Lesson B4–2

Understanding the Characteristics of Wood

Unit B. Plant Wildlife Management

Problem Area 4. Forest Products

Lesson 2. Understanding the Characteristics of Wood

New Mexico Content Standard:

Pathway Strand: Natural Resources and Environmental Systems

Standard: **III:** Apply scientific principles to natural resource management activities.

Benchmark: **III-B:** Examine biological and physical characteristics to identify and classify natural resources.

Performance Standard: **1.** Identify tree species and other woody vegetation.

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.

List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Rolfe, Gary L., Edgington, John M., Holland, I, Irving, and Fortenberry, Gayle C. *Forests and Forestry*. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2003. (Textbook Chapter 2 & 9).

Lee, Jasper S. *Natural Resources and Environmental Technology*. Upper Saddle River, New Jersey: Prentice Hall Interstate, 2000. (Textbook Chapter 9).

Other Resources. The following resources will be useful to students and teachers:

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheets
Samples of hardwoods and softwoods

Terms. The following terms are presented in this lesson (shown in bold italics):

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.

Anticipated Problem: What are the chemical characteristics of wood?

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

   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.

         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.

         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.

         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.

Use text material to strengthen student understanding of concepts. Chapter 9 and 10 in Forests and Forestry, and Chapter 9 in Natural Resources and Environmental Technology are recommended.

Objective 2: Describe the physical characteristics of wood.

Anticipated Problem: What are the physical characteristics of wood?

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

   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.

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.

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.

    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.

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

    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.

        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.

            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.

        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.

        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. 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.

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

        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.

            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.

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.
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.
    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.
    2. Specific gravity provides a relative measure of the amount of wood material contained in a sample of wood.
    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.
    4. The basis for specific gravity is generally the dry weight and volume at a moisture content of 12 percent.

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.
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.
    b. Properties such as color, luster, taste, hardness, odor, and texture are important in wood identification.
    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: B4–2A, TM: B4–2B, and TM: B4–2C as material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 9 and 10 in Forests and Forestry, and Chapter 9 in Natural Resources and Environmental Technology are recommended.

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

Anticipated Problem: What are the characteristics of hardwoods and softwoods?

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.

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.
2. Hardwood was the term given to hard maple, a dense wood, and there after to all deciduous species.
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. Pines show small, fairly evenly distributed resin ducts on a transverse surface. Resin dust should not be confused with the pores in hardwoods. The pores in hardwoods are closer together than are the resin ducts in softwoods.
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.
   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. 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.
   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.
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.
   a. Hardwood vessels are cells with open ends, one above the other, and continuing as open passages for long distances. 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.

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: B4–2D and TM: B4–2E as material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Chapter 1, 9 and 10 in Forests and Forestry, and Chapter 9 in Natural Resources and Environmental Technology are recommended.

Review/Summary.

Application.

Lab Sheet B4–2A

Evaluation.

Answers to Sample Test:

Part One: Matching

1=j, 2=h, 3=d, 4=I, 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

Lesson B4–2: 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.

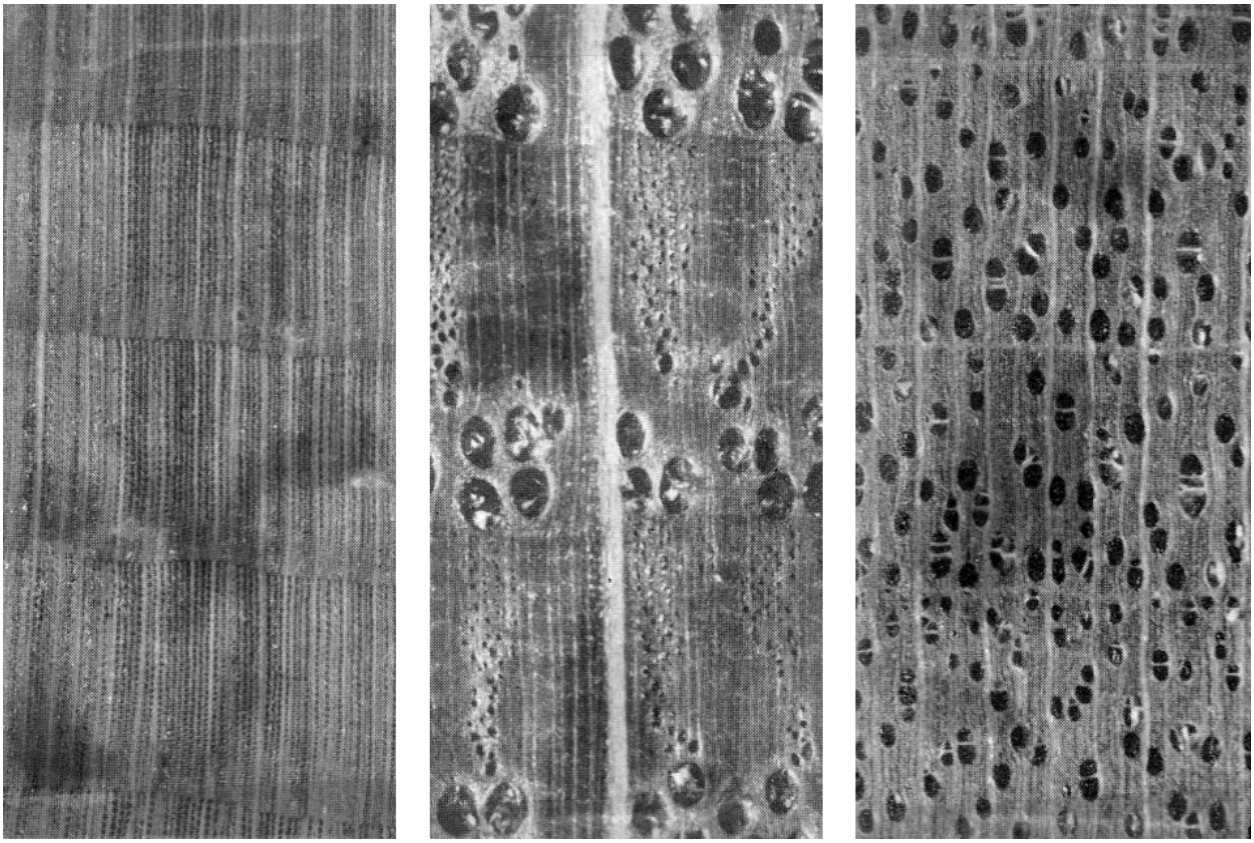
1. What properties are important in wood identification?

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: B4–2A

POROUS AND NON-POROUS WOODS



TM: B4–2B

PROPERTIES OF COMMON WOODS

Properties for wood identification:

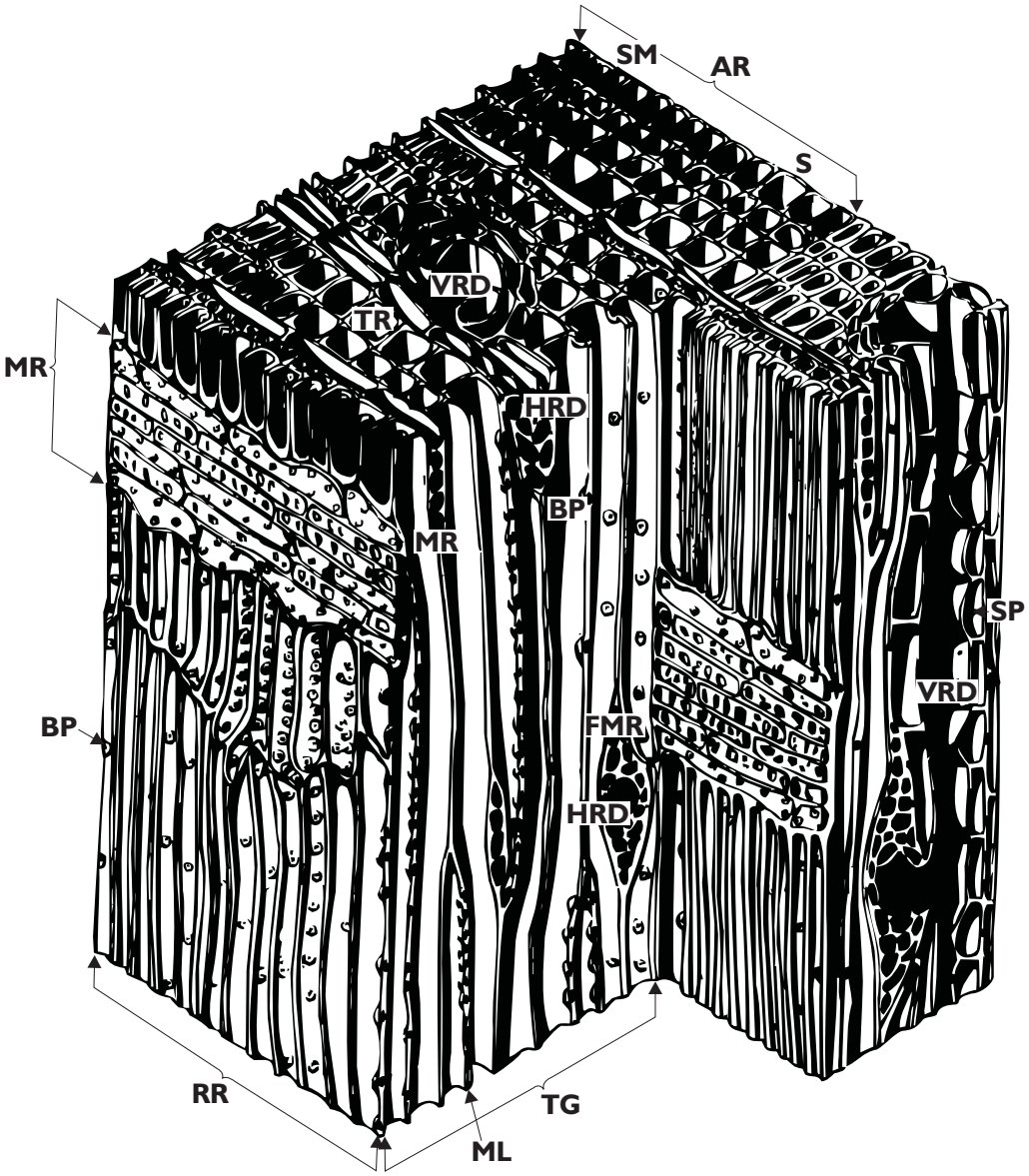
- color
- luster
- taste
- hardness
- odor
- texture

Properties important for wood use:

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

TM: B4–2C

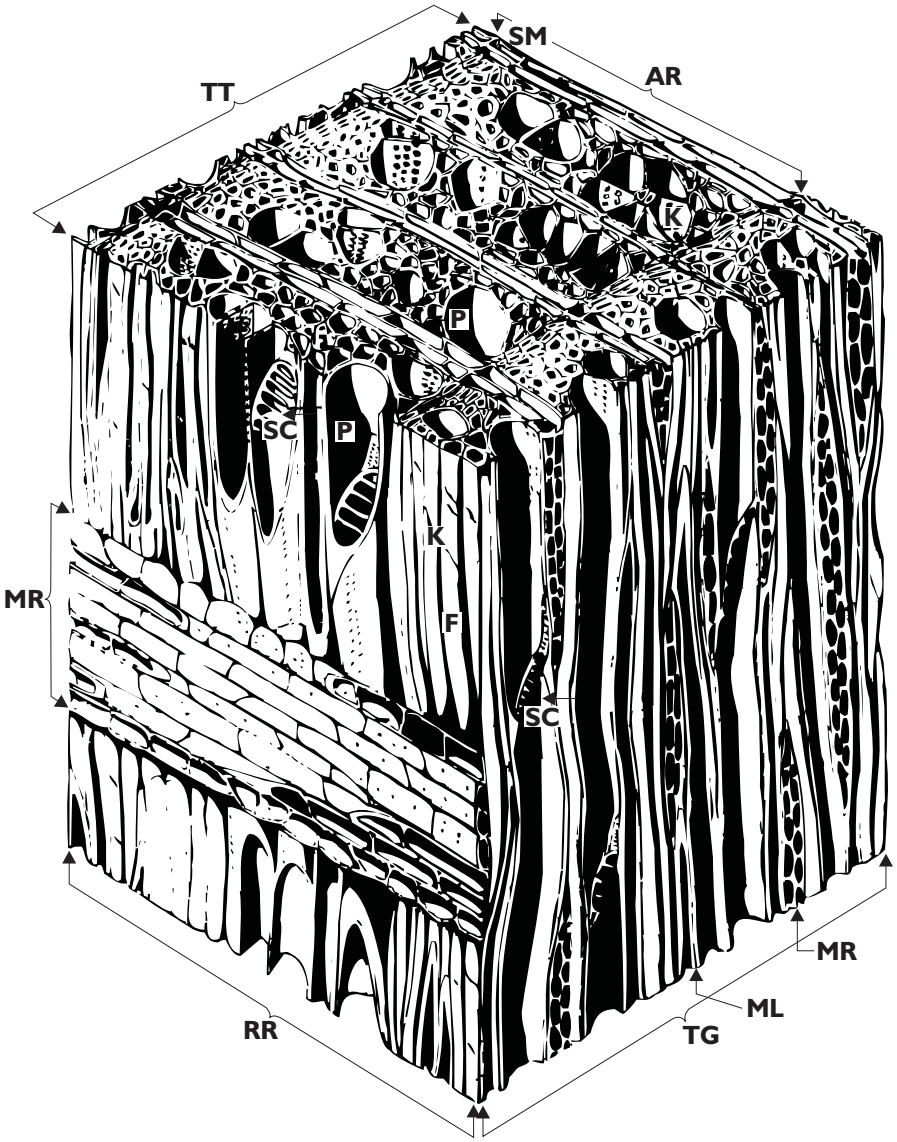
SOFTWOOD CROSS-SECTION



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: B4–2D

HARDWOOD CROSS-SECTION



AR = annual ring
F = wood fibers
K = pits
ML = middle lamella
MR = medullary rays
P = pores
RR = vertical plane
S = springwood
SC = grating
SM = summerwood
TG = surface cut at right angle to radius
TT = horizontal plane

 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.