

Course	Agricultural Science II
Unit	Agricultural Mechanics II
Subunit	Material Selection, Plan Reading, and Interpretation
Lesson	Selecting Building Materials
Estimated Time	Three 50-minute blocks
Student Outcome	

Identify common building supplies using standard terms and sizes.

Learning Objectives

1. Describe softwood and hardwood.
2. Explain how softwood is classified.
3. Explain how hardwood is classified.
4. Describe how lumber is measured and sold.
5. Describe plywood and how it is graded and measured.
6. Describe some common steel materials and how they are measured and sold.
7. Describe some other common building materials and how they are measured and sold.

Grade Level Expectations

Resources, Supplies & Equipment, and Supplemental Information

Resources

1. PowerPoint Slides
 - ☐ PPt 1 – Common Softwood Classifications and Grades
 - ☐ PPt 2 – Sample Plywood Grade Stamps
 - ☐ PPt 3 – Veneer Grades
 - ☐ PPt 4 – Dimensions of Steel Stock
2. *Agricultural Mechanics Unit for Agricultural Science II* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 2002.
3. *Curriculum Enhancement for Agricultural Mechanics Unit for Agricultural Science II, "Unit VI – Material Selection, Plan Reading, and Interpretation."* University of Missouri-Columbia: Instructional Materials Laboratory, 2004.

Supplemental Information

1. Internet Sites
 - ☐ Engineered Composite Science. Forest Products Laboratory. USDA Forest Service. Accessed October 26, 2007, from <http://www.fpl.fs.fed.us/rwu4706/>.
 - ☐ Structural Materials. Sci-Tech Encyclopedia. McGraw-Hill Encyclopedia of Science and Technology. The McGraw-Hill Companies, Inc., 2005. Accessed October 26, 2007, from <http://www.answers.com/topic/structural-materials?cat=technology>.
2. Print
 - ☐ Althouse, A., C. Turnquist, W. Bowditch, and K. Bowditch. *Modern Welding*. Tinley Park, IL: Goodheart-Willcox, 2000.

Interest Approach

Show students two pieces of lumber or plywood that have the same dimensions but are of different grades. Ask students how the pieces are similar and different. Differences could include factors such as cost, appearance, and the applications the samples can be used for. Next show students samples that include grade stamps and ask if they know what the stamps are for and what they say about the wood. If needed, explain the purpose of the grade stamps and guide the conversation to include any or all of the following points, or any others that seem relevant.

- Grades allow the builder to pick the material best suited for the job.
- They help ensure that the materials will be consistent for the whole project.
- They allow the builder to specify the type of material he or she needs and enable the supplier to fill the orders efficiently.

Communicate the Learning Objectives

1. Describe softwood and hardwood.
2. Explain how softwood is classified.
3. Explain how hardwood is classified.
4. Describe how lumber is measured and sold.
5. Describe plywood and how it is graded and measured.
6. Describe some common steel materials and how they are measured and sold.
7. Describe some other common building materials and how they are measured and sold.

Instructor Directions	Content Outline
Objective 1 <i>Begin the lesson by discussing the difference between softwood and hardwood.</i>	Describe softwood and hardwood. Softwood comes from coniferous (cone-bearing) trees. These trees have needles and are often called evergreens because they remain green throughout the year. Examples include pine, fir, and spruce. Hardwood comes from deciduous trees, which have broad leaves that fall off and are replaced each year. Examples include oak, walnut, and maple. “Softwood” and “hardwood” do not refer to the actual hardness or softness of the wood.
Objective 2 <i>There are a number of ways softwood is classified. Several common methods are covered in general terms below. Discuss all</i>	Explain how softwood is classified. By how it will be used <ol style="list-style-type: none">1. Construction or yard lumber - the least expensive and most readily available lumber; used for general construction


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<p><i>methods that will be used in the shop, in as much detail as needed. Refer to TM 3.1 Common Softwood Classifications and Grades.</i></p> <p>☐ PPT 1 – Common Softwood Classifications and Grades</p>	<ol style="list-style-type: none"> 2. Factory and shop or remanufacture lumber - made and graded to be significantly reworked for a specific application, such as doors or windows <p>By its size</p> <ol style="list-style-type: none"> 1. Boards – nominal thickness is less than 2 in. 2. Dimension lumber – nominal thickness is at least 2 in. and less than 5 in. 3. Timbers – nominal thickness and width are 5 in. or greater <p>By how much it has been dressed or worked</p> <ol style="list-style-type: none"> 1. Rough lumber – has been sawed and trimmed to length but has not had any of the surfaces smoothed (dressed) 2. Dressed or surfaced lumber – has had at least one surface planed smooth. A piece of lumber designated S2S1E has been surfaced on two sides and one edge. 3. Worked lumber – has been surfaced and had some additional processing, such as cut with a tongue on one edge and a groove on the other so that pieces can be fit together <p>By its grade</p> <ol style="list-style-type: none"> 1. Grades are based on moisture content, intended use, and the location and size of irregularities, such as knots, splits, decay, and manufacturing defects. 2. The basis for softwood lumber grades is the American Softwood Lumber Standard PS 20-70, which is published by the U.S. Department of Commerce and applied and expanded on by lumber producers, such as the Western Wood Products Association. 3. Most lumber is graded on a number system from 1 to 5, with 1 being the best. There may be additional grades, such as Select. 4. Appearance grades are given to lumber that is used in applications where appearance is important, such as flooring and paneling. They range from A to D, with A being the best. 5. The grade assigned to a piece of lumber is stamped on it and contains the following information. <ol style="list-style-type: none"> a. Grading agency

Instructor Directions	Content Outline
	<ul style="list-style-type: none"> b. Species of the wood c. Grade d. Mill identification e. Moisture content when the wood was stamped
<p>Objective 3</p> <p><i>Discuss hardwood classification.</i></p>	<p>Explain how hardwood is classified.</p> <p>A board's grade is based on the size and number of pieces without defects that can be cut from it.</p> <p>Standards for hardwood are set by the National Hardwood Lumber Association.</p> <p>The general grades of hardwood are as follows:</p> <ol style="list-style-type: none"> 1. Firsts and Seconds 2. Selects 3. Number 1 Common 4. Number 2 Common 5. Number 3 Common <p>Hardwood may be sold separately by grade or in a combination of grades. Lumber designated FAS would include pieces that were Firsts and Seconds.</p>
<p>Objective 4</p> <p><i>Explain how lumber is measured and sold. This question includes information on calculating board feet. Calculating board feet was discussed in Agricultural Mechanics Unit for Agricultural Science I, Unit III Lesson 1. As a review, the instructor can ask students how board feet is figured, if desired.</i></p>	<p>Describe how lumber is measured and sold.</p> <p>The common unit of measurement for lumber is the board foot.</p> <ol style="list-style-type: none"> 1. To determine board feet, multiply the thickness of the board in inches by its width in inches by its length in feet and then divide by 12: $(T'' \times W'' \times L') \div 12 =$ board feet. Label the answer in board feet (BF or bd ft). 2. A board foot is a piece of lumber 1 in. thick, 12 in. wide, and 12 in. long, or 144 cubic in. 3. Stock that is less than 1 in. thick is figured as 1 in. 4. For boards over 1 in. thick, use the nominal size for figuring board feet. 5. Nominal or "name only" size is based on the dimensions of the lumber when it is green and its surfaces are rough. The same piece of lumber will have a smaller actual size after it has been dried and planed. This is why a 2 x 4 has an actual measurement of 1 1/2 in. by 3 1/2 in.

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	<p>6. Remember to take into account the difference between nominal and actual size when figuring the bill of materials.</p> <p>Orders for lumber should indicate the grade desired and be written in nominal dimensions using standard terms.</p> <p>Softwood is cut to standard thickness, width, and length. Common lengths range from 8 ft to 20 ft in 2-ft intervals.</p> <p>Because hardwoods are in limited supply, they are generally cut and sold in random widths and lengths.</p>
<p>Objective 5</p> <p><i>Discuss how plywood is measured and sold. Refer to PPts 2 and 3.</i></p> <p><input type="checkbox"/> PPt 2 – Sample Plywood Grade Stamps</p> <p><input type="checkbox"/> PPt 3 – Veneer Grades</p>	<p>Describe plywood and how it is graded and measured.</p> <p>Plywood is a structural panel made of a core material between two thin sheets of wood called face veneers. Typical plywood cores include additional sheets of veneer, thin boards laid side by side, and composite materials, such as wood chips or pressed paper.</p> <p>Plywood is classified as softwood or hardwood based on the type of wood used for the face veneers.</p> <p>Plywood is also classified based on the type of adhesive used to manufacture it.</p> <ol style="list-style-type: none"> 1. Exterior grade plywood is made with fully waterproof adhesives. 2. Interior grade plywood uses moisture-resistant adhesives. <p>Both softwood and hardwood plywood are commonly designated by the general grade G2S or G1S, meaning “good two sides” or “good one side.” (They may also be referred to as S2S and S1S, meaning surfaced or sanded on one or two sides.)</p> <p>Both softwood and hardwood plywood panels are stamped with grades from the group that oversees their manufacture. This stamp includes information about the panel, including such things as the following.</p> <ol style="list-style-type: none"> 1. Species of wood on the face veneer 2. Quality of the face veneer

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	<ol style="list-style-type: none"> 3. Type of adhesive used 4. Standard governing manufacture 5. Mill identification <p>Standards for softwood plywood are set by manufacturers associations, such as the APA-Engineered Wood Association, in accordance with specifications made by the National Bureau of Standards.</p> <ol style="list-style-type: none"> 1. Veneer grades are assigned to the front and back face veneer. <ol style="list-style-type: none"> a. The best grade of veneer is N, which is suitable for a natural finish. b. Other grades range from A to D, with A being the best. c. A typical veneer grade might be A-D, which would indicate a panel with A-grade veneer on one face and D-grade on the other. This type of panel would generally be used for an interior application where the appearance of only one side was important. 2. The grade stamp also includes a group number. <ol style="list-style-type: none"> a. All the woods that are used for making softwood plywood are put into one of five groups according to their strength, with one being the strongest. b. The group number is assigned based on the weakest wood used in the face veneer. c. Sanded panels include the exact species of wood as well. <p>Standards for hardwood plywood</p> <ol style="list-style-type: none"> 1. Standards for hardwood plywood are set by the Hardwood Plywood & Veneer Association. 2. Face veneers are given a number from 1 to 4, with 1 being the best. Specialty cuts can also be ordered. 3. Like softwood plywood, hardwood plywood is available in a number of different combinations of front and back panel grades. <p>Plywood is commonly sold by the square foot.</p> <ol style="list-style-type: none"> 1. To figure square feet, multiply length in feet by width in feet. Label the answer as square feet or sq. ft.

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	<p>2. A standard sheet of plywood measures 4 ft by 8 ft and contains 32 sq ft.</p>
<p>Objective 6</p> <p><i>Discuss common steel materials and how they are sold. Pipe and some basic shapes of steel stock are covered below. Refer to PPt 4.</i></p> <p><input type="checkbox"/> PPt 4 – Dimensions of Steel Stock</p>	<p>Describe some common steel materials and how they are measured and sold.</p> <p>Rounds</p> <ol style="list-style-type: none"> 1. Specify external diameter 2. Standard length is 20 ft <p>Angle iron</p> <ol style="list-style-type: none"> 1. Specify the width of each leg and the thickness 2. Standard length is 20 ft <p>Flats and strips</p> <ol style="list-style-type: none"> 1. Specify width and thickness 2. Standard length is 20 ft <p>Channel iron</p> <ol style="list-style-type: none"> 1. Specify depth of channel and width of flange 2. Standard length is 20 ft <p>Black or galvanized steel pipe</p> <ol style="list-style-type: none"> 1. Specify inside diameter 2. Standard length is 21 ft
<p>Objective 7</p> <p><i>Discuss additional common building materials that students might need to include on a bill of materials. A few examples are listed below, along with their usual unit of measure. Include any additional materials as needed.</i></p>	<p>Describe some other common building materials and how they are measured and sold.</p> <p>Items like molding and dowel rod are measured and sold in linear or running feet.</p> <ol style="list-style-type: none"> 1. Linear feet is a measurement of the actual length of the material. 2. It does not include thickness or width. <p>Roofing is sold by the square (1 square equals 100 sq ft). One bundle of shingles contains 1/3 of a square.</p> <p>Hardware cloth and screening are sold by the linear or running foot.</p> <p>Hardboard, waferboard, and particle board are manufactured in panels, typically 4 ft wide by 8 ft long. They are measured in square feet.</p>

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<p>Application:</p> <p> Unit VI Activity</p>	<p>Answers to Unit VI Activity</p> <p>Answers may vary. Below are the original construction procedure, cut list, and bill of materials from the feed bunk project.</p> <p>Construction Procedure</p> <ol style="list-style-type: none"> 1. Cut four 22" x 3" channel for the Legs. 2. Cut two 27 1/2" x 3" channel for the Crossbraces. 3. Cut two 27 1/2" x 1 1/4" Sch 40 pipe for the Stabilizers. See figure 3. 4. Cut two 8' x 1/14" Sch 40 pipe for the Runners. 5. Weld the Crossbraces and Stabilizers to the Legs. Use pipe bar clamps to assemble. Check for squareness, tack, and weld. 6. Bend 30 degree angles on the Runners 9" from the end as shown in figure 2. 7. Notch the bottom of leg assembly to fit the pipe Runners. 8. Drill 5/16" holes for the carriage bolts as shown in figure 1 and figure 2. 9. Grind all sharp edges smooth, remove weld spatter, prime metal, and paint with enamel paint. 10. Cut two 24 1/2" x 2" x 6" boards for the Center support. 11. Square, mark, and cut seven 8' x 2" x 6" boards for the Floor and Sides. 12. Assemble with 16p nails and carriage bolts. <p>Cutting List</p> <ol style="list-style-type: none"> 1. 4 - 22" x 3" Channel - Legs 2. 2 - 27 1/2" x 3" Channel - Crossbraces 3. 2 - 8' x 1 1/4" Sch 40 Pipe - Runners 4. 2 - 27 1/2" x 1 1/4" Sch 40 Pipe - Stabilizers 5. 7 - 8' x 2" x 6" Boards - Floor and Sides 6. 2 - 24 1/2" x 2" x 6" Boards - Ends 7. 1 - 27 1/2" x 2" x 6" Board - Center Support <p>Bill of Materials</p> <ol style="list-style-type: none"> 1. 12' x 3" Channel Iron 2. 21' x 1 1/4" Sch 40 Pipe

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	<ol style="list-style-type: none"> 3. 8 - 8' x 2" x 6" Lumber 4. 26 - 5/16" x 2" Carriage bolts 5. 1# - 16p Nails 6. Metal Primer 7. Enamel Paint <p>Other activities</p> <ol style="list-style-type: none"> 1. In place of the unit activity, students could draw up a plan of procedure, cutting list, and bill of materials for the project they will be building, if these do not already exist. 2. Ask a knowledgeable representative from a local lumberyard or other building material supply store to speak to the class about grades of lumber that the business carries and how other common building materials are classified and sold.
Closure/Summary	<p>Understanding how building materials are classified, measured, and sold allows a builder to fill out bills of materials correctly and helps ensure that he or she gets the right materials for the job. This lesson includes general information about how some common building materials are classified and the standard units in which they are measured and purchased.</p>
Evaluation: Quiz	<p>Answers:</p> <ol style="list-style-type: none"> 1. a 2. b 3. d 4. d 5. b 6. d 7. a 8. d 9. d 10. b 11. e 12. a 13. c 14. a. Softwood – Wood cut from coniferous trees (trees that do not shed their leaves) <li style="padding-left: 40px;">b. Hardwood – Wood cut from deciduous trees (broad-leaved trees that shed their leaves in the fall)

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	<ul style="list-style-type: none"> c. Nominal size – Measurement of a board when it is green and has not been planed; boards are sold using their nominal measurements d. Actual size – Measurement of a board after it has dried and has been planed <p>15. Student should list three of the following:</p> <ul style="list-style-type: none"> a. How the wood will be used b. By the size of the wood c. By how much the wood has been dressed d. By the grade of the wood <p>16. a. 28 bd ft</p> <p style="padding-left: 20px;">b. 16 bd ft</p> <p>17. a. \$24.00</p> <p style="padding-left: 20px;">b. \$7.68</p>