RQF LEVEL 5

TRADE: FORESTRY

MODULE CODE:FORPP501

TEACHER'S GUIDE

Module name: Physical and Mechanical Properties of Wood Assessment

Acknowledgments

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Acronyms

MINEDUC: Ministry of Education

TVET: Technical and Vocational Education and Training

RP: Rwanda Polytechnic

RTB: Rwanda Technical Vocational Education and Training

RQF: Rwanda Qualification Framework.

CBT: Competence Based Training

CBC: Competence based curriculum

AGR: Agriculture

FOR: Forestry

PP: Physical properties of wood assessment

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CBT: Competence Based Training

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AGR: Agriculture

FOR: Forestry

BP: Biological properties of wood assessment

ASTM: American Society for Testing and Materials

IS: International standard

INTRODUCTION

This training manual is to be used by trainers teaching the module entitled **"Physical and Mechanical Properties of Wood Assessment" in TVET Schools Forestry TRADE.** It identifies the learning units and learning outcomes of the module as well as assessment requirements. The trainer manual gives practical ideas about ways of training using this module: suggestions about what to teach, techniques for facilitating learning and teaching, how to assess and suggested assessment tasks. A variety of suggested learning and teaching activities provides trainers with ideas to motivate students to learn, and make learning relevant, interesting and enjoyable. Trainers should relate learning about **Physical and Mechanical Properties of Wood Assessment** to real world, issues and the local environment. Delivering session using clear examples to make students participate in practical activities, facilitate students in acquiring knowledge, skills and right attitude reflecting agriculture sector. Trainers are encouraged to incorporate related modular activities in a way of branching out paths for the future development.

Module Code and Title: FORPP501 ASSESS PHYSICAL AND MECHANICAL PROPERTIES OF WOOD

Learning Units:

Learning unit 1: Prepare tools, materials and equipment for wood sample collection and laboratory analysis.

Learning unit 2: Prepare the wood samples

Learning Unit 3: Conduct physical and mechanical wood analysis

Learning Unit 4: Interpret the laboratory data

Learning Unit 1: Prepare tools, materials and equipment for wood sample collection and laboratory analysis.

Picture/s reflecting the Learning unit 1

Moisture meter

Electronic balance

Thermometer

STRUCTURE OF LEARNING UNIT

Learning outcomes:

1.1. Identify tools, equipment and materials based on laboratory protocol

1.2. Adjustment of tools, equipment and materials based on laboratory standards and manufacture instructions

1.3.Maintenance of tools, equipment and materials based on laboratory standards

Learning outcome 1.1 Proper identification of tools, equipment and materials based on laboratory protocol

Duration: 3hrs

a) Objectives of Learning outcome 1

By the end of the learning outcome, the trainees will be able to:

1. Describe of tool, Equipment and Materials

2.Identify types of tools, Equipment and Materials

3. Describe Criteria of selection wood sample

Resources

Equipment	Tools	Materials
1. Microscope **2.** Electric furnace **3.** Chainsaw **4.** Thermometer **5.** Hygrometer **6.** Electronic balance **7.** Computer **8.** Projector **9.**PPE	**1.** Knife **2.** Axe **3.** Panga **4.** Handsaw **5.** Tape measures	**1.** Wood samples **2.** Pencils **3.** Plastic bags **4.** Papers **5.** Notebooks **6.** Water **7.** Chalk **8.** Wood sample containers **9.** Wooden wedges

Advance preparation: Before starting the session delivery,

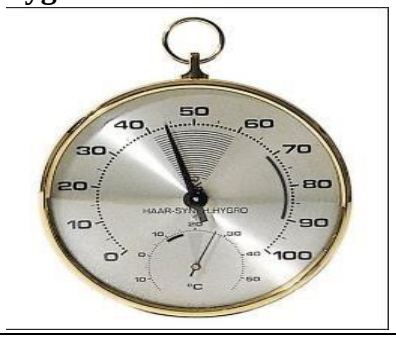
- ✓ There should be availability of required resources as listed above depending on their necessity
- ✓ Learning place should be made ready,

Facilitation techniques should be though about depending on the size of the class, the number of learners, the category of learners, and available learning resources

b) Indicative content 1.1.1: Description of Tools, Equipment, Materials

1.1.1. Description of tools materials and equipment for wood sample collection and laboratory

NO	TYPES OF TOOLS,MATERIALS AND EQUIPMWNT	FUNCTION
1	**Moisture meter** 	It is an instrument used to detect the moisture content (M.C) in materials such as wood to ensure a quality products.
2	**Thermometer**	Instrument used for measuring temperature.

			
	3	**Hygrometer** 	It is an instrument used to measure the humidity or amount of water vapor in the air.
	4	**Electronic balance** 	is a device used to find accurate measurement of weight
	5	**Electronic furnace** 	It is an equipment used for heating the wood samples.
	6	**Audio visual equipment** 	Are used for processing both sound and visual components, such as slides-tapes, television.

	7	**Personal Protective Equipment (PPE)** 	Are designed to protect wearer's body from injury or infection. (such as helmet, goggles, or other equipment)
	8	**Sharp knife** 	Used to cut small pieces of wood.
	9	Wood Sample containers	Are used for packaging and protecting sample against pest and diseases
	10	Wood samples	Used for assessing the wood properties(physical, mechanical and chemical)
	11	Machete	It is an instrument composed of a blade fixed into a handle used for cutting wood sample into medium samples.
	12	Wood laboratory	A place where physical and mechanical properties of wood samples are analyzed.

(Table1: description of tools materials and equipment)

Theoretical learning Activity

- Within groups of four members discuss about different tools and equipment used for wood sample collection.
- Within groups of four members discuss about different tools and equipment used for wood sample for laboratory analysis.

Practical learning Activity

- Each trainee performs selection of tools for wood sample collection.

- Each trainee performs selection of equipment for wood sample analysis.

 Points to Remember (Take home message)

Selection of tools, materials and equipment:

1. Description of tools and materials used for wood sample collection
2. Description of materials used for wood samples collection
3. Description of equipment used for wood samples collection

Selection of tools, materials and equipment:

1. Tools used for wood sample collection
2. Tools used for wood sample analysis
3. Equipment used for wood sample collection

Equipment used for wood sample analysis

c)  Learning out come 1.1 Formative assessment

Written assessment

Q1. **Answer True or False the following statement**

a)Hygrometer It is an instrument used to detect the moisture content (M.C) in materials such as wood

b)Moisture meter is Instrument used for measuring temperature.

c)Thermometer It is an instrument used to measure the humidity or amount of water vapour in the air.

Q2. The following are criteria of selection of tools ,materials and equipment for wood sample except

a)Wood sample size b)Moisture content contain
c)Properties to analyze d) Tree species

Q3. IN laboratory, workers are advised to use a suitable tools and materials of high quality because:

a) The quality and quantity of work output is cleanly determined by the quality tool used.

b) The work with high quality tools is less tremors than work with poor tools.
c)The task is accomplished with spending high efforts.
e) a and b

Answer

Q1.a) **F**alse b) **F**alse c) **F**alse

Q2. **D** (Tree species)

Q3. **E**(a an b)

Practical assessment

1. In group of 4 learners go in the warehouse and separate tools, materials and equipment

1.2 TYPES OF TOOLS, MATERIALS AND EQUIPMENT

1.1.2. TYPES OF TOOLS, MATERIALS AND EQUIPMENT

One can classify tools according to their basic function or users:

- ✓ Cutting and edging tools: knife, sickle, ideally the edge of the tools need to be harder than the materials being cut.
- ✓ Guiding, measuring and perception tools including the rulers, glasses, set square, theodolite, microscope, monitor, clock, phone and printer.
- ✓ Fastening tools such as welder, nails, adhesives/ glues gun

Information and data manipulation tools

 Theoretical learning Activity

- ✓ Brainstorming on type of tools, materials and equipment

 Practical learning Activity

With a group of four members classify two tools according to their basic function

 Points to Remember (Take home message)

We can classify tools according to their basic function or users

d)  Learning outcome 1.2 Formative assessment

Written assessment

Q1. During cutting and edging tools the following tools are used except:

a) knife ,sickle and machete
b) nail, and glue
c) ruler, glasses, and set square
d) b and c

Q2.These are classification of tools ,materials and equipment according to their function except:

a)Cutting and edging tools b)Measuring and perception of tools
c)Harvesting tools

Answer

Q1. D (b and c)

Practical assessment

In group of 4 learners go in the warehouse and separate tools, materials and equipment

e) Indicative content 1.3: Criteria of selection tools,materials and equipment

1.1.3. **CRITERIA OF SELECTION OF TOOLS, MATERIALS AND EQUIPMENT**

i. Wood sample size (dimensions, number,)
ii. Properties to analyze (physical ,mechanical and biochemical)
iii. Tree species /groups of wood(hard wood and soft wood)

Theoretical learning Activity

. Within groups of four members discuss about different types of tools and equipment used for wood sample collection.

- Within groups of four members discuss about different types of tools and equipment used for wood sample for laboratory analysis.

Practical learning Activity

- Each trainee performs categorization of tools used for wood sample collection.
- Each trainee performs categorization of equipment for wood sample analysis.

Points to Remember (Take home message)

Selection of tools, materials and equipment:

4. Tools used for wood sample collection

5. Tools used for wood sample analysis

6. Equipment used for wood sample collection

Equipment used for wood sample analysis

f)  Learning outcome 1 .3 Formative assessment

Written assessment

Q1. **The following are criteria of selection of tools,materials and equipment for wood sample except**

a)Wood sample size b)Moisture content contain
c)Properties to analyze d**)Tree species**

Q2. Wood sample size is criteria based on selection of tools, materials and equipment they include the following element except

a) Dimensions of wood sample
b) Quantity of wood sample
2. Number wood sample

Practical assessment

In group of 4 learners go in the warehouse and separate tools, materials and equipment

Practical assessment

In group of 4 learners go in the warehouse and separate tools, materials and equipment

References:

Learning Outcome 1.2. Adjust tools and equipment.

Duration: 3hrs

Objectives of Learning outcome 1.2

g)

By the end of the learning outcome, the trainees will be able to:

1. Adjust correctly tools used for wood sample collection and laboratory analysis.

2. Adjust correctly equipment used for wood sample collection and laboratory analysis.

Resources

Equipment	Tools	Materials
1. Moisture meter **2.** Microscope **3.** Electric furnace **4.** Chainsaw **5.** Thermometer **6.** Hygrometer **7.** Electronic balance **8.** Computer **9.** Projector PPE	**1.** Knife **2.** Axe **3.** Panga **4.** Handsaw **5.** Tape measures	**1.** Wood samples **2.** Pencils **3.** Plastic bags **4.** Papers **5.** Notebooks **6.** Water **7.** Chalk **8.** Wood sample containers **9.** Wooden wedges

Advance preparation:

Before starting the session delivery,

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Indicative content 1.2.1: Adjustment instructions

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

1.2.1. Adjustment instructions

IN laboratory, workers are advised to use a suitable tools and materials of high quality because:

-The quality and quantity of work output is cleanly determined by the quality tool used.
-The work with high quality tools is less tremors than work with poor tools.
-When we use high tools qualities, the number of accidents which is costly is decreased.
-The task is accomplished without spending high efforts.
-It speed up the work (the activities are executed in short time possible

Theoretical learning Activity

- Within groups of four members discuss on how to adjust wood sample analysis equipment.
- Within groups of four members discuss on how to adjust wood sample collection tools and equipment.

Practical learning Activity

- In a group of two perform adjustment of tools and equipment used for wood sample collection.
- In a group of two perform adjustment of tools and equipment used for wood sample analysis

Points to Remember (Take home message)

Selection of tools, materials and equipment:

1. Adjustment of tools and equipment used for wood sample collection

Adjustment of tools and equipment used for wood sample analysis.

i) Indicative content 1.2.2: Adjustment standards

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

1.2.2. Adjustment standards of tools and equipment to be used in wood sample collection *Adjustment criteria

a. Checking
b. Screwing
c. Jointing:
d. Depth and spacing,
e. Fixing of screw,

f. Sharpening,
g. Handle fixing
h. Replacement

Theoretical learning Activity

Discuss about adjustment standards of tools and equipment of wood sample analysis.

Practical learning Activity

- ✓ You are called to measure wood sample for microscopic analysis; before measuring adjust the balance on required standards

Points to Remember (Take home message)

Selection of tools, materials and equipment:

1. Adjustment standards of tools and equipment used for wood sample collection

Adjustment standards of tools and equipment used for wood sample analysis.

j) Indicative content 1.2.3: Adjusting tools and equipment

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

Adjustment of tools and equipment must follow information from the manufacture

Theoretical learning Activity

- Discuss about adjustment of tools and equipment of wood sample analysis.

Practical learning Activity

. You are called to measure wood sample for microscopic analysis; before measuring adjust the balance on required standards

Points to Remember (Take home message)

Selection of tools, materials and equipment:

1. Adjustment of tools and equipment used for wood sample collection
2. Adjustment of tools and equipment used for wood sample analysis.

Formative assessment of 1.2

Q1.IN laboratory, workers are advised to use a suitable tools and materials of high quality because:

a)The quality and quantity of work output is cleanly determined by the quality tool used.

b)The work with high quality tools is less tremors than work with poor tools.

c) a and b

d)The task is accomplished with spending high efforts

Q2.These are adjustment criteria for adjustment standard except:

a) checking and screwing

b) sharpening and replacement

c)jointing and handle fixing

d) setting and cleanliness

Q3. These are maintenance and keeping tools and materials except:

a)cleanliness and light

b)setting and switch on, off

c) checking and screwing

Learning outcome 1.3 MAINTENANCE AND KEEPING TOOLS AND MATERIALS

Duration: 4hrs

Objectives of Learning outcome 1.3

By the end of the learning outcome, the trainees will be able to:

1. Maintain correctly tools used for wood sample collection and laboratory analysis.

2. Maintain correctly equipment used for wood sample collection and laboratory analysis.

3. Keep appropriately tools and equipment used for wood sample collection and laboratory analysis.

Resources

Equipment	Tools	Materials
1. Moisturemeter **2.** Microscope **3.** Electric furnace **4.** Chainsaw **5.** Thermometer **6.** Hygrometer **7.** Electronic balance **8.** Computer **9.** Projector PPE	**1.** Knife **2.** Axe **3.** Panga **4.** Handsaw Tape measures	**1.** Wood samples **2.** Pencils **3.** Plastic bags **4.** Papers **5.** Notebooks **6.** Water **7.** Chalk **8.** Wood sample containers **9.** Wooden wedges

Advance preparation:

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Indicative content 1.3.1: Maintenance instructions,

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

1.3. MAINTENANCE AND KEEPING TOOLS AND MATERIALS

- **Cleanliness:** consist of removing dirt, grease and rust on tools and material by using a mixture of diesel oil, kerosene and turpentine on the proportion of 70% of kerosene, 20% for turpentine and 10% for diesel oil.
- **Light:** tools and material require excellent light natural day light is preferable to artificial light.
- **Setting:** sometimes the blade can be in wrong condition must be bent to right and left.
- **Switch on/off** to turn on/off the tool
- **Contact customer service**.
- **Replace or sharpen blade**.
- **Use recommended accessories**

Theoretical learning Activity

- Within groups of four members discuss on four types of maintenance of tools and equipment used for wood sample analysis.

Practical learning Activity

- ✓ In a group of four, perform four maintenance techniques of tools and equipment used for wood sample collection.

Points to Remember (Take home message)

Maintenance instructions:

1. Types of maintenance of tools and equipment used for wood sample collection

2. Types of maintenance of tools and equipment used for wood sample analysis.

3. following instructions about maintenance of tools and equipment.

b) Indicative content 1.3.2: Keeping instructions

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc

1.3.2. Keeping instructions to respect in laboratory

The following are the general principles of care, keeping and serving that should be applied as a routine matter for all sampling and laboratory tools, materials and equipment.

a. All tools, materials and equipment should be kept in a clean and dry place as practicable, particular if they are to be transported or stored.
b. Wooden surface should be kept against moisture (don't leave them spending the night outside).
c. Metal surfaces should be cleaned and wiped as dry as practicable to prevent rust during their storage.
d. Keep wood samples separately
e. Count and label all samples collected
f. All samples must be kept in their respective containers.
g. Avoid any biological contaminations by sterilization before use (fungi, bacteria, viruses and insect borers).

Theoretical learning Activity

- Discuss about operating instructions of tools and equipment of wood sample analysis.

Practical learning Activity

- By following instructions of tools and equipment, operate wood sample collection for laboratory analysis


Points to Remember (Take home message)

Keeping instructions:

Following instructions during the use of tools and equipment.

Formative assessment of 1.3

Q1. The following are the general principles of care, keeping and serving tools,materials and equipment except:

a) Keep wood samples separately

b) Count and label all samples collected

c) All samples must be kept in their respective containers.

d)All tools, materials and equipment should be kept in a clean and dry place

e) Adjustment of tools and equipment used for wood sample collection

Indicative content 1.3.3: Safety precautions


Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc

SAFETY PRECAUTIONS IN WOOD LABORATORY

A. Laboratory rules to respect in the laboratory

When you are working in laboratory, the following safety rules must be respected:

1. Trainees (workers) may work in laboratory only during regular scheduled time and supervised by his/her trainer/supervisor.
2. Approved safety PPE must be available at all time.
3. Open flames are prohibited.
4. Keep out all chemical from your skin and eyes (body).
5. Don't drink and eat any types of tools and materials located in laboratory.
6. All laboratory workers must know the condition and proper use of all laboratory safety equipment.
7. All accidents must reported to an instructor immediately.
8. Laboratory equipment and work area must be cleaned.
9. Read and abide of the laboratory handouts.
10. Clean all tools and equipment before and after use.
11. Return tools, and equipment in the store.

12. Respect exactly the information mentioned on the label.

B. Wood laboratory Ventilation

Good laboratory ventilation is the single and important ingredient in maintaining the safety laboratory environment.

The good laboratory ventilation will allow the teacher, trainees, and administration to feel safe and comfortable in doing all of the experiments and activities needed to provide an outstanding laboratory experience.

C. Hazardous substance

Working safely with hazardous chemicals requires proper use of laboratory materials, tools and equipment. Maintenance and regular inspection of laboratory equipment, materials and tools are essential part that can guide you when (allow you) working with each laboratory activity. The reason why many of accidents can be occur in laboratory or can be attributed to improper use or maintenance of laboratory tools ,materials and equipment. These accidents can be caused by devices powered by electricity, high or low pressure and temperatures. The care also should be taken to use appropriate gloves when handling lab. Tools, materials and equipment to protect against electrical, thermal and chemical burns, cuts, etc.

D. First aid kits

First aid is defined as the provision of emergency treatment and life support for people suffering injury or illness. Although all injuries can wait the arrival of medicines. All accidents must be reported by submitting an accident, incident repo rt to the environment health and safety office.

Theoretical learning Activity

- Discuss about general laboratory rules and regulations

Practical learning Activity

- Maintain tools and equipment for wood samples analysis as well as taking into account safety precautions.

Points to Remember (Take home message)

n)  Learning outcome 1.3 Formative assessment

Q1. When you are working in laboratory, the following safety rules must be respected

Answer **True** or **False**

a)Trainees (workers) may work in laboratory only during regular scheduled time and supervised by his/her trainer/supervisor. **True**
b) Approved safety PPE must be available at all time. **True**
c)Open flames are prohibited. **True**
d)Keep out all chemical from your skin and eyes (body). **True**
e)Drink and eat any types of tools and materials located in laboratory. **False**

Practical assessment

In group of three trainees ,discuss on maintenance of tools ,materials and equipment

Learning Unit 2: Prepare the wood samples

STRUCTURE OF LEARNING UNIT

Learning outcomes:

2.1. Collect wood sample

2.2. Handle and transport wood sample

2.3.Store wood sample

Learning outcome 2.1 Collect wood sample

Duration: 3hrs

o) Objectives Learning outcome 2.1

By the end of the learning outcome, the trainees will be able to:

•Identify trees Species identification

• Describe types of cuts of wood

• Demonstrate Location of a part to pick up a sample

• Describe Sample size , Cutting out procedures and Sample preparation

Resources

Equipment	Tools	Materials
1. Moisturemeter **2.** Microscope **3.** Electric furnace **4.** Chainsaw **5.** Thermometer **6.** Hygrometer **7.** Electronic balance **8.** Audi visual equipment **9.** Oven **10.** Relascope **11.** Computer **12.** Projector PPE	**1.** Knife **2.** Axe **3.** Panga **4.** Handsaw **5.** Tape measures	**1.** Wood samples **2.** Pencils **3.** Plastic bags **4.** Papers **5.** Notebooks **6.** Water **7.** Chalk **8.** Wood sample containers **9.** Wooden wedges **10.** Forest stand **11.** Bath or volumetric tank

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Indicative content **2.1. 1: S**pecies identification

p)

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

2.1.1. Species identification (Hard wood and soft wood)

Wood is commonly grouped into two categories which are representative of the basic botanical classification of the two families of trees.

- **Hardwoods** - Angiosperms (broadleaf, mostly deciduous), for example: oak, maple, walnut E.g: *Alnus accuminata, Ficus thoninghii, Eucalyptus sp entandrophragma exersum(UMUYOVE), etc.*.
- **Softwoods** - Gymnosperms (mostly conifers), for example: *pine, Douglas fir, white fir, hemlock, Pinus sp,Synphonia globurifera, Callitris sp, Araucaria cunninghamiana, cupressus lustanica etc.*, etc.

Hardwoods are generally denser, have a finer texture and are more attractive than most softwoods (although some softwoods are harder than some hardwoods), a direct result of differences in wood structure. For example, hardwoods have specialized cells including a cell type for support, and a cell type for water conduction. Softwoods have one cell type that functions in both support and conduction

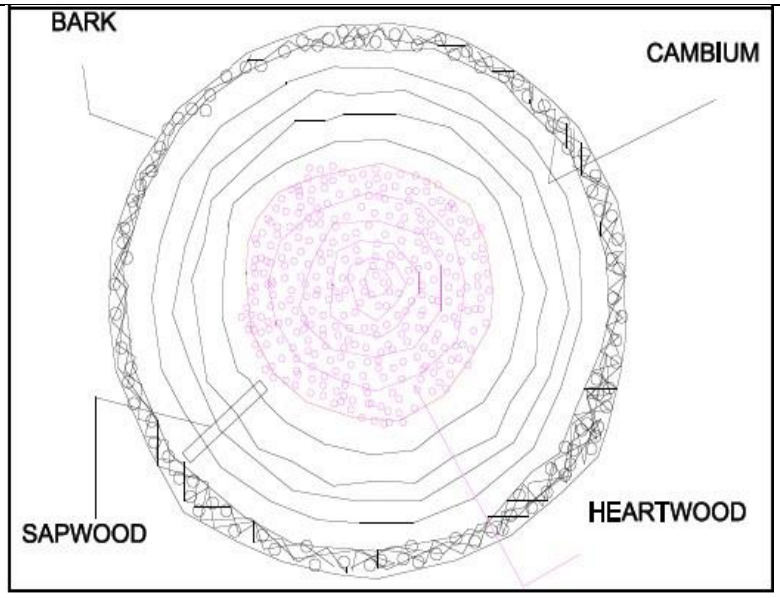
Basic features of all types of wood (Macroscopic)

Bark - Outer layer of protection for the tree, and transport of food from the leaves to the rest of the tree.
Cambium - Thin layer of cells that produces all other cells, xylem (wood) cells towards the center of the tree and phloem (bark) cells to the outside.
Growth rings - Light and dark rings of wood as seen on a cross-section of a tree. The rings are related to the growing conditions (e.g. growing seasons).

Early wood - Cells formed during favorable growing conditions (spring) forming a light colored band of cells.

Latewood - Cells formed during slow growth periods (summer) appear flattened out forming a thin dark band of cells. Latewood cells are usually denser than early wood cells.

Sapwood - Zone of wood cells active in transport of water from roots to leaves and the storage of food in the living tree.
Heartwood - Cells in this zone have all died and are no longer active in water transport and food storage.



Sketch of a tree cross-section

Comparison between hard wood to the soft wood)

No	Hard wood	Soft wood
1.	Comes from angiosperm trees.	Comes from gymnosperm trees.
2.	Trees are usually broad leaves.	Trees which usually have needle leaves.
3.	Has vessel elements that transport water through the wood appear as pores.	Medullary rays and tracheid transport water and produces sap, they have no visible pores.
4.	Hard wood are more likely to be found in high quality furniture.	Soft wood are more likely in medium quality.
5.	Most hard woods have a higher density.	Most soft wood have a lower density
6.	Hard wood is typically more expensive.	Soft wood is typically less expensive
7.	Hard wood has a faster rate of growth.	Soft wood has a slower growth rate.
8.	Hard wood shed their leaves over a period of time in autumn and winter.	Soft wood tent to keep their needles through the year.

9. More resistance to the fire.	Poor resistance to the fire. (Because of resin content found in soft wood)
10. Hard wood capture higher amount of water into the soil.	Soft wood capture less amount of water into the soil

-  Theoretical learning Activity

Within groups of four members discuss on hardwood and softwood

 Practical learning Activity

- ✓ Trainees in group outside of classroom differentiate types of hardwood and softwood

 Points to Remember (Take home message)

Species identification:

- Softwood
- Hardwood

Basic features of all types of wood(bark, cambium, sapwood, heartwood

q)

r)  Learning outcome 2.1 Formative assessment

Q1. Answer True or false the following statement,

a) Softwood coms from angiosperm trees **F**

b) Hardwood comes from gymnosperm trees F

c)Cambium - Thin layer of cells that produces all other cells, xylem (wood) cells towards the center of the tree and phloem (bark) cells to the outside. **T**

d)Growth rings - Light and dark rings of wood as seen on a cross-section of a tree. The rings are related to the growing conditions (e.g. growing seasons). **T**

e)Late wood - Cells formed during favorable growing conditions (spring) forming a light colored band of cells. **F**

f)Early wood - Cells formed during slow growth periods (summer) appear flattened out forming a thin dark band of cells. Latewood cells are usually denser than early wood cells. **F**

Practical assessment

Trainees in groups differentiate hardwood and softwood

s) Indicative content 2.2: Demonstrate Location of a part to pick up a sample

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

2.1.2. Location of part to pick up a wood sample

Bark : is a part of wood composed by outer bark having dead cells and this part act as a protection of tree (**against diseases attack and losing of water**) and inner bark that having phloem and xylem.

Vascular cambium: is a very thin layer of tree produces both new phloem on one side (outside) and new xylem on the other side (inside) the phloem becoming bark and the xylem inside becoming sap wood.

The phloem, on the bark side transport foods not manufactured by tree leaves down to the roots and xylem carries water and other nutrients up to the leaves. The cambium is located between sap wood and inner bark.

Sap wood: definition is that sapwood is the band of lighter colored wood adjacent to the bark. Sap wood is the living outer most portion of wood comprises the majority of a stem cross section. Its function is to support, storage.it contains the rays that provide water and nutrients transportation of phloem.

Heart wood: Heartwood is the darker colored wood found to the interior of the sapwood.

Is a part of wood act as supporting wood and production of extractives (tannin, gums, resins, latex etc.) if cells are died.

Process of heart wood formation

What happen during heartwood formation?

- All cells are dead;
- The moisture content is in the sap wood is 100 % or more;
- The moisture content in the heart wood fall until of 40 – 50 %;
- The cells are to varying extent filled with heartwood extractives(gums, tannin, phenols, resins, latex ,and other related substances);
- The wood serves no other function than to give rigidity and support to the tree.

Sapwood and Heartwood

In both softwoods and hardwoods, the wood in the trunk of the tree is typically divided into two zones, each of which serves an important function distinct from the other. The actively conducting portion of the stem in which parenchyma cells are still alive and metabolically active is referred to as sapwood.

(Table 4: Comparison between sap wood and heart wood)

Sap wood	**Heart wood**
a) It forms outer wood of an old stem	It forms the central wood of an old
b) It is light in color	It is dark in color
c) It is lighter in weight	It is heavier
d) It contains living cells	Living cells are absent(died)
e) It is the function part involve in ascent of sap.	It is dead and no functional part
f) Tyloses are absent	Tylose ere present
g) Has high moisture content(M.C)100% or more	Low moisture content(40-50%)
h) Occupy approximately 25-30 %	Approximate 70-75%
i) Sap wood is for production	Is for storage (deposit of mineral)
j) Less durable	Resistance to fungal degradation and insect attack.

Theoretical learning Activity

Within groups of four members discuss on Location of part to pick up a wood sample

Practical learning Activity

- ✓ Trainees in group outside of classroom differentiate sapwood and heartwood

Points to Remember (Take home message)

-**Location of part to pick up a wood sample** (bark, cambium, sapwood, heartwood)
-Comparison between sapwood and heartwood

Learning outcome 2.2 Formative assessment

Q1.These are Location of part to pick up a wood sample except:

a)bark and sapwood

b) Heartwood and cambium

c**) Heardwood and softwood**

Q2. These are what happen during heartwood formation except:

a)All cells are dead;
b)The moisture content is in the sap wood is 10-20 %
c)The moisture content in the heart wood fall until of 40 – 50 %;
d)The cells are to varying extent filled with heartwood

2.3. TYPES OF WOOD CUTS

The different wood cuts are:

i. **Through and through cuts (plain saw, line saw):** in this type of cutting, the saw cuts forms a tangent to one of the annual ring. It consists to cut wood into series of parallel cuts.

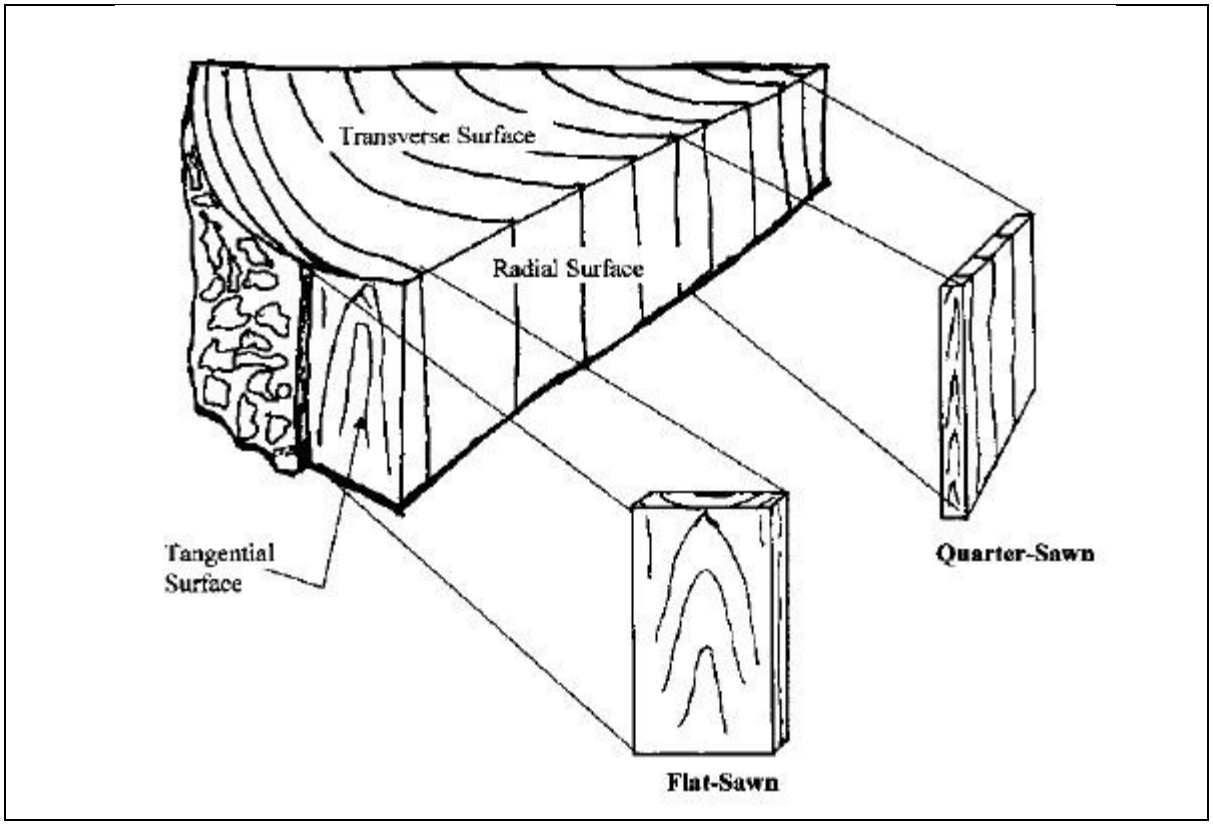
ii. **Quarter sawing (radial cut):** to mill/cut sawn wood each log is sawed at a r ight angle (90⁰) into four quarters

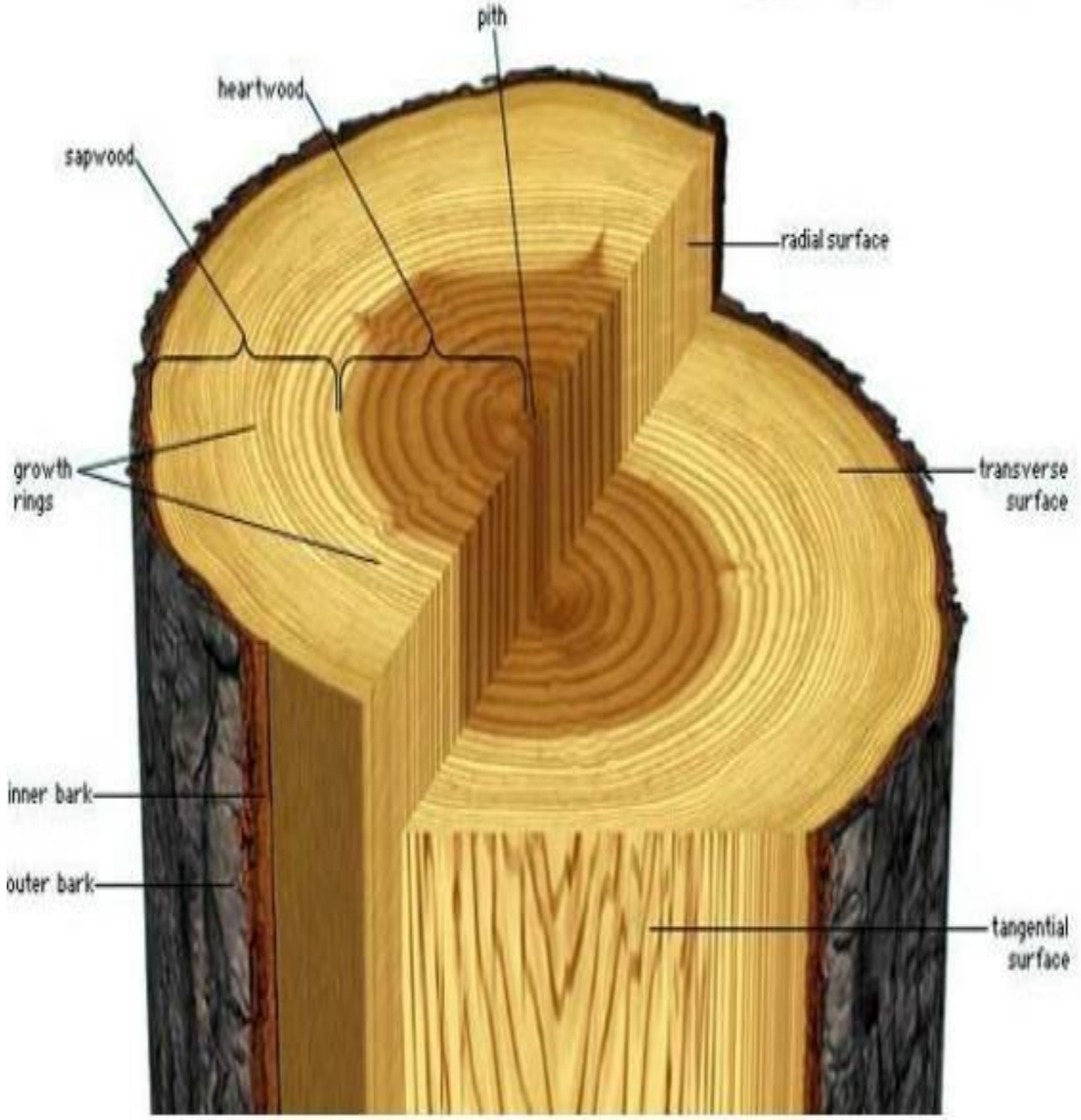
iii. **Tangential cut (cant sawing):** the cut is made parallel to the annual rings of the log and log must be turned at 90⁰ after each cut. iv. **Transversal cut or crosscut: wood** is cut through perpendicular to the fibers.

v. **Grade sawing:** grade sawing consists of procedures to follow in other to produce improved grades of timber.

Structural Planes of Wood

Transverse - Surface exposed by cutting across the stem (cross-section).
Tangential - Surface exposed by cutting tangent to the growth rings (flat-sawn).
Radial - Surface exposed by cutting across the growth rings from the pith to the bark (quartersawn).


Transverse Surface
Radial Surface
Tangential
Surface
Quarter-Sawn
Flat-Sawn


pith
heartwood
sapwood
radial surface
growth rings
transverse surface
inner bark
outer bark
tangential surface

Theoretical learning Activity

Within groups of four members discuss on type of cut wood sample

Practical learning Activity

Trainees in group outside of classroom differentiate type cut wood sample

Points to Remember (Take home message)

Type of cut wood sample (Plain saw, quarter saw and tangential saw)
Structural Planes of Wood (transversal, radial and tangential)

t)  Learning outcome 2.3. Formative assessment

Written assessment

Q1.Answer True or False

The Structural Planes of Wood are

a)Transverse - Surface exposed by cutting across the stem (cross-section). **True**
b)Radial- Surface exposed by cutting tangent to the growth rings (flat-sawn). **False**
c)Tangential - Surface exposed by cutting across the growth rings from the pith to the bark **F**alse

Practical assessment

In group of four trainee,Discuss on type of cutting wood

Indicative content 2.4 Describe Sample size , Cutting out procedures and Sample preparation

2.1.4. WOOD SAMPLE SIZE

A number of factors determine the wood sample size (number of sampling units, dimensions) that can be taken a given population are:

- Method of sampling (random, stratified and systematic sampling);
- Variability of population(age, composition, etc);
- Precision (exactness)of estimation desired;
- Size and shape of population on which samples will be taken; □ Time and money you have or financial means.
-

2.1.5. Cutting procedures

After c utting down a tree, we start to prepare the wood sample by removing braches (delimbing or debranching) by using an axe, panga and sharp knife for smallest wood samples and chain saws for the largest tree diameter branches, etc.

After we execute the crosscutting logs according to the desired dimensions.

2.2. HANDLE AND TRANSPORT THE WOOD SAMPLES

2.2.1. Handling and packaging conditions for wood samples

- In other to keep the good, hygiene conditions, there are some general rules to respect during wood Avoid biological and mechanical contamination of wood samples during their packaging.
- Package wood samples separately,
- Count (inventory) of wood samples collected.
- Label all wood samples before their packaging (date, tree species, number, properties to analyze, etc.)

2.2.2. Handling techniques for wood samples

a) Weighing the wood samples

b) Sealing the wood samples

c) Labeling the wood samples

sample packaging:

- Use a clean and dry samples during their packaging

2.2.3. Transport means for wood samples

There are 3 ways (means) of transport of wood samples:

a) **Air transport**: air ways transport that uses air (air planes), to supply wood to the production sites

b) **Water transport**: in water way transport of wood by using boats,

c) **Land transport:** (pathways transport): those types of transport is used in undeveloped countries where peoples carry wood over their shoulders or heads and also animals are involved. Also trucks and vehicles use roads to dispatch the wood to the production sites.

2.3. STORE THE WOOD SAMPLES

2.3.1. Wood samples storing conditions

The storage of wood sample is necessary in other to reduce their damages (biological and mechanical) and can be stored according to the species, collection times and properties to be analyzed.

The following are the conditions for wood sample storage:

- Keep the wood samples in a ventilated area
- Store wood samples on underlying support (keep above the ground)
- Keep the wood samples in large houses

  Hygienic storage conditions

Theoretical learning Activity

Within groups of four members discuss on HANDLE AND TRANSPORT THE WOOD SAMPLES

Practical learning Activity

Trainees in group outside of classroom discuss wood sample storage

Points to Remember (Take home message)

Handling and packaging conditions for wood samples Transport means for wood samples Store wood sample

u) Learning outcome 2.3 Formative assessment

Written assessment

Q1.These are a number of factors determine the wood sample except:

a) Method of sampling (random, stratified and systematic sampling);
b) Invariability of population
c)Precision (exactness)of estimation desired;
d)Size and shape of population on which samples will be taken;

Practical assessment

In group of four trainees discuss on storage of wood sample

Learning Unit 3:Conduct physical and mechanical wood analysis

Picture/s reflecting the Learning unit 1

STRUCTURE OF LEARNING UNIT

Learning outcomes:

1. Arrange the laboratory tools, materials, and wood sample
2. Carry out the laboratory experiment/analysis
3. Record the experiment data

Learning outcome 3.1 Arrange the laboratory tools, materials, and wood sample

Duration: 3hrs

Objectives of Learning outcome 3.1 Arrange the laboratory tools, materials, and wood sample

v)

By the end of the learning outcome, the trainees will be able to:

- Arrangement instructions
- Identify Wood sample categorization
- Describe tools and Materials categorization
- First aid and Working safety

Resources

Equipment	Tools	Materials
Wood laboratory equipment first aid kit ,Moisture meter, Hygrometer, electronic balance, electronic furnace, audio visual equipment	Knife, sample container, machete, hand saw, sample container	books, newspapers, reports, scientific paper, water, antiseptic gel, chalks, wood sample

Advance preparation:

. Ensure research documents and material (pictures, books, journals, etc) materials and equipment are in classroom

. Ensure the video and images of different tools are available

. Prepare questions to assess the trainees

Indicative content **3.1.** Arrange the laboratory tools, materials, and wood sample w)

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

3.1. Arrange the laboratory tools, materials and wood samples

Laboratory tools, materials and equipment are many apparatus that are used in laboratory which are arranged in different seven (7) groups namely:

1. **22Glassware**: although these objects have different uses. Eg: glass, conical flask, beaker, thermometer, test tubes, etc.
2. **Heating**: these objects which are used in the process of heating but each one has different functions .eg: Bunsen burner, electronic furnace, oven, et
3. **Measuring**: we use these tools to measure different measurement such as mass, volume, time, and temperature, etc
4. **Observing**: the observing equipment allow to have look substances and different materials .eg: microscope
5. **Holding**: these items in this group keep things in right position, so that as to be used. Eg :test tube ,spatula, etc
6. **Cuttings**: these two objects have a sharp edge which can penetrate or divide things. Eg:
disserting scissors.

Filtering: through these materials a fluid is passed to separate out matter in suspension.eg: filter paper.

3.2. WOOD SAMPLE CATEGORIZATION

Wood samples are categorized into 3 main categories:

i) High categories: are wood which have the high quality compared to the others.eg: which don't have any physical, biological and mechanical degradation.

ii) Medium categories: wood samples which have some wood defects

iii) iii) Low categories: are wood which have many defects like knots, splits, shakes etc.

✓  Theoretical learning Activity

- ✓ Brainstorming on arrangement of tools, materials and equipment for wood sample
- ✓ Demonstration of wood sample categorization

 Practical learning Activity

- ✓ In pair of 4 trainees arrangement of tools, materials for wood sample

Points to Remember (Take home message)

Description on arrangement of wood sample
Categorization of wood sample (higher, medium and low categories)

x) Indicative content 3.2: CARRY OUT WOOD LABORATORY EXPERIMENTS

Summary for the trainer related to the indicative content (key notes using bullets such as ticks etc)

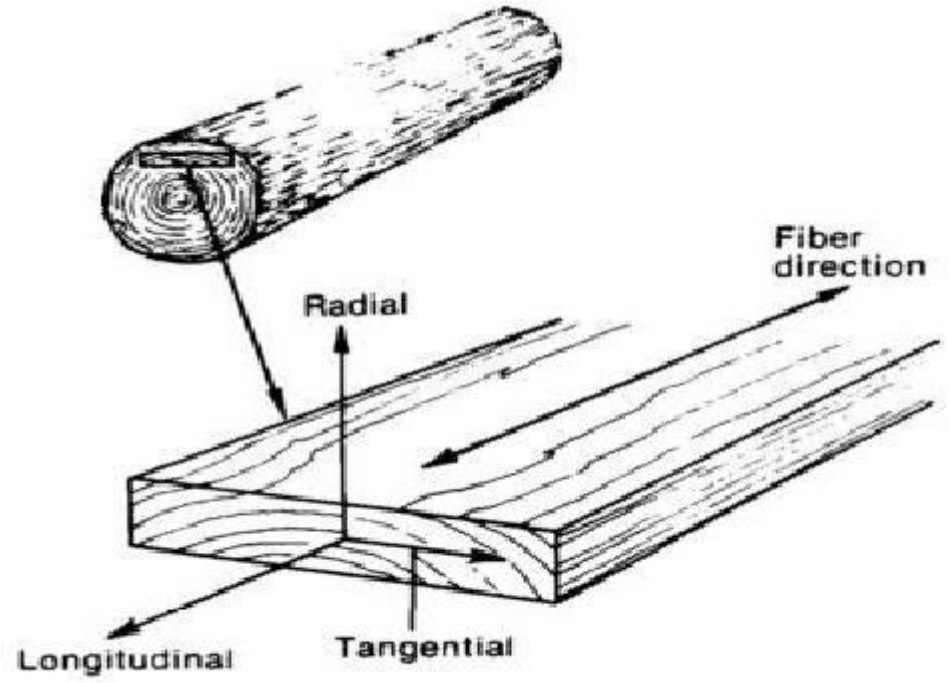
3.2. CARRY OUT WOOD LABORATORY EXPERIMENTS

A) Physical properties of wood determination

Physical properties of wood are the quantitative characteristics of wood and its behavior to the external influences other than applied forces.

They include: directional properties, moisture content, dimensional stabilities thermal properties, pyro lytic properties (fire), density electrical resistance and decay resistance.

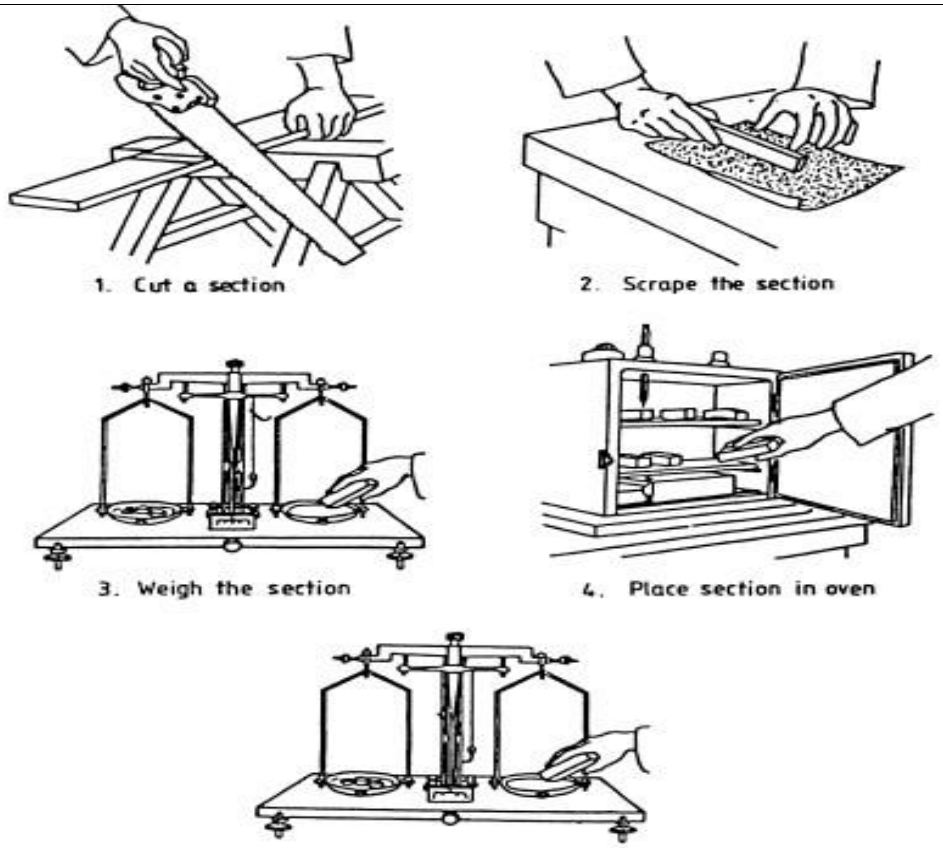
i. **Directional properties:** in this wood properties wood is anisotropic material (means that it can vary in different directions). Because of the orientation of the wood fibers and the manner in which a tree increase in diameter as it grows properties varies along the three mutually perpendicular axes: longitudinal, radial, and tangential.



ii. Moisture Content

The moisture content of wood is the amount of water present in it expressed as a percentage of its oven dry weight. This means that a piece of wood which is one half dry wood fibre and onehalf moisture, has a moisture content of 100 percent. Green timber therefore can have moisture content well over 100 percent. It may be determined in several ways but two methods have become established as standard practice. They are the oven drying method and the moisture meter method. The oven drying method involves cutting samples from the wood to be tested, weighing the cut samples, drying them at a temperature of 101 - 105 degrees C and reweighing**.**

Oven drying method



Determination of moisture content

The moisture content is then calculated from the formula:

Initial weight - Final weight

M.C =---------- x 100 = Moisture content (%) or Final weight

$$MC = \frac{Green\ weight - Ovendry\ weight}{Ovendry\ weight}\ x\ 100\ (\%)$$

As a result, the moisture content of wood is a function of atmospheric conditions and depends on the relative humidity and temperature of the surrounding air. The time required for wood to reach the EMC depends on the size and permeability of the member and the EMC potential of that environment.

Effect of moisture content in wood

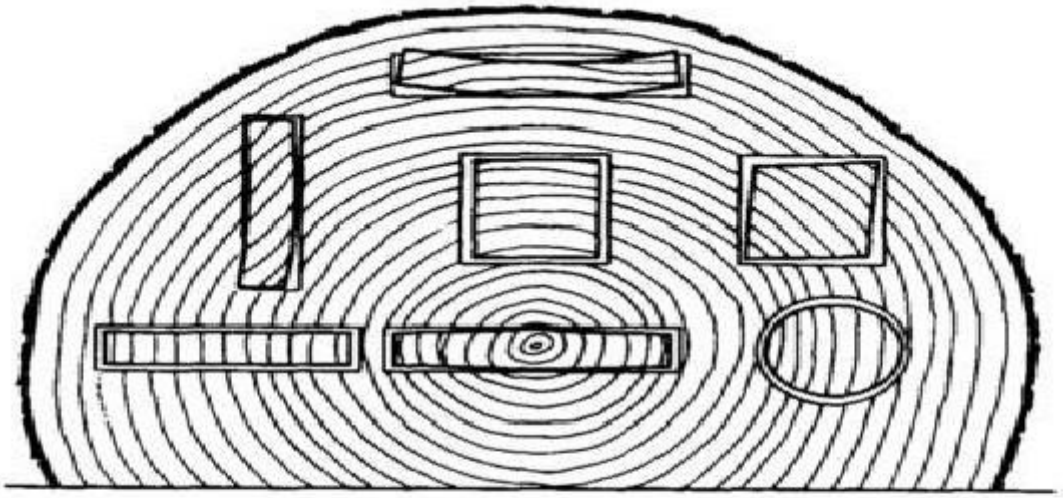
- It increases the weight of wood, thus increases transport cost;

- When water dries from wood below below fiber saturation point, the process can lead to defect like warping, splitting, and checking;
- Stiffness, mechanical properties and nail holding power decreases with increasing moisture content of wood below the fiber saturation point;
- Moisture in wood reduces the efficiency in painting;
- Wood with moisture content above 20% is more susceptible to decay;
- The calorific value of wood is inversely proportional to the moisture content of wood.

- iii. **Dimensional Stability**

Above fiber saturation point, the wood will not shrink or swell from changes in moisture content because free water is found only in the cell cavity and is not associated within the cell wall. Wood changes in dimension as the moisture content varies below the fiber saturation point.

Wood shrinks as it loses moisture below the fiber saturation point and swells as it gains moisture content up to the fiber saturation point. These dimensions changes may result in splitting, checking, and wrapping



Swelling: is defined as increasing of the wood size and capturing of moisture content due to the soaking wood in water.

Shrinkage: Is defined as the reduction of wood size and loosing of Moisture Content (water) in the wood due to the sunlight.

WAYS FOR TESTING OF WOOD SHRINKAGE

- You take the different pieces of moist wood/timber.
- You measure the timber width and you record data;
- Place/ dry it on the same sunlight ;
- After a given period of time, you take away from the sun;
- And you measure it again after drying and you see how the timber sizes reduced.

WAYS FOR TESTING OF WOOD SWELLING

- You take the different pieces of dried wood/timber;
- You measure the timber width and you record the data;
- Place those wood/timber in the water ;
- After a given period of time , you remove those pieces of wood in the water;
- You measure it again the width of the timber and you see how the wood is increased in width (swelled).

iv. THERMAL EXPENSION

The thermal expansion of the dried wood is positive in all directions, wood expands when heated and contracts when cooled. Wood that contains moisture reacts to temperature changes differently than dry wood.

v. PYROLYTIC PROPERTIES

Under appropriate conditions wood will undergo thermal degradation or pyrolysis. The byproducts of pyrolysis may burn, and if enough heat is generated, and retained by the wood, the wood can be set on fire.

vi. DENSITY AND SPECIFIC GRAVITY

Density is the wood property that has the greatest effect on the manufacturing and performance characteristics of wood.

The density of a material is the mass per unit volume at the same specified condition.

Measure of the amount of wood substance, defined as the weight per unit volume. Both the weight and volume of wood vary with the moisture content of wood. Therefore, when density is measured the moisture content of the wood must be noted.

Density is the single most important indicator of the strength in wood. A wood that is heavier will generally tend to be stronger than lighter one. For hygroscoping material such as wood, density depends on two factors: the weight of wood

structure and the moisture retained in the wood. Density is the mass of wood per unit volume and is often given in g/cm^3.

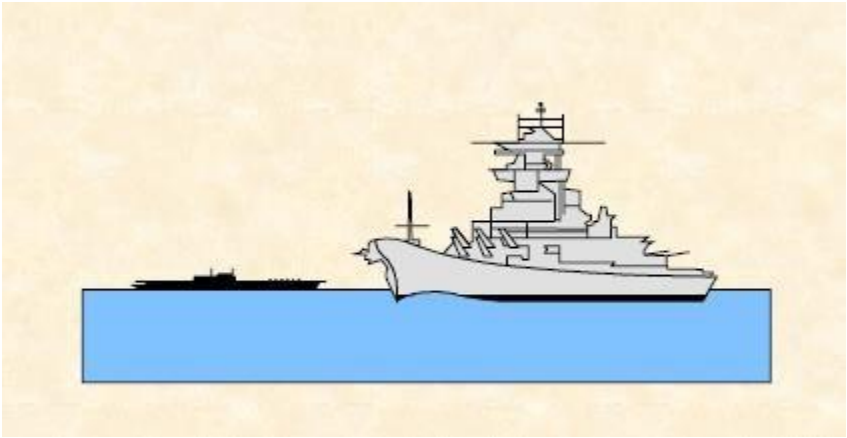
Ways to test wood density is the following:

A test of specimen of wood is cut and soaking in water to attain green state and weight of the test specimen is measured (volume) after the sample is dried in oven at temperature of 103^{0}C plus minus 20^{0}C until it reaches 12% moisture content and then they dry wood weight is measured (mass), finally the basic density for each sample is calculated as follow:

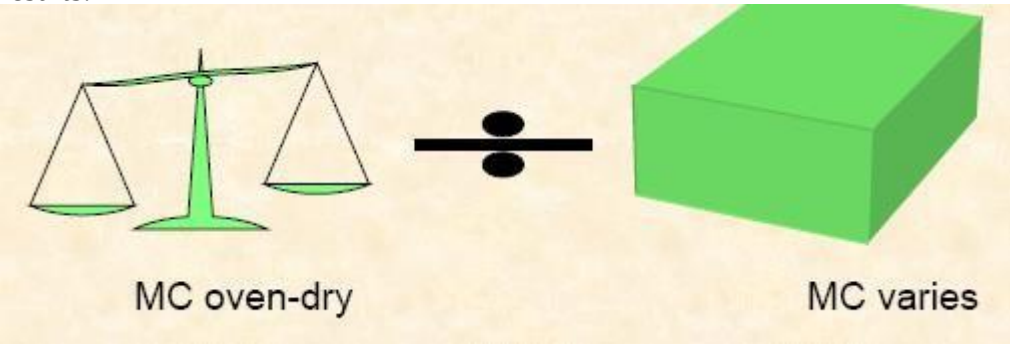
ʃ= Mo/Vu where: **ʃ**=Basic density (Kg/m^3); **Mo:** oven dry weight (Kg); **Vu**: Green Volume(m^3).

Specific gravity is a unitless ratio of the density of wood at standard conditions (usually ovendry mass/green volume) to the density of water at ambient conditions.

Specific Gravity (SG) is the density of a substance relative to the density of water and is sometimes called relative density or basic density Substances with a SG of less than one will float Specific gravity is a measure of relative density.



The specific gravity of wood is always calculated using its oven-dry mass. Therefore, only the MC during volume measurement will affect specific gravity results.



$$SG = \frac{\text{Oven dry weight}}{\text{----------}}$$

Weight of the displaced volume of water specific gravity (S.G.) is a dimensionless ratio of the weight of ovendry volume of the wood to the weight of an identical volume of water. Is the ratio of the substance to the density of a reference substance.

SG=DENSITY OF WOOD /DENSITY OF WATER IN THAT WOOD

SG is unity less or no unit.

The factors that are known to affect wood density within a species.

- Location within the tree
- Location in its range
- Site conditions
- Genetic factors

vii. ELECRICAL RESISTANCE

Wood is a good electrical insulator .significant variations in conductivity do eexist. These variations in grain orientation, temperature and moisture content. The conductivity of the wood in the longitudinal axis is approximately twice that in the radial axes. The electrical conductivity of wood generally doubles for each 10^0C increases in temperature.

Conductivity: ability of a material (wood) to conduct electricity, heat fluid or sound.

A good insulator: a substance that does not transmit the heat (thermal

insulator)

viii. DECAY RESISTANCE

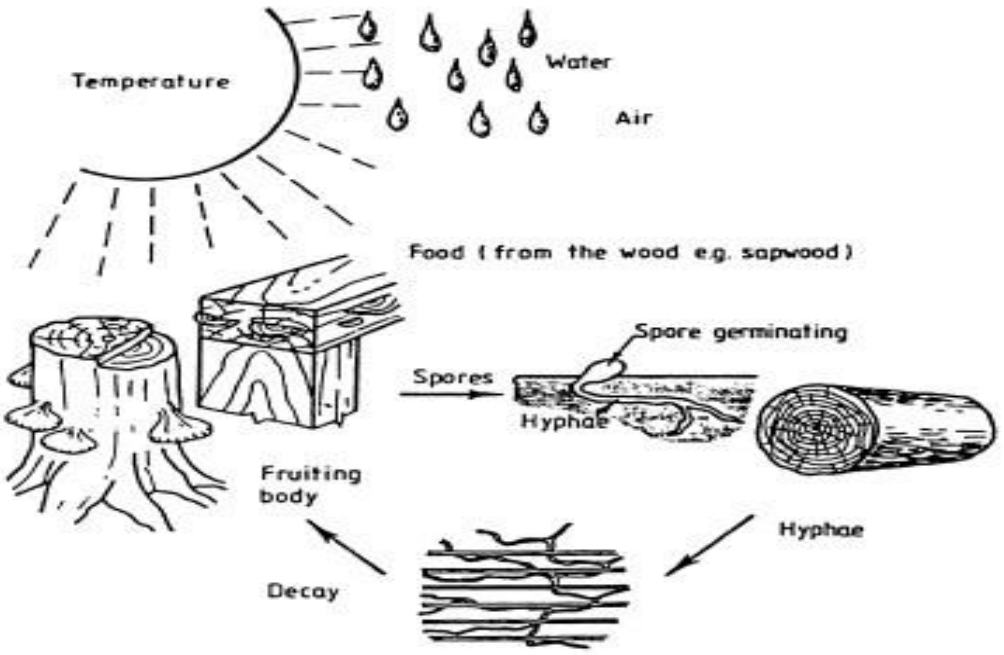
Decay resistance is the natural durability of the wood to the mechanisms and process of deterioration is related to the anatomical characteristic and spices of wood. Wood decay fungi and wood destroying organisms require oxygen, appropriate temperature, moisture content and a food reserves.

Wood will not decay if kept dry (moisture content less than 20%). other extreme if continuously submerged in water at a sufficient depths wood will usually not decay.

Decay Requirements

The conditions necessary for the development of decay producing fungi in wood are:

- A suitable substrate or a suitable supply of food
- Adequate moisture
- A favorable temperature
- Adequate supply of air or oxygen.



Fungi in wood (growth requirements)

WAYS OF WOOD DECAY RESISTANCE TEST

- Take the different dried wood species
- Place plug those wood species in the permanent water (moist area); or exposed on the different fungus area;
- After a given period you remove those pieces of wood;
- And finally you see how fungus attacked the wood (or how the wood resists to decay).

2) Mechanical properties of wood determination

Mechanical properties of the wood are the characteristics of a material in response to the externally applied forces. They includes Elastic properties; which characterized the resistance to deformation and distortion and strength properties which characterized by the resistance to applied loads (weight to be carried).

Mechanical properties values are given in terms of **stresse**s (force per unit area) and **strain** (deformation resulting from the applied stress) .distortion= breakage (break).

i. Elastic properties

Elastic properties relates the resistance of a material to deformation under an applied stress to the ability of the material to regain its original dimensions when

the stress is removed. Elastic properties are measured by measuring 2 constants namely modulus of elasticity and modulus of rupture.

- **MODULUS OF ELASTICITY (MOE):**

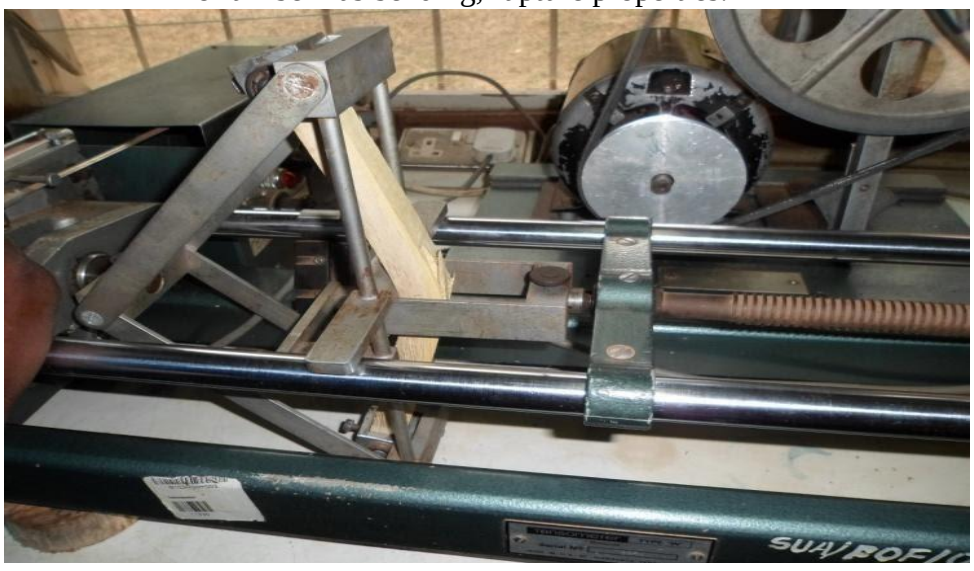
MOE expresses the relationship between stress and strain/tension of wood. It is important in determining the deflection of beam under load. It is also considered as a measure of stiffness/toughness of a timber which control the load bearing capacity of long columns. The greater the MOE, the stiffer the wood.

Ways used for testing wood elasticity

- Take a pieces of wood or timber;
- Measure the initial timber dimensions(length ,volume);
- Place the timber above two supports;
- Put the stress or pressure material on the timber during a determined time;
- Remove the pressure on the timber ;
- Measure the final timber dimensions;
- When the timber sizes increased we conclude that the timber has elastic properties.

- **MODULUS OF RUPTURE (MOR) :** is considered as the equivalent stress in the extreme fibers of the specimen at the point of failure and a measure of the ultimate bending strength of the timber that is toughness and surprise resistance in the wood. **Modulus of rupture test**

- Takes a piece of wood or timber;
- Place horizontally that wood above two supports ;
- Introduce the pressure above that timber during a determined period of time;
- Remove the pressure after a given time;
- Make observation on timber and obtained results give the conclusion if the timber has the maximum load carrying capacity according to the users or timber has bending, rupture properties.



NOTE: if necessary you have to measure the slope after removing the pressure. **ii. COMPRESSION PARARELL TO THE GRAIN**

This is an important test done on a small clear specimen of wood in other to determine the wood ultimate stress in compress along the grain at a gradually in increasing compressive load.

The results from this test are important for predicting wood used in columns and structural materials.

iii. SHEAR PARALELL TO THE GRAIN

Shear parallel to the grain is the ability to resist internal splitting of the part upon another along the grain. It is the measure of the resistance of the timber to break when subjected to joining.

Hence the lower shear strength presents design of joints problem. i.e : the cross grain ,shear strength is high so high compared to parallel shear that it can only occur if the timber was deliberately shear loaded.

iv. WOOD CLEAVAGE

Cleavage strength in wood is the measure of resistance of the wood against splitting. Wood which has low cleavage strength property is suitable in end use like packaging cases and other uses where nails and crews holding is required but undesirable in fuel wood and other uses where splitting is necessary.

This test is normally carried out on both radial and tangential surfaces to give an average cleavage strength value. **Wood cleavage test**

- You take a piece of timber or wood;
- You nail at the edge of timber, then you see how the wood is resisting to the splitting.

✓ Theoretical learning Activity

✓

✓ Brainstorming on physical properties of wood determination

✓ Group Discussion on mechanical properties of wood determination

✓ Demonstration of of physical and mechanical properties analysis

✓ Practical learning Activity

✓ Trainees in group outside of classroom conduct analysis of physical and mechanical properties of wood

Points to Remember (Take home message)

Physical properties of wood are (density, moisture content, dimension stability, thermal properties, decay resistance, electrical resistance
Mechanical properties of wood are (elastic properties, strength properties, and cleavability of wood

Learning outcome 3.3: Record the analysis result

Duration: 3 hours

Objectives of Learning outcome 3.3

By the end of the learning outcome, the trainees will be able to:

1. Record correctly the time of analysed data of wood sample.
2. Characterize the data of wood sample to be analysed in laboratory.
3. Fill appropriately laboratory format sheet during laboratory analysis of wood sample.

Resources

Equipment	Tools	Materials
1. Moisturemeter 2. Microscope 3. Electric furnace 4. Chainsaw 5. Thermometer 6. Hygrometer 7. Electronic balance 8. Audi visual equipment 9. Oven 10. Relascope 11. Computer 12. Projector 13. PPE	1. Knife 2. Axe 3. Panga 4. Handsaw 5. Tape measures 6. Thermal conductivity meter.	1. Wood samples 2. Pencils 3. Plastic bags 4. Papers 5. Notebooks 6. Water 7. Chalk 8. Wood sample containers 9. Wooden wedges 10. Forest stand 11. Bath or volumetric tank

Advance preparation:

Before starting the session delivery,

- ✓ Avail laboratory for wood sample
- ✓ There should be availability of required resources as listed above depending on their necessity
- ✓ Learning place should be made ready,
- ✓ Facilitation techniques should be though about depending on the size of the class, the number of learners, the category of learners, and available learning resources

Indicative content 3.3.1: Recording time

Recording time: Any sample to be analyzed must show date and time of analysis to avoid any confusion with other ongoing wood sample being analysed.

Instructions for Recording Data in the Laboratory Notebook

1. All entries should be made in a legible and orderly manner using permanent ink, preferably black. Make entries clear and complete so that someone else could repeat the experiment if necessary.
2. Avoid erasures. If an error is made, cross it out and make the correction immediately thereafter. Cancellations or insertions should be initialed, dated and explained (in the margin, if possible), by an appropriate notation.
3. Make sure the control page information is filled out prior to usage.
4. Each day's work should, whenever possible, be started on a separate page with lines drawn diagonally across the unused portion of the previous page. (This gives legal evidence that additions were not made at a later date.)
5. Each page must be signed and dated by the individual who makes the entry and does the work. In addition, each page should be witnessed (signed and dated), using the notation "Read and Understood", preferably on the same day, but at least within one week.
6. For copying purposes, graphs, charts, analytical data, etc. should be attached to the notebook pages with a permanent adhesive and should, when unfolded, be kept within the confines of the opened notebook.

Theoretical learning Activity:

- Discuss about recording time about results from analysis.

Practical learning Activity

- Identify different rules of recording time of results of laboratory analysis.

Points to Remember

Timing of recording of results of laboratory analysis

- Hours
- Day
- Month

Indicative content 3.3.2: Data characteristics

Characterisation of data

- **Weight:** is define as the quantity of wood sample to be analyzed which is measure in kg or grams
- **Volume**: is also quantity of wood sample to be analyzed and it is measured in m^3 or cm^3
- **Form**: is about wood quality by observing its physical characteristics.
- **Percentage**: quantity of wood used during analysis and it is expressed in percentage compared to wood used initially.

Theoretical learning Activity:

- Discuss about different wood sample data for analysis.

Practical learning Activity

- Describe any 4 wood sample data for laboratory analysis.

Points to Remember

Characteristics of wood samples for laboratory analysis.

- Weight
- Volume
- Form
- Percentage

Indicative content 3.3.3: Filling laboratory format sheet

Filling laboratory format sheet

A **laboratory format sheet** report is broken down into eight sections: title, abstract, introduction, methods and materials, results, discussion, conclusion, and references. The title of the lab report should be descriptive of the experiment and reflect what the experiment analyzed.

1. Title

The title of the lab report should be descriptive of the experiment and reflect what the experiment analyzed.

Ex: "Determining water content in a wood sample"

2. Introduction

- The introduction of a lab report discusses the problem being studied and other theory that is relevant to understanding the findings.
- Write the introduction in your own words. Try not to copy from a lab manual or other guidelines. Instead, show comprehension of the experiment by briefly explaining the problem.

3. Methods and Materials

- The methods and materials section provides an overview of any equipment, apparatus, or other substances used in the experiment, as well as the steps taken during the experiment. If using any specific amounts of materials, make sure the amount is listed.

Ex: pipette, graduated cylinder, 1.13mg of Na, 0.67mg Ag

- List the steps taken as they actually happened during the experiment, not as they were supposed to happen.

- If written correctly, another researcher should be able to duplicate the experiment and get the same or very similar results.

4. Results

- The results show the data that was collected or found during the experiment.
- Explain in words the data that was collected.
- If using graphs, charts, or other figures, present them in the results section of the lab report.
    - Tables should be labeled numerically, as "Table 1", "Table 2", etc. Other figures should be labeled numerically as "Figure 1", "Figure 2", etc.
- Calculations to understand the data can also be presented in the results.

5. Discussion

- The discussion section is one of the most important parts of the lab report. It analyzes the results of the experiment and is a discussion of the data.
- If any results are unexpected, explain why they are unexpected and how they did or did not affect the data obtained.
- Explain your results and discuss them using relevant terms and theories.
- When writing a discussion, try to answer these questions:
    - What do the results indicate?
    - What is the significance of the results?
    - Are there any gaps in knowledge?
    - Are there any new questions that have been raised?

6. Conclusion

- The conclusion is a summation of the experiment. It should clearly and concisely state what was learned and its importance.
- If there is future work that needs to be done, it can be explained in the conclusion.

7. References

- If using any outside sources to support a claim or explain background information, those sources must be cited in the references section of the lab report.
- In the event that no outside sources are used, the references section may be left out.

Theoretical learning Activity:

- Discuss about how to fill laboratory format sheet.

Practical learning Activity

- Describe the way of filling laboratory format sheet.

Points to Remember

Fill laboratory format sheet reflect the following points:

- Title
- Introduction
- Methods and Materials
- Results
- Discussion
- Conclusion
- References

N/S	Parts of format sheet	Description
1	Title	
2	Introduction	
3	Methods and Materials	
4	Results	
5	Discussion	
6	Conclusion	
7	References	

Learning Unit 4: Interpret the laboratory data

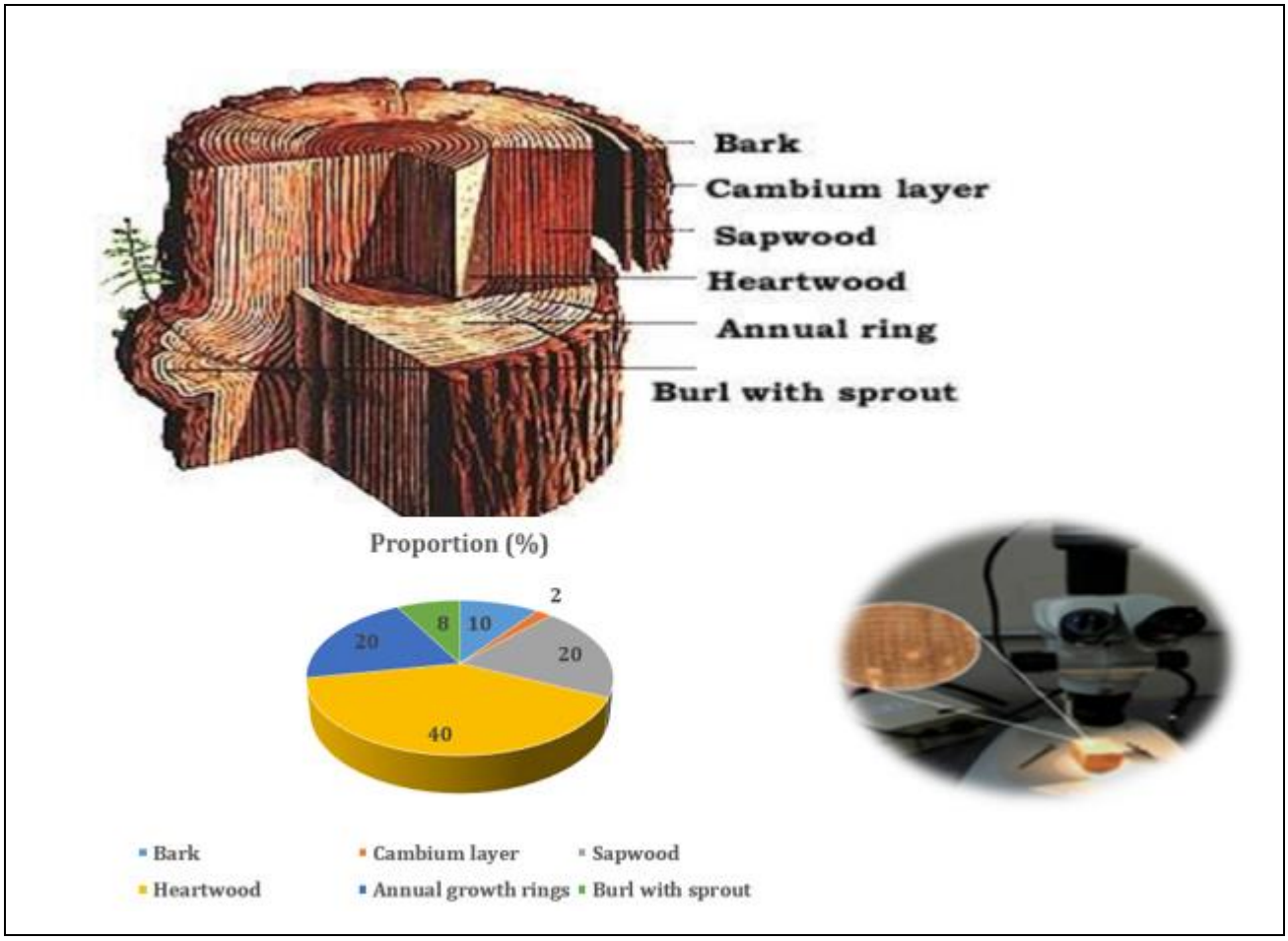
Points to Remember

Fill laboratory format sheet reflect the following points:

- Title
- Introduction
- Methods and Materials
- Results
- Discussion
- Conclusion
- References

N/S	Parts of format sheet	Description
1	Title	
2	Introduction	
3	Methods and Materials	
4	Results	
5	Discussion	
6	Conclusion	
7	References	

Learning Unit 4: Interpret the laboratory data



Structure of learning unit 4

Learning outcomes:

4.1: Consult standard norms
4.2: Compare the laboratory result to the standard norms
4.3: Conclude the test results

Learning outcome 4.1: Consult standard norms

Duration: 3 hours

Objectives of Learning outcome 4.1

By the end of the learning outcome, the trainees will be able to:

1. Define correctly the standards norms used in laboratory analysis of wood.

2. Identify correctly different types of standards norms used in wood laboratory analysis.

3. Analyse correctly laboratory data using descriptive statistics.

Resources

Equipment	Tools	Materials
1. Moisturemeter **2.** Microscope **3.** Electric furnace **4.** Chainsaw **5.** Thermometer **6.** Hygrometer **7.** Electronic balance **8.** Audio visual equipment **9.** Oven **10.** Relascope **11.** Computer **12.** Projector **13.** PPE	**1.** Knife **2.** Axe **3.** Panga **4.** Handsaw **5.** Tape measures **6.** Thermal conductivity meter.	**1.** Wood samples **2.** Pencils **3.** Plastic bags **4.** Papers **5.** Notebooks **6.** Water **7.** Chalk **8.** Wood sample containers **9.** Wooden wedges **10.** Forest stand **11.** Bath or volumetric tank

Advance preparation:

Before starting the session delivery,

- ✓ Avail wood laboratory
- ✓ There should be availability of required resources as listed above depending on their necessity
- ✓ Learning place should be made ready,
- ✓ Facilitation techniques should be though about depending on the size of the class, the number of learners, the category of learners, and available learning resources

Indicative content 4.1.1: Description of standards norms

Description of standard norms:

ASTM's wood standards are instrumental in the evaluation and testing of the physical and chemical properties of a wide range of wood and wood-based products. Wooden materials covered here include timber, lumber, wood-base fibers, commercial softwoods and hardwoods, wood preservatives, laminated timber, and composite lumber to name a few. These materials are notably used in the fabrication of

construction materials such as structural panels and members, construction poles, and log buildings. These wood standards are helpful in guiding wooden material and product manufacturers and end-users in their proper testing and fabrication procedures to ensure acceptable quality towards safe and satisfactory use.

Theoretical learning Activity:

- Discuss about standards norms referred to when carrying out laboratory analysis of wood sample.

Practical learning Activity

- In groups of two analyse wood sample by referring to standard norms.

Points to Remember

Standard norms to refer to when analysing wood sample in the laboratory.

Indicative content 4.1.2: Types of standards norms

Different types of standard norms:

1. Modulus of rupture:

Modulus of rupture is the maximum load carrying capacity of a wood sample. It is generally used in tests of bending strength to quantify the stress required to cause breakage. (Test Method: IS: 1734 (P-11)1983, RA-2003, IS: 1708 (P-5) 1985)

2. Modulus of elasticity:

This test helps in determining the flexural stiffness and modulus of elasticity properties of wood-based materials by nondestructive testing using transverse vibration in the vertical direction. (Test Method: IS: 1734 (P-11)1983, RA-2003, IS: 1708 (P-5)1985)

3. Internal bond strength:

The purpose of this test is to design a compression shear device for easy and fast measurement of the bond shear strength of wood-based materials. (Test Method: IS: 1734 (P-1) 1983, RA-2003)

4. Moisture Content Test:

This test helps in determining the moisture content (MC) of solid wood, veneer, and other wood-based materials, including those that contain adhesives and chemical additives. (Test Method: IS: 1734 (P-1) 1983, RA-2003)

5. Density Test:

Analyzing tree density can serve great ecological and scientific function. These tools are easy to understand and eliminate the risk of damage done to tree specimens. (Test Method: 1708 (P-2)1986, RA-2008)

6. Bending Strength Test:

In bending, it is assumed that wood is linearly elastic for low values of stress, i.e., the stress and strain are proportional to each other and the output on stress-strain curve is either an elastic or straight-line plot. (Test Method: IS: 1734 (P-11) 1983)

7. Absorbability Test:

This test helps in determining the quantity of water absorbed in a specified time through the surface of an overlaid wood-based panel. The test method measures the rate of water weight gain within a controlled surface area of the overlaid panel surface when exposed to standing water. (Test Method: ASTM D 5795.)

8. Wood Quality Test:

This test helps in determining the quality of wood. The kind of wood that is used has a lot of bearing on the lifespan of any furniture. It may be made of hardwood, softwood, or engineered wood. (Test Method: IS: 4020 (P-4)1998)

Theoretical learning Activity:

- Discuss about types standards norms referred to when carrying out laboratory analysis of wood sample.

Practical learning Activity

- In groups of two analyse wood sample by referring to different types of standard norms.

Points to Remember

Types of standard norms.

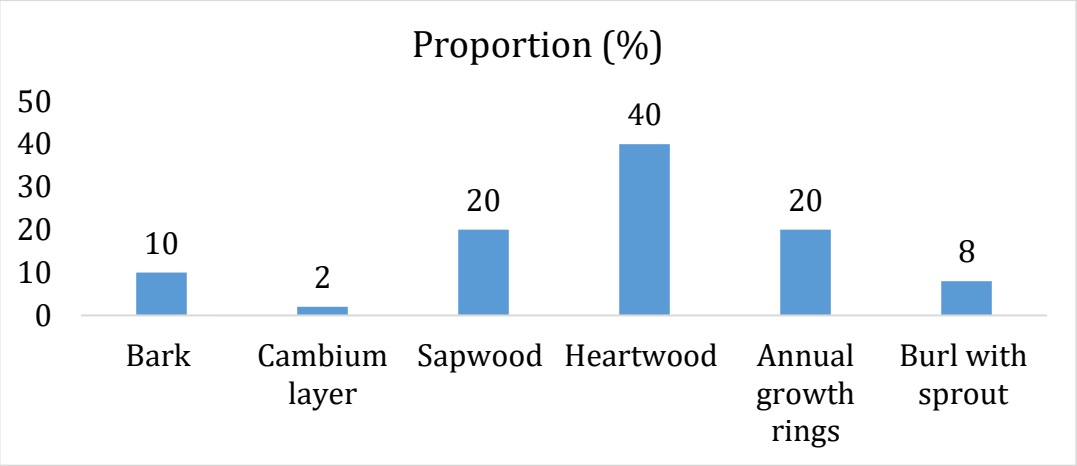
1. Modulus of rupture:
2. Modulus of elasticity:
3. Internal bond strength:
4. Moisture Content Test:
5. Density Test:
6. Bending Strength Test:
7. Absorbability Test:
8. Wood Quality Test:

Indicative content 4.1.3: Laboratory data analysis:

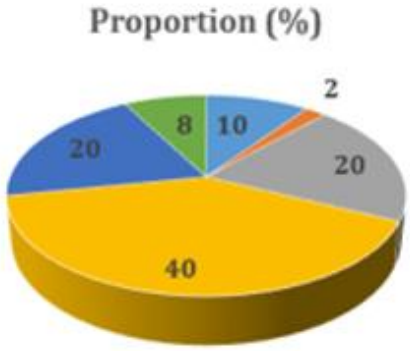
Analysis of laboratory data:

Descriptive statistics:

- **Graphs:** Graphical Representation is a way of analysing numerical data. It exhibits the relation between data, ideas, information and concepts in a diagram. It is easy to understand and it is one of the most important learning strategies.



- Pie-charts: Pie charts make sense to show a parts-to-whole relationship for categorical or nominal data. The slices in the pie typically represent percentages of the total. With categorical data, the sample is often divided into groups and the responses have a defined order.



- **Tables:** In tabular representation of data, the given data set is presented in rows and columns. When a table is used to represent a large amount of data in an arranged, organised, engaging, coordinated and easy to read form it is called the tabular representation of data.

Parts of wood	Proportion (%)
Bark	10
Cambium layer	2
Sapwood	20
Heartwood	40
Annual growth rings	20
Burl with sprout	8
Total	100

Theoretical learning Activity:

- Discuss about types standards norms referred to when carrying out laboratory analysis of wood sample.

Practical learning Activity

- In groups of two analyse wood sample by referring to different types of standard norms. .

Points to Remember

Laboratory analysis.

Data representation in the following three form: graphs, pie-chart and table form

Learning outcome 4.2: Compare the laboratory result to the standard norms

Duration: 4 hours

Objectives of Learning outcome 4.2

By the end of the learning outcome, the trainees will be able to:

1. Apply correctly four methods of data comparison in laboratory analysis of wood.

2. refer correctly standards norms in wood laboratory analysis.

Resources

Equipment	Tools	Materials
1. Moisturemeter **2.** Microscope **3.** Electric furnace **4.** Chainsaw **5.** Thermometer **6.** Hygrometer **7.** Electronic balance **8.** Audio visual equipment **9.** Oven **10.** Relascope **11.** Computer **12.** Projector **13.** PPE	**1.** Knife **2.** Axe **3.** Panga **4.** Handsaw **5.** Tape measures **6.** Thermal conductivity meter.	**1.** Wood samples **2.** Pencils **3.** Plastic bags **4.** Papers **5.** Notebooks **6.** Water **7.** Chalk **8.** Wood sample containers **9.** Wooden wedges **10.** Forest stand **11.** Bath or volumetric tank

Advance preparation:

Before starting the session delivery,

- ✓ Avail wood laboratory
- ✓ There should be availability of required resources as listed above depending on their necessity
- ✓ Learning place should be made ready,
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Indicative content 4.2.1: Data comparison methods:

Comparison methods of data analysis:

- **Data presentation mean:**

The mean (average) of a data set is found by adding all numbers in the data set and then dividing by the number of values in the set.

- **Data correlation:**

  Correlation is a statistical measure that expresses the extent to which two variables are linearly related (meaning they change together at a constant rate). It's a common tool for describing simple relationships without making a statement about cause and effect. E.g: correlation between density and hardness of wood.

- **Data discussion:**

  What is data discussion? The discussion section links the results of your research to the conclusions you are drawing, explaining how you use your data to explain your results. Before you present your data, you should explain again, very briefly, the purpose and scope of your research study.

- **Regression:**

  Formulating a regression analysis helps you predict the effects of the independent variable on the dependent one. Example: we can say that age and height can be described using a linear regression model. Since a tree's height increases as age increases, they have a linear relationship.

Theoretical learning Activity:

- Discuss about different methods of data analysis.

Practical learning Activity

- In groups of two describe 4 method of data analysis of wood sample by referring to standard norms.

Points to Remember

Comparison methods applied during data analysis:

- Data presentation mean or average
- Data correlation shows relationship between variables
- Data discussion before you draw a conclusion for presentation
- Regression show the relationship between dependent variable and independent variables.

Indicative content 4.2.2: Laboratory standard norms

Laboratory standards norms:

- **Fixed location:** everything should have a dedicated location and not "wander".
- **Fixed item:** a place for everything, and everything in its place.
- **Fixed quantity:** only a pre-determined amount of items can be stored; no mound-hills are allowed.
- **Emergency equipment:** available and visible.
- **Personal protective equipment:** must be available in the laboratory.
- **Waste management:** availability of chemical waste disposal mechanism.

Theoretical learning Activity:

- Discuss about standards norms referred to during data analysis of wood sample.

Practical learning Activity

- In groups of two identify standard norms referred to when carrying laboratory analysis of wood samples.

Points to Remember

Standard norms to refer to during data analysis of wood sample:

- Fixed location

- Fixed item
- Fixed quantity
- Emergency equipment
- Personal protective equipment
- Waste management

Learning outcome 4.3: Conclude the test results

Duration: 3 hours

Objectives of Learning outcome 4.3

By the end of the learning outcome, the trainees will be able to:

1. Conclude appropriately wood laboratory analysis procedures.

2. Identify correctly two elements of conclusion in wood laboratory analysis.

3. Describe appropriately indication data of wood laboratory analysis.

Resources

Equipment	Tools	Materials
1. Moisturemeter **2.** Microscope **3.** Electric furnace **4.** Chainsaw **5.** Thermometer **6.** Hygrometer **7.** Electronic balance **8.** Audio visual equipment **9.** Oven **10.** Relascope **11.** Computer **12.** Projector **13.** PPE	**1.** Knife **2.** Axe **3.** Panga **4.** Handsaw **5.** Tape measures **6.** Thermal conductivity meter.	**1.** Wood samples **2.** Pencils **3.** Plastic bags **4.** Papers **5.** Notebooks **6.** Water **7.** Chalk **8.** Wood sample containers **9.** Wooden wedges **10.** Forest stand **11.** Bath or volumetric tank

Advance preparation:

Before starting the session delivery,

- ✓ Avail wood laboratory
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✓ Facilitation techniques should be though about depending on the size of the class, the number of learners, the category of learners, and available learning resources

Indicative content 4.3.1: Concluding procedures

Procedure of conclusion

When writing a conclusion you should: briefly restate the purpose of the experiment (i.e. the question it was seeking to answer) identify the main findings (i.e. the answer to the research/analysis question) note the main limitations that are relevant to the interpretation of the results.

Theoretical learning Activity:

- Discuss about conclusion procedures of wood sample during laboratory analysis.

Practical learning Activity

- In groups of two describe conclusion procedures of data analysis of wood sample.

Points to Remember

Conclusion procedures of wood sample during laboratory analysis.

Indicative content 4.3.2: Elements of conclusion

Elements of conclusion:

A conclusion paragraph contains a description of the purpose of the experiment, a discussion of your major findings, an explanation of your findings, and recommendations for further study.

Theoretical learning Activity:

- Discuss about element of conclusion about wood sample during laboratory analysis.

Practical learning Activity

- In groups of two identify element of conclusion about laboratory analysis of wood sample.

Points to Remember

Elements of conclusion about wood sample during laboratory analysis.

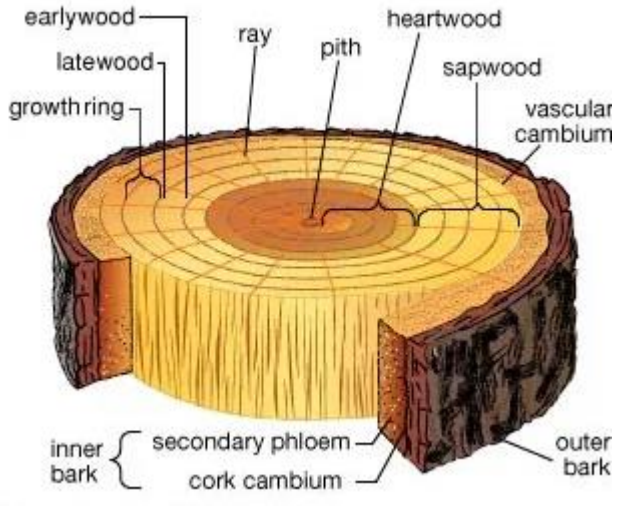
- Purpose of experiment about wood sample
- Discussion about findings
- Explanation about findings
- Recommendation for further study

Indicative content 4.3.3: Indication of data:

Indication of data:

wood, Hard, fibrous material formed by the accumulation of secondary xylem produced by the vascular cambium. It is the principal strengthening tissue found in the stems and roots of trees and shrubs. Wood forms around a central core (pith) in a series of concentric layers called growth rings.

A cross section of wood shows the distinction between heartwood and sapwood. Heartwood, the central portion, is darker and composed of xylem cells that are no longer active in the life processes of the tree.



(**Picture:** cross section of wood)

- **Wood structure:** is arrangement of wood components that can be observed in cross section on a wood material as it is observed on the above picture.
- **wood texture:** The term texture describes the degree of uniformity of appearance of a wood surface, usually transverse. Grain is often used synonymously with texture, as in coarse, fine, or even texture or grain, and also to denote direction of wood elements, whether straight, spiral, or wavy, for example.

Theoretical learning Activity:

- Discuss about indication of data of wood sample during laboratory analysis.

Practical learning Activity

- In groups of two identify indication data of laboratory analysis of wood samples.

Points to Remember

Indication data of wood sample during laboratory analysis.

- Wood structure,
- wood texture

Reference books:

1. Brian Porter. 2002, Carpentry and Joinery, third edition, Elsevier.

2. George Mitchell, 1997, Carpentry and Joinery, second edition, Wellington House.

3. ShrivastavaMB, 1997, Wood Technology, Vikas Publishing House PVT L