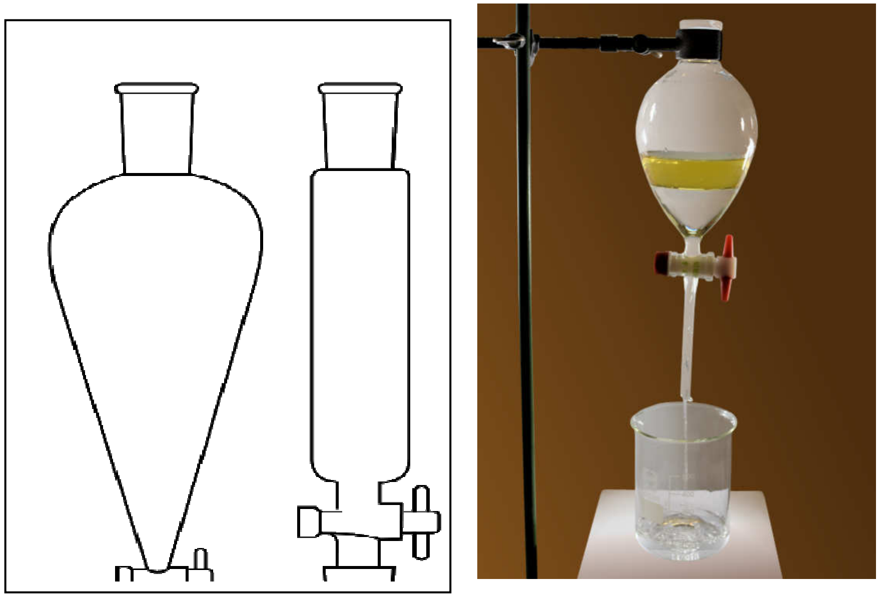


Figure 3: Using Separatory Funnels to separate Liquids in two layers

(Figures brought in by the reviewer}

Reagents: Kerosene and Water

Procedure: Carefully mix kerosene and water in a beaker and transfer the resulting mixture into a separating funnel. Let the funnel stand clamped to the retort stand, until two distinct layers of the mixture emerge. Place an empty conical flask or beaker under the tap of the separating funnel. Open the tap gradually to drain off completely the lower layer. Thereafter, run out the upper layer into another beaker. Record your observations.

1.When two immiscible form a mixture, what apparatus would you use to separate them?
2.What difference in the two liquids would make possible for you to separate them?
3. A mixture contains two liquids of different boiling points,

Self-Assessment Questions 1

UNIT 2 STANDARD SOLUTIONS

1.4.1: Preparation of Standard Solutions of Solid substances

1.4.1: Introduction

A standard solution is a solution whose concentration is accurately known. This means that the amount of solute dissolved in a given volume of solvent is accurately known. The amount of substances is measured in moles or grams, while the volumes of liquid substances is measured in cubic meters (m^3) or its lower scale equivalents such as cubic centimeters (cm^3), cubic decimeters (dm^3). The IUPAC Unit for a standard solution is moles per dm^3 (Mol./dm^3 or Mol. dm^{-3}). The concentration of solutions or the molarity of solutions is expressed in moles per dm^3, that is, the number of moles of the solute dissolved in one dm^3 of the solvent. Standard solutions are used to determine the concentrations of other substances, such as solutions in titration. Using standard solutions and stoichiometric equations, it is possible to predict the amount of any product from a chemical reaction. Thus the idea of standard solution is used in industrial production of substances such as fine chemical like drugs and perfumes or heavy chemicals like cement or fertilizers.

Activity 1.4.1. Steps in preparing standard solution of solid substance

Aim: Develop skills and acquire knowledge in weighing chemical substances accurately

i). Weighing of chemical substances

The instrument for weighing chemical substances is the weighing balance also called chemical balance. The chemical balance may be mechanical balance such the beam balance or top-loading Ohaus balance. The beam double pan balance is more or less out dated and hardly used again in school laboratories. In weighing with the mechanical balances, standard weights are used to balance for the weight you are trying weigh out. Top-loading balances like the Ohaus balance has notches indicating the various weight one may want to weigh out. There a venieer scale for measuring small masses. It may give accuracy to the nearest hundredth (100^{th}).

Apparatuses: Weighing balances, specimen bottles, beakers, funnels, standard flasks, Stirring rods,

Fig 5: Ohaus Chemical or
Scale Balance (Meanical
Open Electronic chemical balance

Fig 6: Shielded Electronic Chemical Balance

Fig 7 : Top loader electronic Balance

{Figures brought in by Reviewer}

Electronic Balance is easier to use than mechanical beam balance. Some electronic chemical balances can be accurate to the nearest ten thousandth ($10,000^{th}$). The electronic balances are very accurate.

ii). In using electronic chemical balance, the mass of the substance required to prepare a given concentration of a solution is determined from the molecular mass of the substance. The electronic balance is set at zero reading. An empty weighing bottle or any other suitable container for the substance is weighed by placing the container on the pan of the balancing and reading off the mass. Then the material/substance which is required for preparing the standard solution is gradually added to the empty container while watching the digital scale reading the mass added. This gradual addition of the substance is continued until the accurate mass of the substance is read off on the scale of the balance. The weighed substance is removed from the pan of the balance.

Note the following precautions:

a). The electronic chemical balance is very sensitive hence the cover of the weighing chamber must be closed before the reading is taken on the electronic digital scale for purposes of accuracy. If the cover is not in place, the balance would give wrong reading because even the moving air outside of the chamber affects the reading.

b). Substances being weighed must not be splashed on the pan of the balance during weighing. Certain kinds of chemical substances can react with pan thereby destroying it over time. The pan of the balance should be cleaned properly before weighing to ensure accuracy.

iii). Dissolving the weighed substance to make standard solution

Put the accurately weighed substance whose standard solution you want to prepare into a beaker that has been washed very clean with soap solution and water, (See figure 8). Add little distilled water that is much less than the volume of solution you want to prepare into the beaker. Ensure that all the weighed substances are collected into the flask.

Figure 8: Beakers with stirring Rods

Figure 9: Filter Funnels

{Figures Brought in by Reviewer}

Using the stirring rod, gently stir the mixture in the beaker until all the solid substance has dissolved completely to give a clear solution. Using a clean filter funnel (See Figure 9) gently transfer the solution completely from the beaker into a standard flask which is the volume of the solution you want to prepare (Figure 10).

Rinse the beakers thoroughly with small amount of distilled water to ensure that all the dissolved substance is collected. Pour the solution in the beaker into the standard flask. Rinse again with small amount of distilled water and again pour into the solution in the standard flask. Using distilled water from wash bottle or beaker, make up the volume of the solution in the standard flask to the standard mark such that the bottom of the meniscus of the solution stands on the standard mark of the flask. Cock the standard flask properly and shake the solution briskly to ensure uniformity.

Figure 10: Standard Flasks of different sizes

In preparing standard solutions, you should note the following:

1. A molar solution is one containing one mole or the molecular mass of the solute dissolved in one dm^3 (or $1000cm^3$) of the solution.
2. If your available standard flask is $500cm^3$, it means that you will weigh out and dissolve (0.5Moles) half of the molar mass of the solute in the available standard flask of 500 cm^3 to make the Molar solution.
3. If you want prepare 0.5 molar solution, you will weigh out half of the molar mass of the solute and dissolve in one dm^3 ($1000cm^3$) of solution.
4. If you want to prepare 0.1M solution, you should weigh out the malar mass divided by 10 to give 0.1 moles of the solute and dissolve in $1dm^3$ or $1000cm^3$ of the solution.

Let us give example with preparation of standard sodium hydroxide solutions of different concentrations using different sizes of standard flasks, as follows:

- The Formula of sodium hydroxide is NaOH
- Molar mass of NaOH = (23 +16 +1) = 40g/mole.
- 1M NaOH contains 40g of NaOH in $1dm^3$ or $1000cm^3$ of solution. So 40g is weighed out and dissolved in $1dm^3$ or $1000cm^3$ of distilled water.
- 0.5M NaOH contains 40g x 0.5 ie 20g to be weighed out and dissolved in 1 dm^3 or $1000cm^3$ of water

- 0.25M NaOH contains 40g x .0.25M ie 10g to be weighed out and dissolved in 1 dm^3 or $1000cm^3$
- 0.1M NaOH contains 40g x 0.1M ie 4g to be weighed out and dissolved in 1 dm^3 or 1000 cm^3 of water.

- 1M in 1000cm3 or 1dm3 flask contains Molar mass or 40g of NaOH dissolved in 1000cm3 of water in standard flask.
- 0.5M in 500cm3 flask = 40g x $500cm^3 \div 1000cm^3$ x 0.5M ÷ 1M = 10g to be weighed out and dissolved in 500cm3 of water in standard flask.
- 0.25 M in 250 cm^3 flask = 40g x0.25M ÷ 1M x$250cm^3 \div 1000cm^3$ = 2.5g to be weighed out and dissolved in 250 cm^3 of water in 250 flask.
- 0.1M in 100cm3 flask = 40g x 100cm3 ÷ 1000cm3 x0.1M ÷ 1M = 0.4g to be weighed out and dissolved in 100cm3 of water in 100 cm3 flask.

1.4.2. Preparation of Standard Solution of Liquid substance using dilution method.

1.4.2. Introduction

Dilute acid solutions such as the one used in titration experiments are made from concentrated acid solution bought from dealers in laboratory chemicals and other resources. On the container of concentrated acids are labels indicating density/specific gravity, formula, and molar mass of concentrated acid. The commercial acids do not often come with their concentrations written on their containers. It is therefore the teacher that prepares dilute acids from the concentrated ones using dilution equation, during which he/she must determine the concentration of the conc. commercial acid.

($M_1V_1 = M_2V_2$) where M = Molarity, V = Volume

Concentrated acids are very dangerous and should be handled with absolute care. They are corrosive to the body and can damage human body, clothing materials and furniture or even the floor of the laboratory. Concentrated acids release fumes and therefore should be stored proper corked in the fume chamber of the laboratory. Only trained and knowledgeable technicians should handle concentrated acids. On no account should students in primary or secondary schools be allowed to handle concentrated acids such as Hydrochloric acid, Nitric acid and sulphuric acid. These are the common concentrated acids found in the teaching laboratory.

UNIT 3 DILUTE SOLUTIONS

Activity 1. 4.1. Preparing Dilute Acid solution from concentrated acid solution

The teacher should wear laboratory coat, eye goggle, gloves for protection.

If the molarity of the concentrated acid not given on the label of the container, the teacher should work it out from the information available of the label. If the label on the Winchester Bottle of Conc. Sulphuric acid has the following information:
Density /specific gravity = 1.8g/cm3 or 1.8g/L
Percentage purity = 98%

A general formula for calculating the Molarity of the conc. acid from the information given is as follows:

$$\text{Molarity } M = \frac{10 \times D \times \%}{\text{Molar Mass}}$$

Where:
D = Density or Specific gravity;
% = Percentage purity of the acid
10 = constant dilution factor
M = Molarity of the Conc. acid

Based on the label information on the above Concentrated Sulphuric acid we can calculate Molarity using the above formula and thereafter prepare dilute solution of the acid using dilution equation.
Molecular Formula of Sulphuric Acid = H_2SO_4 [H =1, S = 32, O =16]
Molar Mass = 1x2 +32x1 +16 x4 = 2+32 + 64 = 98g/Mol.
Density/specific gravity = 1.8g/cm^3
% purity of the acid = 98%

$$M = \frac{10 \times 1.8gcm^{-3} \times 98}{98g} = 18 \text{ Mol. } dm^{-3}$$

This is 18 moles per dm^{-3} of the conc. acid. When we dilute to prepare standard dilute acid solution we must remember that Molarity is expressed in number of moles per dm^3

Dilution equation is given as: $M_1V_1 = M_2V_2$; $V_2 = \underline{M_1V_1}$ Where M1 = Molarity of conc. Acid, M2 = Molarity of Dilute Acid, V1 = Volume of conc. Acid, V2 = Volume of Dilute Acid. If we intend to prepare 0.5M bench Sulphuric Acid, we need to find the volume of the conc. acid that we would dissolve in $1dm^3$ flaks to get 0.05M solution
$M_1 = 18$, $M_2 = 0.05$, V_1 $1dm^3$, V_2 = ?

$$V_1 = \frac{M_2V_2}{M_1} = \frac{0.05\text{mole } dm^{-3} \times 1000cm^3}{18\text{molesdm}^{-3}} = \frac{50\ cm^3}{18} = 2.78cm^3$$

2.78 cm^3 of concentrated acid will be diluted to 1 dm^3 or 1000 cm^3 to prepare 0.05M solution of dilute Tetraoxosulphate (VI) Acid (Sulphuric acid).

Use measuring cylinder to measure out $2.78cm^3$ of conc. H_2SO_4 in a fume chamber to avoid inhaling acid fumes. Put about $200cm^3$ of distilled water into the $1000cm^3$ standard flask. Using the funnel gradually add the measured conc. acid into the standard flask while stirring continuously with magnetic stirrer. Use water from the wash bottle to wash down the funnel into the flask to ensure none of the acid is lost. Remove the stirrer and wash it into the standard flask using wash bottle. Note that the standard flask and its content become hot because the reaction of the acid and water releases heat. Using distilled water carefully make up the volume of the solution to the standard mark of the flask. Cork it properly and shake to ensure complete mixing. Leave the standard flask in the fume chamber overnight for the solution to cool to room temperature. The volume of the solution would be short of the standard mark the following day due to cooling and contraction. Use wash bottle to carefully make up the solution to the standard mark. Your solution is 0.5 M Tetraoxosulphate(VI) Acid (sulphuric acid).

(Note: You do not add water to conc. acid because the reaction to form solution may become very violent and dangerous. You can acid gradually into water and there would be no violent reaction)
If the conc. acid available to be diluted is 6M hydrochloric acid to produce 0.2M bench solution, the dilution equation would be used directly to find the volume of the conc. acid that would be diluted to $1000cm_3$ of solution.
$M_1V_1 = M_2V_2$, $6 \times V_1 = 0.2 \times 1000cm3$, $V_1 = 0.2x1000/6 = 33.33\ Cm^3$.

This means that 33.3 cm^3 of the conc. acid would be measured out in a measuring cylinder, added gradually into distilled water in a standard flask, and then the solution is made up to $1000cm^3$.

If a solution of 0.3M is to be prepared in 250 cm^3 standard flask, the volume of conc. HCl that would be made up to the mark is: $M1V1 = M_2V_2$, $6xV_1 = 0.3m \times 250$
$V1 = M_2V_2/ 6 = 0.3x250/6.$, = $12.5cm^3$. This means that **12.**5 cm^3 of the conc. Acid will be added to the standard flask and the volume is made up to 250 cm^3 using wash bottle.

Self – Assessment Questions 2.

1. State and identify the variables in formula for calculation of the molarity of concentrated acid before using it to prepare dilute standards solution.
2. What is standard solution?
3. Why should you avoid adding water to concentrated acid but

Figure 11: Measuring Cylinders of different sizes. Figure 12: Stock Winchester bottle of Conc. Acid

{Figures Brought in by Reviewer}

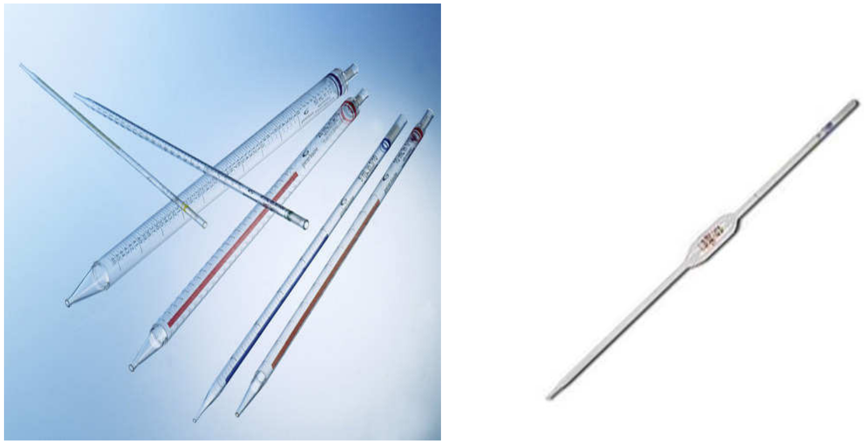


Figure 13: Pipettes of different sizes
{Fig Brought in by Reviewer}

Activity 1.4.2: Practising to draw given volumes of Liquids using the Pipette and Burette

Accurately measuring the volume of a dilute solution is one of the essential skills in volumetric analysis. For purposes of titration, the volume of a solution can be measured using a pipette of desired size. Figure 13 shows an array of pipettes which are standard measure of volumes of solution for analysis purposes. The measurement is called pipetting and is carried out as follows:

(A). **The Pipette:** Wash the pipette thoroughly using water and soap solution

Suck up clean water with the pipette and using your fore finger to close the mouth of the pipette, discharge the water gradually and exercise control of the rate of discharge of the water.

ii. Dip the end of the pipette inside the chemical solution. With the upper end of the pipette inside your mouth, carefully suck up a little of the solution and use this to rinse the pipette thoroughly. Then empty the pipette

iii. Then suck the solution and fill the pipette beyond the standard mark. Place your right forefinger across the mouth to seal the upper end of the pipette immediately you remove the pipette from your mouth.

iv. Gradually and carefully release the solution into its container by opening the sealed end and watch the solution in the pipette drain smoothly and gradually. Bring your observing eyes at parallax with the standard mark of the pipette and stopper the draining of the solution when the meniscus of solution stands on the standard mark. When this done properly, the solution in the pipette is exactly the volume indicated on the standard mark. The volume of solution measured using the pipette is very accurate. The sizes of pipettes vary so that you can select the size you want depending on the nature your laboratory activity you are carrying out.

(B) **The Burette:** A **burette** is a graduated glass tube with a tap at one end. It is standard and used for delivering known volumes of liquid, especially in titrations. It is a long, graduated glass usually mounted on retort stand during titration. Using the burette, even one drop of liquid can be delivered during titration experiments. Figure 14 shows a $50cm^3$ – burette.

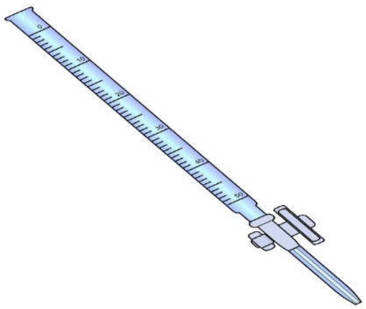


Figure 14: $50cm^3$ – Burette for Titration

UNIT 4 TITRATION EXPERIMENTS

1.4.3: Volumetric Analysis (Carrying out Titration Experiment)

1.4.3.1. Introduction

Volumetric analysis is a basic operation chemical process of determining the amount reacting species that are involved during chemical reactions. It is an accurate quantitative approach, whereby a standard chemical quantity is used to standardize an unknown chemical quantity by allowing the two substances to react quantitatively, and using the stoichiometric equation to find out the quantity of the unknown substance that has been consumed by a known quantity of the standard solution. In this way the chemical substance of unknown quantity is standardized and its concentration in grams or moles per dm^3 becomes known through calculations.

In the case of acid base titration which is often carried out by secondary school chemistry students, a standard solution of acid is used to titrate a given volume of base of unknown concentration to determine the molarity (number of moles per dm^3) of the base. The base thus becomes standard solution. In the same way a standard base solution can be used to standardize an acid solution. Other chemical substance than acids and bases can be involved in volumetric analysis as long as the reaction of the substances is quantitative, and it is possible to observe the end point when one reacting species is completely used up. In acid – base titration, substances like methyl orange, phenolphthalein, screened methyl orange, methyl red, ortho cresol, etc can be used as indicators because their colours change at different pH of the solution. Thus they have different colours in acid and basic mediums.

Activity 1.4.3.1: Titration

1. Pipette out 20 cm^3 or 25 cm^3 (depending on which type of pipette is available) of the solution provided (usually a base) into a conical flask. Note that this should follow the procedure described under the use of a pipette.

2. Add about 2 or 3 drops of the indicator to the base and shake the flask. Usually, Methyl Orange is provided but occasionally, Phenolphthalein may be used. Methyl Orange is yellowish in a base and pinkish in an acid solution, while Phenolphthalein is red in a base and colourless in an acid solution.
3. Fill the burette with the titrant (acid solution) following the procedure described under the use of a burette

4. Adjust the level of the solution in the burette as appropriate. Take the reading of the burette and record it as “initial reading” ensuring there is no leakage in the burette.

5. Now place the conical flask on the white tile at the base of the retort stand. Use white paper if there is no white tile.

6. In order to prevent careless spilling of the acid solution while titrating, adjust the height of the burette so that the jet just lies slightly within the mouth of the conical flask

7. Open the burette tap to allow the solution to run into the conical flask but this should be at a controlled rate. The thumb, index finger and second finger of your hand (preferably left hand) are used for the control

8. Use the other hand (right hand) to swirl the conical flask continuously as the acid solution is being added from the burette. The agitation will ensure a proper mixture of the acid and base solutions.

9. Since you are expecting a colour change at the end point, add the acid solution drop by drop towards the end point. You should end the titration by turning off the burette tap immediately you observe that addition of a single drop of the acid solution causes a permanent colour change (yellow to faint or pink in the case of Methyl Orange indicator).

10. Read and record the burette reading. The titre value is obtained by subtracting the initial reading from the final reading. The titre value is the volume of the acid solution required to react completely with the volume of the base in the conical flask.

Activity 1.4.3.2: Recording data obtained from Volumetric Analysis
Rules Guiding the Writing of Burette Readings and Calculation of Average Titre Value

1. Usually the first titration is regarded as rough/trial, so have to repeat the titration two or three more times, ensuring that two titre values do not vary by more than ± 2.0 cm^3

2. Record burette reading to two decimal places.

$$\frac{19.50 + 19.55}{2} = 19.53\ cm^3$$

3. The burette readings are conveniently tabulated as shown below:

Burette Readings	**Titrations (cm^3)**		
	Trial	**First**	**Second**
Final Burette Reading	21.10	41.60	21.55
Initial Burette Reading	0.00	21.10	1.00
Volume of Acid Used	21.10	20.50	20.55

Average volume of acid used to neutralize 25 cm^3 of the base:

$$\frac{20.50 + 20.55}{2} = 20.53cm^3$$

4. You should use for averaging only titre values that are concordant to the level of not more ± 2.0 cm^3
5. Make sure you record the calculated value of concentrations in moles per dm^3 (molarities) to three decimal places e.g. 0.560M
6. Concentration in grams per dm^3 and any other calculation should be expressed in three significant figures e.g. 2.68g/dm^3

Self-Assessment and Practice Questions

Question 1

A is a solution of Tetraoxosulphate (VI) acid containing 5.8g per dm^3. Solution B contains 9.3g of an impure potassium hydroxide per dm^3.

Put the acid solution A into the burette and titrate with 25 cm^3 or (20 cm^3) portion of B, using methyl orange or screened methyl orange as indicator.

From your result, calculate;

a. The concentration in moles/dm^3 of the Tetraoxosulphate (VI) acid in solution A

b. The concentration in moles/dm^3 of the potassium hydroxide in solution B

c. The concentration in grams/dm^3 of potassium hydroxide in solution B

d. The percentage purity of potassium hydroxide in solution B

The equation for the reaction is:

$$H_2SO_4 + KOH \longrightarrow K_2SO_4.2H_2O$$

(H = 1.0; S = 32.0; O = 16.0; K = 39.0)

Question 2

X g of anhydrous sodium trioxocarbonate (IV) was treated with 1000cm^3 or (1 dm^3) of 0.300M hydrochloric acid to obtain a solution A, which contains excess hydrochloric acid after the treatment. B is a 0.09M solution of sodium hydroxide.

Put the acid solution A into the burette and titrate against 25 cm^3 or (20 cm^3) portion of B. Use methyl orange or screened methyl orange as indicator.

Record the volume of your pipette. Tabulate your burette readings and calculate the average volume of acid required to neutralize the stated volume B.

From your result calculate:

(a) The concentration of acid in solution A in mole per litre (dm^3)

(b) The mass, X, of the sodium trioxocarbonate (IV)

Question 3

Solution A is a solution of sodium hydroxide containing 0.025 mole of the alkali in 250 cm^3 of solution. B is a solution of a dibasic acid, H_2Y.

Put solution B into burette. Pipette 25 cm^3 or (20 cm^3) portion of solution A into a conical flask and titrate with solution B using phenolphthalein as indicator.

Record the volume of your pipette. Tabulate your burette reading and calculate the average volume of acid used.

(a) Calculate the concentration in moles/dm^3 of solution B from your results

(b) if the concentration of the acid in solution B is 4.90g/dm^3, what is the molar mass of the acid to the nearest whole number?

(c) Calculate the percentage by mass of Y in H_2Y

Question 4

P is a solution of either hydrochloric acid or trioxonitrate (V) acid containing 4.6gdm^3. Q is a solution of potassium hydroxide. The concentration of solution Q is 5.75gdm^3.

Put solution P into the burette and titrate against 25 cm^3 or (20 cm^3) portion of Q. Use methyl orange or screened methyl orange as indicator.

Record the volume of your pipette. Tabulate your burette readings and calculate the average volume of acid required to neutralize the stated volume Q.

From your results, calculate:

(a) The concentration in moles/dm^3 of the base solution Q.

(b) The concentration in moles/dm^3 of the acid solution P.

(c) The molar mass of the acid

(d) From your result in (c) above identify the acid. Explain clearly how you arrived at your conclusion.

(H = 1.0; O = 16.0; Na = 23.0; Cl = 35.5; K = 39.0).

Question 5

E is a solution containing 15.7g/dm^3 of hydrated sodium trioxocarbonate (IV). F is a solution of Tetraoxosulphate (VI) acid. The concentration of solution F in mole per dm^3 is 0.065M.

Put F into the burette and titrate with 25 cm^3 or (20 cm^3) portion of solution E. Use methyl orange or screened methyl orange as indicator.

Record the volume of your pipette. Tabulate your burette readings and calculate the average volume of acid required to neutralize the stated volume of E.

From your result, calculate:

(a) The concentration in moles/dm^3 of solution E
(b) The molar mass of hydrated sodium trioxocarbonate (IV).
(c) The value of X.

The equation of the reaction is;

$Na_2CO_3XH_2O + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + (X + 1) H_2O$.

UNIT 5: QUALITATIVE ANALYSIS

1.5.1: Qualitative Analysis

1.5.1. Introduction: Chemical substances are made up of particles. The particles may be atoms, molecules or ions. The ions carrying charges which may be negative charge (negatively charge ions are called anions), or positive charge (positively charged ions are called cations). Qualitative analysis is an effort to identify the compositions or constituents of a chemical substance. It involves the identification of the individual atom or ion - anions and cations - present in a sample of the chemical substance. The chemical substance to be analyzed may be a salt or a mixture of salts, metallic oxides or bases or organic molecule. Chemical substances are grouped according to their characteristics. It is these characteristics that are used to identify their presence in a given sample that is being analyzed. For instance, acids turn blue litmus paper red; therefore, if a chemical substance causes litmus to turn red then the sample is an acid or it is acidic. In the same way, all chemical substances have their characteristic chemical reactions that give away their presence in a sample.
Chemical analysis of a given sample for identification of the composition of the substance follows some procedure for achieving the aim of the analysis. This procedure is the scientific methods of analysis that will surely lead to the achievement of the objectives of the analysis. Analysis of a simple salt involves:

a. Physical observation/examination of physical looks of the sample to note whether it is a liquid or solution or solid; whether it crystalline, or powdery, its colour, and general structure.
b. The action of heat on a salt: does it melt, burn, decompose, deprecate, the colour of the flame when burnt etc.
c. Does it dissolve in water, colour of the solution formed, is the solution of the sample acidic, or basic or neutral to litmus?
d. Does it dissolve in acid, or base, or organic solvent like ethanol or acetone?

e. The reactions of a salt or solution of it with dilute acids and alkalis
f. The reactions of solutions of salt with other reagents, and
g. Flame test.

1.5.2: Techniques and Procedures for Qualitative Analysis

In qualitative analysis, salts or a mixture of salts are usually supplied. At times, a solution of a salt may be given. This is an unknown compound as far as the students are concerned, the containers are appropriately labelled like specimen A, B, C etc.

When you are given an unknown salt, you are expected to carry out specified tests on it or the solution of it, observe the changes and carefully record them and finally arrive at inferences or conclusions about the nature of the unknown substance tested. For good performance, since this is part of the practical, the following guidelines should be carefully employed.

1. Bench Solutions

Bench Solutions are solutions prepared and left on the laboratory benches or racks. They are used for qualitative chemical analysis. They are usually 2 Molar solutions. Some bench solutions in the Chemistry laboratory include:

HCl, HNO_3, H_2SO_4, $KMnO_4$, NH_4OH, $NaOH$, KOH, $Ca(OH)_2$, $K_2Cr_2O_7$, Na_2CO_3, $Cu(NO_3)_2$, KI, KIO_3 , $BaCl_2$, $AgNO_3$ $Pb(CH_3COO)_2$, $Pb(NO_3)_2$, CH_3CH_2OH, CH_3COOH, etc.

2. Heating of Dry Salt in a Test Tube

When a given substance is to be tested in a dry state, heat is gently applied at the initial state, while observing any change taking place and then heat is strongly applied until no further change is observed. You will be expected to describe the residue, its appearance when hot and when it has been allowed to cool to room temperature. When heating, the test tube must be held with a test tube holder in a slanting position, with its mouth pointing away from you or your fellow worker in the laboratory. Observe whether the sample decomposes on heating and whether any gases are released on decomposition.

a. The amount of substance required here for heating or preparing solutions is always a small quantity
b. Describe any gas evolved giving its colour, odour and a chemical test for confirmation of the gas.

2. Preparing Solution of Salt

When you are not given the solvent for preparing the solution of an unknown substance, use a suitable solvent to prepare the solution of the substance. The following solvents should be tried in that order: water, dilute hydrochloric acid and dilute trioxonitrate (V) acid, ensuring that the solid added dissolves completely.

If dissolution is slow, you can warm the solution gently ensuring that the solution is cooled under a tap or left to cool on its own, before carrying out chemical tests on the solution of the salt. The solution must be clear and during filtration, the solution must be carefully poured into the middle of the cone of the filter paper.

3. Adding a Reagent to Solution in a Test Tube

a. Any reagent to be added to the prepared solution must be a little at a time or (few drops at a time) while observing any changes that take place, shake after addition, until there is no further change. Use only about 2 – 3 cm^3 of the prepared solution. A dropping pipette is usually useful for adding reagents to solutions.

b. If you observe any precipitate after the addition of the reagent, describe its colour and/or appearance such as crystalline or gelatinous or powdery.

c. If it happens that no change is observed after adding the necessary reagents to the solution, then record 'there is no visible change'.

1.5.3: Common Gases, their characteristics and sources

GASES	PROPERTIES	SOURCES OF GASES
Hydrogen (H_2)	Colourless, odourless, explodes with a slight pop sound when flame is applied	Evolves when metals react with dilute acids e.g. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
Oxygen (O_2)	Colourless, odourless, re-lights or rekindles a glowing splint	Evolves when oxides (peroxides, salts or oxy-acids, trioxonitrate (V), trioxochlorate (VII), trioxoiodates (VII) are heated, e.g. $2KClO_3 \rightarrow 2KCl + 3O_2$
Carbon(IV)oxide (CO_2)	Colourless, odourless, slightly acidic, turns calcium hydroxide solutions (lime water) milky.	Evolves when Trioxocarbonate (IV) or some metals are heated Dilute acids react with Trioxocarbonate (IV) e.g.
		$CaCO_3 \rightarrow CaO + CO_2$ $Na_2CO_3 + 2HCl \rightarrow CO_2 + H_2O + 2NaCl$
Chlorine (Cl_2)	Yellowish green colour, choking smell, turns moist blue litmus paper red and then bleaches	Evolves when certain chlorides react with oxidizing agents. $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

	it.	
Hydrogen Chloride ($HCl_{(g)}$)	Colourless, irritating smell, turns blue litmus paper red, white fumes with ammonia, fuming in moist air.	Evolves when a chloride reacts with concentrated Tetraoxosulphate (VI) acid (H_2SO_4), e.g. $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

What is a preliminary Test?

Confirmatory Test of Some common gases

Gas	Confirmatory Test	Sources of the gas
Hydrogen Sulphide (H_2S)	Colourless, smells like bad (rotten) egg, burns with light blue flame and deposits Sulphur, turns Lead Ethanoate paper black.	Evolves when a dilute acid reacts with a Sulphide e.g. $FeS + 2HCl \rightarrow FeCl_2 + H_2S$
Nitrogen (IV) Oxide (NO_2)	Brown gas with choking smell, turns moist blue litmus paper red, turns starch iodide paper blue black.	NO_2 Evolves when Trioxonitrate (V) or dioxonitrite (III) salts of some metals below Na in the Electrochemical Series are heated. Egs. $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2$

		Conc. HNO_3 reacts with metals e.g. $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2$ $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
Sulphur (IV) Oxide (SO_2)	SO_2 turns litmus paper red, It has colourless, irritating smell or (smell of burning Sulphur), It turns Potassium tetraoxomanganate (VII) solution colourless and turns litmus paper dipped in acidified potassium heptaoxodichromate (VI) solution green.	Trioxosulphate (IV) salts (SO_3^-). SO_2 evolves when dilute acid reacts with some tetraoxosulphate (VI), trioxosulphates (IV) or thiosulphates e.g. $Na_2SO_3 + 2HCl \longrightarrow 2NaCl + NH_3 + H_2O + SO_2$
Ammonia (NH_3)	NH_3 turns moist red litmus blue, Colourless gas with characteristic choking smell, forms white fumes with concentrated hydrochloric acid, condenses on the side or around the mouth of	Salts of Ammonium ion (NH_4^+) when reacted with Alkali with warming. NH_3 gas evolves when sodium hydroxide is

	the test tube containing conc. HCl.	added to an ammonium salt, e.g. $NH_4Cl + NaOH \longrightarrow NaCl + NH_3 + H_2O$
Water Vapour (H_2O)	Turns anhydrous copper tetraoxosuphate (VI) salt blue.	It evolves when hydrated salts are heated and converted to anhydrous salt. $NaCO_3 \cdot 10\,H_2O$

What is confirmatory Test?

1.5.4: Recording of Experiment Results

1.5.4.Introduction

Experiment results should be recorded in a clear and unambiguous language that states what action that is done the unknown sample, the observation of the effects of the action on the sample and the inference or conclusion drawn from the observations. The recording of results experiments intended to find out what the make of unknown samples are is recorded in a tabular format with three columns entitled: Test/action on sample, observation and inference/conclusion. These columns are completed as soon as the test and observation are completed. Identifying an unknown sample usually starts with describing the physical characteristics of the sample to identify its colour, whether it is liquid or solid, whether it is crystalline or powdery, deliquescent or hygroscopic etc. These initial observations and descriptions of the physical nature of the sample is the right point to start qualitative chemical analysis of an unknown sample. Further tests are carried out on the sample to identify the constituents of the sample and then mention what the sample is. The Table below shows how to record observations during qualitative chemical analysis.

Test	Observation	Inference/Conclusion
Physical observation	Describe the sample accurately	What conclusion can you reach due to the physical nature of the sample
Pick small quantity of the sample on platinum spatula and heat it gently on the Bunsen burner flame and then strongly to observe the colour of the flame and nature of the burning of the substance	Organic substances often burn with luminous flames, heavy carbon hydrocarbons burn with smoky flames, Metal ions burn with characteristic flames	Brilliant yellow for Na^{+}, Blue-Green flame for Cu^{2+}, Lilac for K^{+} ,Orange red for Ca^{2+},
To small portion of the given sample of unknown substance, add dilute HCl or dilute H_2SO_4	There is a quick effervescence of a colourless odourless gas which turns Calcium hydroxide solution (lime water) milky.	The gas given off is Carbon (IV) Oxide (CO_2) and the anion is CO_3^{2-} or HCO_3.
To original sample add concentrated Tetraoxosulphate (VI) acid	There is an effervescence of a colourless gas with a rotten egg smell and turns Lead Ethanoate paper black	The gas evolved is Hydrogen Sulphide (H_2S) and the anion involved is S^{2-}
To original sample add concentrated Tetraoxosulphate (VI) acid	There is an effervescence of brown gas with choking smell,	The gas evolved is Nitrogen (IV) Oxide (NO_2) and the anion

	which turns moist blue litmus paper red and starch iodide paper blue black.	NO_2^- (dioxonitrite (III)), are present in the sample.
To original sample add concentrated Tetraoxosulphate (VI) acid then heat in the flame	There is an effervescence of a colourless gas with irritating smell which turns both potassium tetraoxomanganate (VII) paper and acidified Potassium heptaoxodichromate (VI) paper colourless and green respectively.	The gas given off is Sulphur (IV) oxide (SO_2) and the anion is SO_3^{2-} (trioxosulphate (IV))
In the same manner if the test (b) indicates the presence of Cl^-, mix the unknown salt with MnO_2 and add concentrated Tetraoxosulphate (VI) acid to the mixture.	1.There is an effervescence of a colourless gas with irritating smell which turns moist blue litmus red and forms white fumes with ammonia.	The gas given of is HCl_g hydrogen chloride gas from the anion Cl^- (chloride).
	2.There is an effervescence of a brown gas (on strong heating) with choking smell, turns moist blue litmus paper red	The gas is nitrogen (IV) oxide and the anion is NO_3^- trioxonitrate (V).

Confirmatory Tests anions

Tetraoxosulphate	1. White precipitate	$SO4^{2-}$ is confirmed.

(VI) ion ($SO4^{2-}$) 1. To the original sample solution, add solution of Lead ethanoate solution ($Pb(CH3COO^{-})_2$ or Lead Nitrate solution ($Pb(NO_3^{-})_2$ insoluble in excess Ethanoic acid or Trioxonitrate (V) acid respectively 2. Add aqueous solution of $BaCl_2$ to the original solution of the given sample.	(PPT) of Lead Tetraoxosulphate (VI) is formed. It is insoluble in excess dilute acid. 2. A white precipitate of $BaSO_4$ indicates the presence of SO_4^{2-} ion	
Chloride ion (Cl^-): To the aqueous solution of the original sample add Silver Nitrate solution in drops until excess	Cuddy white precipitate which darkens on exposure to light.	Cl^- is confirmed
NO_3^- ion. This is the Brown Ring Test. Add to original solution of the sample freshly prepared solution of iron (II) sulphate. Then gently add concentrated	A brown coloured ring forms at the interface between the aqueous layer and the acid layer.	NO_3^- is confirmed

H_2SO_4 solution gradually along the wall of the test tube. The conc. acid forms a layer below the aqueous solution.

Preliminary Testing of samples with NaOH and NH_4OH solutions for identification of Cations

Cation	**Sodium hydroxide (NaOH) Solution**	**Ammonia (NH_4OH) Solution**
	Observations	**Observations**
Ca^{2+}	A white precipitate is formed which is insoluble in excess of sodium hydroxide	There is no precipitate formed with ammonia solution
	Solution	
Cu^{2+}	A blue precipitate is formed which is insoluble in excess of sodium hydroxide Solution	A blue precipitate is formed which is soluble in excess of ammonia solution to give a deep blue solution
Fe^{2+}	A green precipitate is formed which is insoluble in excess of sodium hydroxide Solution	A green precipitate is formed which is insoluble in excess of ammonia solution
Fe^{3+}	A reddish brown precipitate is formed which is insoluble in excess of sodium hydroxide solution	A white precipitate is formed which is soluble in excess of ammonia solution to give a clear colourless solution
Pb^{2+}	A white precipitate is formed	A white precipitate is formed

	which is soluble in excess of sodium hydroxide solution giving a clear colourless solution	which is soluble in excess of ammonia solution to give a clear colourless solution
Zn^{2+}	A white precipitate is formed which dissolves in excess sodium hydroxide solution giving a clear colourless solution	A white precipitate is formed which is insoluble in excess of ammonia solution

Confirmatory Tests for Cations

Test	**Observation**	**Inference**
$\mathbf{Ca^{2+}}$ Ammonium oxalate is added to the aqueous solution of the salt	A white precipitate is formed which is soluble in dilute hydrochloric acid but insoluble in dilute ethanoic acid	Ca^{2+} confirmed
$\mathbf{Cu^{2+}}$ Potassium hexacyanoferrate (II) solution is added to the aqueous solution of the salt	A brown precipitate is formed which is insoluble in excess of Potassium hexacyanoferrate (II) Solution	Cu^{2+} confirmed
$\mathbf{Fe^{2+}}$ i. Add dilute H_2SO_4 to the aqueous solution of the salt,	The solution of $KMnO_4$ is decolorized, turning slightly yellow because it has been	Fe^{2+} is confirmed

followed by a few drops of $KMnO_4$ solution.	reduced by Fe^{2+} to Mn^{2+}	
ii. Add Potassium hexacyanoferrate (III) solution to the aqueous solution of the Salt	A deep blue precipitate is formed	Fe^{2+} is confirmed
Fe^{3+} i. Add Potassium hexacyanoferrate (III) solution to the aqueous solution of the salt. ii. Add ammonium hexacyanoferrate (II) thiocyanate solution to the	A deep blue precipitate is formed A blue-red solution results.	Fe^{3+} is confirmed Fe^{3+} is confirmed
aqueous solution of the salt		
Pb^{2+} i. Add dilute HCl to a cold aqueous solution of the salt ii. The mixture in (i) above is Heated iii. The resulting solution is	A white precipitate is formed which is insoluble in excess of dilute HCl A precipitate dissolves to give a clear colourless solution The precipitate reappears as white	The precipitate is $PbCl_{2(s)}$ Pb^{2+} $+2Cl^-$ $PbCl_{2(s)}$ Pb^{2+} is confirmed ($PbCl_2$ is also confirmed)

Cooled	Crystals.	
Zn^{2+}: Add ammonium Sulphide solution to the aqueous solution of the salt or pass H_2S gas into the solution if it is neutral (not acidic)	A white precipitate is formed	Zn^{2+} is confirmed

Note

1. $BaCl_2$ can form white precipitates with CO_3^{2-} and SO_3^{2-} as $BaCO_3$ and $BaSO_3$ respectively, but soluble in dilute HCl.

2. $AgNO_3$ can give white precipitate with CO_3^{2-} and SO_4^{2-} but not soluble in excess ammonia.

UNIT 6: SOLUBILITY OF SALTS

Solubility of Salts

A good knowledge of the solubility of salts is essential since it enables a you to narrow the choice of possible salts. It further helps you to suspect the identity of a salt. Information given below on solubility of salts will serve as a good guide.

a. All ammonium salts are soluble in water

b. All trioxonitrate (V) salts are soluble in cold or warm water

c. All common salts of sodium and potassium are soluble in water

d. All Tetraoxosulphate (VI) salts, except those of calcium, Lead (II) and barium are soluble in water

e. All chlorides, except those of Lead (II), copper (I), mercury (II) and silver are soluble in water but more soluble in hot water.

f. All trioxocarbonate (IV) are insoluble in water except those of sodium, potassium and ammonium.

Colour of Some Common Salts and Appearances of Residues

colour	**Possible Compound**
White	Probably in Alkali Metal compounds or halogen compounds of Mg, Ca or Ba
Yellow Hot	Zinc (II) Oxide, Zinc Salts
White Cold	

Yellow	Lead (II) Oxide, hydrated iron (II) salts, AgI, AgBr
Black	CuO, FeO, Fe_3O_4, FeS, CuS, PbS, MnO_2
Black Hot	Iron (II) Oxide, many Iron (II) and Iron (III) compounds
Brown Cold	
Brown	PbO_2, Iron (III) salts, e.g. $CuCrO_4$, $CuBr_2$
Blue	Hydrated copper (II) salts e.g. $CuSO_4H_2O$
Green	Hydrated Iron (II) salts, $CuCO_3$, hydrated $CuCl_2$
Red	Fe_2O_3, Cu_2O, Pb_3O_4, HgO
Orange	$K_2Cr_2O_7$
Purple	Potassium tetraoxomanganate (VII), ($KMnO_4$), Iodine (I_2)

Self-Assessment Questions 3

1.What is the formula for determining Molar Concentration of Concentrated Acid
2. State Dilution equation and name the variable
3. What is a standard solution?
4. What is preliminary test?

Sample Practical Examination Questions

1. X is a solution of a simple salt. Carry out the following test on 20 cm^3 portions of it. Do not perform any other test. State your observation and conclusions.

   a. Add 2 drops of dilute sodium hydroxide solution, and then in excess, warm gently.

   b. Add 2 or 3 drops of dilute ammonia solution and then in excess, warm slightly

   c. Add 2 drops of hydrochloric acid and then a few drops of

6: Summary

In this unit we have gone great lengths discussing practicum in Chemistry education. Various practical activities carried in secondary school Chemistry have been discussed, starting with separation techniques of different kinds of chemical substances, methods of preparation of chemical solutions, quantitative chemical analysis and qualitative chemical analysis. The various practical activities described and meant to be hands-on. You are therefor expected to approach a school with well-equipped Chemistry laboratory to carry out most of the described Chemistry practical activities. Check the section on further reading to discover the resources you need for more discoveries in practicum in Chemistry education.

1.7: Possible Answers to Self-Assessment Question

Self – Assessment 1:

1. When two immiscible form a mixture, what apparatus would you use to separate them?

Separatory Funnel

2. What difference in the two liquids would make it possible for you to separate them?

The density the two liquids are different. One is denser than the other and the less dense one will float on the denser one, showing different columns.

3. A mixture contains two liquids of different boiling points. Name the method you can use to separate them.

Distillation apparatus can be used to separate them

4. A solid dissolved in a liquid to form a solution, what method would you use to separate the solid from the liquid?

Evaporation method can be used to separate the liquid or solvent from the solute or the dissolved substance

Self – Assessment Questions 2

1. What is standard solution?

A standard solution is a solution whose concentration is accurately known

2. Why should you avoid adding water to concentrated acid but you can add concentrated acid gradually to water?

When water is added to concentrated acid, the reaction is very rapid and it generates much heat which make the mixture blow out spilling the acid. It is dangerous. But concentrated acid can be added to water gradually without explosion the water gradually dilutes the conc. Acid with over-boiling and spilling. It is safe.

Self-Assessment 3:

The formula for determining the molar concentration of concentrated acid from the manufacturers is the following:

1. Molarity $M = \dfrac{10 \times D \times \%}{M \text{ (Molar Mass)}}$

Where:

D = Density or Specific gravity of the conc. acid;

% = Percentage purity of the acid
10 = constant factor of dilution
M = Molarity of the Conc. Acid

2. State Dilution equation and the variables
   $M_1V_1 = M_2 V_2$
   M_1 = Molarity of the original solution; M_2 = Molarity of Dilute Solution
   V_1 = Volume of Original solution; V_2 = Volume of Dilute solution

3. What is a standard solution?
   A standard solution is a solution whose concentration is accurately known per Known volume of solvent.

4. What is preliminary test?

   A preliminary test is a test carried out on a chemical substance to find direct in the determination of the contents of the substance. It gives the analyst clue for further test to find out the constituents of the substance.

   What is confirmatory test in the Chemistry Laboratory?
   A confirmatory test is a test targeted to find out whether a particular species (ion, molecule, bond type etc. is present in a sample. A confirmatory chemical test is specifically sensitive to confirm the presence or absence of a targeted species in a sample under given conditions.

1.8: **References/Further Reading:**

1. Google search on the preparation and characterization of any named chemical substance
2. Achimugu Lawrence. (2017). Senior Secondary School Practical Chemistry.
3. Osei Yaw Ababio. (2016). New School Chemistry for Senior Secondary School.

MODULE 4: COMPUTER SCIENCE EDUCATION

Reviewed and Reprocessed by

Professor Z. C. Njoku
Department of Science Education,
University of Nigeria, Nsukka
zephrinus.njoku@unn.edu.ng
&
Dr. Chijioke Jonathan Olelewe
Department of Computer &
Robotics Education,
Faculty of Vocational &Technical
Education,
University of Nigeria, Nsukka

UNIT 1: ELECTRONIC MAILS

1.1 GENERAL INTRODUCTION TO ELECTRONIC MAILS

The computer is an electronic machine used for various purposes ranging from data input, processing, output, analysis, word processing, media publishing, data storage, retrieval, transmission, etc. The computer can be used to generate, transmit and receive messages, data, pictures, video and audio information. Thus the computer is very versatile as input, process, storage, and output devices. In this unit we shall consider in terms of various activities related to topics covered in the curriculum of computer science education. Electronic mail (e-mail) is messages generated, transmitted and received electronically by a digital computer through a network. An email allows computer users to send text, share graphics, sound and animated images to other users. Electronic Mail Account refers to the server's name; one creates the email account in Window by using the information service provider by your internet service provider (ISP) or an administrator.

1.2. LEARNING OUTCOMES

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

1. Create Email account
2. Sign into an email account
3. Create and send emails
4. Delete an e-mail
5. Create and send an e-mail attachment
6. Open Email attachment

1.3 ELECTRONIC MAILS

Electronic mail is a form of information interchange in which messages are sent from one personal computer or computer terminal to another via modems and a telecommunication system. It is the most prevalent application of computer networking. It allows people, irrespective of their location in the world to exchange correspondence at telephone speeds. Your mail address provides all of the information required to get an electronic message to you from anywhere in the world. Each mail subscriber has his own unique address or an Internet Provider (IP) address. This address has three major components namely: (i) **the user's name** (ii) **an @ symbol** and (iii) **the user's domain or location.** An example of a typical email address is: chijioke.olelewe@unn.edu.ng which is the mail address of University of Nigeria Nsukka.

1.3.1. ADVANTAGES OF ELECTRONIC E-MAIL

1. It is cheaper than telephone; fast, flexible and reliable means of communication either in real time or offline mode. This is why organizations that are computerized make extensive use of e-mail.
2. With email, one can attach files, sound clips and videos to messages
3. It improves groups interaction

4. One's email address can easily be followed irrespective of location and time
5. It allows access to very important personalities who may be unreachable through phones
6. It offers a better means of saving transaction messages or document for future reference.
7. It also provides a content record of interaction that can be retrieved, edited, forwarded and reused.

1.3.2. PRACTICAL STEPS REQUIRED IN CREATING AN EMAIL ACCOUNT

To create E-mail Account for example a Google mail (Gmail)

Step 1: Visit Google account creation page, **accounts.google.com**
Step 2: Click on **Create account.**
Step 3: The sign-up form will appear. Enter your **first** and **last name**.
Step 4: Choose a U**sername** for your account. (Here you can also use an existing email address)
Step 5: After choosing a username, **enter a password**. Type the password again to confirm. (As per Google's instruction always use 8 or more characters with a mix of letters, numbers & symbols)
Step 6: At last tap on **Next.** (Right corner of the screen)
Step 7: On the next page enter **your phone number** to verify your account. (It is a two-step verification process for security)
Step 8: On the given mobile number you will receive a text message from **Google** with a verification code. **Enter** the **verification code** and tap on **Verify**.
Step 9: On the next page enter your **DOB** in the specified fields.
Step 10: Choose a **Gender**.
Step 11: Tap on **Next**.
Step 12: Read, Google's Terms of Service and Privacy Policy will appear on the screen and click on **I agree**.

Congratulations! Your account has been created. From now onwards every time you sign in you just have to enter your email id and password. And every time you sign in don't forget to sign out because it prevents others from viewing your emails. Do you know how to sign out?

1.3.3. STEPS REQUIRED TO SIGN IN TO EMAIL

1. On your computer locate the gmail.com app and double click the icon
2. Enter your Google Account email or phone number and password.
   - If information is already filled in and you need to sign in to a different account, click **Use another account**.
   - If you see a page describing Gmail instead of the sign-in page, click **Sign in** in the top right corner of the page

1.3.4. CREATING AND SENDING AN E-MAIL

Step 1: Open your computer, select a browser.
Step 2: Log in to your **Gmail account**, using Id and password.
Step 3: On the new page, click **Compose** (In the top left).
Step 4: A box appears on the screen, here in the **To** field, add recipients email id. (If you want, you can also add recipients in the **Cc** and **Bcc** fields)
Step 5: After that add a **subject**.
Step 6: In the body, write your **message**.
Step 7: At the bottom of the page, there is a send option-click **Send** to send mail.
Note: To add individual recipients and groups of contacts you created with labels to your email, click To.

1.3.5. HOW TO CHECK FOR NEW E-MAIL MESSAGES

Step 1: To check if you have received new messages in your inbox, click Inbox. Note: A list of e-mail messages will be displayed in the Inbox. The messages in the list are organized in chronological order. The name of the sender, the subject, the date and the size of the message are listed along with the message.

Step 2: Click on a message to open it.

Section F: Delete E-mail Message the following step should be followed

To delete a message or several messages, click Inbox. Select the check box beside the messages you want to delete, and then click Delete.

1.3.6. HOW TO REPLY AN E-MAIL MESSAGE

Step 1: To reply to a message, select the message. Then, click Reply. Note: Some Web sites will have a drop-down menu that allows you to choose one option from several choices. Just click on the down arrow and move your cursor to the option you would like to choose. When it is highlighted, click on it.
Step 2: You will notice that you will be directed to the compose page. The sender's e-mail address and the subject will already be filled in.

Step 3: Click on the space below the Subject box. Type your message.

Step 4: If you wish to attach a file to your e-mail, see Section D: Attach a file to your e-mail.
Step 5: If you wish to save the message as a draft, click Save Draft or Save Now.

Step 6: Click Send to send your message

1,4. **SUMMARY**

The desire to communicate is the essence of networking. Email is an answer to this thus it has no doubt provided people with respect to correspondence the fastest means of communication. With a unique email address or an Internet Provider (IP) address for any email subscriber, one can comfortably log on to the internet and maximize the potential inherent in internet communication. For example, it allows a user access to very important personalities who may be unreachable through phone; offers a better means of saving transaction messages or document for future reference and at the same time provides content records of interaction that can be retrieved, edited, forwarded and reused.

SELF ASSESSMENT TEST 1

(a) Create an email account
(b) Write a letter to your coordinator and copy the class rep.
(c) Create an assignment and send it to your class mates
(d) Copy the created email to your classmates
(e) Reply to each mail from your classmates

1.5. References/Further Readings/Web Sources

Agomuo, E.E. (2014). *Moderm Technology: Issues, Procedures and Practice*. Enugu-Nsukka: Debees Printing Services.

https://www.educba.com/what-is-email/

https://www.sciencedirect.com/topics/social-sciences/electronic-mail#:~:text=Electronic%20mail%20(e%2Dmail),advantages%20in%20timeliness%20and%20flexibility.

Wawrowski, B., & Otola, I. (2020). Social Media Marketing in Creative Industries: How to Use Social Media Marketing to Promote Computer Games? *Information, 11(5),* 242.

UNIT 2 SPREADSHEETS

2.1 THE SPREADSHEET

2.1. Introduction

A spreadsheet is a large sheet having data and information arranged in rows and columns. Typical spreadsheet application packages are MS Excel, Lotus 123, SPSS, etc. It is a part of the Microsoft Office suite. The spreadsheet is quite useful in entering, editing, analyzing and storing data. Arithmetic operations with numerical data such as addition, subtraction, multiplication and division can be done using Excel. One can sort numbers/ characters according to some given criteria (like ascending, descending etc.) and use simple financial, mathematical and statistical formulas.

2.2 Learning Outcomes

At the end of the lesson, the student will be able to:

- Create a workbook
- explain the basic features of MS Excel 2007
- work with label
- modify a worksheet
- enter and edit data in a worksheet

2.3. Creating Worksheet

Working Materials: A set of a computer system, keyboard, mouse and MS Excel application.

2.3.1 USES OF SPREADSHEET

- **Finance**: Spreadsheets are ideal for manipulating financial data, such as your checking account information, budgets, transactions, billing, invoices, receipts, forecasts, and any payment system.
- **Forms**: Form templates can be created to handle inventory, evaluations, performance reviews, quizzes, time sheets, patient information, and surveys.
- **School and Grades**: Teachers can use spreadsheets to track students, calculate grades, and identify relevant data; such as high and low scores, missing tests, and students who are struggling.
- **Lists**: Managing a list in a spreadsheet is a great example of data that does not contain numbers, but still can be used in a spreadsheet. Great examples of spreadsheet lists include telephone, to-do, and grocery lists.

2.3.2 PERFORMING SUM FUNCTION

Excel allows you to create worksheets much like paper ledgers that can perform automatic calculations. Each Excel file is a workbook that can hold many worksheets. The worksheet is a grid of columns (designated by letters) and rows (designated by numbers). The letters and numbers of the columns and rows (called labels) are displayed in grey buttons across the top and left sides of the worksheet. The intersection of a column and a row is called a cell. Each cell on the spreadsheet has a cell address that is the column letter and the row number. Cells can contain text, numbers, or mathematical formulas.

Rows are numbered numerically from top to bottom while *Columns* are referred by alpha characters from left to right. In Excel 2007, there are 65536 *Rows* which are numbered as 1, 2, 3, … 65,536. These numbers are shown on the left-most portion of the worksheet. *Columns* (total 256 in Excel) are identified by letters, such as A, B, C, AA… IV, and are shown on the horizontal box just above Row 1.

In a spreadsheet, a value or function or an arithmetic expression is recorded in a *cell*. The intersection of a *row* and a *column* is called a

cell. A *cell* is identified by a combination of a letter and a number corresponding to a particular location within the spreadsheet.
Cell Reference — A cell reference identifies the location of a cell or group of cells in the spreadsheet also referred to as a cell address. Cell references are used in formulas, functions, charts, other Excel commands and also refer to a group or range of cells.
Ranges are identified by the cell references of the cells in the upper left (cell A1) and lower right (cell E2) corners. The ranges are identified using a colon (:) e.g. A1: E2 which tells Excel to include all the cells between these start and endpoints. By default cell reference is relative; which means that as a formula or function is copied and pasted to other cells, the cell references in the formula or function change to reflect the new location.

The other cell reference is **absolute cell reference** which consists of the column letter and row number surrounded by dollar ($) signs e.g. C4. An absolute cell reference is used when we want a cell reference to stay fixed on a specific cell, which means that when a formula or function is copied and pasted to other cells, the cell references in the formula or function do not change.

A mixed reference is also a cell reference that holds either row or column constant when the formula or function is copied to another location e.g., $C4 or C$4.

The first step required to use Excel for a specific application is to decide what values will be entered in which cells and also the cells which will be used for entering the relationships. Once we have decided about the cells which are to be used for the relationships; the formulas (arithmetic expressions) and data can be entered

Values
A value can be entered from the computer keyboard by directly typing into the cell itself. Alternatively, a value can be based on a formula (derived), which might perform a calculation, display the current date or time, or retrieve external data such as a stock quote or a database value. The value rule according to computer scientist Alan Kay implies in a spreadsheet. It states that a cell's value relies solely

on the formula that the user has typed into the cell. The formula may rely on the value of other cells, but those cells are likewise restricted to user-entered data or formulas. There are no 'side effects' to calculating a formula: the only output is to display the calculated result inside its occupying cell. There is no natural mechanism for permanently modifying the contents of a cell unless the user manually modifies the cell's contents. Sometimes it is called a limited form of first-order functional programming.

A what-if scenario is used to generate several alternatives to examine the cause (if) and effect (what). Thus, it helps in analyzing the impact of changes due to variations in one or more input values. Taking the above example, if all the other values are kept the same, one can see how different rates of interest and different periods of compounding would affect the Compound Interest and the Maturity Amount to be received. A text or special character will be treated as labels for rows or columns or descriptive information.

FORMULAS

The formula means a mathematical calculation of a set of cells. Formulas must start with an = sign (equal to sign), e.g. in Figure 2.7 the cell E3 will have formula = D1+E1/F1*G1 which gives a value of 16. When a cell contains a formula, it often contains references to other cells. Such a cell reference is a type of variable. Its value is the value of the referenced cell or some derivation of it. If that cell, in turn, references other cells, the value depends on the values of those.

Order of mathematical operations (expressions) Computer math uses the rules of Algebra. Any operation(s) contained in brackets will be carried out first followed by any exponents. After that, Excel considers division or multiplication operations to be of equal importance, and carries out these operations in the order they occur left to right in the equation. The same goes for the next two operations – addition and subtraction. They are considered equal in the order of operations. Whichever one appears first in an equation, either addition or subtraction is the operation carried out first. Three easy ways to remember the order of operations is to use the acronym:

GEMS PEMDAS
BEMDAS

( ) Grouping	Please - ( ) parenthesis	( ) Brackets
^ Exponents	Excuse - ^ exponents	^ Exponents
* Multiplication:	My - * multiply	* Multiplication
/ or Division:	Dear - / divide	/ Division
- Subtraction:	Aunt - + add	+ Addition
+ or Addition:	Sally - - subtract	- Subtraction

2.4.1: EXCEL WORKSPACE (CREATING NEW WORKSHEET):

Three new blank sheets are always open when you start Microsoft Excel. Below are steps explaining to you how to create a new worksheet if you want to start another new worksheet while you are working on a worksheet, or you close an already opened worksheet and want to start a new worksheet. Step 1 − Right Click the Sheet Name and select Insert option. New Sheet

Step 2 − Now you'll see the Insert dialogue with the select **Worksheet** option as selected from the general tab. Click the **Ok** button.

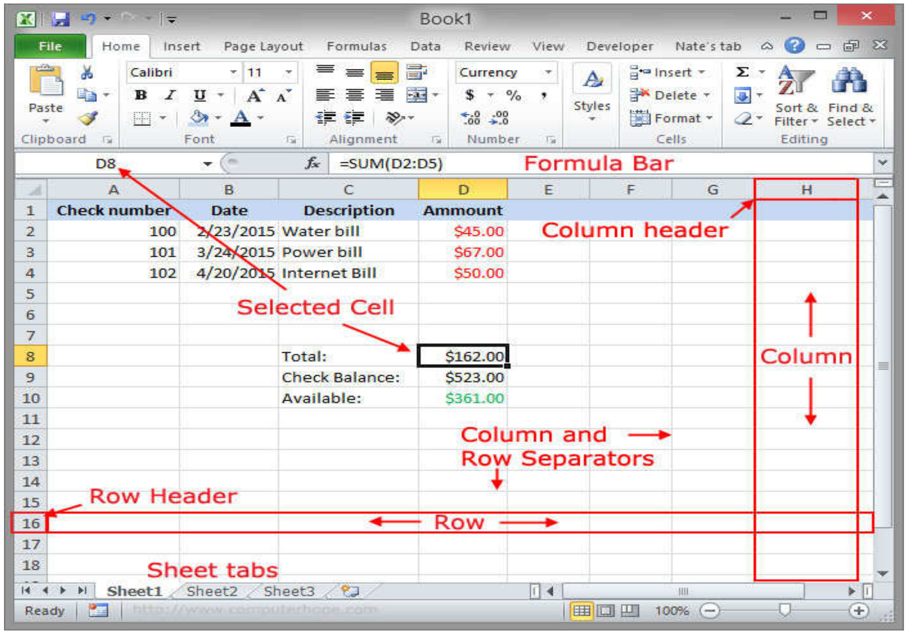


Fig. 1: Basic Features of a Microsoft Excel Spreadsheet

2.4.2: To Perform Addition, Subtraction, Multiplication and Division of Numbers

1. Type: Add, Subtract, Multiply, and Divide in cells A1, B1, C1, and D1
respectively
2. Type: 12, 25, 11 and 75 in cells A2, B2, C2 and D2 respectively
3. Type: 8, 13, 6 and 5 in cells A3, B3, C3 and D3 respectively
4. Type: = A2 + A3 in cell A5 and press Enter
5. Type: = B2 + B3 in cell A5 and press Enter
6. Type: = C2 + C3 in cell A5 and press Enter
7. Type: = D2 + D3 in cell A5 and press Enter

When creating formulas; you can reference cells and include numbers.
The following formulas are valid:
(a) =A2/B2; (b) =A2+12-B3; (c) =A2*B2+12; (d) =24+53/B2

2.4.2.1: Performing AutoSum

The following illustrates AutoSum:
1. Go to cell F1.
2. Type 3.
3. Press Enter. Excel moves down one cell.
4. Type 3.
5. Press Enter. Excel moves down one cell.
6. Type 3.
7. Press Enter. Excel moves down one cell to cell F4.
8. Choose the Home tab
9. Click the AutoSum button in the Editing group. Excel selects cells F1
through F3 and enters a formula in cell F4.
10. Press Enter key and the Excel add cells F1 through F3 and display the result in cell F4.

Note that you can click on the arrow next to AutoSum to access other automatic
calculations like average, minimum and maximum values, count numbers, etc.

2.5: Summary

A spreadsheet is organized in tabular structure with row and columns; with an intersection of a particular row and columns as cell. An electronic spreadsheet is typically a file made of rows and columns that help sort data, arrange data easily, and calculate numerical values. Spreadsheet software is unique given its ability to calculate values using mathematical formulas and the data in cells hence large and small organizations like banks, schools, marketing and accounting firms etc. tend to use it to perform important office tasks like preparing budget, monthly salary, semester results, forecasting, among others.

2.6 Self-Assessment Exercises 2

1. Create workbook
2. Create a worksheet
3. Perform Auto sum and count .

2.7: References/Further Readings/Web Sources

Agomuo, E.E. (2014). *Moderm Technology: Issues, Procedures and Practice*. Enugu-Nsukka: Debees Printing Services.

UNIT 3

3.0. DATABASE

3.1. Introduction

A database is a structured collection of information organized for easy access. A database can be of any size and varying complexity. A database may be generated and manipulated manually or it may be computerized. One reason for database system is that it combines with the database management software that organizes process and presents the necessary data elements in helping a manager to search, probe and query file contents in order to extract answers to unplanned questions that are not available in the regular reports. Database management software will manage the stored data items and assemble the needed items from common database in response to queries of manager.

3.2. Learning Outcomes:

At the end of the exercise, the student SHOULD be able to:

- explain the basic features of MS Access 2007
- Database
- work with label

3.3. Resource Materials for creating database**:** A set of a computer system, keyboard, mouse and Excel.

3.4. MEANING AND ADVANTAGES OF DATABASE

It is a collection of logically related files which can be stored in the form of tables. A database describes anything from an address book, dictionary, or file cabinet to a set of computerized data files with sophisticated data relationships. A file is therefore a collection of information on some subject while a record contains the similar information or data on a particular subject. Some inherent advantages of database includes:

1.Redundancy can be reduced.
2.Inconsistency can be avoided.
3. Data can be shared.
4.Standards can be enforced.
5.Security restrictions can be applied.
6. Integrity can be maintained.
7.Data gathering can be possible.
8. Requirements can be balanced.

3.4.1 Database Management System (DBMS): It is a collection of programs that enables the user to create and maintain a database. In other words, it is general-purpose software that provides the users with the processes of defining, constructing and manipulating the database for various applications

Advantages of DBMS:

1. Data Independence.
2. Efficient Data Access.
3. Data Integrity and security.
4. Data administration. 5. Concurrent access and Crash recovery.
6. Reduced Application Development Time.

3.4.2. Applications of Database

Banking: all banking transactions; Airlines: reservations schedules; Universities: accommodations and
Registration payments, grades; Sales: customers, products, purchases. Online retailers: order tracking, customized recommendations. Manufacturing: production, inventory, orders, and supply chain.

Human resources: employee records, salaries, tax deductions etc.

3.4.3. Database Administrators (DBA): The DBA is responsible for authorizing access to the database, Coordinating and monitoring its use and for acquiring software and hardware resources as needed. These are the people, who maintain and design the database daily. DBA is responsible for the following issues.

3.4.4. Design of the conceptual and physical schemas: The DBA is responsible for interacting with the users of the system to understand what data is to be stored in the DBMS and how it is likely to be used. The DBA creates the original schema by writing a set of definitions and is permanently stored in the 'Data Dictionary'.

3.4.5. Security and Authorization: The DBA is responsible for ensuring unauthorized data access is not permitted. The granting of different types of authorization allows the DBA to regulate which parts of the database various users can access.
Storage structure and Access method definition: The DBA creates appropriate storage structures and access methods by writing a set of definitions, which are translated by the DDL compiler.

3.4.6. Data Availability and Recovery from Failures: The DBA must take steps to ensure that if the system fails, users can continue to access as much of the uncorrupted data as possible. The DBA also work to restore the data to the consistent state.

Database Tuning: The DBA is responsible for modifying the database to ensure adequate
Performance as requirements change.

Integrity Constraint Specification: The integrity constraints are kept in a special system structure that is consulted by the DBA whenever an update takes place in the system. **Database Designers:** Database designers are responsible for identifying the data to be stored in the database and for choosing appropriate structures to represent and store this data.

End Users: People who wish to store and use data in a database. End users are the people whose jobs require access to the database for querying, updating and generating reports, listed as below.

3.5 Microsoft Access

3.5.1: Microsoft Access is a Database Management System offered by Microsoft. It uses the Microsoft Jet Database Engine and comes as a part of the Microsoft Office suite of applications. Microsoft Access offers the functionality of a database and the programming capabilities to create easy to navigate screens (forms). It helps you analyze large amounts of information, and manage data efficiently.

3.5.2. Data types: Data types are the properties of each field. Every field has one datatype like text, number, date, etc.

Table

- A Table is an object which stores data in Row & Column format to store data.
- A Table is usually related to other tables in the database file.
- Each column must have a Unique name
- We can also define Primary Key in a table.

3.5.3. Query

- Queries answer a question by selecting and sorting and filtering data based on search criteria.
- Queries show a selection of data based on the criteria (limitations) you provide.
- Queries can pull from one or more related Tables and other Queries.
- Types of Query can be SELECT, INSERT, UPDATE, DELETE.

3.5.4. Form

- A form is a database object that you can use to create a user interface for a database application.
- Forms help you to display live data from the table. It is mainly used to ease the process of data entry or editing.

3.5.5. Report

- A report is an object in desktop databases primarily used for formatting, calculating, printing, and summarizing selected data.
- You can even customize the report's look and feel.

3.5.6. Advantages of MS Access

- Access offers a fully functional, relational database management system in minutes.
- Easy to import data from multiple sources into Access
- You can easily customize Access according to personal and company needs
- Microsoft Access online works well with many of the development languages that work on Windows OS
- It is robust and flexible, and it can perform any challenging office or industrial database tasks.
- MS-Access allows you to link to data in its existing location and use it for viewing, updating, querying, and reporting.

- Allows you to create tables, queries, forms, and reports, and connect with the help of Macros
- Macros in Access is a simple programming construct with which you can use to add functionality to your database.
- Microsoft Access online can perform heterogeneous joins between various data sets stored across different platforms

3.4.7. Disadvantages of MS Access

- Microsoft Access database is useful for small-to-medium business sectors. However, it is not useful for large-sized organizations
- Lacks robustness compared to DBMS systems like MS SQL Server or Oracle
- All the information from your database is saved into one file. This can slow down reports, queries, and forms
- The technical limit is 255 concurrent users. However, the real-world limit is only 10 to 80 (depending on the type of application which you are using)
- It requires a lot more learning and training compared with other Microsoft programs

3.6. LEVELS OF DATA ABSTRACTION

This is also called 'The Three-Schema Architecture', which can be used to separate the user applications and the physical database.

1. Physical Level: This is the lowest level, which describes how the data is actually stores. Example: Customer account database can be described.
2. Logical Level: This is the next higher level that describes what data and what relationships in the database. Example:

Each record type customer = record
cust_name: sting; cust_city: string;
cust_street: string; end;

3. Conceptual (view) Level: This is the lowest level, which describes entire database. Example: All application

programs.

3.7. DATA MODELS

The entire structure of a database can be described using a data model. A data model is a collection of conceptual tools for describing data models that can be classified into the following types.

1. Object Based Logical Models.
2. Record Based Logical Models.
3. Physical Models. An explanation is as below.

Object Based Logical Models:
These models can be used in describing the data at the logical and view levels. These models are having flexible structuring capabilities classified into the following types.

a) The entity-relationship model.
b) The object-oriented model.
c) The semantic data model.
d) The functional data model.

Record Based Logical Models: These models can also be used in describing the data at the logical and view levels. These models can be used both to specify the overall logical structure of the database and a higher-level description. These models can be classified into,

1. Relational model
2. Network model
3. Hierarchal model

Physical Models: These models can be used in describing the data at the lowest level, i.e. physical level. These models can be classified into

1. Unifying model
2. Frame memory model

3.8.1. ENTITIES

1. It is a collection of objects
2. An entity is an object that is distinguishable from other objects by a set of attributes
3. This is the basic object of E-R Model, which is a 'thing' in the real world with an independent existence
4. An entity may be an 'object' with a physical existence
5. Entities can be represented by 'Ellipses'. Example: Customer, account etc.

ATTRIBUTE Characteristics of an entity are called as an attribute.

The properties of a particular entity are called as attributes of that specified entity. These can be classified into following types.
1. Simple Attributes.
2. Composite Attributes.
3. Single Valued Attributes.
4. Mutivalued Attributes.
5. Stored Attributes.
6. Derived Attributes.

Simple Attributes: The attributes that are not divisible are called as 'simple or atomic attributes'.

Example: cust_name, acc_no etc.
Composite Attributes: The attributes that can be divided into smaller subparts, which represent more basic attributes with independent meaning. These are useful to model situations in which a user sometimes refers to the composite attribute as a unit but at other times refers specifically to its components.
Example: Street_address can be divided into 3 simple attributes as Number, Street and Apartment_no. Street_address City State Zip

Single Valued Attribute: The attributes having a single value for a particular entity are called 'Single Valued Attributes'. Example: 'Age' is a single-valued attribute of 'Person'.

Multi-Valued Attribute: The attributes, which are having a set of values for the same entity, is called 'Multi-Valued Attributes'. Example: A 'College Degree' attribute for a person. i.e, one person may not have a college degree, another person may have one and a third person may have 2 or more degrees. A multi-valued attribute may have lower and upper bounds on the number of values allowed for each entity.

Derived Attributes: An attribute that is derived from another attribute is called a ‘derived attribute. Example: ‘Age’ attribute is derived from another attribute ‘Date’.

Stored Attribute: An attribute that is not derived from another attribute is called a ‘stored attribute. Example: In the above example,’ Date’ is a stored attribute.

3.8.2. : ENTITY SETS

Entity Type: A collection of entities that have the same attributes is called an 'entity type'.

Each entity type is described by its name and attributes.

Entity Set: Collection of all entities of a particular entity type in the database at any point in time is called an entity set. The entity set is usually referred to using the same name as the entity type. An entity type is represented in ER diagrams as a rectangular box enclosing the entity type name. Example: Collection of customers.

Relationships: It is an association among entities.
Relationship Sets: It is a collection of relationships. Primary Key: The attribute, which can be used to identify the specified information from the tables.

Weak Entity: A weak entity can be identified uniquely by considering some of its attributes in conjunction with the primary key of another entity. The symbols that can be used in this model are as

follows.
1.Rectangles ---- ___ Entities.
2.Ellipses ----- ------ Attributes.
3.Lines ------ ------ Links.
4. Diamonds ----- Relationships.
5. Under Lined Ellipse ----- Primary key.
Key Attribute
6. Doubled Lined Ellipse ---- Multi-Valued Attribute.
7. Dashed Ellipse ---- Derived Attributes.
8. Double Lined Rectangle ---- Entity Set.
9. Double Lined Diamond ---- Entity-Relationship, Identifying Relationship.
10. Entity Set having a Primary Key ---- Strong Entity Set.
11. Cylinder ---- Database.
12. Curved Inside Rectangle ---- End Users. EXAMPLE: Name Street City Acc_no Balance
Customer Cust_acc Account

Descriptive Attributes: A relationship can also have some attributes, which are called 'descriptive attributes'. These are used to record information about the relationship. Example: James of 'Employees' entity set works in a department since 1991. Name Dno Dame Street City Since Budget Customer Works_in Departments

Ternary Relationship: A relationship set, which is having 3 entity sets, is called a ternary relationship. Additional Features of the E-R Model

3.8.3: Key Constraints

These can be classified into 4 types as below.
Many to Many: An employee is allowed to work in different departments and a department is allowed to have several employees. Name Dno Dame Street City Since Budget Customer Works_in Departments

One to Many: 1 employee can be associated with many departments, whereas each department can be associated with at most 1 employee as its manager. Name Dno Dame Street City Since Budget Customer Works_in Departments
Many to One: Each employee works in at most 1 department. i.e, many employees can work in the same department. Name Street City Since Customer Works_in
One to One: Each employee can manage at most 1 department. Name Street City Since Customer Works_in

3.9: Create Database from Template

- There are many situations where we need to start with some readymade database template for given requirements.
- MS Access provides many ready to use templates for such types of databases requirements where the data structure is already defined.
- You can keep customizing the template structure further as per our requirements.
- MS Access Databases example includes Contacts, Student, Time tracking, etc.

3.9.1: STEPS TO CREATE DATABASE FROM TEMPLATE

Step 1: With the MS Access application open, Click on File**.**
Step 2: We can select any template by clicking on it. Click on **Contact Template** for further reverence.
Step 3: File name box will appear with the default file name.
Step 4: Enter the new **Name.**
Step 5: Click on **'Create.'**
Step 6: Optionally, you can click on any of the objects from the left navigation pane and open that object for further references and work.

3.9.2.: Create Table – Datasheet View

Step 1: First Click **Create** tab. Then from the **Tables** group, click **Table**.
Step 2: System will display the default table created with 'Table1' name
Step 3: To **Rename** Column, double click on Column Header and enter the new column Name
Step 4: You can **Add a Column** by clicking on any category from **the 'Add & Delete'** group. Alternatively, you can also add a column by clicking on 'Click to Add'
Step 5: Column will be added with the default name as **'Field1.'**
Step 6: Click on Header and rename it as **'COURSE_NAME.**
Step 7: Press 'Ctrl + S' and Enter the new table name to save the table.
Step 8: You can also save a new Name, Caption and Short description for any Column by clicking on '**Name and Caption.'** Click on it
Step 9: Dialog Box will appear. Add the following and Click on 'OK'

- 'Name' – This is the actual name of the column.
- 'Caption' – This is the user view name of the column.
- 'Description' – This is the short description of the column name.

3.9.3: Creating a Form

There are four primary ways to create the form as mentioned below:

- Form Wizard
- Form
- Multiple Item
- Split Form

Let's have a look at each option to create the form, one by one:

3.9.4: Create using Form Wizard

This option allows the user to create the form with the wizard and select the column from the available list of column forms in legacy Select window format.

Step 1: Click on **'Form Wizard.'**
Step 2: System will display below the screen.
Step 3: Select the columns which you want to be there in final form
Step 4: Keep selecting all required column as explained in Step 3 above and then click 'Next.
Step 5: Layout selection box will appear which allows the user to select the different types of form layout. Click 'NEXT'
Step 6: Enter the name of the form as "Contact_Form" and click 'Finish'

3.9.5: Create using Form

It is the simplest way to create the form which will:

- By default, populate all the columns from the selected table in 'form view,'
- The user can delete non-required columns manually

Step 1: Select the table for which we want to create the form and click on 'Form.'
Step 2: Below window will appear
Step 3: Right-click on any cell which we don't want to be part of the final forms and click on 'Delete.'
Step 4: Press 'Ctrl+S' and enter a new Form Name as 'Contact_Form2'. Click 'OK.

3.9.6: Create Form by 'Multiple Item'

It is another type wherein All the records already created will be displayed in Form with an option to add a new record.
Step 1: From the 'Create' tab. Click on 'More forms' and select 'Multiple Items.'
Step 2: Press 'Ctrl+S'. Enter the new form name and click 'OK.'

3.9.7: Creating Form by 'Split from'.

It is a mix of simple form and split form in a way that this form provides the view of **Form and datasheet** in a split window.
Whatever the user enters in Form is visible directly in Datasheet view immediately and vice versa.

Step 1: From the 'Create' tab, click on 'More forms' and select 'Split Form.'
Step 2: Press 'Ctrl+S' and enter the new form name. Click 'OK.'
Edit the existing record via Form.

- One of the features of forms is that we can edit the values and data directly from the form.
- It is more user-friendly because as compared to row format in the table, forms have better visibility of selected fields and the user can do the direct updates.
- These values updated from forms will also be reflected in original tables immediately.

Let's have a look at how to edit value from the form:
Step 1: Click on **'Contact Form**
Step 2: Update some values on 'Contact_Form' value
Step 3: Double Click on the 'Contact' table.

Add a record to a Form.

- Forms also give the flexibility to Add records.
- Again, this is a user-friendly and appealing way of adding records as compared to adding records in a row form.
- Here, we will take the Microsoft Access databases example of Split from ‘Contact_Form_Split’ created above.

Step 1: Open ‘Contact_Form_Split
Step 2: To Add record, click on ‘New (blank) Record Icon
New record window appears in:

1. Form View and
2. Datasheet View

Step 3: Manually fill the data from the Form. Note that in split form all data will be automatically reflected in the below datasheet as well.
Step 4: Double Click on the ‘Contact’ table.

3.9.8: Report

- A report is an object in MS Access that is designed for formatting, calculating and printing selected data in an organized way.
- It contains information from tables and also information that are there in the report design.
- Reports are helpful as they allow you to present all information of your database in an easy-to-read format.

Let’s take an MS Access databases example of **‘Contact’** DB default report – ‘Phone Book.’

Step 1: Click on ‘Phone Book’ under the ‘Report’ section. The system will open the inbuilt ‘Phone Book’ report.
It will display Contact Name, Home, Business and Mobile name displayed for each record present.
Step 2: Now suppose that we want to edit the report Heading from ‘Home’ to ‘Home Number.’ Right click and click on ‘Design View.’
Step 3: Edit the name you want to update and Press ‘Ctrl+S’
Step 4: Double click ‘Phone book’ under report

3.9.9: Summary

A database application is a type of computer application e.g. software dedicated to managing a database. Database application spans a huge variety of needs and purposes from small to user-oriented tools such as an address book, to huge enterprise-wide systems for tasks like accounting. Thus individuals and organizations enjoy the need for databases such as sharing information from one department can be readily shared with others; security of data files; availability of fewer files within an organization thus reducing data redundancy and data integrity.

Self-Assessment Test 3

1. Create a database that will contain your department
2. Create a table that you will use to populate the database using students records

3.10. References

Valentine, T. (2021). Installing and Using the Perl Server. In Database-Driven Web Development (pp. 131-137). Apress, Berkeley, CA.

https://www.educba.com/software-development/software-development-tutorials/software-development-basics/

https://www.oracle.com/database/what-is-database/#:~:text=A%20database%20is%20an%20organized, database%20management%20system%20(DBMS).

UNIT 4

4.0: OPERATING SYSTEM/SOFTWARE

4.1: Introduction

A set of instructions, data, or programs used to control computers and perform certain activities is referred to as software. It is the polar opposite of hardware, which refers to a computer's physical components. Applications, scripts, and programs that operate on a device are all referred to as software. It can be compared to the movable component of a computer, whereas the immovable part is the hardware. Application software and system software are the two major types of software. An application is a piece of software that meets a specific demand or performs a specific purpose. System software is software that runs on top of a computer's hardware and offers a platform for programs to run on. Programming software, which offers the programming tools required by software developers; middleware, which sits between system software and applications; and driver software, which controls computer devices and peripherals, are examples of other forms of software. Early software was built for individual machines and sold in conjunction with the hardware on which it operated. The software was first marketed on floppy disks in the 1980s, then on CDs and DVDs. The majority of software is now purchased and downloaded directly from the internet. The software can be found on the websites of vendors or application service providers. You can accomplish some incredible things with your computer. Digital photo editing, advanced computer games, and video streaming are all feasible thanks to many types of software. New software programs are always being developed by developers, allowing you to do even more with your computer.

4.2 Learning Outcomes

At the end of this topic, the students will be able to:
1. Install Windows operating system
2. Install a CD on a computer with no disc drive

4.3. OVERVIEW OF SOFTWARE

Software is a set of instructions, commands, or programs used to control computers so as to perform certain activities. Unlike hardware, it cannot be seen nor touched hence all applications programs that operate on a device can be referred to as software. Software can be grouped into two namely application software and system software. An application program is a piece of software that meets a specific demand or performs a specific purpose. System software is software that runs on top of a computer's hardware and offers a platform for programs to run on. In other words, it must be present in a computer before it can function. Software is a program or set of instructions that tell a computer what to do. The software comprises the entire set of programs, procedures, and routines associated with the operation of a computer system.

4.3.1 TYPES OF SOFTWARE

As earlier mentioned, there are basically two major types of software: system and application software.

1. System software: The system software is a type of computer software that is designed for running the computer hardware parts and the application programs. It is the platform provided to the computer system where other computer programs can execute. It provide core functions such as operating systems, disk management, utilities, hardware management and other operational necessities.

2. Application software: Software is application software that is designed for the users to perform some specific tasks like writing a letter, listening to music or seeing any video. It helps users perform tasks. Office productivity suites, data management software, media players and security programs are examples. Applications also refer to web and mobile applications like those used to shop on Amazon.com, socialize with Facebook or post pictures to Instagram.
3. Programing languages: The programming language is the third category of computer software which is used by the programmers to write their programs, scripts, and instructions which can be executed by a computer.

4.3.2: Software Installation

Installation refers to the particular configuration of a software or hardware to make it usable with the computer.

4.3.3: INSTALLATION PROCEDURES

How to Install Windows 7

Step 1: Insert the Windows 7 operating system disk into your DVD drive, and then restart your computer

Step 2: You will see a prompt that says ‘Press any key to continue’ after the ZT logo disappears. When you see this press any key immediately.

Step 3: ‘Starting Windows’ with the Windows7 logo will appear.

Step 4: Language options, by default English will be set along with “time and currency format” and “keyboard or input method” Step 5. Click “Install Now”

Step 6: End User License Agreement (E.U.L.A.), check the box to accept, and click “Next”

Step 7: "Which type of installation?" window will appear. Upgrade will be greyed out; the only option you should be able to choose is Custom (advanced).

Step 8: "Where do you want to install windows?" Make sure the partition is highlighted.

Step 9: Delete the partition by clicking on Drive options (advanced) on the bottom right corner of the field. Make sure the partition is highlighted and click on Delete. If drive advanced options is greyed out, then the

Step 10: Disk 0 Unallocated Space should be the only listing at this point. If it is press next, If not please proceed to delete any additional partitions that may be listed.

4.3.4: Windows 10 Installation Instructions for PC

This quick guide assumes you already have a Windows 10 installation DVD and product key on hand. These instructions are meant to be a quick guide.

1. Before we begin, decide what kind of install you would like to perform.

OPTION 1: You want to 'upgrade' to Windows 10 – This option saves your files and settings and does not require you to reinstall your software. NOTE: This option is not available for all situations. If you choose this option, these instructions are NOT for you.

OPTION 2: You want to do a 'clean install' of Windows 10 but you do not want to wipe the hard drive clean – this option saves your files (not your settings) and you will have to reinstall your software.

OPTION 3: You want to completely wipe your computer and do a 'clean install' of Windows 10 – this option will completely wipe the hard drive of all files and start fresh. NOTE: You will need to make sure you already have your data backed up on an external hard drive/flash drive before proceeding.

2. When asked what type of installation you would like, choose Custom: Install Windows only (advanced) if you chose OPTION 2 or OPTION3 in Step 1.
3. When asked to choose the drive to install to, follow the next step according to the choice you made in Step 1.

OPTION 2: Choose the drive with the largest "Total Size". This indicates the drive that currently has your old Windows installation on it. Click on the drive and click Next to being installation.

OPTION 3: NOTE: This option will completely delete all contents of your hard drive make sure all of your files are backed up. Choose each (or the only) drive listed and click Delete. Once you have done this for each drive, you should be left with a single drive named "Drive # Unallocated Space". Select this and then click Next to begin installation. 2. Insert the Windows 10 installation DVD and boot your computer from the DVD. NOTE: In most cases, simply inserting the DVD and rebooting will work. If this does not work, please refer to your computer manufacturer for instructions on booting from a DVD.

3. When you see the screen below, choose English and click Next.
4. Accept the license agreement terms and click Next.

Once installation is complete, you may need to install drivers for Wi-Fi, Sound, Video, etc. Please refer to your computer manufacturer's website to download any required drivers.

Option 2 or Option 3; For OPTION 2, choose the drive that has the largest "Total Size"

4.4.5: HOW TO INSTALL FROM A CD OR DVD

1. Open “My Computer”.
2. In the “My Computer” window, open the drive that contains the installation files. For example, if the files are on the CD-ROM drive, open the D: drive or letter of your CD-ROM drive. In the drive that contains your files, locate either the executable setup (i.e., "setup.exe") or install file. Double-clicking this file to starts the installation process. If there are multiple setups or install files, locate the executable file or double-click each setup or install
3. Once the files are extracted, double-click the setup or install file to install the program Formatting of Computer System software;
4. Formatting a hard drive means to delete all the data on the drive and set a file system to prepare an available space for the operating system.

4.4.5.1: Install a CD on a computer with no disc drive

1. Download the program from the website providing the program.
2. Open the download folder. Where are the files I downloaded using my web browser?
3. If the file you downloaded is executable, double-click the file icon to start the setup process. If the downloaded file is compressed (e.g., .zip), you must extract the file's contents before setup can begin. Fortunately, this function is built into most versions of Windows.
4. How to extract or decompress a compressed file.

Locate either the executable setup (i.e. "setup.exe") or the install file on the drive that contains your files. The installation process begins when you double-click this file. Locate the executable file or double-click each setup or install file until you reach the file that starts the installation.

4.5 SUMMARY

A set of instructions, commands or programs used to control computers operations towards performing certain activities is called software. Application software and system software are the two major types of software. An application is a piece of software that meets a specific demand or performs a specific purpose. System software is software that runs on top of a computer's hardware and offers a platform for programs to run on.

SELF-ASSESSMENT TEST4

1. Install Mavis in your computer system
2. Download a video game in your computer system

4.6. References/Further Readings/Web Sources

Apiwattpong, T. Linux: the new generation operating system.

Campbell, M. (2019). *Installing RStudio. In Learn RStudio IDE (pp. 1-13).* Apress, Berkeley, CA.

Chatterjee, A. (2017). Introduction to Windows Universal. In *Building Apps for the Universal Windows Platform* (pp. 1-16). Apress, Berkeley, CA.

Hagos, T. (2019). *Setup. In Android Studio IDE Quick Reference (pp. 1-9).* Apress, Berkeley, CA.

Hintea, D., Bird, R., & Green, M. (2017). An investigation into the forensic implications of the Windows 10 operating system: recoverable artefacts and significant changes from Windows

8.1. *International Journal of Electronic Security and Digital Forensics, 9(4)*, 326-345.

https://www.ibm.com/topics/software-development#:~:text=Software%20development%20refers%20to%20a,hardware%20and%20makes%20computers%20programmable.

https://www.educba.com/software-development/software-development-tutorials/software-development-basics/

Lessard, B. (2018). *1. Back to the Future: The Rise of CD-ROM. In The Art of Subtraction* (pp. 17-36). University of Toronto Press.

Malhorta, S. (2021). Download Super Smash Bros For PC Windows 10/7/8 Laptop (Official).

Malhorta, S. (2021). How to Download SnapTube for PC Windows 10/7/8.

Pinto, G., & Castor, F. (2017). Energy efficiency: a new concern for application software developers. *Communications of the ACM, 60(12)*, 68-75.

Singh, S. K. (2021). Linux Yourself: Concept and Programming.

Vinayak, S. P. (2020). [FIXED] Windows Update Installation Failure Error Codes 0x80246007, 0x80246008, 800b0100-Windows 10 Update.

Yousaf, M. S., Durad, M. H., & Ismail, M. (2019). Implementation of Portable Executable File Analysis Framework (PEFAF). In 2019 16th International Bhurban Conference on Applied Sciences and Technology (IBCAST) (pp. 671-675). IEEE.

Z

ahra, S. B. Z. S. B. (2018). Advanced User Interfaces from iOS To Windows 8. *International Journal for Electronic Crime Investigation, 2(2)*, 5-5.

UNIT 5

5.0: INTERNET

5.1. Introduction

The internet is a global network connecting millions of computers together for the purpose of sharing file and resources. Today, more than 100 countries are linked together to exchanges of data, news and opinions. The Internet links are computer networks all over the world so that users can share resources and communicate with each other.

5.2. Learning Outcomes

At the end of the exercise, the student should be able to:

- Define internet
- Define Search engine
- Creating and sending an e-mail using a Search engine

Materials: A set of a computer system, mouse and internet.

5.3: The Concept of Internet

The internet otherwise called the net is a world-wide system of computer network. A network or networks in which users at one computer, can if they have permission, get information from any other computer. The internet was conceived by the Advance Research Project Agency (ARPA) of the United States Government in 1969 and was first known as ARPANET. The original aim was to create a network that will allow users of a research computer at one university to be able to talk to research computers at other universities. Today, the internet has become a public and self-sustaining facility accessible to hundreds of millions of people world-wide. Technically what distinguishes the internet is its use of a set of protocols called transmission control protocol or internet protocol (TCP/IP). One major advantage of the internet is the vast amount of data and information available and accessible by people on any kind of subject matter. It is important to note that to get information on the internet, certain sites are mainly dedicated to information free of charge while some will require that you register and pay subscription fee in other to get access to particular information.

5.3.1: Types of Computer Network:

- Local Area Network (LAN) connects network devices over a relatively short distance. A networked office building, school, or home usually contains a single LAN, though sometimes one building will contain a few small LANs (perhaps one per room), and occasionally a LAN will span a group of nearby buildings Metropolitan Area Network (MAN)
- A metropolitan area network (MAN) is a large computer network that usually spans a city or a large campus. A MAN often acts as a high-speed network to allow sharing of regional resources. A MAN typically covers an area of between 5km and 50km diameter. A MAN might be owned and operated by a single organization, but it usually will be used by many individuals and organizations
- Wide Area Network (WAN) covers a large geographic area such as country, the continent or even the whole of the world. A WAN is a geographically-dispersed collection of LANs. Most WANs (like the Internet) are not owned by anyone organization but rather exist under collective or distributed ownership and management.

To gain access to the internet, the user has to register to any Internet Service Provider (ISP).

5.3.2: Types of Internet connection

– Dail-up
– Integrated services digital network
– Asymmetric Digital Subscriber Line

– Wireless Internet Connections
– Internet over Satellite

Choosing Internet Service Provider**:** the following are some things to consider as you research ISPs

• Speed
• Price
• Ease of Installation
• Service Record
• Technical Support
• Contract Terms

5.3.3: How does the Internet work?

Because the Internet is a global network of computers, each computer connected to the Internet must have a unique address. This address is known as an IP address

5.3.4: Internet Requirements

• Computer with modem/router/network card.
• Internet account with ISP.
• Application software
 ➢ Web browser (Firefox, Chrome)
 ➢ Email client (MS Outlook)
 ➢ Plugins software (Adobe Reader, Flash Player)
 • Optional: Speaker, Printer, Webcam

5.3.5: Internet Usages

• Communication
• Send and receive emails
• Download files
• Post your opinion to a newsgroup
• Chatting
• Surf the World Wide Web
• Business
• Shopping
• Entertainment

5.3.6: Internet Applications

• The World-Wide Web (WWW)
• Electronic Mail (E-Mail)
• File Transfer Protocol (FTP)
• Search Engine
• Chatting
• Video Conferencing
• E-Commerce

World Wide Web (WWW) The World Wide Web is a system of interlinked hypertext documents accessed via the Internet. With a web browser, one can surf the web pages that may contain text, images, videos, and other multimedia and navigate between them via hyperlinks**.** It uses a protocol called Hypertext Transfer Protocol (HTTP). HTTP defines how messages are formatted and transmitted, and what actions Web servers and browsers should take in response to various commands.

5.3.7: Types of the websites

• Static website: A static website has web pages stored on the server in the format that is sent to a client web browser. It is primarily coded in Hypertext Markup Language (HTML)
• Dynamic website: A dynamic website changes or customizes itself frequently and automatically, based on certain criteria.
Search Engine: A search engine is designed to search for information on the internet. The search engine presents the search results in the form of a search results list. The search results can be web pages, images, videos, among others
Type of files.
• Example:
– Google
– Bing
Chatting
• Chatting is the other method for Internet conversation.

• It enables people connected anywhere on the Internet to join in live discussions.
• Chat sessions allow many
Chatting
Examples:
• MSN Messenger
• Yahoo Messenger
• IRC
• Pidgin
users to join in the same free-form conversation, usually centred around a discussion topic.

The internet video Conferencing
• A videoconference or video conference is a set of interactive telecommunication technologies which allow two or more locations to interact via two-way video and audio transmissions simultaneously. The other components required for a videoconferencing system include:
• Video input and output
• Audio input and output
• Data transfer
• Computer
The Internet
E-Commerce
• Electronic commerce or E-Commerce consists of the buying and selling of products or services over electronic systems such as the Internet and other computer networks.
• It includes the entire online process of developing, marketing, selling, delivering, servicing and paying for products and services.

5.4. The Internet E-Commerce: Some common applications related to electronic commerce are the following:
• Domestic and international payment systems
• Group buying
• Automated online assistants
• Online shopping and order tracking

- Online banking
- Shopping cart software
- Electronic tickets

5.5: Summary

The internet is today seen as an integral part of the global village as it has helped to diminish the significance of the concept of nation state. Internet provides numerous opportunities for small and large scale businesses. Thus making those whose essential work is information processing to work from home. With internet is the emergence of new forms of doing things such as e-learning, e-commerce, e-voting, video-conferencing, e-market, etc.

Self-Assessment Test 5

1.Download an application software in your smart phone or computer system

2.Create an Email

3.Using Google to search for material on computer application software

REFERENCES

Agomuo, E.E. (2014). *Moderm Technology: Issues, Procedures and Practice*. Enugu-Nsukka: Debees Printing Services.

Alyami, M., Giri, B., Alyami, H., & Sundram, F.(2017). Social anxiety apps: a systematic review and assessment of app descriptors across mobile store platforms. *Evidence-based mental health, 20(3),* 65-70.

Apaiporn, K. Online job application.

Cintas, J. D., & Massidda, S. (2019). *Technological advances in audiovisual translation. In The Routledge handbook of translation and technology (pp. 255-270)*. Routledge.

Furenes, M. I., Kucirkova, N., & Bus, A. G. (2021). A comparison of children's reading on paper versus screen: A meta-analysis. Review of Educational Research, 0034654321998074.

Gore, J. (2020). A Type of Theft. Available at SSRN 3792393.

Hatchuel, S., & Vienne-Guerrin, N. (2021). From zones to Zoom: Shakespeare on screen in the digital era.

https://www.internetsociety.org/internet/history-internet/brief-history-internet/#:~:text=Internet%20was%20based%20on%20the,radio%20networks%20and%20other%20networks.

Makmal, A., Ephrath, J., Berezin, H., Allerhand, L., Nice, N., & Koenigstein, N. (2019, September). Pick & merge: an efficient item filtering scheme for Windows store recommendations. *In Proceedings of the 13th ACM Conference on Recommender Systems (pp. 472-476).*

Mukherjee, S. (2018). Cloud Computing and Its Use. *International Journal of Marketing and Technology, 8(5)*, 23-36.

Najafabadi, M. M. (2017). *Machine Learning Algorithms for the Analysis and Detection of Network Attacks*. Florida Atlantic University.

Novac, O. C., Novac, M., Gordan, C., Berczes, T., & Bujdosó, G. (2017, June). Comparative study of Google Android, Apple iOS and Microsoft Windows phone mobile operating systems. In 2017 14th *International Conference on Engineering of Modern Electric Systems (EMES) (pp. 154-159).* IEEE.

Payne, W. B., & O'Sullivan, D. (2020). Exploding the phone book: Spatial data arbitrage in the 1990s internet boom. *Annals of the American Association of Geographers, 110(2)*, 391-398.

Ratnaparkhi, P., & Agarwal, S. (2020). Arduino Based CNC Drawing Machine. *International Journal of Progressive Research in Science and Engineering, 1(3),* 145-148.

Rivera, R., Kotzias, P., Sudhodanan, A., & Caballero, J. (2019). Costly freeware: a systematic analysis of abuse in download portals. *IET Information Security, 13(1),* 27-35.

Sweeny, R. W. (2021). *Post-Internet Art and Pre-Internet Art Education. In Post-Digital, Post-Internet Art and Education (pp. 45-59)*. Palgrave Macmillan, Cham.

Thomasson, M. (2018). Video Game Cartridges: The History of Durable, Removable, and Portable Software. In The Routledge Companion to Media Technology and Obsolescence (pp. 311-321). Routledge.

Trevisan, M., Giordano, D., Drago, I., Munafò, M. M., & Mellia, M. (2020). Five years at the edge: Watching internet from the ISP network. *IEEE/ACM Transactions on Networking, 28(2),* 561-574.

MODULE 5 INTEGRATED SCIENCE

Reviewed and Reprocessed by

Prof. Zephrinus .C. Njoku &
Dr. Bianca U. Mbonu-Adigwe
Department of Science Education
University of Nigeria, Nsukka
zephrinus.njoku@unn.edu.ng
08035811170

Contents

1.1. General Introduction

Science as a discipline is the systematic study of nature or environment through experimentation and careful observation, leading to the accumulation of an organized body of knowledge which is useful for problem solving. Science is made of two mutually dependent categories: the scientific method comprising the process of conducting science investigations to gather information about nature, to gain knowledge about nature/environment, and, the products of science comprising the accumulated organized body of knowledge about nature/environment as can be found in scientific books, journals, periodicals, monographs, encyclopedia etc.

The process of science is the same for all aspects of science and can be used for investigations in Biology, Physics, Chemistry and all aspects of nature/environment. Compartmentalization of science into different disciplines is a creation of scientists who needed to manage the large volume of information/knowledge gathered through scientific experimentation and observation in the environment. Knowledge about related things were collated and given names such as Biology, Chemistry, Physics, Mathematics, etc. This is how the disciplines and sub-disciplines of science came about.

Integrated Science at the basic education level is an effort of science teachers to teach and learn science for what it is, in its true nature. The compartmentalization of science into special disciplines is obliterated in Integrated Science such that unity in science is shown because that is the nature of science. Integrated Science is taught in major themes and generalizations which cut across all the disciplines of science. Such themes as energy, environment, living things, non-living things, industrial process, safety in the community, diseases, transport systems, Chemistry of Biological systems, Physics of Chemical systems etc are taught in Integrated Science.

These themes cannot be correctly described as any discipline or sub-disciplines of science. The practical activities that would be dealt in this section of the science manual would be along the major themes that correctly represent science for what it is, process and product of investigation of nature. The practical activities are intended to enable the trainee science teachers acquire science process skills based on contents that have been dealt with during lecture sessions on Integrated Science.

1.2. Learning Outcomes

By time you complete practical activities in this section of the Science Practical Manual, you should be able to:

1. Learn some Integrated Science experiments and practical activities for students in primary and Junior secondary schools

2. Identify resources and places where you can source for materials for Integrated Science Practical activities.
3. Set up equipment and materials for conducting practical activities in science,
4. Develop practical skills or process skills in conducting practical activities, including some experiments
5. Develop positive attitudes to science practical work/activities in science
6. Carry out practical activities on various topics in Integrated Science
7. Take appropriate precautions in the conduct of science practical activities, and handling of resources for practical activities.
8. Establish basic rules for students' use of science laboratory and the equipment and resources there in.

1.3.0. UNIT 1: Microscopy

CONTENTS

1.3.1 MICROSCOPY

AIM/OBJECTIVE: Introduction to the use of microscopes. At the end of the experiment students should be able to:

1. Use microscopes effectively during laboratory activities.
2. Prepare temporary and permanent slides.
3. Draw and label biological specimens appropriately.

APPARATUS: Microscopes, magnifying lenses, lens tissue and specimen slides, cover slips, pipettes, prepared slides of different protozoa, Euglena, Onion slices.

1.3.1. Introduction to microscopy

Microscopy is the technical field of using microscopes to view objects and areas of objects that cannot be seen with the naked eyes (objects that are not within the resolution range of the normal eye). A microscope is an instrument that is used to magnify small objects. In fact, some microscopes can even be used to observe an object at the cellular level, allowing scientists to see the shape of a cell, its nucleus, mitochondria, and other organelles. There are several different types of microscopes used in light microscopy, and the four most popular types are compound, Stereo, Digital and the Pocket or Handheld microscopes. The compound microscope is the most common light microscope used in the laboratory because it contains two types of lenses that function to magnify an object.

To use the microscope efficiently and with minimal frustration, you should understand the basic principles of microscopy. The principles are briefly discussed below.

1. **Magnification**: This is the ability of a microscope to produce an image of an object at a scale larger than its actual size. Magnification serves a useful purpose only when it is possible to

see more details of an object in the image than when observing the object with the unaided eye.

2. **Resolution**: The term resolution is used to describe the ability of a microscope to distinguish details in an object. The resolution or resolving power of a microscope denotes the smallest details that a microscope can resolve when imaging a specimen. In other words, this is the minimum distance at which two distinct points of a specimen can still be seen – either by the observer or the microscope camera – as separate entities. Resolution is a function of the design of the instrument and properties of the light used in image formation of the microscope. The smaller the distance between the two points that can be distinguished, the higher the resolving/resolution power.

3. **Numerical Aperture**: Numerical Aperture (NA) of a microscope is the measure of its ability to gather light and resolve fine specimen detail at a fixed object distance. Numerical aperture is an important consideration when trying to distinguish details in a specimen viewed down the microscope.

4. **Illumination and Focusing**: One of the most critical aspects in optical microscopy is to ensure the specimen is illuminated with light that is bright, glare-free, and evenly dispersed in the field of view. The illumination system of the standard optical microscope is designed to transmit light through a translucent object for viewing. The most common source for today's microscopes is an incandescent tungsten-halogen bulb positioned in a reflective housing that projects light through the collector lens and into the sub-stage condenser. Lamp voltage is controlled through a variable rheostat that is commonly integrated into the microscope stand.

Focusing in microscope is a means of moving the specimen closer or further away from the objective lens to render a sharp image. On some microscopes, the stage moves and on others the tube or head of the microscope moves. Rack and pinion focusing is the most popular and durable type of focusing mechanism.

Activity 1.2. Parts of the Microscope

Objectives: By the end of this activity you should be able to

1. Identify the parts of the compound microscope
2. Draw and label the compound microscope
3. Identify the functions of the parts of the microscope

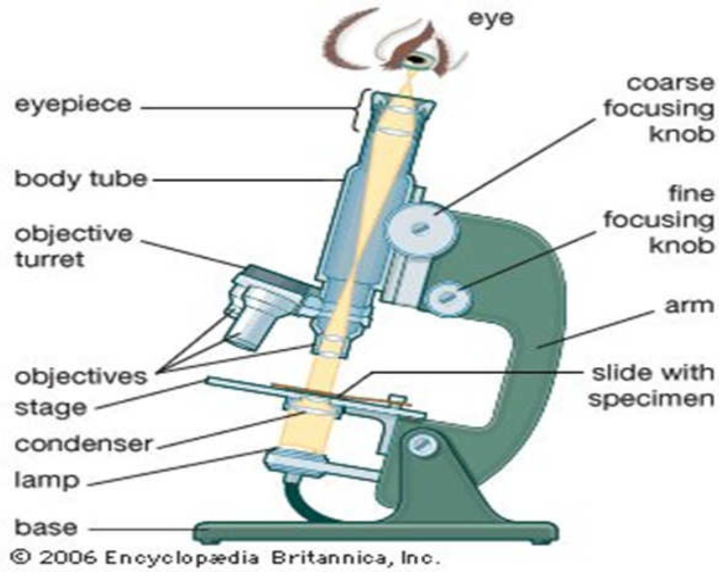


Fig. 1: The Compound Microscope

Functions of the parts of the Microscope

1. Eyepiece – The lens from which one looks into the microscope to see what is mounted on it for observation
2. Body Tube – A straight metal tube between the eyepiece and the objective lens through which specimens are seen on the stage.
3. Objective Turret – The head on which the objective lenses are fixed in a shifting manner.
4. Objective lenses – A set of three shifting lenses attached to objective turret facing the stage, and which focus directly on the objects or specimen to be viewed under the microscope on the stage. The three lenses have different magnifications for viewing specimens of different sizes at different resolutions
5. Stage – The platform on which specimens are mounted for viewing the microscope.

6. Condenser – A short tube below the stage through the image of the object is condensed for greater resolution.
7. Lamp – At the base of the condenser through which light enters the microscope into the objective lens and to the eyepiece for viewing.
8. Base – Keep the microscope balanced and stable on the flat surface or table
9. Slide with specimen – The specimen to be viewed is mounted on the slide and held to the stage for viewing
10. Arm – This is where the Microscope is held while moving it from one point to another
11. Fine focusing knob – It is used for carefully focusing the objective lens on the specimen.
12. Coarse knob – Used for focusing to ensure that the specimen is on the objective lens

Self - Assessment Exercise 1

-Draw and label a simple light compound microscope.

-Give the functions of the following parts of the microscope

a) Body Tube, (b) Condenser (c), Stage, (d) Arm, (e) Base, and

1.3.2. How to draw and label specimens properly

In making biological drawings, the following must be observed:

1. Drawing lines must be smooth and not wavy.
2. Drawing must not be shaded.
3. All cut surfaces are to be represented by double lines.
4. All labels must have their guide lines ruled, and must touch the object being labeled.
5. All labels must be horizontal
6. Ruled guide lines must not cross each other

In making biological drawings, magnifications of specimens and prepared slides of lower plants and animals need to be determined as indicated below:

Activity 1.3: Magnification

1. **Scales of drawing using hand lens**

Magnification (M) = length of drawing (image) ÷ Length of object
OR Width of drawing (image) ÷ Width of object

1. **Magnification of object under microscopes**

Magnification is power of the objective lens X eyepiece, this is called total magnification.

Primary Magnification = L/F

Where L = Tube length of microscope

F = Focal length of objective

Total Magnification = (L/F) X e

Where e = magnification of eyepiece.

Activity 1.4: How to mount slides of fresh specimens

(i) Place one drop of your sample in the center of the clean slide using the pipette. (Sample of pond water).

(ii) Cover the drop by lowering the cover slip gently down onto it in a slanting position. Ensure no air bubbles are trapped. (those air bubbles are frequently mistaken for organisms)

(iii) Use the coarse focusing knob and the low power objective to ensure the sample is properly focused.

(iv) See if you can identify any of the micro-organisms i.e. Amoeba, Paramecium or Euglena.

(v) Ask the demonstrator to confirm any identification you make. Then use the x10 or x20 objective to see more details of the micro-organisms.

(vi) Draw under high power and label fully.

(vii) Indicate briefly the functions of the parts you have seen and labeled.

(viii) Make an onion/rheo epidermal strip and examine the layout of typical plant cell.

Activity 1.5.

1. Observe/examine micro-organism with the help of a microscope
2. Prepare slides of fresh specimens like cells of onion leaves.
3. Make biological drawings following guidelines and 'calculate' magnifications for all drawings.

1.3.3. TUTOR-MARKED ASSIGNMENT

1. Make a temporary slide preparation of the following (a) Strand of Spirogyra (b) Moss or fungi. Observe and focus under microscope. Draw, label and determine the magnification of various specimens as observed under the microscope.
2. You are provided with a cockroach. Make a scale drawing of it 15cm in length and 10cm in width. State its magnification.
3. With a clean finger scratch the inside of your cheek and mount in a drop of water on a clean slide. Examine under the microscope for a typical animal cell. Draw and label properly.

UNIT 2. QUANTITATIVE TREATMENT OF AN ECOSYSTEM DETERMINATION OF NUMBER OF ORGANISMS IN AN ECOLOGICAL COMMUNITY.

CONTENTS

2.1. INTRODUCTION

Ecology deals with the study of organisms (plants and animals) in their environment (Ecosystem) either biotic or abiotic. An Ecological Survey will provide the qualitative characteristics of different sites or habitats. The qualitative features include trees, shrubs, herbaceous plants, floor cover, and their associated animals (scavengers, herbivores, carnivores). Such a survey can form the basis of the description of their symbolic relationships, or their mode of nutrition, and levels of adaptations within the ecosystem.

A **quadrat** is a frame, traditionally square, used in ecology and geography to isolate a standard unit of area for study of the distribution of an item over a large area. Modern quadrats can be rectangular, circular, or irregular shaped.

2.2. Learning Outcomes

At the end of the activities in this unit, you should be able to select an area and

(i) Perform adequate quadrat throws

(ii) Collect samples of living organisms (floral and fauna) for the identification

(iii) Identify the species and construct quadrat chart using a key

(iv) Determine the abundance, frequency and Density of species

(iv) Construct food chain and food webs of the organisms

(v) Construct pyramid of numbers

(vi) Draw Energy Material Relationship of the organisms found

2.3.1: **APPARATUSES: The Quadrat,** Herbaria albums, and **insect boxes.**

The quadrat is a square or rectangular, or circular instrument whose dimensions are known and whose area can be calculated. The quadrat is usually made of wood or plastic or metal. The ecological investigator can easily make his/her own quadrat using locally available resources. There are different types of Quadrat – Ready-made quadrat frame, meter stick, string quadrat (circular, triangular, square, rectangular etc.), Herbaria albums, and insect boxes.

Cover index is the amount of space of ground covered by each species.

Quadrat Chart is the diagrammatic illustration of the distribution of the various organisms (Species) found in the quadrat, using either visual estimation or a scale.

Fig. 2: Typical rectangular quadrat

2.3.2 PROCEDURE for sampling the population of a community

1. Select an area within a Habitat or Ecosystem
2. Throw the quadrat (several times)
3. Record the number of species found within each section of the quadrat for each throw
4. Collect samples of organisms within the quadrat for identification
5. Use experts or herbaria to identify all the species collected
6. Draw Quadrat Chart using a key
7. Determine the abundance, frequency and density of species/organisms, within the quadrant
8. Construct appropriate food chain and food webs of the organisms found.
9. Construct pyramid of numbers.
10. Draw energy/material relationship (Energy flow and material circulation) of organisms observed.

2.3.3. EXPECTED RESULTS

1. Identification of the flora and fauna species within the quadrat from site to site.
2. Drawing of a good quadrat, chart with keys
3. Determination of the abundance, frequency and density of species
4. Construction of associated food chain and food webs of the organisms.
5. Construction of pyramid of numbers.
6. Drawing of energy flow/material circulation relationship.
7. Appropriate description of the qualitative and characteristics of the selected ecology site (or habitat).

2.3.4. TUTOR-MARKED ASSIGNMENT

Select an area within a Habitat or Ecosystem (somewhere around you or your school environment). Repeat the procedure above and record your findings.

2.3.5. Reference/Further Readings

https://en.wikipedia.org/wiki/Quadrat

UNIT 3 QUANTITATIVE TREATMENT OF ECOSYSTEM

CONTENTS

ACTIVITY 3: HOW TO CREATE ANOTHER HABITAT FOR ORGANISMS

3.1. Introduction

The earth serves as home for many kinds of living things. Many living things inhabit the sea, desert, land, grasslands and forests. Any place where an organism or groups of organisms live is called a habitat. Several habitats which have relations with one another is called community. In an ecological community, the organisms live together and depend on one another for survival. Some of the organisms are food producers while others are comsumers (See figure 3).

***Fig. 3: A Grassland Habitat*/community**
Fig. 4: An Ocean habitat/community

3.2. Learning Outcomes:

By the end of these activities you should be able to:

a. Describe a habitat
b. List some organism found in different habitats
c. Create a habitat for organism and monitor their growth

3.3.1. Creating a new habitat of organisms

To create another habitat for living organisms, you need the following

1. One large bucket with some loamy soil
2. Five bean seeds
3. Five live earthworms
4. Five live ants
5. Five small land snails

Procedure

1. Plant the seeds in the soil in the container
2. Put in the different animals. Use whatever you think is necessary for the organisms to grow and remain in the habitat.
3. Draw a picture of the habitat you have made
4. List the changes you observe every day for one month
5. Note any change in the number of organisms in the habitat
6. Note any new member of the habitat as the new habitat gets older
7. Measure the height of the plants each day and record your findings.
8. What do the animal members of the habitat feed on?

3.4. Reference/Further readings

Bajah, S.T., Ryan, J.O. & Samuel, P.S. (2008). *Integrated Science: A new approach for junior secondary schools.* Ibadan. University Press PLC

https://www.google.com/search?q=DIFFERENT+HABITAT&client=firefox-b-d&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjRhbrpvfnzAhWKhP0HHV0BAyAQ_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1

UNIT 4 ACTIVITY 4: EFFECT OF LIGHT ON A GROWING PLANTS

CONTENTS

4.1. Introduction

Green plants use light from the Sun to manufacture carbohydrates which they depend on for their food, and the food all other living things which cannot make their own food from the Sun's light energy. Therefore, light is the main source of energy on earth and without it the planet earth would be a dead planet. Consequently**, green plant** desire the light from the Sun.

4.2. Learning Outcomes: By the end of this activity, you should be able to show the importance of light to a growing seedling of a green plant.

4.3.1: Main Content:

Activity to show the effect of Sun light on growing green plant

4.3.2: Resources you need:

1. Two small bean seedlings in separate pots
2. A cardboard box that can close
3. A source of light (you can carry out the activity near a window)

4.3.3. Procedure

Place one of the pots inside the box and close the box so that no light reaches the plants.

Place the second box in a cardboard box or carton and leave it open so that light can reach it from the open window.

Record the differences you observe between the two plants every two days.

Continue the experiment for eight days.

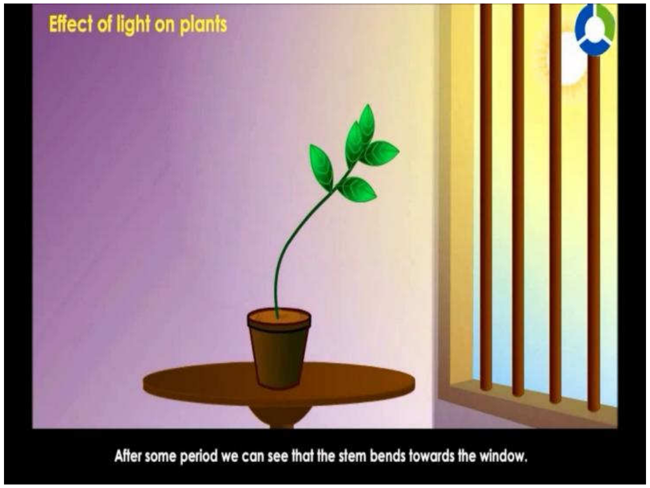


Fig. 5: Plant grows towards the source of light

Fig. 6: Two potted plants after the activity. One grew in the presence of light; the other didn't have light so it died.

4.3 FURTHER READINGS

https://www.google.com/search?q=effect+of+light+on+growing+plants&client=firefox-b-d&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjC8K_KvfnzAhWg57sIHR67ATcQ_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1

UNIT 5

Activity 5: CHANGING LIGHT ENERGY OF THE SUN TO HEAT ENERGY

MAIN CONTENTS

5.1. Introduction

Light is a form of energy. All forms of energy can be transformed to other forms. Human beings, in the quest for survival on this planet, has devised ways of converting one for of energy into another that would be more useful to humans depending on the circumstances of the moment. Light from the Sun can be converted onto heat energy for suitable purposes which light may not serve at that moment.

5.2. By the time you complete this activity, you should be able to convert Sun light energy into heat energy which can be used to heat materials like water. This is what happens when solar heaters are used for heating things including cooking foods.

5.3.0. Main Contents:

5.3.1. APPARATUS

1. Convex lens
2. A small piece of dry paper

5.3.2. PROCEDURE

1. Place the piece of paper flat on a dry surface.
2. Hold the convex lens above it so that the light from the sun passes through the lens.
3. Move the lens up and down until you find the position where the image formed on the paper is just a small bright spot.
4. Hold the lens in position for some time and observe what happens to the paper
5. Record your observation

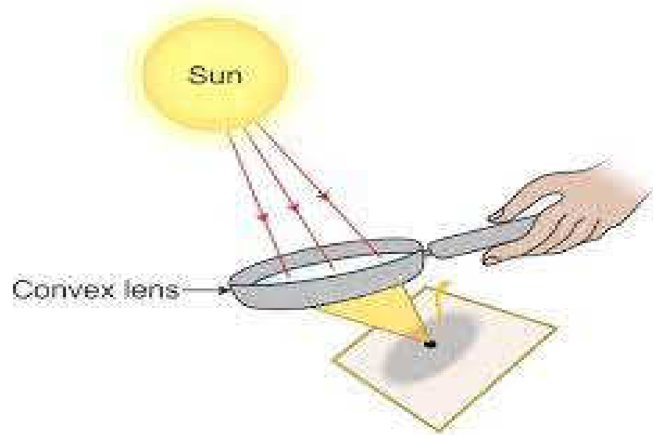


Fig. 7: The picture above shows how the light energy from the sun passes through the lens to a particular point on the piece of dry paper. This concentrated light energy becomes hot enough to burns the paper.

UNIT 6: FOOD TESTS

CONTENTS

ACTIVITY 6

6.1. Introduction: Food of energy to function. Food is the source of energy necessary for functional life. For humans, foods are of different types and they supply different nutrients to give the human body vitality and wellbeing. The various nutrients in foods can be discovered through food tests. Food tests are chemical procedures aimed at finding out what food substances are present in a food sample. It helps to make decision on the type of food to eaf in order to be strong and healthy.

6.2. FOOD TESTS

Learning Outcomes: By the end of this activity, you should be able to successfully carry out laboratory investigation to distinguish between different types of foods such sugars, proteins, oils and starch etc

6.3.1. Test for sugar in food samples

Apparatus

1. Test tubes
2. Food samples (bread, garri, fufu, amala. Yam, meat)
3. 5ml of Benedict’s solution
4. Boiling water

Procedure

1. Put a small piece of each food sample in separate test tubes.
2. Add 5ml of Benedict's solution to the test tube
3. Place the test tube in boiling water
4. Observe for 5 minutes
5. Note any color change

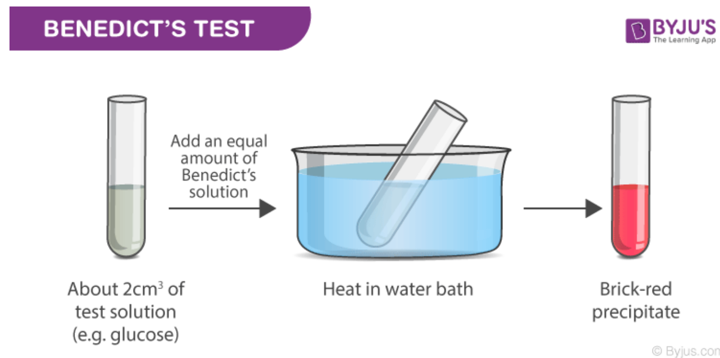


Fig. 8: Red color shows the presence of sugar in the food sample

6.3.2 Test for starch in food samples

Apparatus
1. Test tubes
2. Food samples (bread, garri, fufu, amala. Yam, meat)
3. Iodine solution

Procedure

1. Put a small piece of each food sample in separate test tubes.
2. Add one or two drops of Iodine solution to each tube
3. Observe for 5 minutes
4. Note any color change
5. Record which food item contains starch

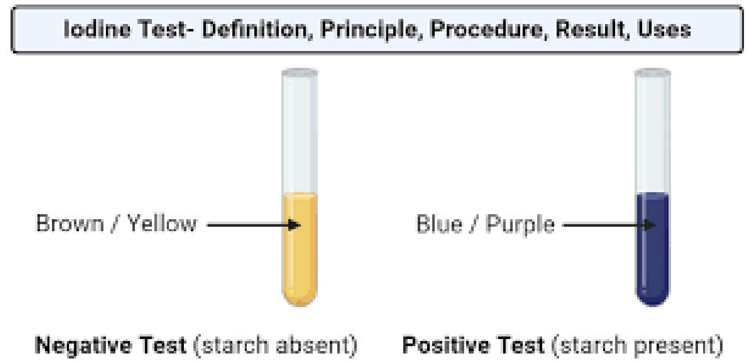


Fig. 9: Blue/ dark Purple color shows the presence of starch in the food sample

6.3.3 Test for protein in food samples

Apparatus

1. Test tubes
2. Food samples (bread, garri, fufu, amala. Yam, meat)
3. Biuret solution

Procedure

1. Put a small piece of each food sample in separate test tubes.
2. Add one or two drops of Biuret solution to each tube
3. Observe for 5 minutes
4. Note any color change
5. Record which food item contains protein

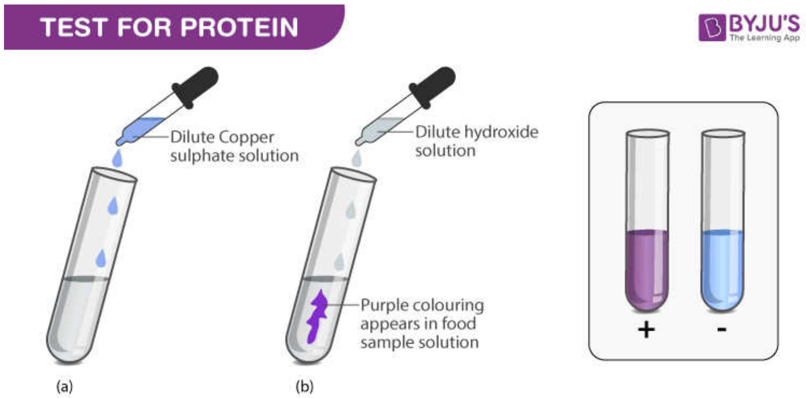


Fig. 10: Purple color shows the presence of protein in the food sample

UNIT 7

Activity 7: MEASUREMENT

CONTENTS

7.2. Learning outcomes

7.1 Finding the mass of a liquid
7.2 Finding the weight of an object
7.3 How To Make A Spring Balance
7.4 Pressure

(i) Self-assessment exercise

7.5 Atmospheric pressure (Demonstration of Egg in Bottle Experiment)
7.6
7.6 Reference/Further Readings

7.1 Aim: by the end of these activities, students should be able to;

a. carry out simple activities in measurement
b. Construct and calibrate a spring balance

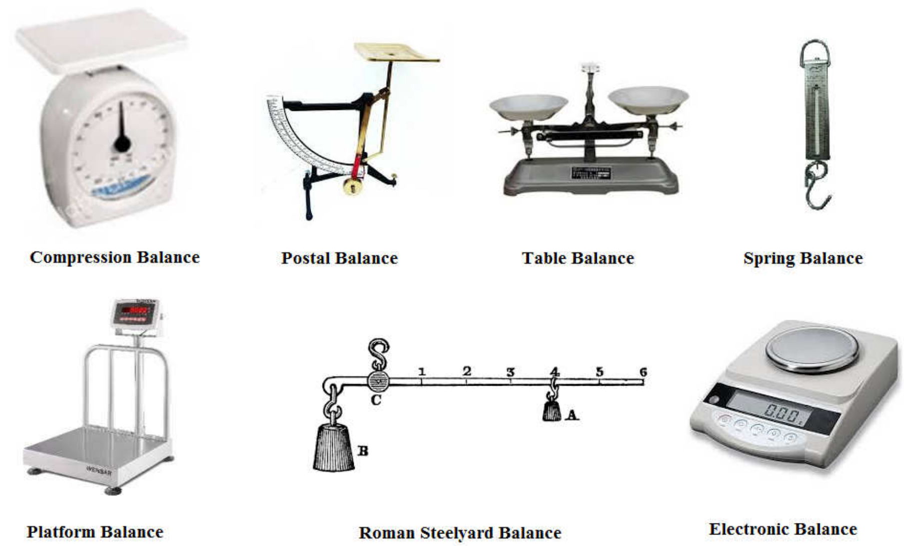


Fig. 11: Different balances for measuring the mass of substances/objects

ACTIVITY 7.1: FINDING THE MASS OF A LIQUID

APPARATUS:

1. A beam balance or an electronic balance
2. Any liquid (e.g water)
3. A container to hold the liquid

PROCEDURE:

1. Place the empty container on the beam balance. Read and note the mass
2. Pour the liquid into the container. Read and note the new mass
3. Subtract the mass of the container from the final mass. This will give you the mass of the liquid
4. Repeat the same procedure for different quantities of any other liquid

ACTIVITY 7.2: FINDING THE WEIGHT OF AN OBJECT (HOW TO MAKE THE SPRING BALANCE)

Introduction: A force is supplied every time you need to move an object. The gravitational force is the force exerted on all objects by the earth. This force which the mass or object will experience is called the weight of the object. The unit of weight is easily measured by the spring balance calibrated in Newtons (N). The weight of a mass of 1 kg is approximately 9.8N. Therefore 100g has a weight of 0.98N

7.3 HOW TO MAKE A SPRING BALANCE

1. Suspend a light spring from a clamp which is attached to a retort stand.
2. Attach a small flexible wire to the bottom of the spring to act as a pointer.
3. Cover a metre rule with a strip of white paper and attach it vertically to the same clamp.
4. Make the pointer (wire) face the back of the metre rule. Make sure the pointer and the spring are not touching the paper.
5. Make a mark on the paper beside the pointer.
6. Get a 20g mass hanger and attach to the spring. Write 20g at the new place the wire is pointing at.
7. Repeat this process by adding more 20g masses until you have a weight of about 100g.

We have now constructed our own simple spring balance.
Now remove the masses abd use the spring balance to find

1. The mass of a small piece of rock
2. The mass of your pen
3. The mass of your eraser

Record your answers in your notebook.

ACTIVITY 7.4: PRESSURE

INTRODUCTION: Pressure is defined as the force acting normally per unit area. Normally in this definition means perpendicular to or at right angles to a surface. Pressure is measured in Newtons per square meter (M/M^2). Pressure plays a very important role in our lives and it is very important that we can measure it. The importance of pressure can be seen in vehicle tyres. Everyone who drices a car or pushes a wheel barrow should understand pressure. We pump a certain amount of air into vehicle tyres. The tyres must all have equal amount of pressure to ensure a smooth ride. Unequal amount of pressure in car tyres leaves the car shaking when it is moving.

SELF-ASSESSMENT EXERCISE

a. Visit a petrol station or a vulcanizer's workshop to observe how tyres are pumped.
b. Describe the instrument used for pumping tyres
c. Describe the instrument used to measure the tyre pressure.
d. Note the tyre pressure placed in the tyres of different vehicles

ACTIVITY 7.4: ATMOSPHERIC PRESSURE

Demonstration of Egg in Bottle Experiment
Materials needed

1) 3 peeled hard-boiled egg
2) A glass bottle or flask with an opening slightly smaller than the diameter of the egg
3) Paper and lighter/matches or very hot water or very cold liquid

Method 1

1) Set a piece of paper on fire and drop it into the bottle
2) Set the egg on top of the bottle with the smaller side downward
3) When the flame goes out the egg will be pushed or sucked into the bottle.

Method 2

1) Set the egg on the bottle
2) Run the bottle under very hot water
3) Warmed air will escape around the egg
4) Set the bottle on the counter
5) As the bottle cools, the egg will be pushed into the bottle

Method 3

1) Set the egg on the bottle
2) Immerse the bottle in very cold water
3) When the bottle is chilled, the egg is pushed into the bottle.

Reference/Further Readings

Bajah, S.T., Ryan, J.O. & Samuel, P.S. (2008). *Integrated Science: A new approach for junior secondary schools.* Ibadan. University Press PLC

https://www.google.com/search?q=beam+balance+uses&tbm=isch&chips=q:beam+balance+uses,online_chips:mass:ufzGbDd8RV4%3D&client=firefox-b-d&hl=en&sa=X&ved=2ahUKEwiwjLHQu_nzAhUIixoKHT4LBF0Q4lYoBXoECAEQGg&biw=1349&bih=643#imgrc=_nyuT-J3Xt_tmM

Bajah, S.T., Ryan, J.O. & Samuel, P.S. (2008). *Integrated Science: A new approach for junior secondary schools.* Ibadan. University Press PLC

https://www.google.com/search?q=food+test&client=firefox-b-d&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiC3P2jvfnzAhUxhf0HHdoTDLYQ_AUoAXoECAEQAw

5.4 Further Readings

Bajah, S.T., Ryan, J.O. & Samuel, P.S. (2008). *Integrated Science: A new approach for junior secondary schools.* Ibadan. University Press PLC

https://www.google.com/search?q=burning+a+piece+of+paper+using+light+energy+and+a+lens&client=firefox-b-d&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjc5fq0vfnzAhVB7rsIHdUxCbsQ_AUoAXoECAEQAw&biw=1366&bih=643&dpr=1#imgrc=cKhIJYnuOe2JjM

MODULE 6: MATHEMATICS EDUCATION

Reviewed and Reprocessed by

Dr. S.s afolabi, NOUN

UNIT 1 INTRODUCTION TO SED305 MATHEMATICS OPTION

This course is a special method in Mathematics teaching. It has been recommended in the NUC Minimum Benchmark that Science education should have additional method of teaching in the subject areas. This has been fashioned out and adopted to suit this purpose.
One of the uncommon thing in Mathematics instruction all over the world is to think of a practical approach to the teaching and assessment in Mathematics

Reasons for Practical Approach in Mathematics Teaching and Assessment

An innovative approach becomes necessary in Mathematics because of:

Lack of Interest
Negative attitude

Abstract nature of maths- cognitively loaded.
Poor instructional strategies with little or no affective or psychomotor learning which also results in low achievement. So this approach of Mathematics instruction will enhance the fulfilment of the mandate of development of the 3 domains of learning experiences in Mathematics.

Essence of this teaching approach

1. To make Mathematics teaching and learning an activity or practical oriented.
2. To arouse and sustain interest of the students.
3. To elicit a paradigm shift from a negative to a positive attitude on students.
4. To attain these changes to enhance high learning outcomes.

How to go about it

Research has shown that some topics in the mathematics content can be isolated, taught practically and assessed practically.
Teacher identify and isolate these topics.
Teacher teaches them with a practical approach.
Teacher assesses it in a practical way as one of the Examination Papers in Mathematics.
Most concepts in geometry (commonly dreaded by students) and some other topics will be considered.

UNIT 2: CONSTRUCTION OF LINES

Objectives
At the end of this presentation, you will be able;

1. to teach your students better on construction of parallel and perpendicular lines;
2. to teach construct of angles 60^o, 90^o.
3. to guide students in construction of angles 30^o, 45^o (bisect 60^o and 90^o)

Construction of Lines I

To Construct a perpendicular line to a given line.
Step1. Draw a straight line AB
Step2. From point A, make an arc on the opposite sides of IABI
Step3. From B, make an arc of the same radius as in 2. Ensure that the arcs intersect each other at the opposite sides of IABI

Step4. Use the ruler to join the points of intersection to meet IABI. This is the perpendicular line to JABI

Construction of Lines II

To Construct a line parallel to given line AB.

Step1: From point A, make an arc on a side of the line AB.

Step2. Using the same radius as in A, make an arc of the same radius from point B.

Step 3. Connect the 2 arcs with a common tangent. The tangent to the 2 arcs is // to IABI.

UNIT 3: CONSTRUCTION OF ANGLES

To construct angles 60º and 90º

To construct angle 60º

Step1: Draw IABI

Step2: From A make an arc of radius AB

Step3: Repeat this at point B so that the 2 arcs meet.

Step4: join the intersection of the arcs to point A. Measure to confirm angle A is 60º

To Construct angle 90º

Step1: The same as construction of perpendicular line to a given line AB.

After your demonstration, allow your students to carry out construction of angle 60º

==
======

Bisection of Angles

Bisection of Angle 60º

Step1: Construct angle 60º at point A

Step2: Make a small arc from point A to cut the 2 lines that make up angle 60º

Step 3: From the 2 points where the arcs cut the lines, make another bigger arcs to cut each other.

Step4: Join the point of intersection of the arcs to A. Measure each of the 2 angles formed. This is the construction of 30°.

Bisection of Angle 90°

To bisect angle 90°,

Step1: Construct angle 90°

Follow the same steps as in the construction of 60°. Measure the new angles. This give 45°

Angle 22½° can be constructed the same way.

Give steps to your students, watch them construct angles 60°, 30° and angle 15°

UNIT 4: CONSTRUCTION OF TRIANGLES

Objectives

At the end of this presentation you will be more skillful to teach your students how to:

1. construct triangles and
2. construct quadrilaterals.

1. Construction of Triangles

Defined in terms of length of the sides there are 3 types of a triangles- equilateral triangles- all sides are equal. Isosceles triangle-2 sides are equal and scalene- no sides are equal.

A. To construct an equilateral triangle:

Step1 Construct a line AB

Step2: Using radius equal to AB, make an arc from point A.

Step3: With same radius make an arc from point B to cut the first arc at C.

Step4: Join AC and BC.

Measure the lengths. Are they equal or not? (of course yes)

B. Construction of Isosceles Triangle

Isosceles triangle has 2 equal sides.

Step1: Construct line AB

Step2: Change your radius.

Step3: From point A make an arc with a radius of your desired length.

Step4: From the point B make an arc with the same radius as in A to cut the first arc at the point C.

Step5: Join AC and BC.

Measure to confirm lACl=lBCl

C. Construction of Scalene Triangle

A scalene triangle has no equal sides.

Step1: Construct line AB

Step2: Change your radius.

Step3: From point A make an arc with a radius of your desired length.

Step4: From the point B make an arc with radius that are different from step1 and step2. Let the arcs meet at the point C.

Step5: Join AC and BC.

Measure the lengths.

Observations

What are the differences in arc manipulations in the 3 triangles?

Let your students take note of these differences.

Thank you. Till we meet again in the construction of Quadrilaterals.

====================***================

UNIT 5: CONSTRUCTION OF QUADRILATERALS

Construction of Quadrilaterals. Quadrilaterals are plane shapes with 4 sides. E.g square, rectangle, kite, parallelogram.

*Note: In constructing any plane shape, its properties must be known and established

A. Construction of a Square

Property: All the 4 sides of a square meet at right angle.

Step1: Construct line AB

Step2: With the same arc of radius AB, construct the perpendicular lines at A and at B.

Step3: Join the points of intersection of the arcs at point C and point D.

B. Construction of a Rectangle

Property: Pair of opposite sides are equal.

The adjacent sides meet at right angle.

Step1: Construct line AB

Step2: Using a radius that is different from AB above, Construct a perpendicular at A.

Step3: As in step 2 with the same radius construct a perpendicular at B.

Step4: Join the intersection of the arcs.

Measure pairs of opposite sides

C. Construction of a Kite

Two adjacent sides of a kite are equal.

The diagonals meet at right angle.

Step1: Construct angle ABC =60o

Step2: Construct the bisector of angle ABC produced at D.

Step3: join AD and CD

Quiz

What are the pair of equalities in the kite?

::::::::::::::::::::::::::

:::::::::::::::::::::::::

Solution

1. pair of adjacent sides are equal
2. Angle ABD=angle CBD
3. Triangles ABD = triangle CBD (BD is symmetric).

MODULE 7: PHYSICS EDUCATION

Reviewed by

Prof Z. C, Njoku (Department of Science Education,
University of Nigeria, Nsukka.
&
Dr Emmanuel Ifeanyi, Orji
Department of Science Education
(Physics Education), Faculty of Education,
University of Nigeria, Nsukka

UNIT 1: BASIC RULES AND OPERATIONS IN CONDUCTING PHYSICS PRACTICAL ACTIVITIES

1.1 Introduction

Physics is a science subject that deals with the study of matter and its constitutes sub-atomic particles by considering their energy and transformation as well as their motion and forces of nature acting among them in space and time. Physics is an exciting subject that inspires both the young and old and contributes immensely to the knowledge of the structure and principles guiding the universe. Thus, to understand the nature, one needs to possess adequate knowledge and skills in physics. Being one of the science subjects, it is important that the students have adequate knowledge of its product, attitude and process. The products of Physics are the various concepts, laws, theories and principles as well as the general knowledge derived from it. The attitudes are the moral standards expected of scientists. For example, sincerity, curiosity, open mindedness to knowledge, among others. The processes of physics are the orderly step by step ways of arriving at the knowledge and principles in physics. This process is also called scientific method, from which science process skills are acquired. For example, observing, measuring, experimenting, predicting, inferring, and hypothesizing skills among others. These skills are generally learnt in the laboratory and are the most important among the various components of science. Thus, it is important that students avail themselves the opportunity of learning these skills in order to become good scientists in their time.

1.2. Learning Outcomes

By the end of this units, you are expected to achieve the following objectives:

1. Understand basic rules in the conduct of practical activities and use of physics laboratory equipment and resources therein.
2. state appropriate precautions in the conduct of physics practical activities
3. Develop positive attitudes towards physics practical work/activities
4. Develop practical skills or process skills in conducting physics practical activities, including some experiments
5. Carry out practical activities on various branches in physics
6. Stimulate creativity by devising similar or different practical activities in each branches in physics and execute it.

1.3 Basic Rules and operations in Conducting Physics Practical activities

To conduct physics practical works effectively, there are basic rules students are expected to understand. These rules range from the materials to be brought in the laboratory, how to set up the apparati, drawing of table of observation, reading of values, drawing of graphs, and interpretation of the graph, precautions not excluded.

1.3.1. Materials Needs

To reduce or eradicate stress during practical exercise arising from students borrowing of practical materials from their fellow students, students are encouraged to come into the laboratory with the following materials. Mathematical sets containing eraser, sharp pencil, ruler, a set of compass, and protractor. Also expected of them are graph book, note book, plain sheet of papers, and practical book.

1.3.2.Apparati Set-up

To set up the apparati appropriately, a student must have enough space in the workbench, and then arrange apparati as shown in the laboratory manual book or practical question paper and connect appropriately as drawn. Also, of importance, is that the student must position her/him in such a manner to take readings conveniently.

1.3.3. Drawing of Table of Observation /Readings

After setting-up of the apparati as shown in the manual or question paper, the next thing is to write the number, heading/title of the experiment with date in plain sheet of the graph book. Thereafter, an observation table should be drawn with all the physical quantities of interest and their accompanying units in the experiment written in the appropriate columns. Every reading recorded must be repeated and the average taken. Effort must be made to ensure that every direct reading must be placed in two decimal points, and calculated or derived values in three or four decimal points depending on the nature of arithmetic involved. For example values from logarithms must be in four decimal points. Values arrived from addition, subtraction, division, square, square roots and the likes should be in two or three decimal points with consistency ensured.

1.3.4.Plotting of Graphs

To draw graphs, effort must be made by the student to label the axes properly with the names of physical quantities being plotted. There are two major axes in a plane coordinate system, y and x. y-axis represents the vertical axis, while the x-axis is the horizontal axis. If for instance you are plotting a graph of distance against time, it means that distance will be in vertical axis (y), with time at the horizontal axis (x) and their units properly indicated. Also, after labeling the axes, the next thing is to choose suitable scale for the values being plotted. A good scale must cover at least two-third of the graph being used. Every scale chosen by you must be easily interpretable by you. For example, a scale of 1cm to 2units, means that every small box in the axis stands for 0.1cm. This means that scales that pose difficulty in interpretation should be avoided as much as possible. Scales like 2cm equal, 5, 6 or 7 units should be avoided. While scales like 1cm to 1or 2units, 2cm to 2 or 4 units are appropriate. It is important to know that if you are plotting current against voltage for instance, in the vertical axis, the scale should be perhaps 1ampere to 2units, while at the horizontal axis, should be 1volt to 2units. This means that units of the physical quantities being plotted should be used in naming the scale. Also, while plotting your graphs, dots (.), crosses(x), and small circle (o) are used to represent the points being plotted. This must be done using sharp pencil. Furthermore, you should try and ensure that large triangles are used to represent the slope. Finally, always start should scale from origin if the intercept is required, but if not don't.

UNIT 2: STATEMENT OF PRECAUTIONS DURING PHYSICS PRACTICAL

1.3.5 Statement of Precautions During Physics Practical Activities

During practical, it is important that the student takes appropriate precautions that will help her/him get accurate or near accurate results. Based on this, the student will be expected to write down the precautions taken after the experiment. Precautions must be personalized and stated in past tense and the how clearly explained. Precautions vary from one experiment to another depending on the nature of the experiment. For example, assuming you just finished experiment on verification of Ohm's law, you state the following precautions:

1. I ensured tight connections by checking the connections before readings were taken;
2. I avoided error due to parallax in reading the voltmeter and ammeter by viewing the readings in a direct opposite;
3. I ensured that zero errors of ammeter and voltmeter are corrected by ensuring the pointer is at zero before using them; and
4. I ensured that the key is opened when readings are not being taken

A close look at the each of the precautions above notices that each was stated in the past tense, and contains the how it was arrived at.

UNIT 3: ATTITUDE TO PHYSICS PRACTICALS

1.3.6. Attitude to Physics Experiment

A positive attitude towards physics practical activities is the first step to achieving success in practical work. This means that the outcome of an experiment must not be based on what you want, or what you know all the times, but can change and point to another direction. Thus, it is important you report your results as found and interpret them accordingly. So of importance during practical is that you observe all the precautions and rules during the practical and report your findings as they are. This means that you must be guided by setting moral values like honesty, objectivity, curiosity, skepticism, willingness to change opinion, humility, precision, open-mindedness , positive approach to failure, respect for the opinions of others, willingness to accept criticism, unwillingness to believe in superstitions, co-operation with fellow students among others.

UNIT 4: PRACTICAL SKILLS/ PROCESS SKILLS IN CONDUCTING PHYSICS PRACTICAL EXPERIMENTS

1.3.7. **Development of Practical Skills or Process Skills in Conducting Physics Practical Activities**

One of the basic requirements in practical physics is your ability to interpret your data in a graphical format so that at a glance information about the data can be viewed and explained and logical conclusion could be reached. In view of this, you are expected to take the plotting of graphs explained below seriously.

1.3.8. Graphs and Data Handling

After experiment, the data obtained are usually presented in a graphical format. This means that a graph is a statistical tool for analyzing and interpreting results from experiment at a glance. Graphs can be linear or curved. Both linear and curved graphs are not tedious to plot, just do them with little patience and seriousness. The only major difference lies on the fact more points are needed to plot curve graphs, unlike the linear or straight line graphs. It is important to note that both graphs show the nature of relationship between variables measured, however, linear graphs are generally easily interpretable.

1.3.9. The Straight Line Graph

The general equation of a straight line is

$$Y = mx + c$$

Where x and y are variables and m and c are constants, m is the slope or gradient of the graph and c is the intercept of the line on the y – axis as shown below

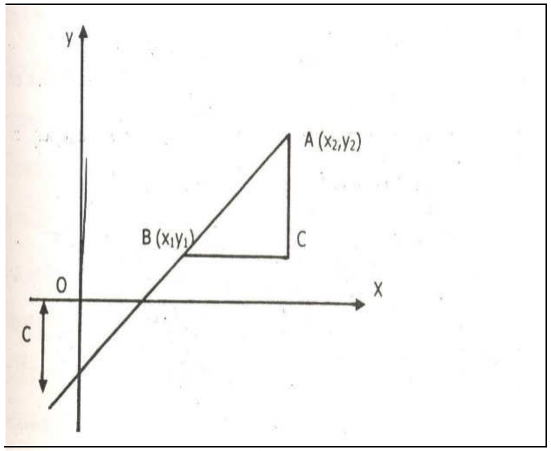


Fig. 1: Straight Line Graph
Fig. 1: Example of a straight line

The slope m is given by = $\frac{AC}{CB}$

The intercept c is read directly from the graph. At certain times, it is difficult to choose a suitable scale which starts the graph from the origin without the graph being crowded in one corner. In such cases, it is advisable not to start the graph from the origin but from some other convenient point. The intercept c can then be found by calculation from the equation y = mx + c. For example, if (5, 3) is a point on the graph, and the slope of the graph is 0. 4.

Then c is given by $3 = 0.4 \times 5 + c$. From which c = 1

However, in most cases it is possible to choose a suitable scale for a straight line graph so that the line cuts the y – axis but does not include the origin (0, 0) ; c can then be read directly as before.

1.3.10. CURVED GRAPHS;

The slope of a curve graph varies from point to point. The slope at any point on the curved is defined as the slope of the tangent to the curve at that point. In the figure above, the slope at the point P(x, y) is given by

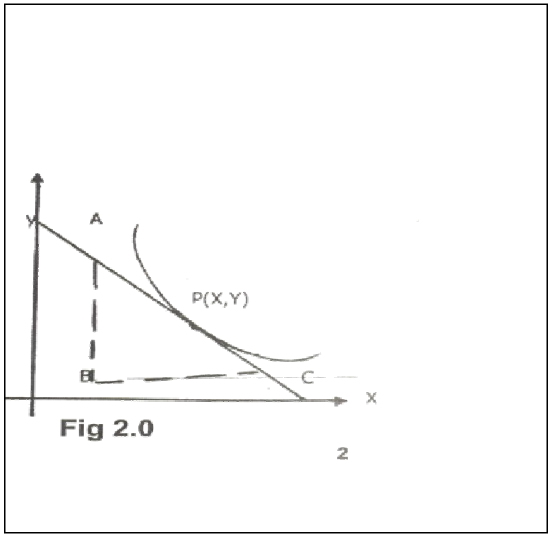


Fig 2.0

It is important to note that most equations of physics give smooth curves or straight lines. The plotted points may not all lie on the curve or line because of random errors which are inevitable in an experiment. A best curve or best straight line should be drawn and this is a curve or line which passes through as many points as possible such that the points which do not lie on the line are evenly distributed on either side of the line or curve.

1.3.11 ERRORS IN PRACTICAL MEASUREMENTS

Whenever a measurement of a physical quantity is performed, an error or uncertainty will appear in the reading and therefore in the result calculated from the reading. The error depends on the measuring instrument and on the observer.

Errors fall into two main groups: systematic errors and random errors. We speak of systematic errors, if the result of the measurement is always higher or lower than true value and of random error if the result is sometimes higher and sometimes lower than the true value, that is if the error is sometimes positive, and sometimes negative. For example in the timing of a pendulum using a stopwatch or a stop-clock, a systematic error will arise if the stop-clock or stopwatch runs fast, as the time indicated will then always be longer than the true time. Random errors are introduced in the experiment if the observer does not start and stop the stopwatch at the right moment. For an inexperienced observer these errors may be quite large, up to 0.5 seconds for measurements with a stopwatch. The observer may also have a systematic or personal error like always starting the stopwatch too late but stopping it at the right moment.

Random errors can be detected if the measurement is repeated several times with the same apparatus and observer. The results of the different measurements will not agree if a random error is present but will be spread out through a certain range, which gives information of the magnitude of the errors.

Systematic errors cannot be detected in this way but only by repeating with a different apparatus and a different observer.

1.3.12. THE ACCURACY OF READINGS

Random errors arise in two ways: by all sorts of momentary external influences like sudden shaking of the hands of the observer, an air current, and by the limitation of the instrument used for the measurement. Both these types always occur, but one or the other may be of dominant importance depending on the instrument used.

Suppose that we measure the side of a small metal cube with a metre rule. In this way we cannot get a better accuracy than 0.5mm, i.e there is always an uncertainty of 0.5mm in the reading, and this is probably much greater than errors caused by external influences. If instead we use a pair of calipers the uncertainty is ± 0.1mm, and with a micrometer screw gauge we can get down to an uncertainty of ± 0.01. In this last case external influences, may well cause errors of the same order of magnitude as the reading uncertainty. Depending on which method we use to measure the length, the accuracy of any result we calculate from this reading, e.g. the density of the metal will vary within wide limits. Therefore the result of any physical measurement should always be given with the uncertainty, often called the reading error, started. The number of figures given should be such that the error is the last figure. E. g. in the first case mentioned above the reading should be given as (34.5 ± 0.5) mm or (3.45 ± 0.05) cm

In the second case as

(34.5 ± 0.1) mm or (3.45 ± 0.01) cm

and in the third case as

(34.37 ± 0.1) mm or (3.437 ± 0.001) cm

Never give a reading like

Current: 2 amps, this has no value at all for a calculation! Instead write current: (2.0 ± 0.1) amps or whatever other reading errors you may have. In physics, a current of 2 amps means anything between 1.5 and 2.5 amps.

The following list gives the reading error of some of the commonly used instruments:

mm scale	0.5mm
Calipers	0.1mm
Micrometer screw gauge	0.01mm
Stop-clock	0.3s or more

Stop watch	1.0 – 0.2s
Thermometer graded to 1º	0.2º
Thermometer graded to 0.5º	0.1º
Thermometer graded to 0.1º	0.05º

Standard moving coil instrument 2% of the max. scale reading (ammeter, voltmeter)

NOTE: In many cases there is an uncertainty in the adjustment
of the instrument that is greater than the reading error, e.g. in in balancing a Wheatstone bridge. In this case the spread of a series of reading will be greater than the error.

Self-Assessment and Practice Questions

(1) Draw on the same axes graphs of

y = x + 6

y = 2x + 4

And y = 7x – 5

For values of x between -5 to 5

(2) In an experiment, the following readings were obtained:

V(V)	2.4	2.0	1.7	1.5	1.4
I(A)	0.95	0.70	0.55	0.50	0.45

Plot the graph of V against I and determine the slope of straight line obtained.

(3) The following readings were obtained in an experiment:

U(cm)	55.0	45.0	35.0	25.0	15.0	10.0
V(cm)	1.6	2.2	2.3	4.6	9.4	18.7

The equation connecting u and v is uv – f^2 where f is a constant. Plot a suitable graph to obtain the value of f. Write down the value of f.

(4) In an experiment, the following readings were obtained

h(cm)	5.0	16.0	23.0	43.0	59.0	82.0
t(s)	37.0	36.6	36.1	35.3	34.1	32.6

Make a table of T^2 and h where T is the periodic time for 10 complete oscillations. Plot a graph of T^2 against h. Determine the intercept on the T^2 axis and the slope of graph. Write down the linear relation between T^2 and h.

(5) In a cooling experiment, the following readings were obtained r(°C/min)

r(°C/min)	5.4	3.1	2.6	1.8
	1.5	0.6		
Q°C	79.0	56.0	41.5	32.0
	26.5	16.5		

Where r is the rate of fall of temperature and Q is the excess temperature over the surroundings. If the law of cooling is given by $\mathbf{r = aQ^n}$, find the value of the constant **a** and **n** by plotting **log r** against **log Q**

1.4 . MEASUREMENT OF MASS

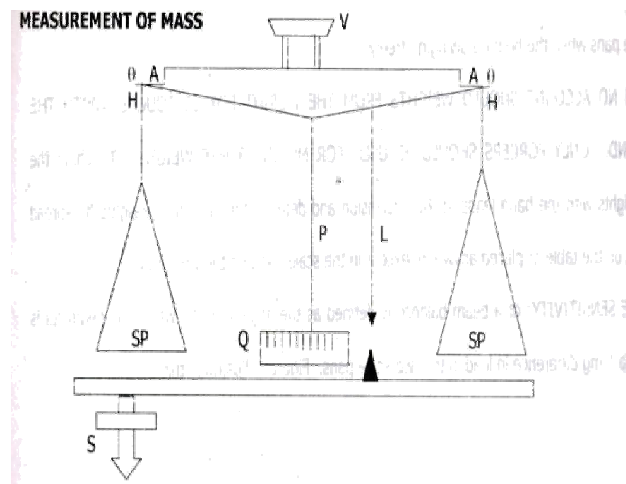


Fig. 3·0

Fig 3: The Beam Balance

H_1H = Horizontal screws Q = scale

V = Gravity bob K = Knob for raising beam

S,S = Leveling screw A,A = A gate knife edges

L = Plumb line SP = Scale pan

The essential features of the beam balance are shown in the above diagram Fig 3.0. Before any weighing is done, the base of the balance and the balance beam must be horizontal. To level the base, the leveling screws (S,S) are adjusted until the plumb line L is vertically above the projection on the balance case. To level the balance beam, the small nuts (H,H) are adjusted until the pointer P is at the central mark on the scale Q. Where it is not possible to level the base in this way the scale pan SP should be interchanged. The balance is set swinging in readiness for weighing by turning the knob K clockwise. To avoid damage to the gate knife edges A on which the balance beam and scale pans swing <u>it is important to raise or lower the beam gently</u>. For the same reason, weights should not be added to or remove from the pans when the beam is swinging freely.

ON NO ACCOUNT SHOULD WEGHTS FROM THE WEIGHT BOX BE TOUCHED WITH THE HAND. ONLY FORCEPTS SHOULD BE USED FOR MOVING THESE WEIGHTS. Touching the weights with the hand leads to their corrosion and deterioration, Nor may weights be spread out on the table or placed anywhere except in the scale pan and the weight box.

1.5.1 THE SENSITIVITY: The sensitivity of a beam balance is defined as the angle through which the beam turns for a 1 mg difference in load in the two scale pans. Figure 4 illustrates this:
i.e S = where DM is the difference in load in the two scale pans. In

general, since DM is small, is of the order of a few hundredths of radians and may be expressed approximately as
θ =

Where **x** is the horizontal displacement of the tip of the pointer, and **d** the length of the pointer. For practical purposes therefore the sensitivity may be expressed as

S =

Self-Assessment and Practice Question

Exercise 6
Determine the sensitivity of the balance by measuring the displacement of the pointer from its rest position per milligram difference in weight in the two scale pans, when both pans carry loads 0, 5, 10, 20, 30, 50gf. Plot a graph of sensitivity against load DM should be chosen in such a way that the distance x can be read fairly accurately: i.e. 3-4 scale divisions.

1.5.2 DOUBLE WEIGHING: can be employed to obtain the actual mass of a body when the beam is initially not horizontal. This does not mean that the arms of the balance are unequal. If M_1 and M_2 are the two apparent weights of a body when placed in turns in the two scale pans, the real mass of the body is given by
$M=\frac{1}{2}(M_1+M_2)$

The proof of this result is left as an exercise to the student and should be included in the report.

Self-Assessment and Practice Questions
Exercise 7

Misplace the nut at the end of one of the arms of the balance by giving the nut one complete turn. Use the balance in this condition to weigh a body by the method of double weighing. Compare the result with that obtained with the balance in the normal condition.

1.5.3. TIMING

For accurate timing of oscillations of swings, it is essential to start the watch or stop-clock at a definite point of the swing and to stop the watch at the same point of the swing. Since a vibrating body, like a simple pendulum, moves fastest pass the equilibrium position, it is best to start or stop the watch when the vibrating body is at the equilibrium position. In all experiments involving timing and swings a pointer or fiducial mark should be set to mark the equilibrium position and the counted when the body moves past the pointer or mark from the direction. For more consistent results however, it is best to mark the equilibrium position of a vibrating body by means of two pointers or marks and to start or step the watch when the body is balanced with the pointers or marks. See fig 5.0.

Pp = fiducial mark

passing through

equilibrium position

UNIT 5: PRACTICAL ACTIVITIES ON VARIOUS BRANCHES IN PHYSICS

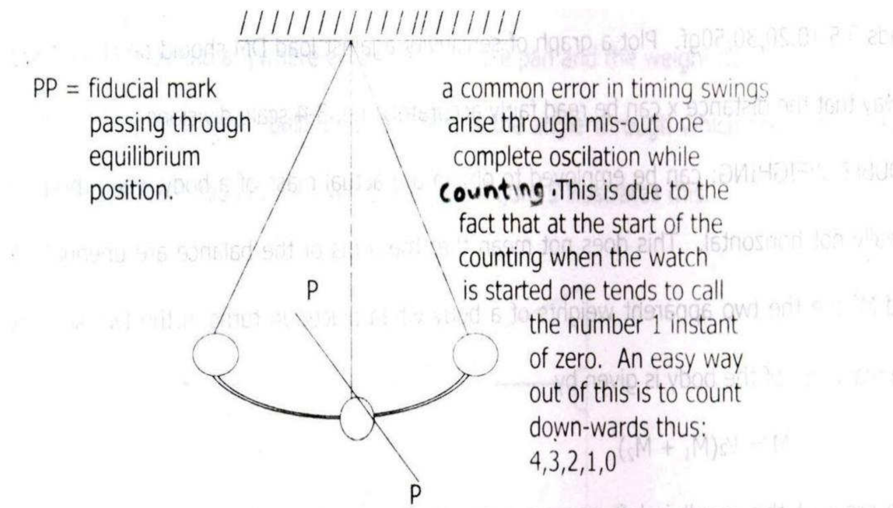


Fig. 5.0

RCISE 8.0

a common error in timing swings arise through the omission of one complete oscillation while counting. This is due to the fact that at the start of the counting when the watch is started one tends to call the number 1 instead of zero. An easy way out of this is to count downwards thus: 4,3,2,1,0

Self-Assessment and Practice Questions

EXERCISE 8.0

Determine the period of one oscillation of the given short swing by timing 50 complete oscillations. Repeat nine times. Find the mean of the nine counts, calculate the departures of each reading from the mean and hence find the greatest deviation from the mean. Repeat the whole experiment by timing 10 complete oscillations. Comment on the accuracy of timing in the two sets of experiments.

EXERCISE 9.0

Determine the period of the oscillation of the longer pendulum (suspended from the ceiling, by timing 50 complete oscillations twice 10. Repeat the experiment by timing to complete oscillations 10 times. Compare the accuracies of the two sets of measurements.

EXERCISE 10.0

Place a load of about 300g on the scale pan of the given spiral spring. Allow the pan to move to rest and carefully displace it about 1cm in the vertical direction. Release the pan and time a convenient number of oscillations 9 times. Calculate the mean period and the greatest deviation from the means. Replace the load of 300g by a load of 100g and repeat the experiment and calculations

QUESTIONS:

1. Which quantity is largest in these experiments, the reading error in the stop clock or the greatest deviation from the mean value of the time measured?
2. Does this type of experiment (timing a certain number of oscillations) give a more accurate result if it is repeated.

1.5.4. EXPERIMENT ON MECHANICS

1.6.1 Experiment 1 (A)

Title: Relative density of a solid and a liquid

APPARATUS: Metal cube, spring balance, water, beaker, liquid, thread,

Lever balance and specific gravity bottle.

METHOD: Measure the given metal cube's weight in air using the

Spring balance and record this value, then in water, and finally in the given liquid. Remember to record the label on your metal in your notebook.

THEORY:

Relative density of solution
=And the relative density of the liquid is given by

Calculate the relative densities of the solid and liquid using the above relations.

1.5.5. EXPERIMENT 1 (B)

TITLE: Relative density of a liquid using the specific gravity bottle.

METHOD: Weight an empty specific gravity bottle using the lever balance. Fill the specific gravity bottle with water, insert the stopper and weigh again using the lever balance. Empty the contents of the bottle and finally fill the bottle with the given liquid and weigh again as before. Calculate the relative density of the liquid using relation,

Relative density =

1.6.1. MECHANICS 2

TITLE: Determination of Relative density of liquid – hydrometer method.

APPARATUS: Test tube, lead shot, beaker, kerosene, graph paper, water.

METHOD: Put enough lead shot in a test tube so that it can float vertically in a beaker of water as shown in the diagram below. With the aid of a scale made from graph paper, measure the height of the test-tube submerged below the liquid surface level h_k.

Repeat the experiment with water and record the height h_w

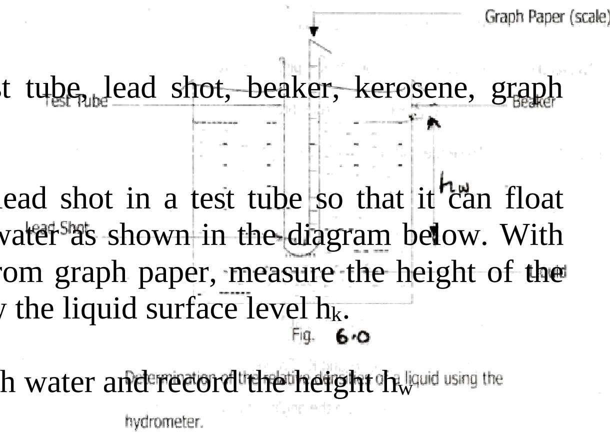


Fig. 6.0: Determination of the relative densities of a liquid using the hydrometer

THEORY: Let the cross-sectional area of the test-tube be **A** therefore,

Volume of liquid displaced = Ah

And weight of liquid displaced = Ah g

(Where is the density of the liquid) from the principle of floatation.

Weight of the hydrometer = Weight of the liquid displaced = Ah g

Therefore $Ah_w{}_w = Ah_k{}_k$

And =

0r =

= relative density of kerosene

QUESTION: Calculate the quantity

1.6.2. EXPERIMENT ON LIGHT

ITLE: Refraction in a triangular prism.

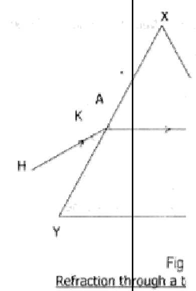
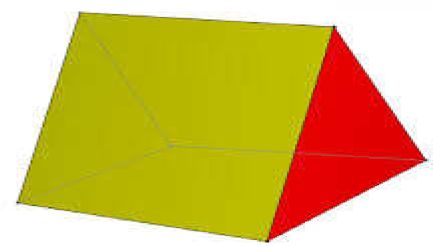
APPARATUS: 60 glass prism, four optical pins, four drawing pins, drawing board, cardboard sheet, metre rule, protractor.

METHOD: Trace the outline of the glass prism XYZ on a sheet of paper. Remove the prism and draw the normal at point A using a protractor and ruler, Draw the incident ray at A with i = 30º and insert two pins H and K separated by reasonable distance (must be more than 5cm). Looking through the prism, insert two other pins at **M** and **N** so that they appear to be in line with the images of **H** and **K**. Produce **NM** to meet the edge of the prism at **P**. Join AP. Measure the angles of deviation **D** and emergence **e**. Repeat the experiment for values of i = 40º,45º,50º, and 65º. Tabulate your results as shown below.

I	D	E	(D – e)

1.6.3. Refraction through a triangular prism

QUESTIONS: (a) Plot a graph of (D – e) against I (b) Measure the slope

 	Triangular Prism (Note the 3 rectangular faces and 2 triangular bases 

(c) Measure also the intercept on both axes.

(d) What can you conclude from the experiment?

(e) On a separate sheet, plot a graph of D against i.

(f) From your graph obtain the minimum deviation

Dm and the angle of incidence at minimum deviation im.

(g) Calculate the refractive index from

N

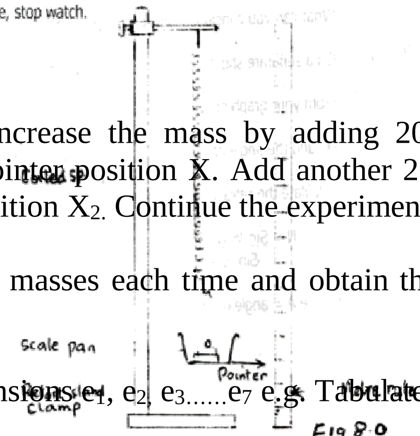
Wh of prism = 60º

1.5.7 EXPERIMENT ON MECHANICS (1C)

Determination of acceleration due to gravity using a coiled spring

APPARATUS: A coiled spring, slotted weights 0-250g metre rule, retort stand and cl

scale pan, plasticine, stop watch.



position x. Now increase the mass by adding 20g at a time and observe the new pointer position X. Add another 20g mass and note the new pointer position X_2. Continue the experiment by adding

20g to the existing masses each time and obtain the reading X_3, X_4, X_5, X_6, and

X_7. Obtain the extensions e_1, e_2, e_3......e_7 e.g. Tabulate your results.

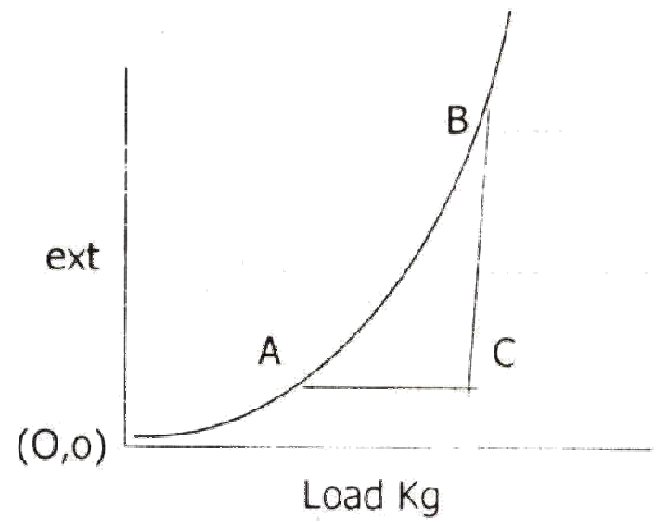
METHOD:
Suspend the coiled spring from the clamp as shown and hang a small scale pan or slottec

weight from its lower end. Add a 50 gramme mass to the scale pan and observe the pointe

S/N	Mass of load No of Kg	Extensions CM^{-1}		Average Extension
		Load Increasing	Load Decreasing	

Repeat the experiment by obtaining the results when, the load is decreased by 20g at a time until the entire load are removed.
Plot a graph of mass of load on x axis against extension on the y-axis. Find the slope of the graph.

Slopes S = M/Kg



2C) Fig 9.0.

1.5.8. EXPERIMENT (2C)

Suspend a kink removing load (between 50 to 80g) on the spring and observe that the spring has no more kinks. Attach the pointer formally. Now add. Another 20g mass and note the new extension e cm. Now displace the scale pan slightly downward by pulling along the vertical. Release the scale pan. Notice

that the pointer oscillates vertically. Measure the time for 20 oscillations. Find the time for one oscillation i.e the periodic time T. Record the total load on spring, the time for 20 oscillations, and the period. Repeat the experiment when the additional loads to the kink-removing load are 20, 40, 60, 80, 100g. Tabulate your results.

S/N	Load Kg^{-1}	Time for 20 Oscillation	Period T/S^{-1}	T^2/S^2

Plot a graph of T^2 on the y-axis against load M Kg on the x-axis

(a). Find the slope and the intercepts of this graph.

THEORY

The theory of this experiment is based on simple harmonic motion of the mass M attached to the spring and the spring extended further by x, the period is given by

$T = 2\pi$ ……………….. (1)

Where S = the extension per unit load = slope of the **e** versus **load** graph

M = the load on the spring, g = acceleration due to gravity.

For spring with effective mass M,

The period of oscillation

$T = 2\pi$ ……………….. (2)

$^2 = 4$ …………………. (3)

Equation 3 is of form

$Y = Kx + c$

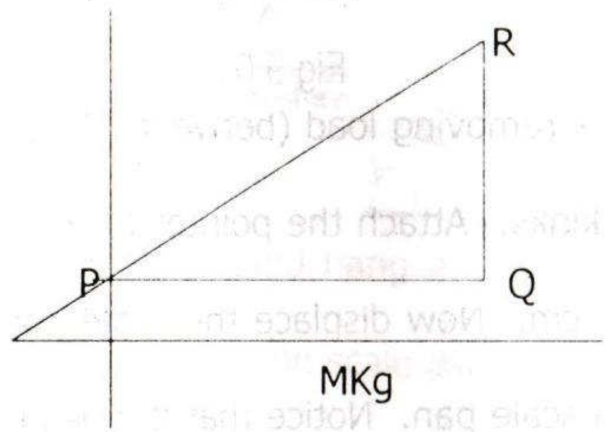


Fig 10.0

(b) ind the value of

(c) Comment on your results.

XPERIMENT 2

1.5.9. Determination of the density of a liquid using a loaded boiling-tube

APPRATUS

A boiling-tube or tall test-tube fitted with a calibrated tape (e.g strip of graph paper attached inside) a deep beaker, lead-shots, set of masses, calipers, Kerosene or other liquid e.g Alcohol, orange juice, diluted acid.

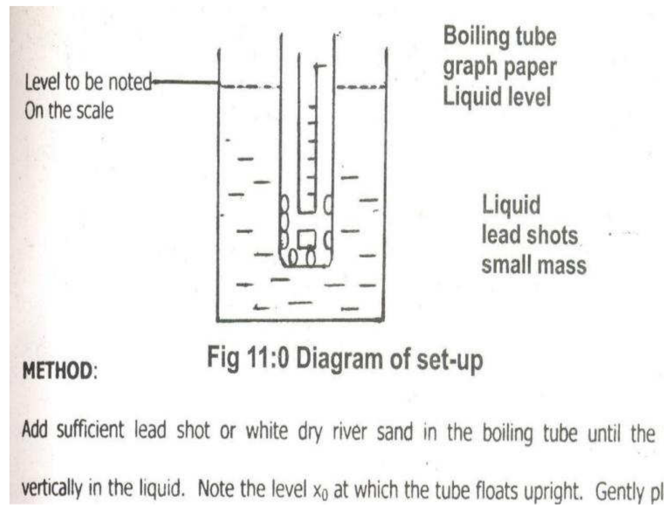


Fig 11:0 Diagram of set-up

METHOD

Add sufficient lead shot or white dry river sand in the boiling tube until the tube floats vertically in the liquid. Note the level x_o at which the tube floats

upright. Gently place a small mass (1 or 2g) inside the boiling tube and note the new position x at which the tube floats. Repeat the experiment for four different additional masses (e.g 2g, 3g, 4g, 5g).

For each additional load, measure the depth of immersion $d = x - x_o$. Complete

the table.

RESULTS:

Additional Load/g	Scale reading xcm	Depth of immersion $D = (x - x_o)$ cm
0		
1		
2		
3		
4		
5		

INSTRUCTION

Measure the diameter of the boiling tube in about four points and find the mean radius of tube.

Plot a graph of immersion on the y-axis against additional mass on the x-axis.

Start the graph from the origin.

1. Find the slope of the graph
2. Find the value of P =

P =

QUESTIONS

1. What does P represents?
2. Why was it necessary to measure the diameter of the tube at different points?
3. What are the essential precautions in this experiment?

1.5.10 EXPERIMENT 3

Determination of the refractive index of a liquid using a concave mirror

PPARATUS

A concave mirror, Liquid e.g. Water, retort stand and clamp, rubber cork, optic pin, metric rule.

Fig. 12.0 (a)

METHOD:

The concave mirror is placed on the base of a retort of a stand which is on a level floor. Adjust a bright optical pin along the principal axis of the mirror until the pin coincides with its image at c. Now put sufficient liquid into the mirror and find a new position c where the pin now coincides with its image.
Measure the distance CA and C'A

Calculate the value

QUESTION:

1. What is the physical meaning of CA/C'A?
2. Deduce the theory of the experiment
3. What are the essential precautions in this experiment?

1.5.11. EXPERIMENT

Determination of the refractive index of a liquid using a concave mirror

APPARATUS

A concave mirror, liquid e.g water, retort stand and clamp, rubber cork, optic pin, metric rule.
ig. 12.0 (a)

METHOD:

The concave mirror is placed on the base of a retort of a stand which is on a level floor. Adjust a bright optical pin along the principal axis of the mirror until the pin coincides with its image at **c.** Now put sufficient liquid into the mirror and find a new position c' where the pin now coincides with its image.
Measure the distance CA and C'A.

Calculate the value

QUESTION:

1. What is the physical meaning of CA/C'A?

2. Deduce the theory of the experiment

3. What precautions are essential for accurate results?

1.5.12. EXPERIMENT

Determination of the focal length of a convex lens by the illuminated object method
APPARATUS: Convex lens (f 10 – 20cm), lens holder, ray box, illuminated object, white screen, meter rule

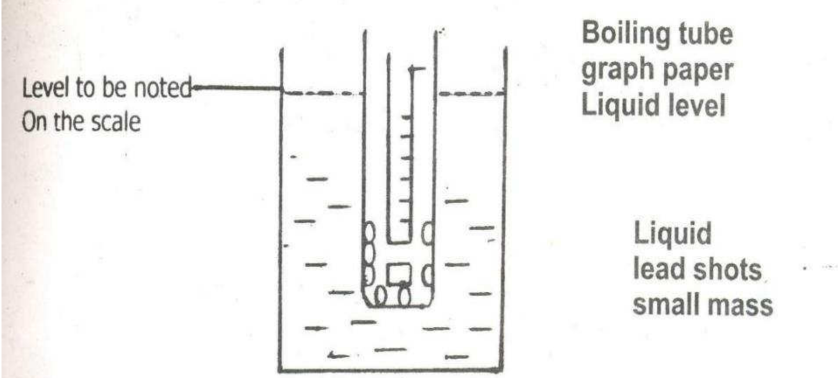


Fig 11:0 Diagram of set-up

METHOD:

Add sufficient lead shot or white dry river sand in the boiling tube until the

vertically in the liquid. Note the level x_0 at which the tube floats upright. Gently

Fig. 13.0

METHOD:

Place the ray box on a flat horizontal table. Place the illuminated object at the open hole of the box. Then place the convex lens with the lens stand in front of the illuminated object such that the separating distance must be greater than the approximate focal length of the lens.

Place and adjust the white screen on the opposite side of the lens until a sharp image of the illuminated object in formed on it.

Now measure and record

(a) The distance between the illuminated object and lens (u)
(b) The distance between the lens and screen (v)

Displace the lens by 5cm and obtain new values for u and v. Repeat the experiment for four other positions of the lens.

INSTRUCTION: Plot a graph of — on the vertical against on the horizon at —
starting from (0, 0). Find the slope and intercepts of the graph.

QUESTIONS:

1. Measure the slope and intercepts of this graph.
2. What precautions do you requires for the experiment?

1.5.13.EXPERIMENT

Focal length of a convex lens by plotting magnification against image distance

APPARATUS: Convex lens, lens stand, meter rule, cork with two optical pins2cm apart, split cork with pins retort stand with clamp to support pins.

(Illuminated object and screen could be used)

METHOD: the cork with two optical pins is placed near the convex lens but ata distance greater than f so that an enlarge image is formed. The positions of the two images of the pins are located. On the other side using the split corks. Assure that there is no parallax between the image and locating pins.

Then measure the separation of the two image pins (d) and the separation of the object pins (a) and the image distance V.
Repeat the experiment with four other positions of the object pin – carrying cork, and measure corresponding v, a, and d.
Calculate the value of magnification, m, for each position.

Tabulate your results as follows

S/N	v	a	d	M =

Plot a graph of magnification on the vertical axis against image distance v on the horizontal.

1.5 References/Further Readings/Web Resources

Ndupu, B.L.N. and Okeke, P.N. (2011). Senior secondary certificate practical Physics. Longman Publisher

Anyakoha, M.W. (2013). New school Physics (4^{th} Ed.). Africana First Publisher