Unit D: Forest Products

Lesson 2: Understanding the Characteristics of Wood

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. Describe the chemical characteristics of wood.
2. Describe the physical characteristics of wood.
3. Identify hardwoods and softwoods according to wood characteristics.

Recommended Teaching Time: 2 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has also been developed with use of this lesson plan
- http://www.woodbin.com/ref/wood/
- http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr113/ch01.pdf
- http://pages.swcp.com/~awa/characteristics_of_wood.htm

List of Equipment, Tools, Supplies, and Facilities

Writing surface
PowerPoint Projector
PowerPoint slides
Transparency Masters
Lab Sheets
wood samples: hardwoods and softwoods
metric ruler
balance or scale
graduated cylinder

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide #2 and #3):

- Bound water
- Cellulose
- Diffuse-porous
- Extractives
- Fiber saturation point
- Free water
- Hardwoods
- Lignin
- Medullary rays
- Middle lamella
- Moisture content
- Parenchyma cells

- Resin
- Resin ducts/canals
- Ring-porous
- Softwoods
- Specific gravity
- Tracheids
- Tyloses
- Wood fibers

Interest Approach: Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Have different samples of hardwoods and softwoods for student observation. Ask students to identify characteristics of each type of wood. Lead a class discussion on the characteristics of wood. Direct the conversation towards the introduction of the lesson.

Summary of Content and Teaching Strategies

Objective 1: Describe the chemical characteristics of wood.

(PowerPoint Slide #4)

I. Wood is often thought of as the hard, fibrous substance that forms the greatest part of the stems and branches.

(PowerPoint Slide #5)

A. There are several chemical properties of wood.

1. Wood is made up of about 50 percent cellulose, 28 percent lignin, and minor quantities of other materials.

(PowerPoint Slide #6)

a. Cellulose and lignin are responsible for some of the properties of a wood, such as the wood's ability to absorb moisture and its resistance to corrosion by salt water.

1. Hardwoods have less lignin than softwoods.

(PowerPoint Slide #7)

b. ***Cellulose*** forms the framework of the cell walls and is the product used in the manufacture of paper.

c. ***Lignin*** is the cementing material that binds the cells together and is also found mixed with cellulose in the cell walls. When the lignin is dissolved with chemicals, the cells may be separated for papermaking.

(PowerPoint Slide #8)

d. Characteristics like color, odor, and natural resistance to decay cannot be attributed to cellulose or lignin, but rather to other materials in the wood.

Objective 2: Describe the physical characteristics of wood.

(PowerPoint Slide #9)

II. Wood is indispensable in our everyday lives, and many products are derived from trees.

(PowerPoint Slide #10)

A. There are several physical characteristics of wood.

1. The relationship between moisture and wood is very important in understanding wood behavior. The wood-water relationship causes most of the problems in using wood products.

(PowerPoint Slide #11)

a. Nearly all wood properties are affected by the amount of water in wood. The amount of water in wood is affected by changes in temperature and humidity.

(PowerPoint Slide #12)

b. The water found in wood originates in the living tree. When a tree is harvested, most of the cells still contain a high percentage of water. The water in wood is found in two areas.

(PowerPoint Slide #13)

1. Water contained in the cell wall is called ***bound water*** and the bond formed with the cell wall is not easily removed.

a. Heat must be used to remove bound water. Bound water is the last to leave the wood when a wet piece of wood is dried.

(PowerPoint Slide #14)

2. Water contained in the cell cavity is called ***free water***. Free water is the first to be removed.

(PowerPoint Slide #15)

3. The ***fiber saturation point*** is reached when there is no free water in the cell cavity and any remaining water is in the cell wall.

a. Wood reaches the fiber saturation point when the cell wall contains 20 to 30 percent water.

(PowerPoint Slide #16)

b. Sometimes the amount of water varies because of the amount of extractives in the cell wall. Extractives tend to bond to the same sites as does water.

(PowerPoint Slide #17)

1. ***Extractives*** are organic, non-wood substances that give color, odor, or other characteristics to wood. Their presence may or may not affect the amount of water in the wood.

(PowerPoint Slide #18)

c. The ***moisture content*** of wood is a measure of the amount of water contained in the wood. Moisture content is the weight of water in a wood sample expressed as a percentage of the dry wood weight.

(PowerPoint Slide #19)

d. Shrinking and swelling of wood occur as a result of changing moisture content within wood.

1. Shrinking does not occur until the fiber saturation point is reached.

(PowerPoint Slide #20)

Shrinkage will occur until all water is removed, or the moisture content is 0 percent.

2. Shrinkage and swelling are important because dimensional changes in wood often cause structural and appearance problems.

(PowerPoint Slide #21)

2. Woods can be divided into two groups: those without pores (non-porous) and those with pores (porous).

(PowerPoint Slide #22 shows an example of porous and non-porous wood)
(PowerPoint Slide #23)

a. The porous woods are further divided into ring-porous and diffuse-porous.

1. ***Ring-porous*** woods have larger pores found in the springwood and smaller pores found in the summerwood.

(PowerPoint Slide #24)

2. ***Diffuse-porous*** woods have rather small and evenly scattered pores throughout both the springwood and the summerwood.

3. The weight of wood is usually expressed in terms of weight per cubic foot or weight per thousand board feet.

(PowerPoint Slide #25)

a. Since wood readily absorbs moisture, its weight depends on two factors: the weight of the wood material and the moisture retained in the wood.

(PowerPoint Slide #26)

b. When the moisture content of wood changes, the weight and the dimensions of the wood also change. A more practical way of expressing the weight of wood in relation to its moisture content is in terms of its specific gravity.

(PowerPoint Slide #27)

1. ***Specific gravity*** is the ratio of the weight of an oven-dried volume of wood to the weight of the same volume of water.

a. If a specific gravity of a wood is expressed 0.66, it means that a given volume of this wood weighs 0.66 times as much as an equal volume of water.

(PowerPoint Slide #28)

2. Specific gravity provides a relative measure of the amount of wood material contained in a sample of wood.

(PowerPoint Slide #29)

3. Specific gravity of wood is largely influenced by: the amount of gum, resins, and other extractives in the wood; the size of the wood's cell cavities; and, the thickness of the wood's cell walls.

(PowerPoint Slide #30)

4. The basis for specific gravity is generally the dry weight and volume at a moisture content of 12 percent.

(PowerPoint Slide #31)

4. In the manufacturing of furniture it is sometimes necessary to bend wood. Some hardwoods are more readily softened by heat and moisture for bending than are other hardwoods.

a. A variety of chemicals are used to aid in the bending of wood. Urea, dimethyl sulfoxide, and liquid ammonia are a few.

(PowerPoint Slide #32)

5. Other physical properties of wood.

a. ***Resin ducts or canals***, found in pine, are intercellular passages surrounded by resin-secreting cells. The ducts are often filled with resin. ***Resin*** is a vegetable substance secreted by certain plants and trees and is a characteristic of coniferous trees.

(PowerPoint Slide #33)

b. Properties such as color, luster, taste, hardness, odor, and texture are important in wood identification.

(PowerPoint Slide #34 shows a list of properties mentioned above. Review these with the class, and discuss how these properties are used.)
(PowerPoint Slide #35)

c. Properties such as weight, strength, stiffness, bending and woodworking qualities, hardness, durability, permeability to staining and shrinkage are among the most important characteristics to someone using wood.

****Use TM: D2-1, TM: D2-2, and TM: D2-3 or PowerPoint Slide #36 as material for lecture and discussion.**

Objective 3: Identify hardwoods and softwoods according to wood characteristics.

(PowerPoint Slide #37)

III. Trees are divided into two classes: ***hardwoods***, which have broad leaves, and ***softwoods***, which have needlelike leaves or scale leaves and are called conifers.

(PowerPoint Slide #38)

A. No degree of hardness divides the hardwoods from the softwoods. Some hardwoods are soft and some softwoods are hard.

1. The term softwood originated in New England, where the loggers applied it to the light wood of white pine, a conifer. The term was applied to all conifers, regardless of their wood density.

(PowerPoint Slide #39)

2. Hardwood was the term given to hard maple, a dense wood, and there after to all deciduous species.

(PowerPoint Slide #40)

3. Wood can readily be identified as a hardwood or softwood by the presence or absence of pores when viewed in a transverse section.

a. If no pores are present, the section is a softwood.

(PowerPoint Slide #41)

Pines show small, fairly evenly distributed resin ducts on a transverse surface. Resin ducts should not be confused with the pores in hardwoods. The pores in hardwoods are closer together than are the resin ducts in softwoods.

(PowerPoint Slide #42)

4. When the wood from a conifer is viewed from the top, in transverse section, ***tracheids*** or water carriers, form the bulk of the wood surface.

(PowerPoint Slide #43)

a. Between the various cells is a cementing substance called the ***middle lamella***. Springwood (formed in the spring) cells are distinguished by their larger size from the smaller summerwood (formed in the summer) cells.

(PowerPoint Slide #44 shows a hardwood sample.)
(PowerPoint Slide #45)

Together the springwood and summerwood cells make up the annual ring, which is added to the tree each year.

1. Certain chemicals can be used to dissolve the middle lamella, remitting the fibers to be separated. A process used in making paper.

b. When the wood is viewed in a vertical plane, ***medullary rays*** will be seen and their function is to store food and distribute it horizontally. There are two types of rays: fusiform medullary rays and rays with horizontal resin ducts.

(PowerPoint Slide #46)

c. Softwoods use fibers to transfer sap. Simple pits are unthickened portions of cell walls through which sap passes from ray cells to fibers, or vice versa. Bordered pits on the surface have their margins overhung by the surrounding cell walls.

(PowerPoint Slide #47)

5. Hardwoods have specialized pores or vessels for conducting sap. The pores in hardwoods vary in size depending on the species. Some are visible to the naked eye.

(PowerPoint Slide #48)

a. Hardwood vessels are cells with open ends, one above the other, and continuing as open passages for long distances.

(PowerPoint Slide #49)

In the heartwood and sapwood of some species, the pores are filled with ***tyloses***, which is an organic material that is extruded into tracheids and pores of trees from adjacent parenchyma cells. ***Parenchyma cells*** are thin-walled structures that participate in the metabolism and storage of sugars.

(PowerPoint Slide #50)

b. The strength giving elements of hardwood are called ***wood fibers***. Usually wood fibers have small cavities and thick walls. In the fiber walls are found pits by which the sap passes from one cavity to another.

****Use TM: D2-4 and TM: D2-5 as material for lecture and discussion. Have students complete LS: D2-1 to get a better understanding of the objectives.**

Review/Summary: Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. The objectives listed on PowerPoint Slide #51 can also be used as review.

Application: Students will be able to apply skills learned in LS: D2–1

Evaluation: Use the following sample test to evaluate the students' comprehension of the material covered in this lesson.

Answers to Sample Test:

Part One: Matching

1. j
2. h
3. d
4. l
5. g
6. b
7. f
8. c
9. a
10. e

Part Two: Completion

1. board feet
2. pores
3. cellulose
4. moisture content
5. resin,
6. 20, 30
7. lignin

Part Three: Short Answer

1. color, luster, taste, hardness, odor, and texture
2. the weight of the wood material, the moisture retained in the wood
3. weight, strength, stiffness, bending and woodworking qualities, hardness, durability, permeability to staining and shrinkage

Sample Test Name_____

Test

Unit D Lesson 2: Understanding the Characteristics of Wood

Part One: Matching
Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. bound water
b. diffuse-porous
c. fiber saturation
d. free water
e. hardwoods
f. medullary rays
g. middle lamella
h. parenchyma cells
i. softwoods
j. specific gravity

_____ 1. Ratio of the weight of an oven-dried volume of wood to the weight of the same volume of water.
_____ 2. Thin-walled structures that participate in the metabolism and storage of sugars.
_____ 3. Water contained in the cell cavity.
_____ 4. Have needlelike leaves or scale leaves.
_____ 5. Between the various cells is a cementing substance.
_____ 6. Wood with rather small, evenly scattered pores throughout the springwood and summerwood.
_____ 7. Function is to store food and distribute it horizontally.
_____ 8. Point reached when there is no free water in the cell cavity and any remaining water is in the cell wall.
_____ 9. Water contained in the cell wall.
_____ 10. Have broad leaves.

Part Two: Completion
Instructions. Provide the word or words to complete the following statements.

1. The weight of wood is usually expressed in terms of weight per cubic foot or weight per thousand _____.

2. Wood can readily be identified as a hardwood or softwood by the presence or absence of _____ when viewed in a transverse section.

3. The framework of the cell walls and the product used in the manufacture of paper is known as _____.

4. The weight of water in a wood sample, expressed as a percentage of the dry wood weight is called _____.

5. A vegetable substance secreted by certain plants and trees, characteristic of coniferous trees is called _____.
6. Wood reaches the fiber saturation point when the cell wall contains _____ to _____ percent water.

7. _____ is the cementing material that binds the cells together and is found mixed with cellulose in the cell walls.

Part Three: Short Answer
Instructions. Provide information to answer the following questions.

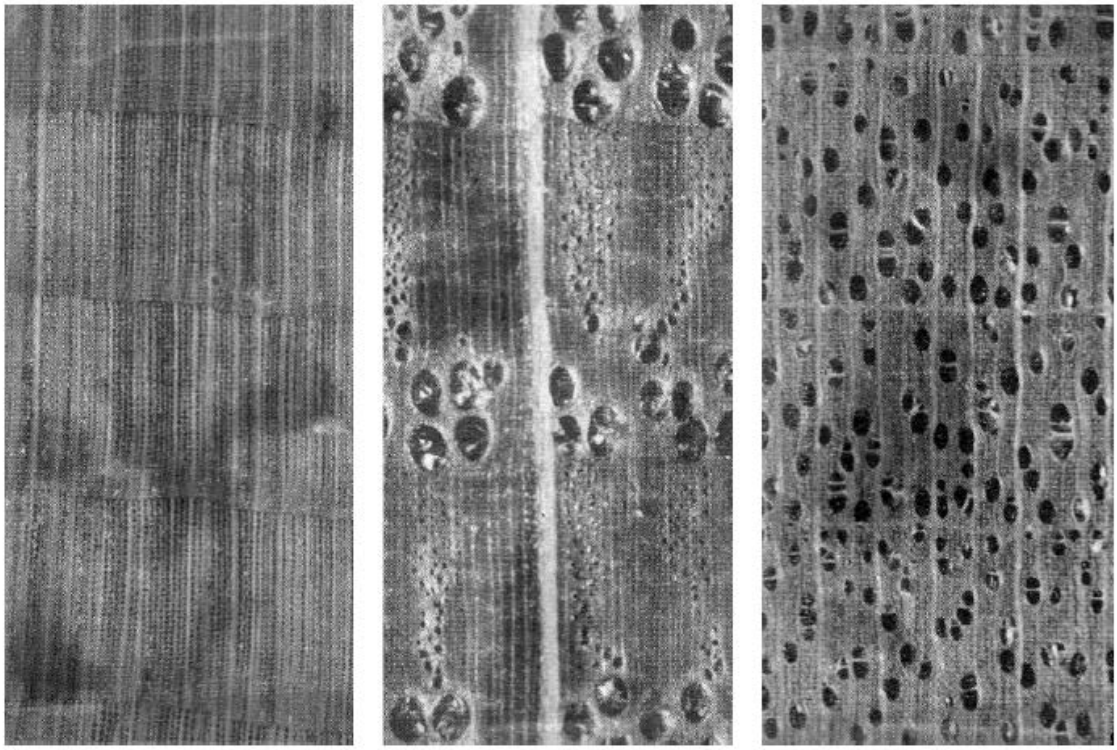
1. What properties are important in wood identification?

2. Since wood readily absorbs moisture, its weight depends on two factors. What are those two factors?

3. What properties are among the most important characteristics to someone using wood?

TM: D2-1

POROUS AND NON-POROUS WOODS



TM: D2-2

PROPERTIES OF COMMON WOODS

Properties for wood identification:

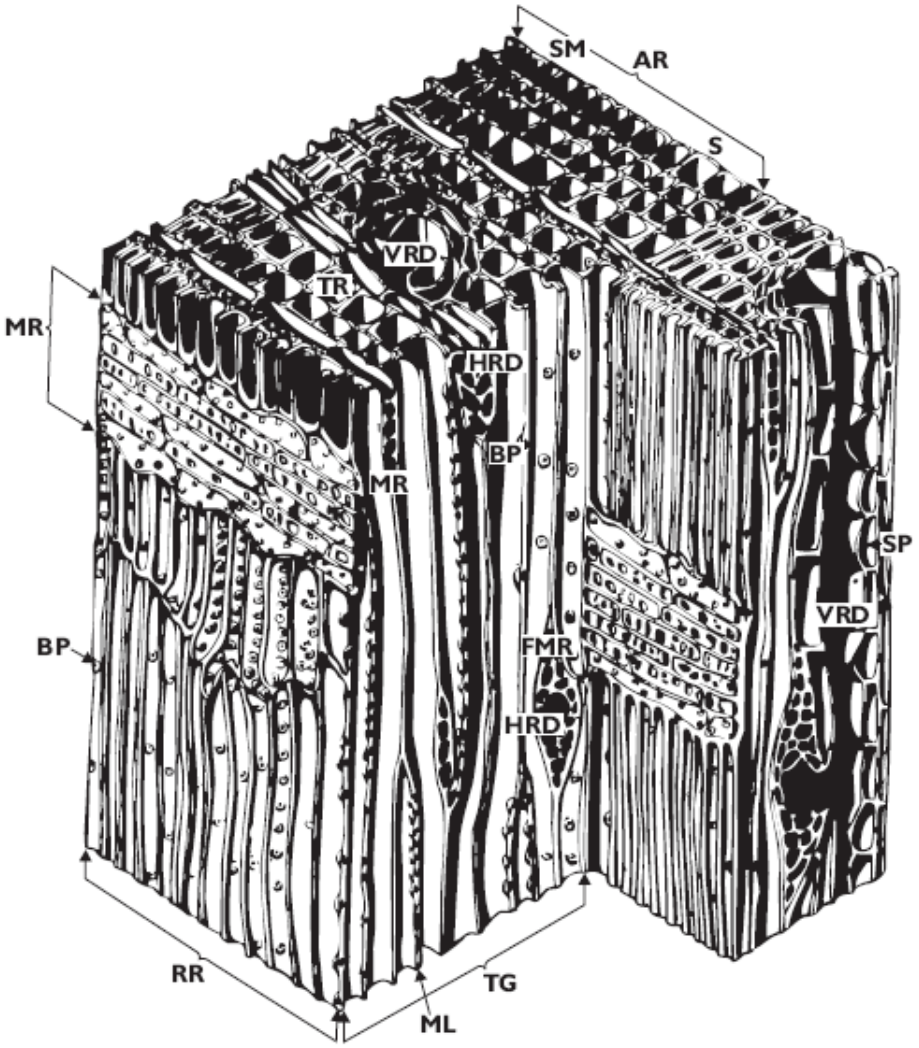
- color
- luster
- taste
- hardness
- odor
- texture

Properties important for wood use:

- weight
- strength
- stiffness
- bending
- woodworking qualities
- hardness
- durability
- permeability to staining and shrinkage

TM: D2-3

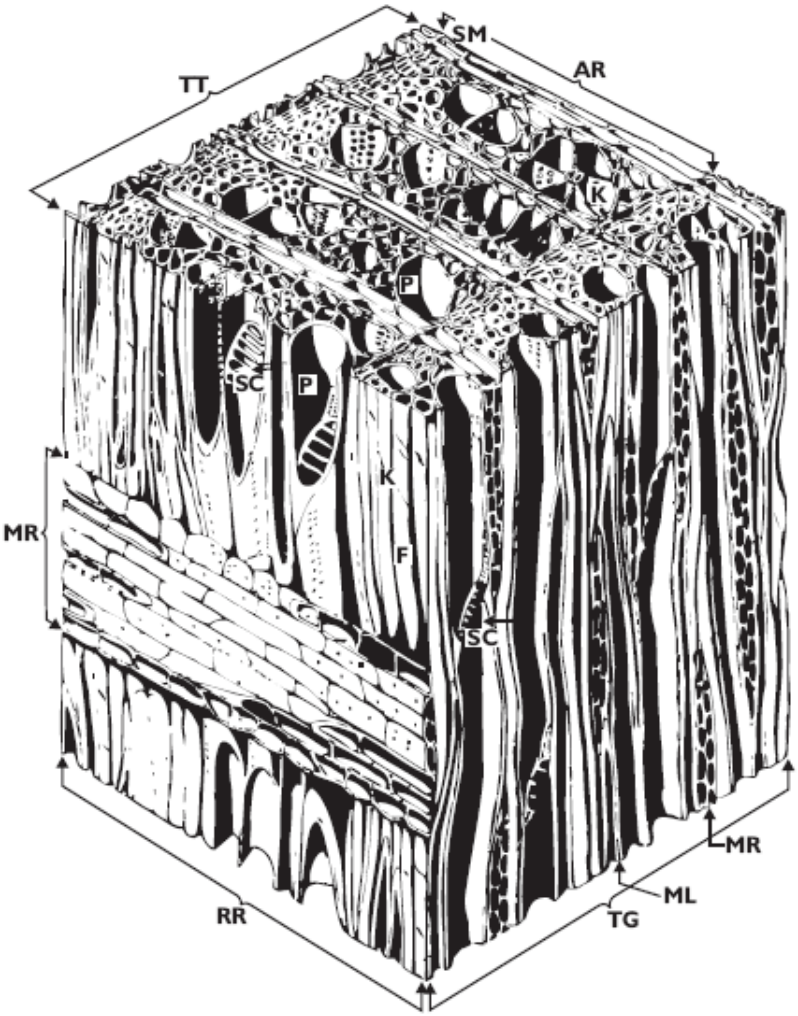
SOFTWOOD CROSS-SECTION



AR = annual ring
BP = bordered pits
FMR = fusiform medullary rays
HRD = rays with horizontal resin ducts
ML = middle lamella
MR = medullary rays
RR = endgrain
S = springwood cells
SM = summerwood cells
SP = simple pits
TG = surface of wood sample
TR = tracheids
VRD = vertical resin duct

TM: D2-4

HARDWOOD CROSS-SECTION



LS: D2-1 Name_____

Lab Sheet

Wood Density

Equipment:
wood samples: hardwoods and softwoods
metric ruler
balance or scale
graduated cylinder

Procedure:

Part A
1) Use a metric ruler to find the length, width, and height of a block of wood. Measure in centimeters.
2) Record data in a chart.
3) Calculate the block's volume. Volume equals length X height X width and volume units are expressed as cubic units.
4) Use a balance or scale to find the mass in grams of the block and record this value.
5) Calculate the density of the wood. Density equals mass divided by volume and units used to express density are g/cm^3.
6) Repeat steps 1–5 for a block of different type of wood.

Part B
1) Obtain a piece of wood dowel.
2) Determine its mass in grams. Record this value in a chart.
3) Determine its volume. Because its shape is irregular, you cannot measure it with a metric ruler. Use a technique for determining volume called water displacement.
    a) Fill a graduated cylinder to the 100 ml mark with water.
    b) Drop the wood dowel into the cylinder, and hold below the water level with the end of a pencil. Reread the new volume.
    c) Subtract the original volume (100 ml) from this new volume and record this number as the volume for the wood dowel. Use ml units.
4) Calculate the density of the piece of wood. Record this value using the units for density as g/ml.