UC
CE

Woodworking

This We Believe:

- The boy and girl are more important than the projects.
- The member should be their own best product.
- No award is worth sacrificing the reputation of a member or leader.
- Competition is a natural human trait and should be recognized as such. It should be given no more emphasis than other fundamentals.
- Learning how to do the project is more important than the project itself.
- Many things are caught rather than taught.
- A blue ribbon member with a red ribbon project is more desirable than a red ribbon member with a blue ribbon project.
- To learn by doing is fundamental in any sound educational program.
- Generally speaking, there is more than one good way of doing most things.
- Every member needs to be noticed, to feel important, to win, and to be praised.
- Our job is to teach members *how* to think, not what to think.

CALIFORNIA 4-H PROJECT SHEET

4-H WOODWORKING PROJECT

Woodworking's usefulness can be applied to many areas of life through learning how to safely use tools to build with wood. The woodworking project teaches the full scope of constructing a wood piece from design to completion.

- Learn how to use tools correctly and safely
- Design your project including all steps from start to finish
- Develop a materials list
- Select wood suited for your project
- Use of hand and power tools to cut, shape, join and sand your wood
- Learn techniques including turning, joinery, and finishing

Starting Out *Beginner*	Learning More *Intermediate*	Exploring Depth *Advanced*
○ Tool use; Hand tools, miter box cuts with a hand saw, drill press and scroll saw ○ Wood is milled from specific parts of trees ○ Use tree limbs and sticks to build a miniature tree house with glue guns ○ Simple butt joinery project such as a tool box – joinery technique – glue and screws ○ Scroll saw projects such as an ornament	○ Identify safety hazards in tool use ○ Tool use; planer, scroll saw, band saw, drill press, circular saw for rip cuts and cross cuts, and plate joiner, router ○ Soft and hard woods and how that effects cutting, shaping, and sanding ○ Scroll saw puzzle projects ○ Finish techniques include sanding in progressive steps, simple 3 coat finishes	○ Tool use; dovetail jigs, lathe and turning tools, power miter saws ○ Encourage member's own design, draw it out, dimensions, materials list, cut list, step-by-step ○ Explore turning, joinery, and finishing techniques such as paring, dovetailing, finger joints, dyeing, and sealing ○ Adding detail – keyed joints, hand carving, marquetry

The activities above are ideas to inspire further project development. This is not a complete list.

4-H THRIVE

Help Youth:

Light Their Spark

A spark is something youth are passionate about; it really fires them up and gives them joy and energy. Help youth find what it is about woodworking that excites them.

Flex Their Brain

The brain grows stronger when we try new things and master new skills. Encourage youth effort and persistence to help them reach higher levels of success.

Reach Their Goals

Help youth use the GPS system to achieve their goals.

Goal Selection: Choose one meaningful, realistic and demanding goal.

Pursue Strategies: Create a step-by-step plan to make daily choices that support your goal.

Shift Gears: Change strategies if you're having difficulties reaching your goal. Seek help from others. What are youth going to do when things get in their way?

Reflect

Ask project members how they can use their passion for this project to be more confident, competent and caring. Discuss ways they can use their skills to make a contribution in the community, improve their character or establish connections.

Expand Your Experiences!

Science, Engineering, and Technology

- Take a wood planer apart and put it back together to see how it is engineered
- Using a variable speed lathe, turn a piece of wood with a turning tool using different speeds from slow to fast and see how it effects the look of the wood
- Examine different grades of sand paper under a magnifying glass to explore differences

Healthy Living

- Build a balance board and keep it in your living room to help strengthen your legs and maintain good balance
- Think out the whole process of construction and calculating dimensions which involves the body and mind

Citizenship

- Build bird feeders to put around your local senior housing
- Build large raised vegetable planters for your school's lunch program
- Volunteer to build with Habitat for Humanity
- Set up a fair booth to demonstrate scroll saw techniques

Leadership

- Be a Junior or Teen Leader for the Woodworking project
- Lead a "Build It" day for your club members – choose something fun for everyone to build and incorporate teaching shop safety in to the day
- Lead a committee to build wood A-frame signs to advertise your club's events

Resources

Fine Wood Working
Finewoodworking.com

Inside Woodworking
www.insidewoodworking.com

Museum of Woodworking Tools
http://www.antiquetools.com/

WoodNet
http://www.woodnet.net/

Woodworking Safety

4-H Clover Safety Notes for using tools and equipment
safety.ucanr.org/4-H_Resources/Clo-ver_Safe_Notes_by_Project_Area/

Fine Wood Working Safety
http://www.finewoodworking.com/pages/woodworking-safety.asp

Connections & Events

Presentation Days – Share what you've learned with others through a wood-related presentation.

Field Days – At these events, 4-H members may participate in a variety of contests related to their project area.

YouTube has many home made "How To" videos that can help you build just about anything.

Volunteer with your local Habitat for Humanity

Curriculum

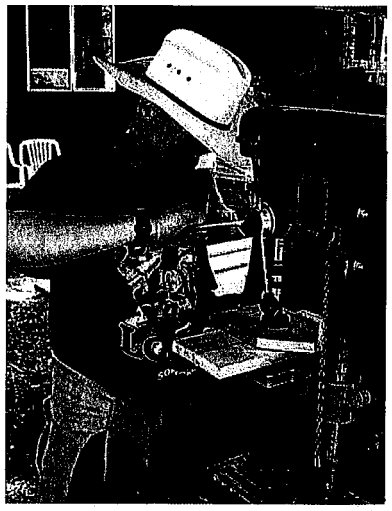
- National 4-H Curriculum at 4-hmall.com – Woodworking Curriculum is good for beginners
  - Making the cut
  - Nailing it together
  - Measuring Up
  - Finishing Up
  - Helper's Guide
- 4-H Wood Science from OSU

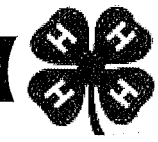
4-H Record Book

4-H Record Books give members an opportunity to record events and reflect on their experiences. For each project, members document their personal experiences, learning and development.

4-H Record Books also teach members record management skills and encourage them to set goals and develop a plan to meet those goals.

To access the 4-H Record Book online, visit





subtract from wood's usefulness. In your home, you may have experienced a drawer or a door that became difficult to open in humid summer weather due to swelling. Shrinking and swelling can be controlled by controlling the moisture content, but wood is often used where it is not practical to control temperature and relative humidity. Protective coatings can retard (but not prevent) the movement of moisture from the air into and out of wood. The adverse effects of changes in moisture content can often be partially offset by good design and careful selection of materials.

How much does wood shrink? The maximum shrinkage, from fiber saturation point to oven dry, varies in three principal directions. Along the grain, such as along the length of the board, the normal shrinkage is very, very little. This is called longitudinal shrinkage. Infrequently, there are individual pieces of wood which exhibit abnormal longitudinal shrinkage, but for the most part, shrinkage along the grain is no problem.

Flat grain boards shrink more in width than edge grain boards, but less in thickness. The across-the-width shrinkage of a flat grain board is called tangential shrinkage (tangent to the growth rings) while the across-the-width shrinkage of an edge grain board is known as radial shrinkage (in the direction that radiates from the center of the tree). Heavier woods generally shrink more than light woods.

Tangential shrinkage is as much as 12 percent for hickory, a very heavy wood, to as little as 5 percent for redwood, a very light wood. Radial shrinkage for hickory is 7 percent and for redwood is 3 percent. Note that this is the total shrinkage from 30 percent moisture content to oven dry. Most wood in use never shrinks this much because most wood does not dry completely.

If left long enough in the equilibrium moisture content conditions in which it will be used, wood will dry to the proper moisture content. However, this may take an excessively long time, especially for some hard-to-dry woods. Left outside (in most regions of the country), wood will never reach the desired moisture content for interior use. Outside humidities are simply too high most of the year.

Most lumber intended for interior use is dried at high temperatures in controlled humidities, in lumber dry kilns. This removes moisture rapidly. The moisture content of lumber in kilns can be accurately controlled. However, proper care of lumber after drying is also important. Just because lumber has once been kiln dried does not assure that it will be satisfactory for your needs when you go to use it, because it could have regained moisture from the air during the storage period after drying.

It is important that a woodworker learn to use lumber that is at the proper moisture content. In addition to the undesirable shrinkage or swelling which would result from improper moisture content, some other woodworking operations, such as gluing and finishing, can be adversely affected by too much or too little moisture in the wood.

Unfortunately, it is not possible to tell by looking at wood if it is at the proper moisture content. Electrical moisture meters can be purchased to measure moisture content of lumber, but, lacking a meter, the simplest way for a woodworker to check the moisture content of wood is to dry a scrap piece of the wood in an oven.

Measuring moisture content would be a good class exercise. You will need an accurate scale. See the activity called "Measuring the Moisture Content of Wood" in Appendix X ("Suggested Wood Science Experiments") in this leader's guide.

Specific Gravity of Wood

Specific gravity of wood, like that of any other substance, is its weight compared to the weight of an equal volume of water. None of the domestic woods when dry are as heavy as water, although some foreign woods are heavier than water. Any wood, if wet enough, will sink rather than float. Specific gravities of U.S. woods range from about 0.30 for northern white cedar to about 0.88 for live oak (based on 12% moisture content). In general, the higher the specific gravity, the stronger the wood, and the lower the specific gravity, the easier the wood is to work.

(See the activity called "Specific Gravity and Strength of Wood" in Appendix X ("Suggested Wood Science Experiments.")

Other Characteristics of Wood

Each wood has some unique working qualities. Woods weather differently. Woods have differing degrees of decay resistance. There are substantial differences in mechanical properties that are not explained by differences in specific gravity alone. The mechanical properties of wood are explained and values given for American species in Chapter 4 of the 1974 U.S.D.A. Wood Handbook (see "Reference Materials").

Renewability—A Most Important Property

Forests are renewable. Wood products can be produced without expending large quantities of energy. Wood scientists have improved the efficiency in using forest resources so that the same quantity of raw material goes further. Knowledge of how to use wood properly is a scarce resource. Well designed wood products, carefully made, can extend this valuable wood resource even further. 4-H youth can play an important role in this important process.

Tools and Machines

The beginning 4-H'er should use simple tools. As he or she continues in the wood science program, each should learn to use a wider variety of tools and materials. Simple and easy-to-use tools are described in Unit 1. Additional tools and their uses are described in other project manuals.

Members should be encouraged to acquire their own set of tools; however, inability to do so should not be a deterrent to anyone. Local donors, individuals or groups, probably can be found to purchase tools and materials which will remain club property.

Many leaders will allow members to use their personal tools. Remember, youngsters are active, energetic, inexperienced, and need guidance. Encouraging wise and safe use of tools moves 4-H'ers toward increasing opportunities. Even beginning woodworkers can safely use instruments like the short stroke, finetooth jig saw; the oscillating electric sander; and the light duty quarter-inch drill, if properly instructed and supervised in their use. Other power tools and machinery are illustrated in Units II and III; however, the member may satisfactorily complete his or her project work without the use of power tools.

Safety Tips for Using Woodworking Tools, Machines, and Processes

1. Dress appropriately for work in the shop. Wear protective clothing and equipment. Eye protection is always recommended, especially when power tools are being used; and, in many states, eye protection is mandatory.
2. Tools such as screwdrivers, wrenches, and chisels should be of the proper shape and size to fit snugly. Worn tools with rounded corners and blunted edges are dangerous.
3. Electrical equipment grounds on power tools should be properly connected before the machines are started.
4. Never depend upon back muscles in lifting heavy objects. Get help, if necessary, and lift with leg and arm muscles.
5. A sharp cutting tool is less dangerous than a dull one.
6. Lay tools on benches in an orderly fashion. Protect cutting edges and keep sharp surfaces pointed away from the work area.
7. Fasten materials securely in a vise when practical.
8. Keep the work area clean, especially the floor. Put waste stock in the scrap box and oily rags in closed metal containers.
9. Maintain order. No running or playing in the work area!
10. Keep the work area well lighted. Fifty footcandles of illumination is recommended for detailed work.
11. Follow directions and instructions for tools, machines, and materials.
12. Be sure members can successfully pass both written and practice tests before operating machines.
13. Take care of accidents promptly. Apply first aid for any cut or scratch. Keep first-aid equipment readily available.
14. Keep up to date on safety information. Secure posters and visual materials from sources such as the National Safety Council, as constant reminders for 4-H'ers.

NOTE: The leader will note the special emphasis placed on safety in each member's manual.

Criteria for Judging Projects Made from Wood

I. Skills (Total points 75)

A. Quality of Workmanship

1. Cutting

a. Pieces of proper lengths
b. Accurate cuts, either squared or beveled
c. Uniform and smooth saw cuts (some roughness may be appropriate in rustic designs)
d. Free of chipping, dents, and uncut fibers
e. On a woodcarving where the knife cuts remain as an element of texture, the cuts should be clean and uniform as an indication of knife control.

2. Assembly

a. Joints fit snugly
b. Joints assembled with even edges or uniform overlap
c. Wood free of clamp marks
d. Fasteners properly used

Nails

- Use common or box nails where strength is more important than appearance.
- Use brads, finishing, or casting nails where appearance is important.
- Nail heads should be flush with the surface of the wood unless set below the surface 1/16" to 1/8" and filled. The filler should match the wood if a clear finish is used.
- Wood should be free of hammer marks and splits caused by nails.

Screws

- Should be flush with the surface or countersunk enough to plug the hole
- Rim of the bevel or ovalhead screw flush with surface
- Screwdriver slot should be in good condition.
- Wood should be free of screwdriver marks.

Adhesives or glue

- Resorcinol glue should be used for exterior purposes.
- Casein or plastic resin glue should be used for wood turnings.
- Wood surfacing should be delayed several days after gluing to prevent glue line depressions.
- Wood should be free of glue stains.
- Dowels used in end grain to side grain butt joints

B. Surface Preparation and Finish

1. Free of pencil marks, scratches, and dents (unless of rustic design)
2. Furniture-like items free of planer marks and cross grain sanding marks
3. Finish should be dry, smooth and uniform and free of dust specks, brush bristles, runs and sags.

C. Difficulty of Construction (number of skills and operations involved)

1. A well made, complex item should rank higher than a well made, simple item.
2. A perfectly made, small and simple item should rank higher than a poorly made, complex article.

II. General Characteristics (Total Points 25)

A. Attractive and Well-proportioned
B. Can Adequately Serve the Purpose for Which Item is Intended
C. Proper Selection of Wood According to Use. For example:

1. Exterior grade plywood used for areas subject to wetting
2. Heartwood of decay resistant lumber or treated lumber used for lawn and garden furniture

Appendix I

Judging Score Card

		Identification of Article			
I. Skills (Total 75 points)					
A. Quality of Workmanship—cutting, assembly, etc.	**(30)**				
B. Surface Preparation and Finish	**(25)**				
C. Difficulty of Construction and Level of Skills Involved	**(20)**				
II. General Characteristics (Total 25 points)					
A. Attractive and Well-proportioned	**(10)**				
B. Utility Value	**(10)**				
C. Selection of Woods and Materials	**(5)**				

Appendix II
Nail-driving Activity

Objectives
- To develop eye hand coordination
- To gain the skill of driving nails safely, accurately and efficiently into wood

Equipment and Supplies
- Safety goggles for each participant
- A hammer for each participant or team, depending on how the contest is conducted
- Pieces of dimension lumber, such as a 2×4 or 2×6
- Nails shorter than the thickness of the lumber
- Nail driving blocks
- A watch with a second hand (optional)

Leader Responsibilities
The leader sets the rules:
- Sets the amount of time for the activity
- Determines if the activity will be competitive or noncompetitive
- Decides if the activity will be individual or a team effort

Organizes the activity:
- Selects teams and team captains, if necessary
- Distributes goggles, nails, hammers, and driving blocks
- Starts and times the event
- Scores the event

Scoring
For individual learning or self competition, have each individual record his time and try to improve it the next time. For group or team competition, the team with the highest combined score wins. (Time minus 30 seconds for each bent nail and 10 seconds for each hammer mark.)

Hints
This activity can be used to put action into a discussion meeting. It can generate enthusiasm and create interest. You can modify this activity by having both a piece of hardwood and a piece of softwood and both heavy- and thin-shanked nails. A requirement could be that one thin shank and one thick shank be driven in both the hardwood and the softwood. Teen leaders or older teen members may be of assistance to the leader. Get them to help whenever needed.

Appendix III

Wood Products, Tools, and Fasteners Identification Activity

Objectives

- To identify common types of hardwoods and softwoods used in your area
- To identify different types and kinds of fasteners (nails, screws, glues, etc.)
- To identify various kinds of woodworking tools
- To help 4-H'ers feel satisfaction and accomplishment in wood science activities

Equipment and Supplies

- Samples of hardwood and softwood
- Samples of different kinds of fasteners in different sizes
- Samples of woodworking tools

Leader Responsibilities

- Plan the activity and set the rules
- Assemble the wood samples, fasteners, and tools
- Score the event

Scoring

Scores depend upon the rules of the game. Consider the members' ability to identify samples of wood, tools, nails, etc.

> **Note**
> Identification of wood products, tools, and fasteners can be done in various ways. Use your creativity to plan an event keeping in mind the objectives of the activity.

Appendix IV

Hand Sawing Efficiency Activity

Objectives

- To use sawing equipment properly and safely
- To gain skills in sawing techniques
- To provide recognition for the 4-H member

Equipment and Supplies

- Square
- Carpenter's tape or rule
- Coping saw and several blades
- Crosscut saw
- Marking pencils
- Sawhorse or workbench of proper height
- Lumber

Leader Responsibilities

(See responsibilities under Nail-driving Activity, previous page.)

Scoring

(See scorecard on page 13 for an idea.) When developing your scorecard, consider accuracy, safety, and care of tools.

> **Note**
> Praise or a pat on the back can give recognition for a job well done.

Appendix V

Measuring Activity

Objectives

- To learn to read various measuring tools properly
- To understand standard sizes of wood materials
- To develop skills in measuring lumber accurately

Equipment and Supplies

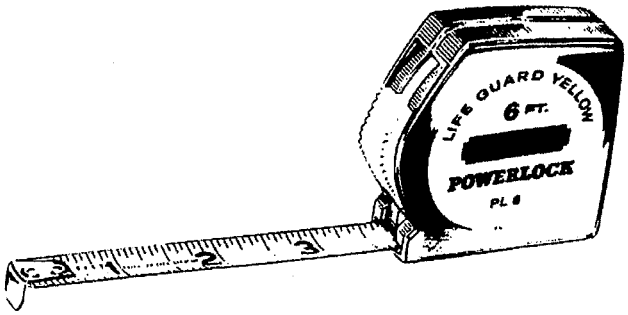
- Carpenter's tapes
- Utility squares
- T square
- Pieces of dimension lumber of different sizes (find pieces and label them according to size)
- Pieces of plywood and particleboard

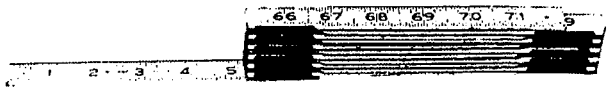
Leader Responsibilities

- Prepare a list of pieces to be measured to specification. Have members demonstrate their skills in measuring.
- Arrange a task of determining the amount of lumber necessary to build a specific item, such as a dog house, etc.

Scoring

- Methods of scoring will depend on the rules of the activity.



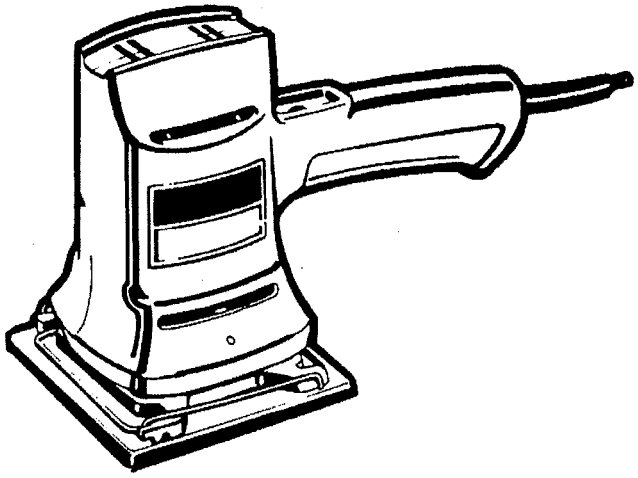


Appendix VI

Wood Finishing Activity

Objectives

- To use good finishing techniques and application of a suitable finish
- To develop skills in finishing wood
- To refine skills in the use of wood finishing tools, abrasives, fillers, etc.



Equipment and Supplies

- Several grades of wood sanding paper
- Steel wool
- One or more types of rasps
- Several types of suitable finish
- Different species and kinds of wood
- Applicators and cleaners

Leader Responsibilities

- Secure a box of scrap lumber samples of hardwoods and softwoods, all unfinished. (Members will select a piece of wood, select a finish and the supplies and equipment needed to complete the finish. In a given time allotment, the 4-H'er will complete a small area for showing.)
- Evaluate the finished product. Consider safety and care of tools. Also consider suitability of the finish selected, especially as it affects function or use of the item.

Appendix VII

Wood Knowledge Contest

Listed below are sample questions that can be used in a wood knowledge contest. Any 4-H leader can design a similar type of contest for his or her club. The same type of questions, with wood samples, can be used in other ways, such as a 4-H Wood Science Bowl.

Instructions: Circle one answer in the right hand column.

1. There are literally hundreds of specialty wood products and by-products. Which one of these is not a wood product? (no sample displayed)
   A. Rayon thread B. Turpentine C. Cooking oil ..... A B C

2. Which one of these groups of tree species is common to the Northwest Christmas tree industry? (no sample displayed)
   A. Austrian Pine, Blue Spruce, Hemlock B. Scotch Pine, Douglas-fir, Noble Fir C. Balsum Fir, White Pine, Giant Sequoia ..... A B C

3. This sample is from a group of different tree species with one common lumber trade name. It is
   A. Spruce B. Pine C. Hem Fir ..... A B C

4. I'm used for flooring, furniture, and wedges, and I'm not a common forest species in (your state or area). I'm
   A. Spruce B. Oak C. Maple (change samples for your area) ..... A B C

5. Of the three samples of plywood shown here, which one would be subject to the least warpage and surface checking? (display your own samples) ..... A B C

6. This wood product is known in the building trade as a
   A. Shake B. Shingle C. Miter ..... A B C

7. This wood product, made by cooking wood chips and then compressing and drying into sheets, is known as
   A. Fiberboard B. Particleboard C. Chipboard ..... A B C

8. This piece of plywood, generally sold with no grade stamp and often used in cabinet shops, is called
   A. C D plywood B. Shop or void plywood C. Marine plywood ..... A B C

9. My wood is quite soft and fine grained, and I'm from a five-needle Pine. My wood is used for interior finish, lumber, and woodworking. I'm
   A. Western White Pine B. Shore Pine C. Ponderosa Pine ..... A B C

10. The wood for this pencil is commonly made from
    A. Alaska Cedar B. Pacific Yew C. Incense Cedar ..... A B C

11. This is a chunk of one of the most common hardwood fireplace woods. I am
A. Maple B. Red Alder C. Douglas-fir ..... A B C

12. In the lumber business, this collection of samples would be called
A. Boards B. Dimension C. Timbers ..... A B C

13. Which sample, when used in home building resting on concrete or near the soil, is required by most building codes?
A. Cedar 2×4 B. P.T. 2×4 C. Douglas-fir 2×4 ..... A B C

14. This sample is from a western tree that produces most of the strongest (group 1) plywood. My common species name is
A. Engleman Spruce B. Douglas-fir C. Western Hemlock ..... A B C

15. Plywood that is made with a waterproof adhesive and can generally be used anywhere is called what grade plywood?
A. Interior B. Exterior C. Veneer ..... A B C

16. Examples of primary processing include
A. Cardboard boxes B. Particleboard C. Paper shopping bags ..... A B C

17. Which group of words (factors) are used in the Christmas tree grading standards?
A. Producer, wholesaler, retailer, marketer B. Balance, foliage, taper, density, deformities
C. Bevel, plane, miter, prune ..... A B C

18. This sample, whose actual measurement is ¾" × 3½", has a "normal size" classification of
A. 1×3 B. 1×4 C. 2×4 ..... A B C

19. Wood can be smoothed and leveled using which tool?
A. Bevel B. Miter C. Plane ..... A B C

20. This sample of dimension lumber is from what tree species?
A. Hem Fir B. Douglas-fir C. Pine ..... A B C

21. You are selecting plywood to make a natural finish, top quality display cabinet. These pieces represent four sheets of plywood. You are to compare and rate these sheets. How did you place the four pieces?

1st choice	2nd choice	3rd choice	4th choice

22. This sample from a broadleaf hardwood, used in furniture and for making other items, is
A. Alder B. Big Leaf Maple C. Oak ..... A B C

23. This sample is called
A. Chipboard B. Particleboard C. Fiberboard ..... A B C

Appendix VIII

Exhibit Ideas

Division A: Wood Science (Display Samples)

- Labeled specimens of hardwoods common to your area
- Labeled specimens of softwoods common to your area
- Different products of dimension lumber
- Different plywood species
- Different hardwood plywoods
- Hardwood products
- Pulp products
- Stages in paper making
- Chemical process products of wood
- Seasoning woods for cooking

Division B: Woodworking: Articles Made from Wood (Display Samples)

- From Unit 1: tie rack, letter holder, note holder, picture frame, art design, bird nest shelf, puzzle, game, etc.
- From Unit II: key holder, cutting board, birdhouse, bookends, footstool, book rack, tool box, games, etc.
- From Unit III: toy, door knocker, sandbox, shoeshine box, step stool/chair, saw horse, garage door creeper, barn medicine cabinet, etc.

Appendix IX

Wood Science and Wood Scientists

You as a leader may be asked for a definition of wood science or an explanation of what wood scientists do. We hope that you will encourage youth in the 4-H Wood Science Project to learn more about wood and wood science.

Wood Science is a relatively new profession. It is a materials engineering science. Graduates of university wood science programs have a comprehensive knowledge and understanding of wood as a raw material. This knowledge includes the anatomy, physical, chemical, mechanical, and biological properties of wood. In addition, they receive extensive training in the major wood processing operations such as drying, machining (including sawmilling and veneering), gluing, finishing, and treating wood. Additional areas of study often selected are industrial engineering, business administration, marketing, personnel relations, economics, civil engineering, and chemistry.

A wood scientist must know chemistry, physics, mathematics, and other sciences. However, he or she is distinguished from the chemist, physicist, mathematician, engineer, and forester in that the wood scientist knows wood. He or she knows wood as a biological product of the forest, as a raw material, as a material for construction, and as a part of our civilization. He or she knows why it acts the way it does and what to look for when it doesn't.

Wood scientists are expanding the broad scientific base for wood science through educational and research efforts. The behavior of wood is often explained by its peculiar structure and organization. Very few materials in the field of construction are as complex as wood, yet wood has been, and still is, being used by those who know nothing of its complex properties.

Because wood is such a common and easily used material, many users do not even know that wood has unique properties. Much of the difficulty encountered when working with wood is due to misinformation or the lack of information regarding its properties and behavior. A wood scientist can help you and your 4-H'ers better understand the properties of wood and how they affect the use of wood.

Wood scientists have organized as professionals into a Society of Wood Science and Technology (SWST). The Society publishes a quarterly journal called *Wood and Fiber Science* which began in 1983. Prior to that were two publications, *Wood and Fiber* and *Wood Science,* which merged. Libraries may have copies of each up through 1982. The new publication (*Wood and Fiber Science*) contains technical information about wood. In addition, there are numerous trade publications which deal specifically with harvesting, processing, furniture manufacturing, and pulp and paper.

Information about the Society and careers in wood science is available from SWST, P.O. Box 5062, Madison, Wisconsin 53705.

Another publication, *The Forest Products Journal,* is published monthly by the Forest Products Research Society, 2801 Marshall Court, Madison, Wisconsin 53705.

Appendix X

Suggested Wood Science Experiments

The youth who are enrolled in this project will learn a great deal about wood and woodworking tools as they progress through each Unit. You can help them even more by conducting some simple experiments. These experiments will help 4-H'ers learn to better use wood. And you, as a leader, may even discover something you didn't know about wood.

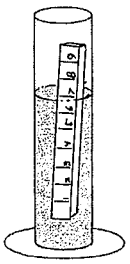
Here are a few suggestions. There are many other possibilities. Feel free to pick and choose those which best suit the needs of your 4-H members. Your reward will be to see your members build better products from wood because of what they have learned through their experiments and experiences with you as a leader.

Specific Gravity and Strength of Wood

Specific gravity tells how heavy wood is compared to water. Most wood is lighter than water, so it has a specific gravity of less than one.

You can do a reasonably good job of finding the specific gravity of wood by floating a piece on end and measuring the proportion of it that gets wet. Do it quickly before the wood gets so wet that it sinks further than it did when dry. If half gets wet, its specific gravity is 0.5, which means that it is half as heavy as water.

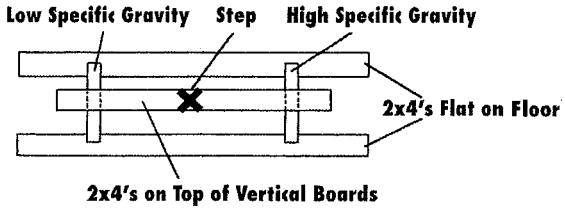
Better yet, dip it in hot paraffin or paint it first. Cut a 10-inch piece of uniform cross section (¾"×¾" or 1½"×1½") from a board or a 2×4. Draw a line at each inch. Float it on end. Count the number of spaces that get wet. Divide by 10. That gives the specific gravity. (You can estimate in between the spaces to be more accurate).



$\frac{6.5}{10}$ = **0.65 SPECIFIC GRAVITY (because 0.65 of sample is under water)**

Note: You will need to support the wood gently in order to get it to float on end rather than float on its side. If in supporting it you accidentally push down or pull up, that will change the level at which the wood floats and, therefore, give an inaccurate reading of its actual specific gravity. A tall glass tube just large enough for the sample works best, but if you do not have one, a paper milk carton will work quite well.

You can demonstrate that a heavyweight wood is stronger than a lightweight wood by using two pieces the same size. Use the two that have the greatest difference in specific gravity. Set them across supports (2×4's laid flat on the floor) and support a third 2×4 on top of them as shown below. Ask progressively heavier members to stand near the center of the third 2×4 until one piece breaks.



Thermal Properties of Wood

You'll need a plastic bag filled with ice cubes, any long metal rod or bolt, and a piece of wood the same length. Stick the rod and wood in the bag of ice cubes at the same time and have the group feel them both from time to time. Note that the rod feels cold while the wood does not. Wood is a good insulator; poor conductor. (You could demonstrate the same property using hot water instead of ice.)

Strength of Nails, Screws, Bolts, Glue

You will need short pieces of 2×3's or 2×4's, all about the same length, each with one end cut at a 45-degree angle. (Making these might be a group exercise.) You will need a variety of fasteners, such as short nails, long nails, modified shank nails, wood screws, bolts, and glue. Fasten two pieces together to form a V at the top.

Hold an old baseball bat, table leg, or pipe in the V notch and have the lightest to the heaviest member pound on or jump on the bat, or hit it with different weights of hammers. Write the pounds force or some qualitative measure on the broken piece (such as, it took Bob to break it; it took James and Lynn). List the fasteners tested, from the weakest to the strongest.

BB Driving Contest

You'll need a hammer, some BB's or ballbearings, one softwood board, and one hardwood board. Have members drive the BB's first into the softwood board and then try to drive them into the hardwood board. Try to drive them in both the sides and the ends of the boards, and then find out which was the easiest and which was the most difficult.

The Tug of War

All you need is one long, smooth board (a furring strip, about ¾×1 would be good). Choose two members approximately the same weight or divide the group into two teams, if the board is long enough. Have the two pull and tug on the board. No matter how hard they pull, as long as they pull straight, they will probably not be able to pull the board apart. (Caution: be sure it is a smooth board and wear gloves for protection from slivers.) This demonstrates the strength of wood in tension.

If the piece of wood is expendable, demonstrate how easily it can be broken by the two smallest students bending it against a post. (Be careful of sharp ends when it breaks.) Cut off any sharp ends. Fasten the two pieces together with a nail or screw. Pull again. This demonstrates that it is hard to fasten wood and have strength equal to the original wood.

Distortion of Wood Upon Swelling

Paint one side of a flat, dry board and both sides of another. Mark the center on each. Measure the board lengthwise from center to end. Soak both boards in water. Again, measure the boards from center to end. Note that the board painted on one side curves because it swells first on the unpainted side, but it flattens out later when both sides have swollen.

Repeat, but first dry the boards in an oven just before painting. Then allow them to pick up moisture from the air, rather than soaking them. You will see that coatings delay swelling but do not prevent it, yet coating both sides is a good practice to prevent uneven swelling.

Measuring the Moisture Content of Wood

Weigh a small wood sample taken at least 20 inches from the end of a board (the ends dry more rapidly, so a sample from the end may not indicate the true moisture content). Weigh the sample accurately right after it is cut. Dry it in an oven set at 225 to 250 °F until the sample reaches a constant weight (this might take 12 hours). This is the **oven-dry weight.** Subtract the oven-dry weight from the weight of the sample when cut. The difference is the weight of water removed in drying. Divide the weight of water removed by the oven dry weight and multiply by 100. This gives percent moisture content. Note that it is traditional among wood scientists to use the oven-dry weight as the denominator when expressing moisture content. (Engineers often use the wet weight as the denominator. This results in a slightly lower value for moisture content in dry wood, and a much lower value in wetter wood.)

Here is an example: If a small sample of wood weighs 220 grams when cut, and 200 grams after drying, it has lost 20 grams of moisture. The percent moisture content equals:

$$\frac{\text{weight when cut minus oven-dry weight}}{\text{oven-dry weight}} \times 100 =$$

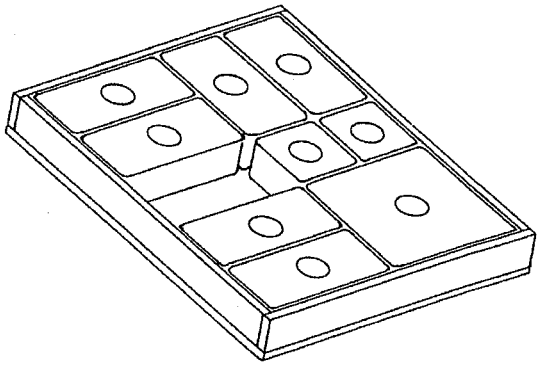
$$\frac{220 - 200}{200} \times 100 = \frac{20}{200} \times 100 = 10\%$$

(Note: If *weight when cut* was used as the *denominator*:

$$\frac{220 - 200}{220} \times 100 = \frac{20}{220} \times 100 = 9\%)$$

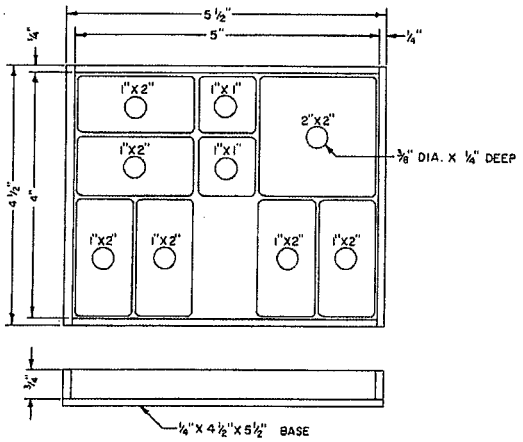
Appendix XI
Suggested Plans for Woodworking Projects

Nine Block Puzzle



Materials needed
- Use ¼-inch plywood for sides and base. Use 1-inch lumber (actual thickness ¾ inch) for the blocks. See illustration for the dimensions.
- Glue
- ½-inch brads

Tools needed
- Tack hammer
- Saw
- Drill with ⅜" countersink bit
- Sandpaper
- Paint or stain and varnish



Instructions
1. Cut all pieces to size.
2. Glue and nail frame together and then glue and nail to base.
3. Drill a shallow countersink hole in the middle of the nine blocks so they can be moved easily.
4. Sand all pieces and round corners so they will move easily in frame.
5. Finish as desired.

Playing instructions
Start from position shown. The object of the game is to move the large block from the upper right corner to the upper left corner. This takes a minimum of 47 moves.

Bed for Dog or Cat

Materials needed

- 1 piece lumber 1"× 8" (actual size ¾"× 7½") × 18" for back
- 2 pieces lumber 1"×8"×12" for ends
- 1 piece lumber 1"×8"×10" for front
- 1 piece lumber 1"×8"×2" for front
- 2 pieces lumber 1"×2" (actual size ¾"× 1½") × 18" for floor supports
- 1 piece ½" plywood 11¼" × 18"
- 6d finishing nails

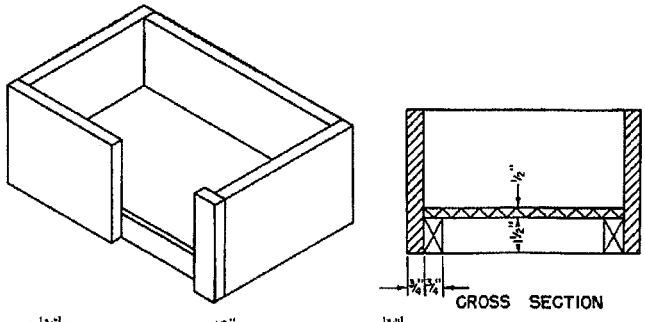
Tools needed

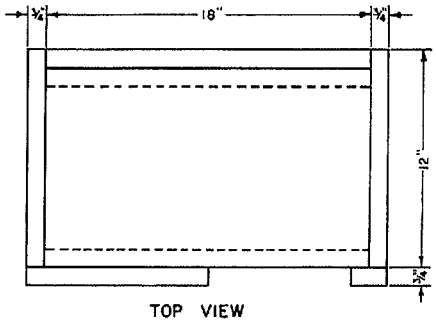
- Saw
- Hammer
- Sandpaper
- Shellac or paint

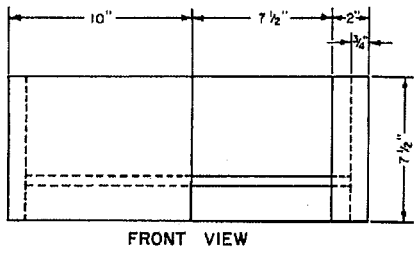
Instructions

1. Cut pieces to size.
2. Nail ends to back.
3. Nail front pieces to ends.
4. Set floor supports in place and nail through end pieces into ends of supports.
5. Nail floor to supports.

Note: If pet is larger or smaller, dimensions can be changed accordingly.







Nail & Tool Box

Materials needed

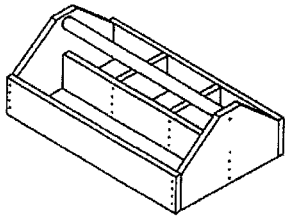
- 1 piece wood ½"× 24"× 24" (use exterior plywood)
- 1 piece of ¾" dowel stock, 15½" long
- Finishing nails 1¼" or 1½"
- 2 No. 8, 1" flathead wood screws
- Glue

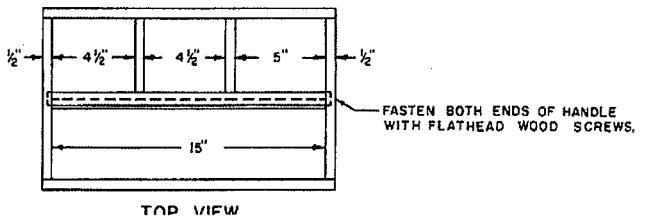
Tools needed

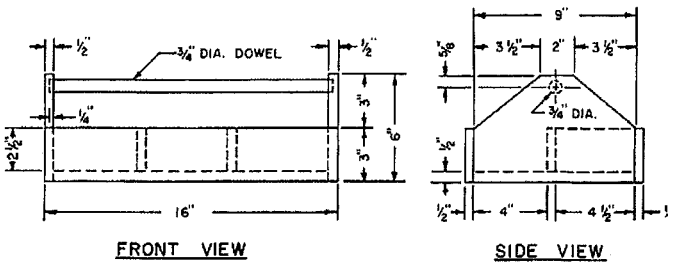
- Hammer
- Saws
- Screwdriver
- Drill with ¾" bit
- Sandpaper
- Paint or shellac

Instructions

1. Cut pieces to size.
2. Drill end pieces ¼" deep for dowel.
3. Sand all pieces before assembly.
4. Glue and nail partitions to base.
5. Glue dowel between ends and fasten with screws.
6. Fit end/handle section over base. Glue and nail.
7. Glue and nail side pieces to unit.
8. Apply finish.





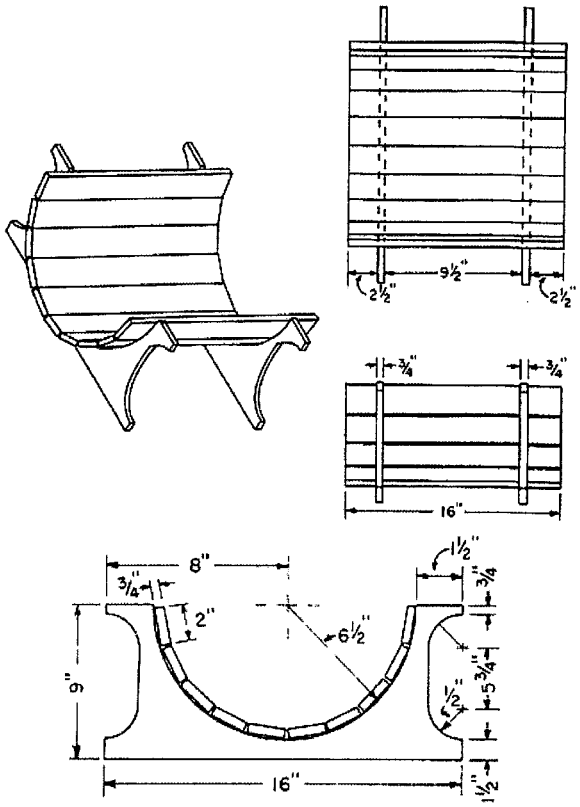


Firewood Basket

Materials needed
- 2 pieces of ¾" × 9" × 16" plywood for ends
- 10 pieces lumber 1×2 (actual size ¾" × 1½") × 16" for slats

Tools Needed:
- Table saw or hand saw
- Jig saw or saber saw
- Hammer
- Hand plane
- Sandpaper on block
- 50 6d box nails

Instructions:
1. Leave ends of plywood square. (Note: If notched out, keep notch shallow or nails will stick through.)
2. Find center on plywood pieces.
3. Use compass on a string and pencil to lay out semi circle to be cut out for basket (6½" radius).
4. Smooth all surfaces.
5. Cut 10 pieces ¾"× 2" for slats.
6. Start at top of semi circle to nail on slats. Keep at 90° angle while nailing. Alternate nailing on slats, first one end then the other.
7. Paint to preference or finish as desired.

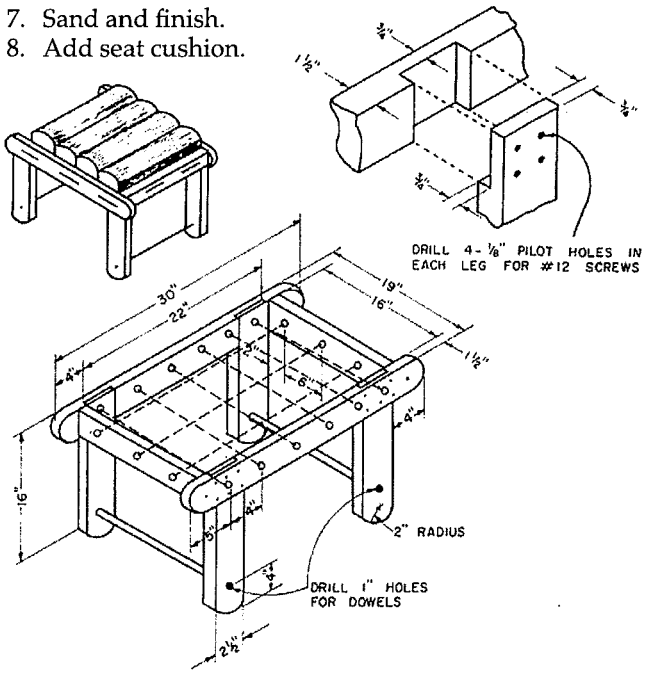


Lawn Stool

Materials needed
- 2 pieces lumber 2×3 (actual size 1½"× 2½") × 2'6"
- 6 pieces lumber 2×3 (actual size 1½"× 2½") × 1'4"
- 2 pieces of 1" dowel stock, 19¼" long
- Waterproof glue
- 8 No. 12, 2½" flathead screws
- 16 No. 12, 1½" flathead screws
- About 23' of ⅜" manila rope
- Foam rubber or other waterproof cushioning material

Tools needed
- Saw
- Drill with 1", 7/16", ⅛", ⅜", and countersink bits
- Screwdriver
- Knife
- Wood file
- Sandpaper
- Exterior paint or stain and exterior varnish

Instructions
1. Cut pieces to size. Round corners as shown with wood file.
2. Glue rails to legs.
3. Drill 1" holes in legs and glue dowels in place.
4. Drill ⅛" pilot holes through legs into rails and fasten with No. 12, 1½" screws (4 per joint).
5. Glue braces between rail ends. Drill ⅛" pilot holes and fasten with No. 12, 2½" screws (2 per joint).
6. Drill 7/16" holes in frame (6 per side and 3 per end) for rope, as seen in illustration. Weave rope through holes, forming a webbed support for the seat cushion.
7. Sand and finish.
8. Add seat cushion.



Book Shelf

Materials Needed:

- 1 piece of ⅜″× 40″× 41½″ interior plywood for back (A)
- 2 pieces of ¾″× 15⅜″× 41″ interior plywood for sides (B)
- 1 piece of ¾″× 10″× 40½″ interior plywood for shelf (C)
- 1 piece of ¾″× 12½″× 40½″ interior plywood for shelf (D)
- 1 piece of ¾″× 15″× 42″ interior plywood for bottom (E)
- 4 pieces of lumber 2×2 (actual size 1½″× 1½″) × 7″ for legs (F)
- 1 piece of lumber 1×2 (actual size ¾″× 1½″) × 29″ for rail (G)
- 2 pieces of lumber 1×2 (actual size ¾″× 1½″) × 9″ for rails (H)
- 8 12d finishing nails
- 6d finishing nails
- Glue
- Wood filler

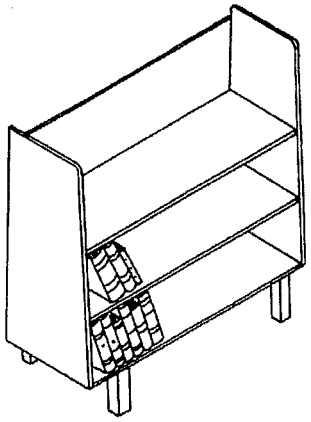
Tools needed

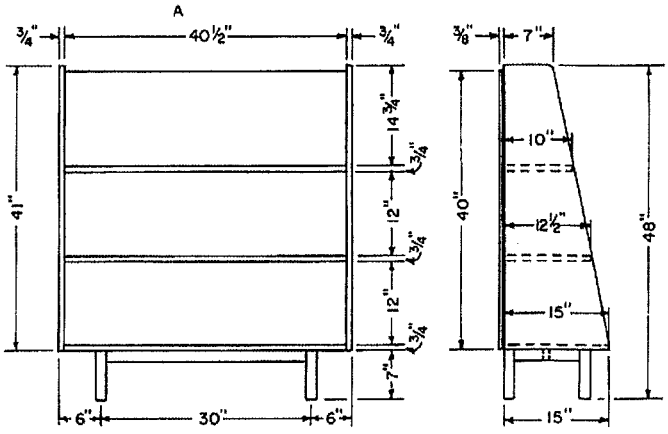
- Saw
- Hammer
- File
- Nail set
- Sandpaper
- Stain and varnish

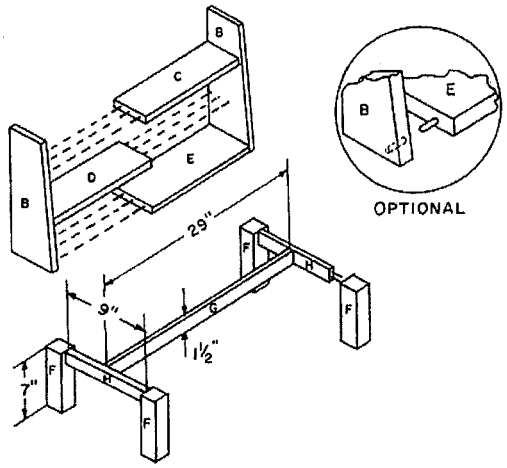
Instructions

1. Cut pieces to size. Round front top corners of side pieces with file.
2. Glue and nail shelves (C, D) and bottom (E) to one end piece (B). Note: Wood dowels may be used in place of nails.
3. Glue and nail other end (B) piece to shelves and bottom.
4. Glue and nail back (A) in place.
5. Glue and nail legs (F) to rails (H) using two 12d nails per leg.
6. Glue and nail end/leg unit to each end of rail (G).
7. Set shelf unit on stand unit and glue and nail in place.
8. Sand and finish.

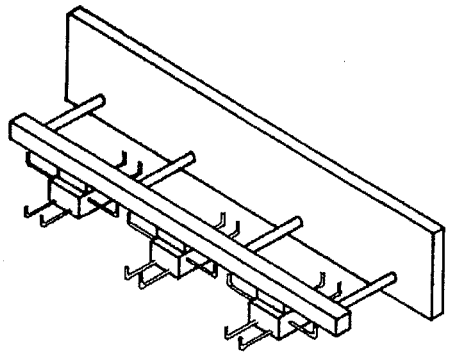
Note: An optional way to join the rail/leg assembly and put the shelving in is to use dowel pins (see circled diagram).





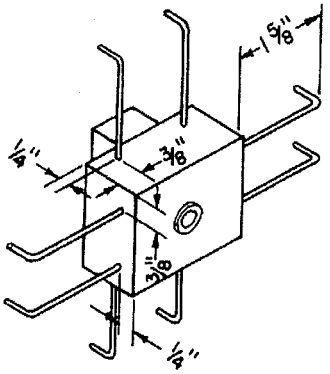


Revolving Tie Rack



Materials needed

- 1 piece of lumber 1×4 (actual size ¾"× 3½") × 20" for back
- 1 piece of lumber ¾"× ¾"× 18" for bar
- 3 pieces of lumber 1×2 (actual size ¾"× 1½") × 1½" for hook holders
- 3 pieces of lumber ¾"× ¾"× 1½" for spacers
- 4 pieces ¼" dowel stock, 3½" long
- 24 metal screw hooks, 3½" long
- 3 No. 8 roundhead woodscrews 2" long
- 6 washers for No. 8 screws
- Glue

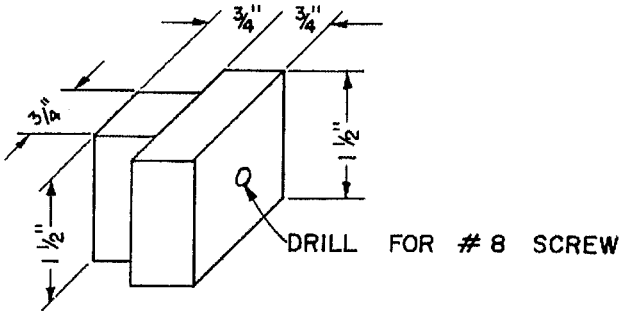


Tools needed

- Drill press or

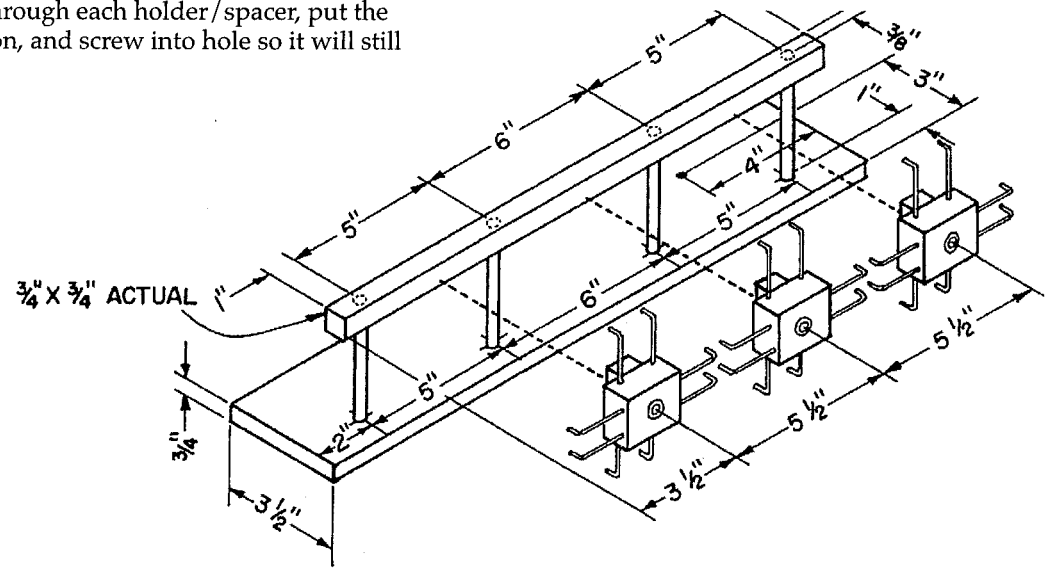
drill with stop gauge and ¼", ⅛", and 1/32" bits

- Screwdriver
- Sandpaper
- Stain and varnish



Instructions

1. Cut pieces to size.
2. Drill ¼" holes in bar, ½" deep. Use drill press or drill with stop gauge for uniform depth holes.
3. Drill ¼" holes in back.
4. Drill 1/32" pilot holes for screws in the bottom of bar.
5. Drill ⅛" mounting holes in back, 4" in from ends and 1" from top edge.
6. Center spacers on hook holders and glue in place.
7. Drill a hole through the center of each holder for the No. 8 screw. Holder should turn free on screw.
8. Sand all pieces.
9. Drill pilot holes in holders for hooks, install hooks leaving them protruding about 1⅝".
10. Mount the bar to the back using the four dowels. Be sure holes for screws are on bottom side of bar.
11. Attach holders to the bar by putting a screw with a washer up through each holder/spacer, put the other washer on, and screw into hole so it will still turn.
12. Apply finish.



Shop Tool Rack & Shelf

Materials Needed:

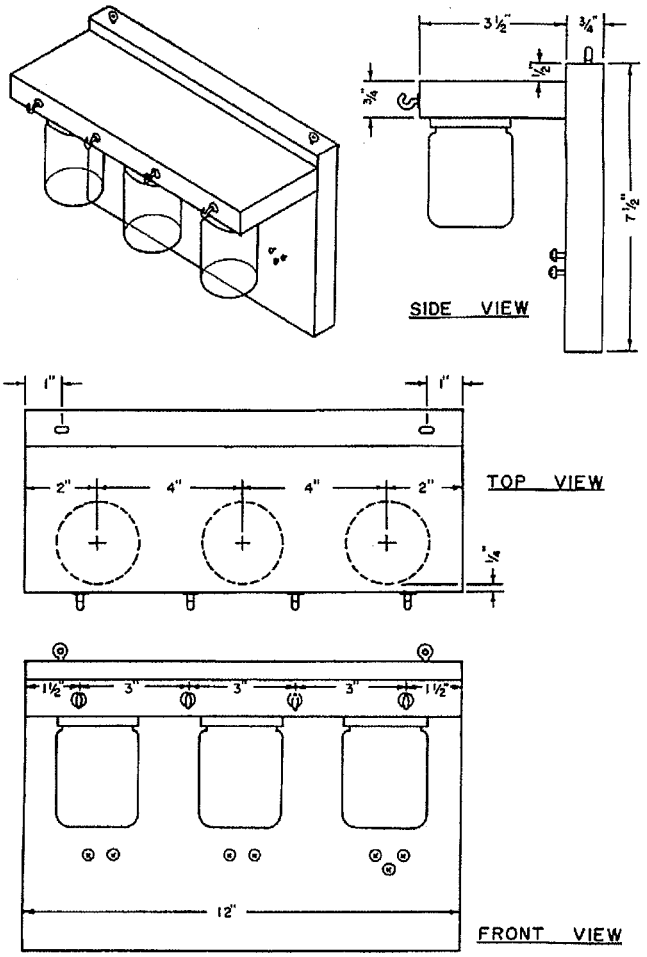
- 1 piece of lumber 1×8 (actual size ¾"× 7½") × 12" for back
- 1 piece of lumber 1×4 (actual size ¾"× 3½") × 12" for shelf
- 3 baby food (or similar) jars with screw type lids
- No. 6, 1¼" round head wood screws
- 3 Round head wood screws ½ inch long
- 4 small cup hooks
- 2 screw eyes
- 3 No. 6 finishing nails
- Glue

Tools needed

- Screwdriver
- Hammer
- Sandpaper
- Shellac

Instructions

1. Cut pieces to size, sand, and finish before assembly.
2. Punch a hole in each jar lid (center) and fasten the 3 lids to one side of shelf.
3. Glue shelf to back and nail.
4. Locate screws in front to hold tools desired.
5. Put screw hooks on front edge of shelf.
6. Put screw eyes in top edge of back.
7. Fasten to wall with nails or screws through eyes.



Shadow Box

Materials needed

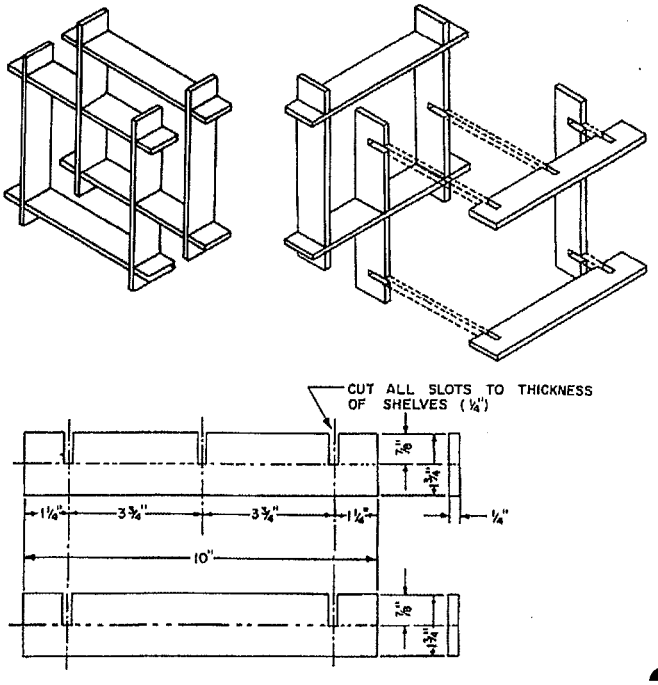
- 8 pieces of interior plywood, ¼"× 1¾"× 10" each
- 2 screw eyes for hanging

Tools needed

- Table saw, bench saw, or fine hand saw
- Square
- Wood file
- Sandpaper

Instructions

1. Cut 4 boards to width and length.
2. Lay out slots to be cut, using small square.
3. Use miter saw, bench saw, or fine hand saw. Be sure to make cuts very accurate. Note: Half of the boards have 3 seats. Others have 2.
4. Sand all surfaces smooth.
5. Try fitting pieces together.
6. Finish boards with stain and clear varnish or, enamel before final fitting.
7. Use two screw eyes to mount shadow box on wall.



Picnic Table with Bench

Materials needed

Table

- 3 pieces lumber 2 × 4 (actual size 1½"× 3½") × 3'6"
- 4 pieces lumber 2 × 4 × 2'6"
- 2 pieces lumber 2 × 4 × 4'
- 11 pieces lumber 2 × 4 × 7'
- 2 pieces lumber 2 × 4 × 6'4"

Bench

- 3 pieces lumber 2 × 4 × 3'
- 4 pieces lumber 2 × 4 × 1'5"
- 2 pieces lumber 2 × 4 × 1'
- 2 pieces lumber 2 × 4 × 1'3"
- 2 pieces lumber 2 × 4 × 1'4"
- 12d galvanized nails for frame or ⅜"× 4½" carriage bolts
- 20d spikes

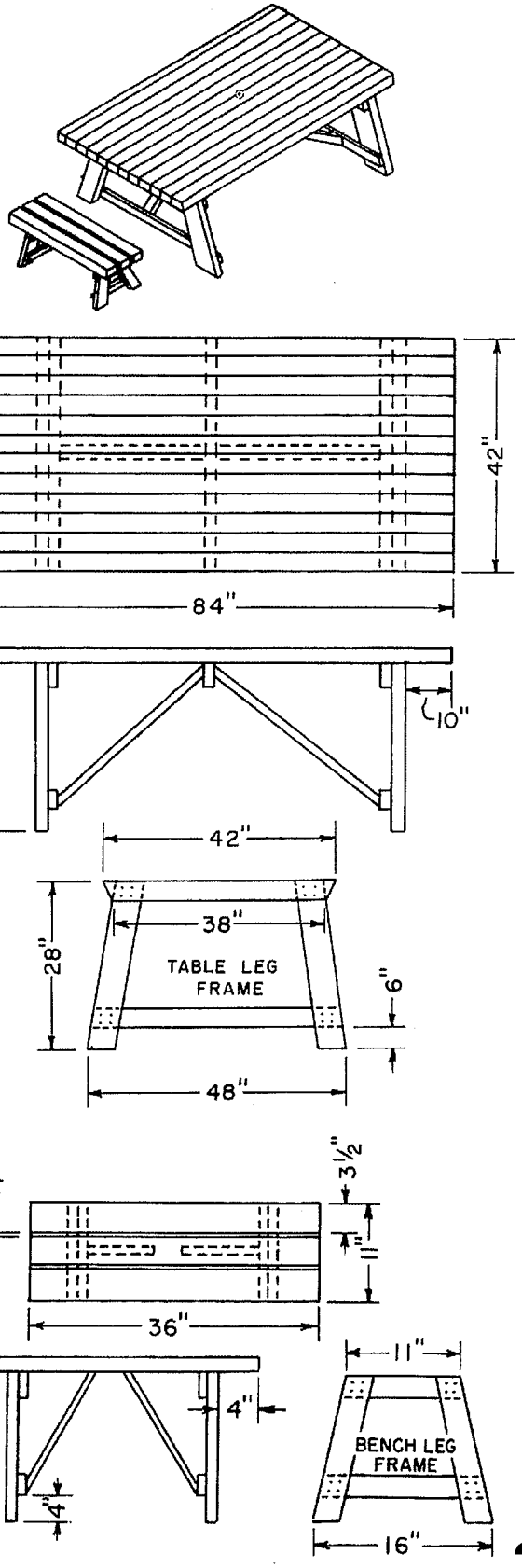
Tools needed

- Saw
- Wood file
- Hammer
- Sandpaper
- Exterior paint or stain and varnish

Instructions:

1. Cut pieces to size.
2. Make 2 table leg frames as shown in drawing. Fasten together using 12d nails.
3. Lay the twelve top pieces flat on the floor. Nail a piece of scrap across them at each end to hold them temporarily; this is removed after table is assembled.
4. Set the leg frames upside down on the top, 10" from either end, and toenail cross members of frames to each top board using 12d nails.
5. Toenail center cross member in place. Mark off diagonal braces and nail them in place with 12d nails.
6. Set table right side up and nail each top board to the cross members of the leg frames using 20d spikes.
7. Use wood file to round rough edges and corners.
8. Bench is made in the same fashion as the table except that the top cross member of each leg frame doesn't extend past legs (i.e., it isn't tapered out).
9. Sand and finish bench and table.

Note: For maximum durability, especially if the table and bench are to remain outdoors, use preservative-treated, decay-resistant lumber.



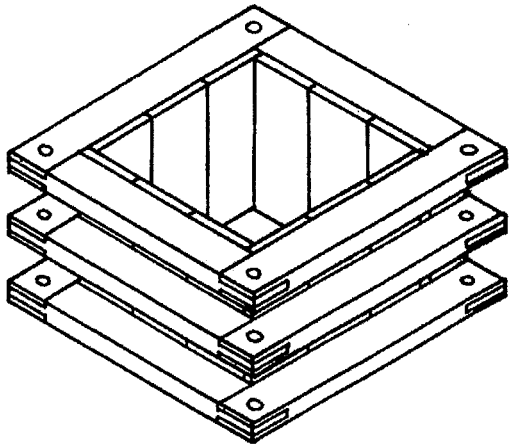
Planting Box

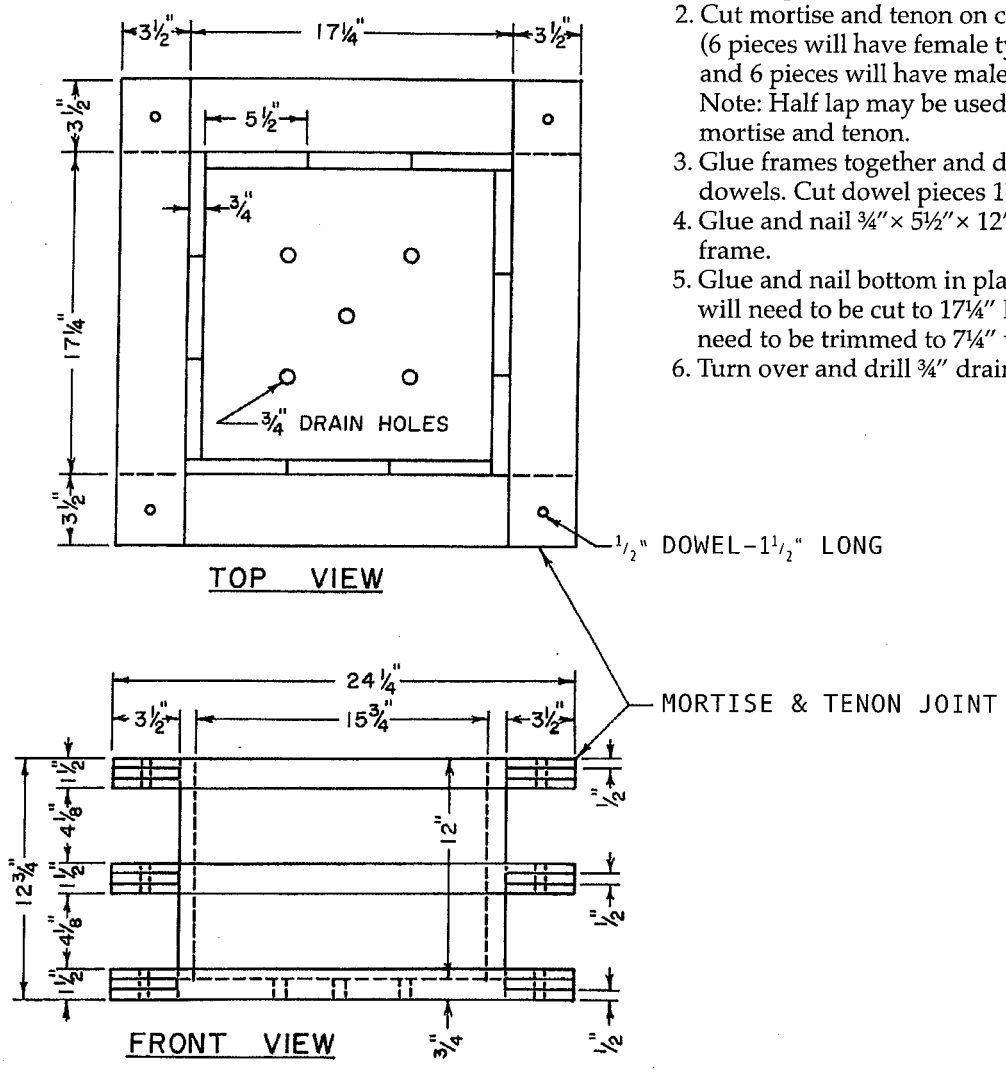
Materials needed

- Redwood or cypress
- 12 pieces lumber 2 × 4 (actual size 1½ "× 3½") × 26" for frames
- 12 pieces lumber 1 × 6 (actual size ¾"× 5½") × 12" for sides
- 2 pieces lumber 1 × 10 (actual size ¾"× 9½") × 18" for bottom
- 1 piece of ½" dowel stock, 24" long
- Waterproof glue
- 6d aluminum nails

Tools needed

- Hammer
- Drill with ½" and ¾" bits
- Saw

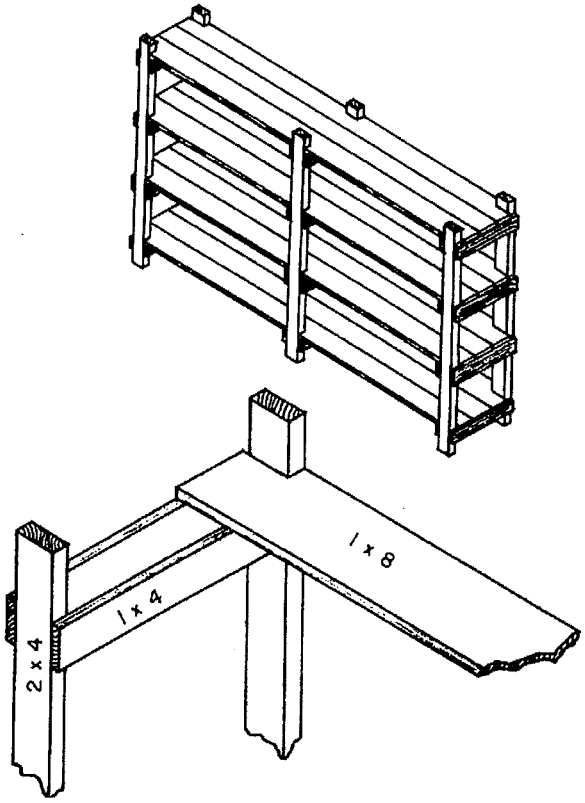




Instructions:

1. Cut all pieces to size as illustrated.
2. Cut mortise and tenon on corners of frame pieces (6 pieces will have female type joint on both ends and 6 pieces will have male type joint on both ends). Note: Half lap may be used as an alternative to mortise and tenon.
3. Glue frames together and drill holes in corners for dowels. Cut dowel pieces 1½" and glue in each hole.
4. Glue and nail ¾"× 5½"× 12" pieces to inside of frame.
5. Glue and nail bottom in place. Note: Bottom boards will need to be cut to 17¼" long, and one board will need to be trimmed to 7¼" wide.
6. Turn over and drill ¾" drain holes in bottom.

Portable Shelving



Materials needed

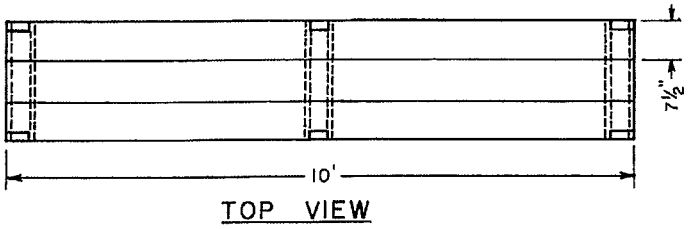
- 6 pieces of lumber 2 × 4 (actual size 1½"× 3½") × 6' for ladder posts
- 12 pieces of lumber 1 × 8 (actual size ¾"× 7½") x 10' shelving
- 24 pieces of lumber 1 × 4 (actual size ¾"× 3½" × 22" for shelving supports (rungs of ladders)
- 96 8d common nails
- 3d and 5d nails for shelving supports

Tools needed

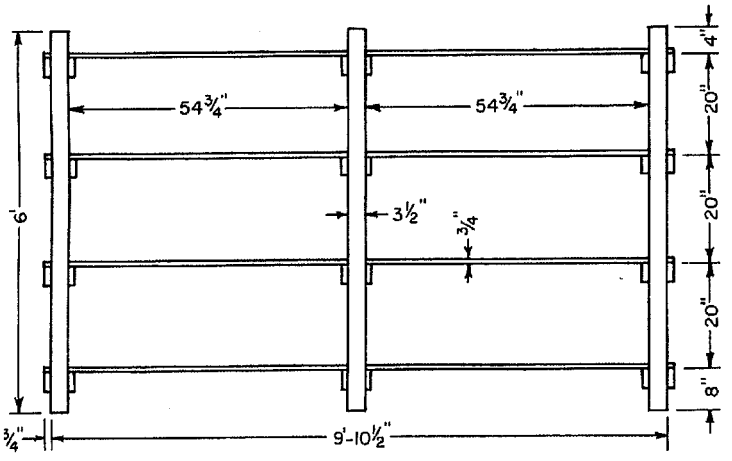
- Saw
- Scale
- File
- Hammer
- Marking pin
- Chisel

Instructions

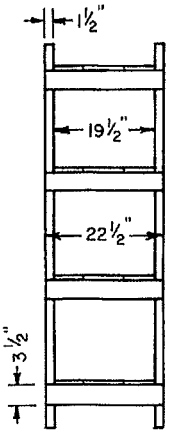
1. Cut six posts to size, 6 feet long, using 2 x 4 pieces.
2. Measure 8" from one end on each post and draw a line on the narrow edge using the square. Repeat process at 28", 48", and 68". These mark the tops of the rungs.
3. Cut the rungs 22" long from the 1×4 boards. Nail in place with 8d common nails. Now check the "ladders" to be sure they stand level.
4. Cut the shelves from the 1×8 boards, 10 feet long each. There will be three of these per level (12 total). Notch out side edges to fit around posts. The two outside shelves need to have three notches cut in them, one at each end and one in the center. These notches should be 1½"× 3½" in size (see illustration).
5. Assemble shelving with 3d and 5d nails. Check for any wobble. If it does not stand level, trim ends of posts to level it.



TOP VIEW



FRONT VIEW



SIDE VIEW

Reference Materials

The following are suggested references for the 4-H wood science leader. They may be helpful in providing additional information about woodworking, finishing tools, wood science and technology, and related materials.

These references are not listed in any of the member manuals, so it is up to you to suggest to your group those references that you would like them to use. Some of the items listed here may be appropriate for youth and may be available at your local library.

Basic Woodworking. Feirer, John L. (gr. 9–12) Peoria, IL: Bennett Pub. Co., 1978.

Basic Woodworking and Carpentry With Projects. Clifford, Jerrold R. (pap. txt., illus.) Blue Ridge Summit, PA: Tab Books, 1980.

Basic Woodworking Projects. McGinnis, Harry and M. J. Ruley. (gr. 7–9) Bloomington, IL: McKnight Pub., 1959.

Bench Woodwork. Feirer, John L. (gr. 7–9) New York, NY: Charles Scribner's Sons, 1978. Text and workbook available.

Canadian Woods: Their Properties and Uses. Mullins, E. J. and T. S. McKnight. 3rd ed. Toronto, Canada: University of Toronto Press, 1981.

Carpentry for Beginners. Hayward, Charles E. Drake Home Craftsman Series (illus.). Verplanck, NY: Emerson Books, 1969.

Carpentry for Children. Walker, Lester. (illus.) New York, NY: Overlook Press, 1982.

Carpentry for Kids. Herda, D. J. and Judy B. (gr. 4 up, illus.) New York, NY: Messner, 1980.

Complete Book of Wood Finishing. Sharff, Robert. 2nd ed. (illus.) New York, NY: McGraw-Hill, 1974.

Farm Builders Handbook. Lytle, R. J. 3rd ed. New York, NY: McGraw-Hill, 1981.

Forest Products and Wood Science: An Introduction. Haygreen, John G. and James Bowyer. (illus.) Ames, Iowa: Iowa State University Press, 1982.

How To Do Your Own Wood Finishing. Hand, Jackson. 2nd ed. Popular Science Skill Book. New York, NY: Harper & Row, 1976.

If I Had A Hammer. Woodworking With Seven Basic Tools. Lasson, Robert. (gr. 4 up, illus.) New York, NY: Dutton Pub., 1974.

Industrial Arts Woodworking. Feirer, John L. (gr. 9–12) Peoria, IL: Bennett Pub. Co., 1977.

Making Toys in Wood. Hayward, Charles H. (rev. ed., illus.) New York, NY: Sterling Pub., 1980.

Making Wooden Toys. Blizzard, Richard (illus.) New York, NY: Sterling Pub., 1982.

Practical Woodwork. Hayward, Charles H. (gr. 9 up, illus.) Verplanck, NY: Emerson Books, 1967.

Projects in Wood Furniture. Douglass, Harvey J. (gr. 7 up, rev. ed., illus.) Bloomington, IL: McKnight Pub., 1967.

What Wood is That? A Manual of Wood Identification. Edlin, Herbert L. (illus.) New York, NY: Viking Press, 1969.

Wood As A Building and Hobby Material: How to Use Lumber and Wood Base Panels and Round Wood Wisely in Construction for Furniture and as Fuel. Kubler, Hans. New York, NY: John Wiley & Sons, 1980.

Wood Handbook: Wood As An Engineering Material. USDA Forest Products Laboratory. Agriculture Handbook #72. Washington, DC: Government Printing Office, 1974.

Wood Materials and Processes. Feirer, John L. (illus.) New York, NY: Charles Scribner's Sons, 1976.

Wood: Materials and Processes. Feirer, John L. (gr. 7–12, rev. ed.) Peoria, IL: Bennett Pub. Co., 1980. Student and teacher edition available.

Wood Structure and Identification. Core, Harold A. et al., (pap. txt., illus.) Syracuse, NY: Syracuse University Press, 1979.

The Woodworker's Pocket Book. Hayward, C. and R. Lento. (illus.) Englewood Cliffs, NJ: Prentice-Hall, 1982.

Woodworking for Kids. Torre, Frank. (gr. 3–7) New York, NY: Doubleday & Co., 1978.

Woodworking for Kids. Starr, Richard (illus.) Newtown, CT: Taunton Press, 1982.

Working With Wood. Background Information. Parker, Sheila. Science 5–13 series (illus.) Milwaukee, WI: Raintree, 1977.

Working With Wood. Stages 1 & 2. Parker, Sheila. Science 5 13 series (pap. txt., illus.) Milwaukee, WI: Raintree, 1977.

Magazines

The following magazines may have dimensioned plans for woodworking projects and are usually available at your local magazine stand or library.

The Family Handyman

Fine Woodworking

Popular Mechanics

Popular Science

Woman's Day

Workbench

Other Sources of Educational Aids

The following sources may have literature and/or audiovisuals available to help. Some items may be free; others may be available at cost. Write for a guide or catalog to what's available.

American Plywood Association, P.O. Box 11700, Tacoma, WA 98411. "Plywood Publication Index." It covers films, pamphlets and plans that are available.

American Forest Institute, 1619 Massachusetts Ave., N.W., Washington, D.C. 20036. Guide to forest industries, educational materials, movies, and slide show rentals.

American Wood Council, 1619 Massachusetts Ave., N.W, Washington, D.C. 20036. Pamphlet, "Some Little Known Facts About Wood." Leaflet, "A Reader's Guide to Wood Products."

American Paper Institute, 260 Madison Ave., New York, NY 10016. Guide to literature and audiovisuals.

Craft Patterns Studio, 2200 Dean Street, St. Charles, IL 60174. Write for information on woodworking plans and craft patterns.

Directions Simplified, Inc., P.O. Box 215, Briarcliff Manor, New York 10510. Write for a catalog and order form for patterns and books. Audiovisuals may also be available.

Hardwood Plywood Manufacturers Association, 1825 Michael Faraday Dr., Reston, VA 22090. A list of hardwood plywood literature and plans is available.

Mastercraft Plans, Box 631, Park Ridge, IL 60068. "Popular Plans & Patterns."

National Forest Products Association, 1619 Massachusetts Ave., N.W., Washington, D.C. 20036. Write for information on free and inexpensive literature.

National Particleboard Association, 2306 Perkins, Silver Spring, MD 20910. Write for information on free and inexpensive literature.

Southern Forest Products Association, P.O. Box 52468, New Orleans, LA 70152. Write for a copy of "Everything You Always Wanted To Know About Southern Pine and Ought To!"—a catalog of consumer, technical, and educational literature, films, and services.

Southern Forest Institute, 3395 Northeast Expressway, Suite 380, Atlanta, GA 30341. Booklet: "How Paper Comes From Trees"; also other aids.

Stanley Tools, Educational Department, 600 Myrtle Street, New Britain, CT 06050. Write for information on woodworking plans and safety charts.

Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Write for information on literature related to wood science, woodworking, and forestry.

Weyerhaeuser Company, Box A, Tacoma, WA 98401. Write for information on literature and audiovisual aids relating to wood science and woodworking.

Hand Tool Institute, 707 Westchester Avenue, White Plains, NY 10604. Write for information on the "Hand Tool Safety Guide to Selection and Proper Use"; also ask for information on any other related aids that are available.

Glossary of Woodworking Terms

A. General Terms

d—the abbreviation for "penny" in designating nail size; for example, 8d nails are 8 penny nails, 2½" long.

fiber—A general term used for any long, narrow cell of wood or bark, other than vessels.

grain direction—The direction of the annual rings showing on the face and sides of a piece of lumber.

hardwood—Wood from a broad leaved tree and characterized by the presence of vessels. (Examples: oak, maple, ash, and birch.)

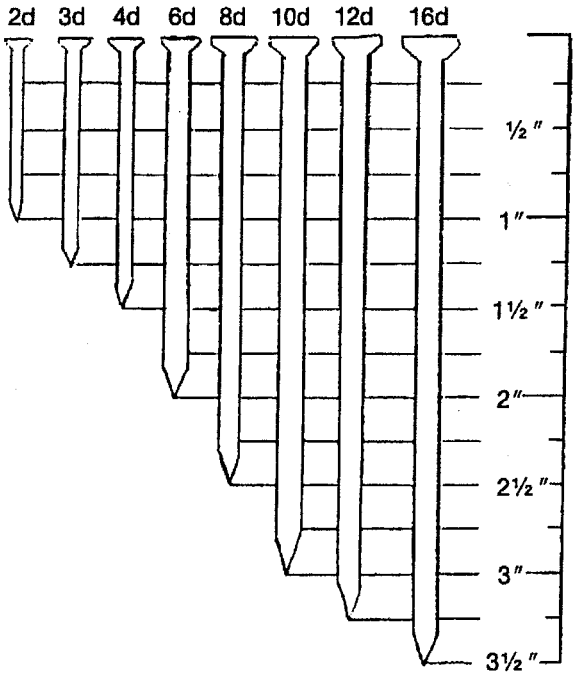
heartwood—The older, harder, nonliving portion of wood. It is usually darker, less permeable, and more durable than sapwood.

kiln dried—Wood seasoned in a humidity and temperature controlled oven to minimize shrinkage and warping.

sapwood—Wood immediately inside the cambium of the living tree that contains living cells. This wood is more permeable, less durable, and usually lighter in color than heartwood.

softwood—Wood from a coniferous or cone bearing tree and characterized by having needles, such as pine.

vessel—A series of cells having fused together to form a long tube. They extend longitudinally in the stem.



B. Terms Used in the Lumber Industry

boards—Lumber less than 2 inches in nominal thickness and 1 inch and wider in width.

board foot—A measurement of wood. A piece of wood that is 1 foot long by 1 foot wide by 1 inch thick. It can also be other sizes that have the same total amount of wood. For example, a piece of wood 2 feet long, 6 inches wide, and 1 inch thick; or a piece 1 foot long, 6 inches wide, and 2 inches thick would also be 1 board foot. To get the number of board feet in a piece of lumber, measure your lumber and multiply Length (in feet) x Width (in feet) x Thickness (in inches). The formula is written:

$$T'' \times W' \times L' = \text{Board feet} \quad \text{or} \quad \frac{T'' \times W' \times L'}{12} = \text{Board feet}$$

$$\text{or} \quad \frac{T'' \times W' \times L'}{144''} = \text{Board feet}$$

dimension lumber—Lumber 2 to 5 inches thick and up to 12 inches wide. Includes joists, rafters, studs, planks, girders, and posts.

nominal—Refers to the size of lumber by which it is known and sold in the market. Nominal size often differs from the actual size.

timbers—Lumber that is 5 inches or more in its least dimension. According to use in construction, they are classified as beams and stringers, girders, purlins, and posts.

veneers—A thin slice of wood cut from a log with a knife or saw. Veneers are also produced in a giant lathe, by turning a log on a horizontal axis against a long knife cutting the log into thin wood slices.

Note: Also refer to the glossary in each of the member manuals.

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4-H Wood Science Project Record
(Use with all Wood Science units)

Year _____

Member's name _____ Age _____ County _____

Address _____ Zip Code _____

Units of Wood Science completed this year _____
(Name of project manual—Unit)

1. Write a short story about the new things you learned this year regarding wood and its use. (Attach an extra sheet of paper.)

2. List the item(s) you made, refinished, repaired, etc. Indicate total cost of materials used for each and the value of the finished product. Estimate the number of hours you spent on each item. (You should keep a separate itemized list of materials and costs for each woodworking item that you complete. In some states, it may be necessary to attach it to your project record sheet.)

Item	Total cost of materials	Value of product	Hours spent

3. List the primary tools and procedures used in this project.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

4. Describe the safety precautions you observed in your woodworking activities or safety precautions you learned about for the first time.

_____

_____

_____

_____

(Continued on next page.)

5. When making items from wood, did you use the blueprints/plans provided in the 4-H manual, blueprints from another source, or make up your own plans? (Check as many as apply.)

❑ Blueprints in 4-H manual ❑ Blueprints from another source ❑ Made my own blueprints

6. Note any problems you encountered, if any, while making, refinishing, or repairing items from wood. If you could do the same item again, what would you do differently?

7. What additional items would you like to learn how to make in future project work?

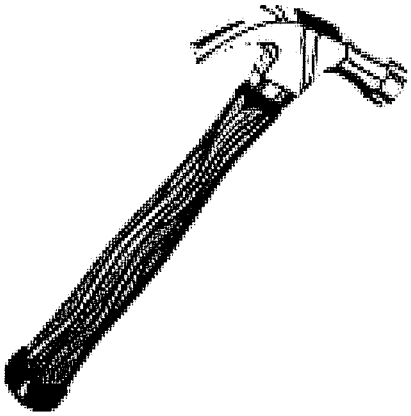
8. What tools and skills would you like to utilize in wood science?

Tools	Skills

9. List any demonstrations, speeches, talks, news articles, radio or TV appearances that you were involved in related to your project work.

10. What leadership and citizenship activities did you do as an individual and/or in a group?

(Note: You may attach an extra sheet of paper for answering questions, if necessary, but try to be brief and concise with all answers.)



Skill-a-Thon

Woodworking

Parts of a Hammer

Supplies Needed:

Figure of Hammer or real hammer with parts numbered, Sheet to record answers or flash cards to put in the area, Pencils

Situation:

You have enrolled in woodworking and would like to do a demonstration on how to build a bird house. It is important for you to know the parts of the hammer so you can use the proper terminology during your demonstration.

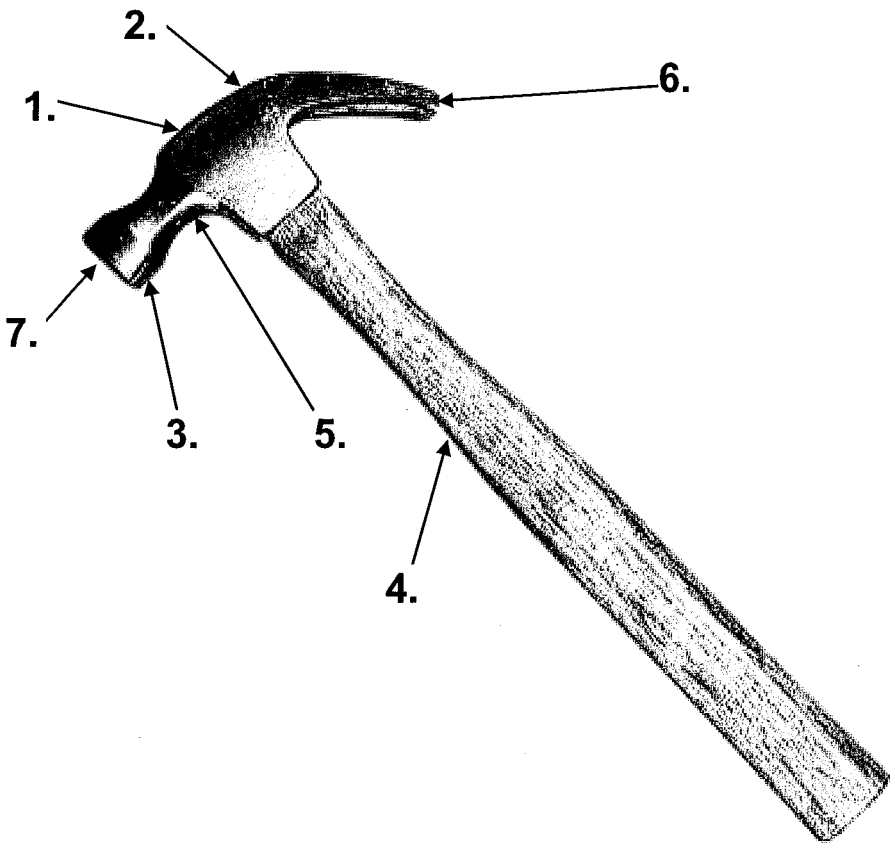
Task:

Identify the labeled parts of the hammer.

Directions:

- For using the paper figure: Label the parts of the hammer on the sheet provided.
- For using flash cards: Arrange the answer card closest to the correct marking on the hammer.

Figure of Hammer



1.

2.

3.

4.

5.

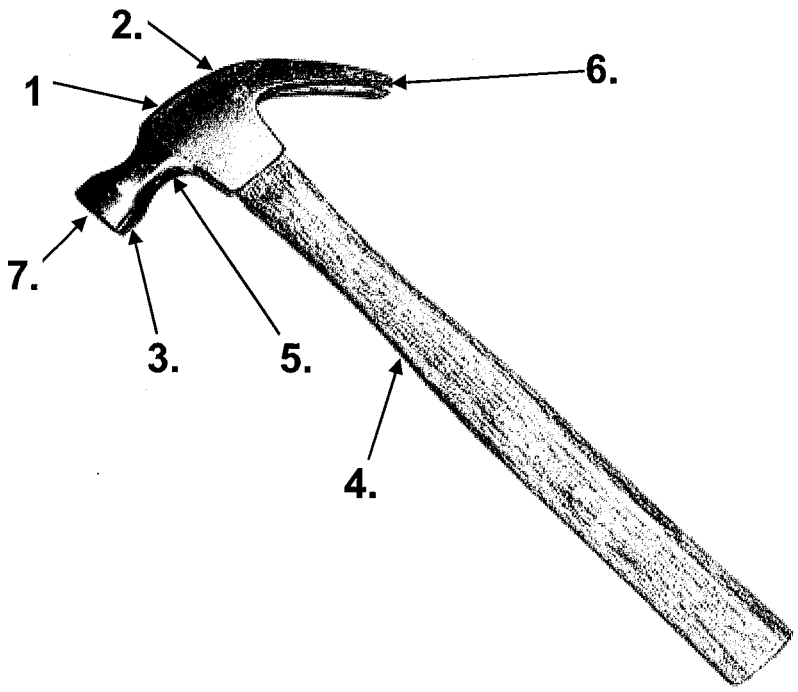
6.

7.

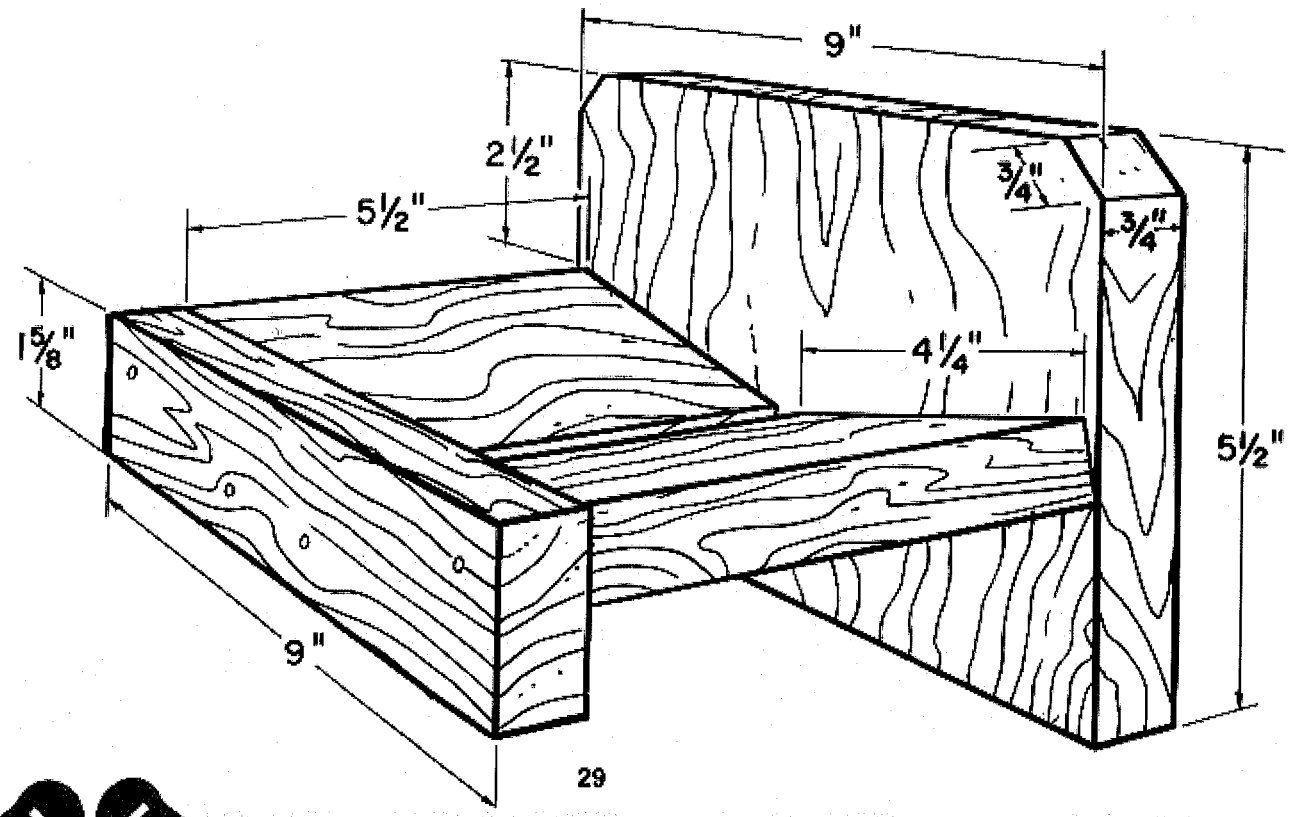
Answer Cards

Head	Face
Check	Poll
Handle	Neck
Claw	

Parts of a Hammer Answer Key



1. Head
2. Check
3. Poll
4. Handle
5. Neck
6. Claw
7. Face



29

Working with Wood & Tools

Unit I Member Manual

National 4-H Wood Science Series

4-H 4421
Reprinted September 2006

Oregon State University | Extension Service

Working with Wood & Tools

Acknowledgement
Reprinted for use in Oregon.
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Contents

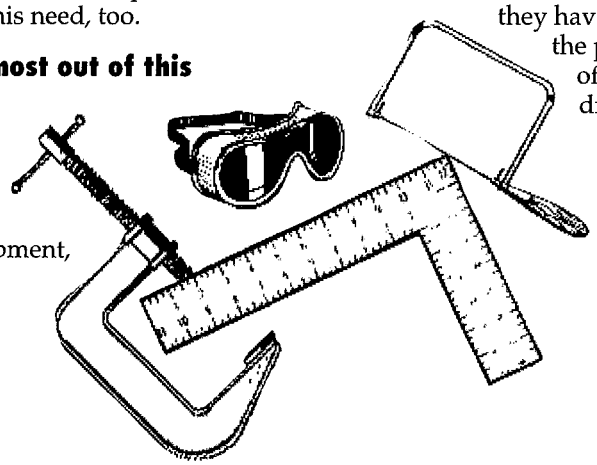
Note to Parents and Home Helpers

You, as parents or home helpers, are the most important and influential persons in your children's lives. You can nurture and cultivate their interest in this project by guiding their planning, helping them carry out their projects, and recognizing them for a job well done.

The information in this manual can provide significant learning experiences for your children. Helping them plan the things they will learn and do, followed by assessing their progress based on these plans, will make their experience more worthwhile. Your children's project leader usually helps them plan and evaluate their work. If this is not possible for some reason, you could fulfill this need, too.

Help children get the most out of this project:

- Become familiar with the material in this manual.
- Work with them to decide what tools, equipment, and supplies they will need and what they can realistically expect to obtain.
- Thoroughly review the tasks they are expected to complete, making sure they understand them. DO NOT DO ANY OF THE WORK FOR THEM.
- Assist them in scheduling their time.
- Discuss their progress with them from time to time.
- Help them distinguish between a good job and a poor one.
- Help them to get to know themselves, including their strengths and weaknesses, and to improve on their abilities.
- Review their accomplishments based on what goals they have for themselves. Avoid comparing the progress of any one child with that of other members who may have different goals and equipment.



Introduction

Hi, Woodworker! This is the first unit of the 4-H Wood Science series. This manual tells you some important things about using wood tools and building objects with wood.

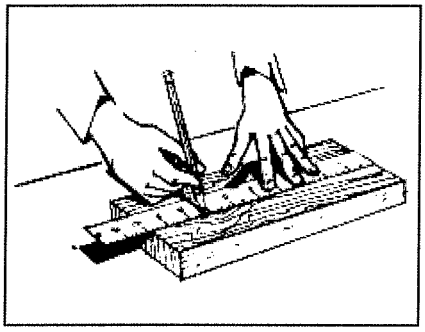
Remember that the wood you will be using was once a tree in the forest! We know that the forest keeps growing, year after year. It keeps giving us a rich harvest of wood. Many people work with the forest and with forest products.

The forest also can be a fun area as well as a work area. Make a list of fun things people can do in the forest, like watching animals and camping.

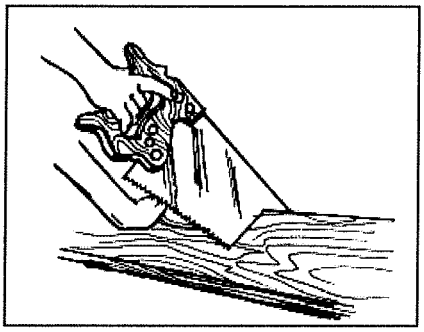
Building things out of wood and wood products can be fun, too. In the back of this manual are plans for some items you may want to make. There also are many other easy-to-build items that you could make. But before you start building anything, discuss your project with your parent or your leader. Make sure you have the materials and tools and work area that you need. Your parent or leader may be able to provide you with a good place to work.

There is a lot to say about wood and wood products! Remember this tip: the more you know about wood, the better you can use it. So get permission to tour places where people work with wood, such as lumberyards, carpenter or cabinet shops, forest areas, or lumber mills.

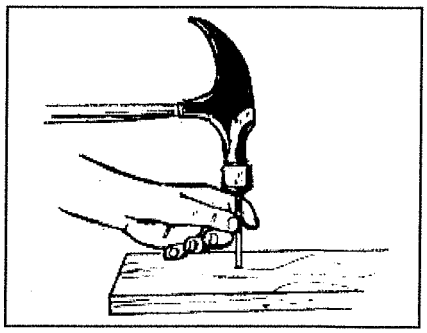
The Wood Science Program gives you a chance to do some fun things!



Measure and Mark

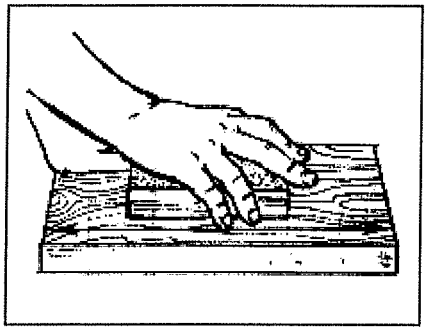


Saw Boards

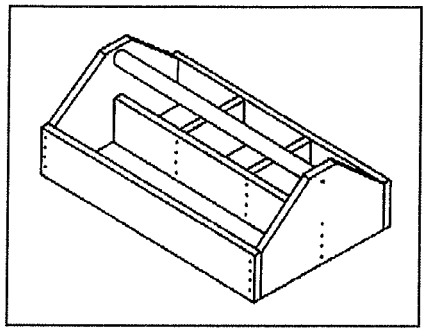


Drive and Pull Nails

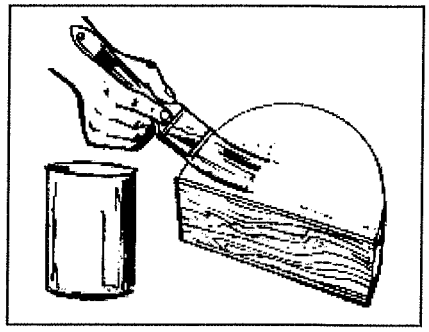
And learn how to use wood tools to help you do these things correctly and easily.



Sand Wood



Build Things



Use glue and finishes

Get a notebook and be prepared to jot down drawings, ideas, and important information about wood and wood tools. If you keep a good notebook, you will remember more things about wood as you go along!

The wood that you will be working with may be in the form of lumber, plywood, particleboard, or fiberboard. Even though all of this wood comes from trees, each product looks different and has different uses. In Unit I, you will be working more with lumber and plywood. You will work with other kinds of wood in later manuals.

Some types of wood cost more than others. Wood comes in different grades. The better the grade, the higher the price. You may save money by buying a lower grade and cutting the material you need from the good parts of the piece. Use low-cost lumber if you can find it.

Other things being equal, the heavier the wood, the harder and stronger it is. Some woods are more likely to split than others. Some woods are easier to cut, sand, and finish. Ask your parents, your leader, or the people at the lumberyard about suitable materials.

Things you can do

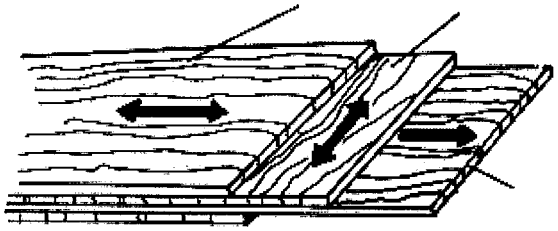
We can divide all kinds of trees into two basic wood groups, called **hardwoods** and **softwoods.** Hardwoods (such as oak, maple, and cottonwood) have broad, flat leaves. They usually turn colors and lose their leaves in the fall. Softwoods (such as pine and cedar) have needle-like or scale-like leaves and usually keep their leaves through the entire winter.

- Make an exhibit showing the two major groups of wood. Show what kinds of trees are in each group.
- Have your leader, or someone who works with wood, show you how plywood is made.

Lumber and Plywood

Lumber contains a lot of water when it is cut. Much of this water evaporates into the air. When this happens, the wood begins to shrink! If the wood becomes wet again, it will get bigger, or **swell**. When wood loses water it also can **warp**, or change its shape.

Plywood is made by gluing together thin layers of wood. (See the picture below.) The grain in each layer goes in the opposite direction, shown by the arrows. Plywood does not shrink and swell as much as lumber. It does not crack or split as easily, either. But the edges on plywood are harder to smooth and finish.



Plywood has three or more layers of wood. The grain of each is placed in the opposite direction of the layer below it.

Some plywood is made for outdoor use. If you use the indoor plywood outside, it may come apart when it gets wet.

Plywood is normally sold in sheets 4 feet by 8 feet. But many lumberyards do sell smaller pieces. It comes in many thicknesses. Plywood called ¼-inch plywood is ¼ inch thick. ¾-inch plywood is ¾ inch thick.

Marking and Measuring

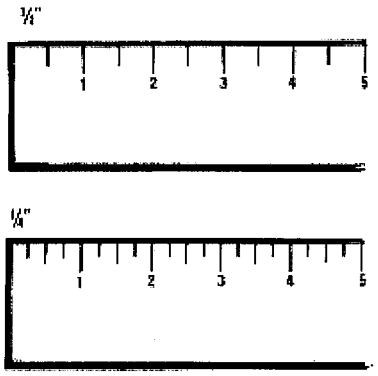
English Measure

If you want to make pieces of a certain size, you will have to measure and mark them before you do any cutting.

Examine a rule and find an inch mark. The mark (") shows inches. Find the number that relates to the inch mark. (1", 2", and so on).

Can you find a long mark that is halfway between the inch marks? This is called the **half-inch mark**. If the half-inch mark is equally divided into two parts, what is the correct name for each of those parts? If these parts are divided in two again, what would those parts be called? If they were divided still one more time, what would these tiny sections be called?

Look at the drawing below. The inch is divided into a number of smaller sections, all of which are labeled. Check your answers against the labels on the drawings.

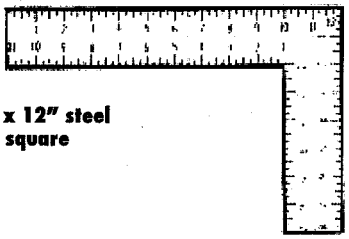


(Above drawings not to scale)

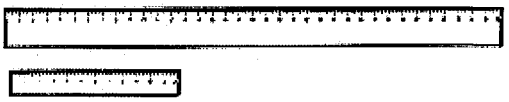
Let's practice a bit. Find the following points on your rule or square: 2", 5", 7½", 3¼", 6⅛", and 10⁵⁄₁₆". If you have any trouble, ask your parent or leader to help you.

The unit of measurement larger than an inch is a **foot**. The mark (') shows feet. There are 12 inches in 1 foot. Some 6-foot rules number the inches from 1 to 72. Others number the inches from 1 to 11, the next number being 1 foot; the next numbers are 1-1, meaning 1 foot, 1 inch, or 13 inches.

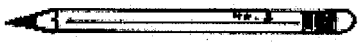
Tools you will need:



An 8" x 12" steel utility square



A straight rule, yardstick, folding rule, or steel tape



A No. 2 or No. 3 pencil, kept sharp

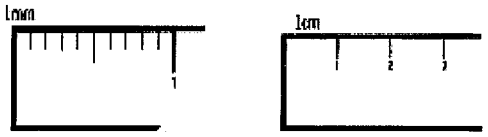
Metric Measure

The metric system, which is coming into wide use, uses a pure base 10 arithmetic. Each one of the counting units is 10 times larger than a smaller one.

Find a metric rule. The smallest unit of measure on the rule is a **millimeter**. Can you find two of the short marks on your rule that mark the beginning and the end of a millimeter?

Ten millimeters form a **centimeter**. A centimeter is actually about this long (_____). See if you can find the nine marks between the two larger centimeter marks.

These marks divide the centimeter into 10 millimeters.



(Above drawings not to scale)

Ten centimeters form a **decimeter**. A decimeter is not shown in the measurement of most rules. Ten decimeters, or 100 centimeters, form a **meter**. A meter is about 39.37 inches long. One thousand millimeters form a meter.

Measuring Wood

To build things well, you need to measure the correct width and thickness of a piece of lumber. For example, if you buy a piece of 2 x 4 at the lumberyard, you should measure it to see how wide and thick it really is. Remember, the wood may have shrunk due to evaporation. If you do not measure the wood, you might find that you bought a piece that is actually too small for your project.

Let's practice measuring on a piece of scrap lumber. Measure and mark spots ¾", 1⅝", 3½", and 5⅝" from the end. Have your parent or leader check your measurements. Did you use a sharp pencil or a dull pencil to mark the spot? Would that make any difference in how accurate your measurement is?

Hold the edge of the rule on the wood and make your mark at the exact spot. You may have watched a cabinetmaker marking his spot with a knife or scratch awl. Why does he use these tools instead of a pencil? Because his measurements will be more accurate.

If you have to measure a long distance, use a long rule. You increase the chances of a mistake if you move a short rule several times to complete the measurement.

Keep practicing until you can measure a certain distance from the end of the board and accurately mark the spot. The next thing to learn is how to make a line squarely across the board.

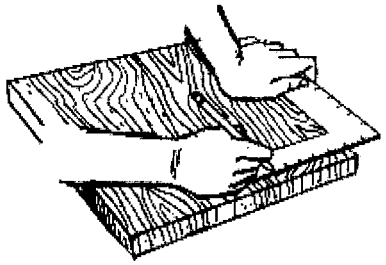
Squaring a Line

A square line makes a perfectly square corner with the edge of the board. If you would tip the board on edge so that the line pointed upward and the board was level, this line would look perfectly straight up and down. It would not slant toward either end of the board.

To square a line, you may use a tri-square, steel combination frame, utility square, or framing square.

Hold the handle of the square firmly against the edge of the board. Mark along the blade or the other part of the square with a sharp-pointed pencil. Make only one mark with the pencil. Don't go over it a second time.

Just to see what happens, try holding one end of the handle of the square about ⅛" away from the edge of the board. What does this do to the direction of the line?



When squaring a line, use your utility square to see that the line is straight.

Some beginning woodworkers like to make lines across the edges and the back of the board as well. You could try this and see if it helps you make a straighter cut with your saw. To mark an edge, hold the handle of the square tightly against the face of the board with the blade of the square over the edge. Mark along the edge of the square.

To make the square line across the back of the board, hold the square handle against the same edge as when you made the mark on the face or the top side.

CAUTION! Remember to:

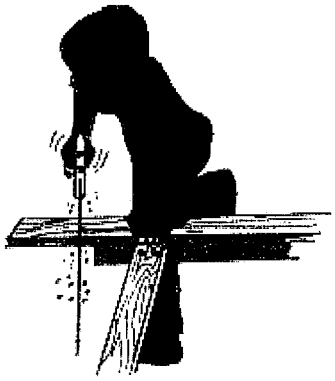
1. Make sure the end you measure from is square to begin with.
2. Examine the end of the board. If you see cracks or other defects, re-square beyond the damaged area.

Things you can do

- Practice squaring lines on a piece of 2 x 4 until you can make two perfect squares on the surface of the board.
- Measure a piece of 2 x 4. Mark down how wide and how thick it is. Start from the opposite side of the wood and make your measurement again. Is your measurement the same?

Cutting Wood

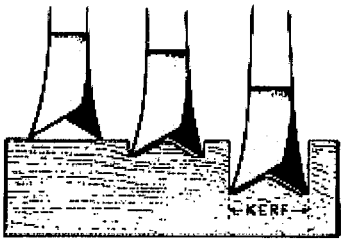
Are you ready now to practice making a square cut with a hand saw along the marks that you drew on the board? Before you do any actual cutting, make sure you read this section very carefully.



When sawing a large board, use both your hand and your knee to brace it while you cut, or use a clamp.

If you look closely at the end of your piece of board, you will notice that it is made up of a collection of extremely fine fibers grown together. You could compare these fibers to broom straws that have been glued together.

The **crosscut saw** is a tool used to cut across the fibers of the wood. The teeth of a crosscut saw are filed and bent so the teeth act as a row of knife points on each side of the saw. The teeth are bent slightly as they go along, the first one to the right, the second to the left, and so on. This bending of the saw teeth is called "setting." This design makes the saw cut a strip wider than the blade so the saw can move back and forth easily.



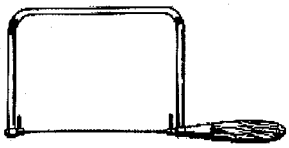
Sharp points cut wood fibers. The kerf is the slit made by a saw.

Top view of crosscut saw teeth.

Tools you will need:

A crosscut hand saw (20" or 22" – 10 or 11 point hand saw) to cut off boards crosswise and to cut plywood in any direction

A rip saw is recommended for cutting with the grain, not to cut end pieces.



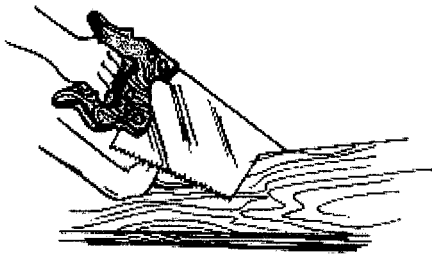
Coping saw for cutting curves in thin wood

Safety goggles to keep sawdust and chips out of your eyes

What would a carpenter or cabinetmaker say about making a true and square cut? He or she would say to hold the saw straight up and down, or "square" with the board. What would happen if you held the saw at an angle so the top of the saw would slant to the left or right? Try it, just to see!

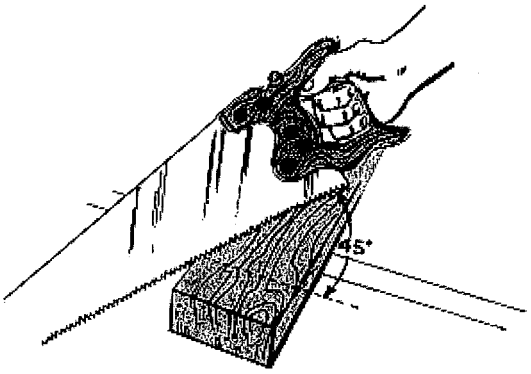
Saw on the waste side of your line. If you saw right on the line, your board may be too short.

Remember, each time you cut the wood you remove some of it. The wood that is removed should be to the outside of the line.



Youth grip

Sometimes you may have to hold the saw flat so the teeth come into contact with the entire surface of the board at the same time. This may be necessary when using a miter box or other guiding device. When you do not have to do this, raise the handle of the saw so the saw blade is at about a 45-degree angle with the surface of the board on ordinary lumber. When sawing plywood, a flatter angle (about 15 degrees) is best.

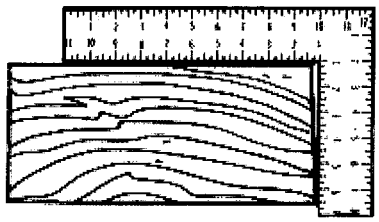


45° angle for lumber and 15° for plywood

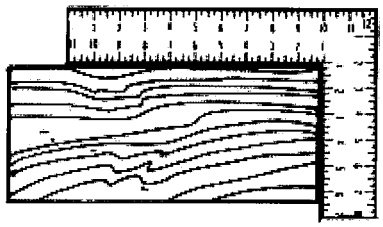
Try cutting a board in this manner.

Do you have a true, accurate, square cut? Did you push down on the saw? The weight of the saw will make it cut fast enough. Did you hold the cut-off piece so it did not fall on the floor? If it is not held, the last little uncut portion of wood may break off. What could happen to the nice corners of your piece of wood if it fell on the floor or the ground?

How would you use your square to check the accuracy of the saw cut? Hold the handle of the square tightly against the board and the blade of the square along your new cut. If you can see light between the square and the board, the cut is not square (See the illustration on this page.) Remember to check both crosswise and edgewise of the board.



Poor cut



Square cut

Safety Notes

Hey Kids! Did you know...

1. **A saw cuts very quickly. Handle it so that the teeth will not touch your skin.**
2. **Protect the saw by storing it in a safe place.**
3. **Prevent cutting your thumbs! Use a squared piece of wood to keep the saw on the cutting line.**
4. **Sawdust can be very slippery. Sweep it up after you cut.**
5. **Keep the saw sharp. It cuts much better and takes less work to do the job.**

How to Make a Saw Guide

Materials:

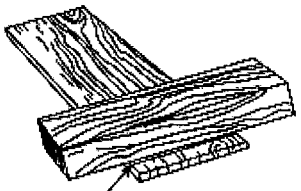
- A 2 x 4, about 12 inches long
- A board ¾" thick and 15–16 inches long (or other lumber to be cut)

Tools

- Hammer or block of wood
- Pencil
- Two C-clamps
- Saw

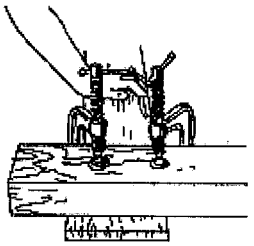
Instructions

1. Make a square line across the board.
2. Position the 2 x 4 saw guide:
   a. Place the 2 x 4 flat on the board surface close to the marked line (Illus. 1).



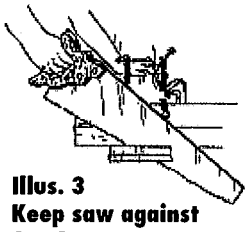
Illus. 1
2 x 4 close to the line

   b. Place the clamps in position with slight pressure. (Illus. 2). Be sure to have the thumbscrews up! (If they are down, you may hit them while sawing.)



Illus. 2
C-clamps in position—thumbscrews up

   c. Use a hammer or block of wood to tap the 2 x 4 gently until it lines up along your pencil line.
   d. Now tighten the clamp enough to hold the 2 x 4 in place.



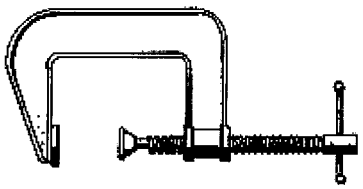
Illus. 3
Keep saw against 2 x 4

3. Place the flat side of the saw blade against the 2 x 4. Pull the saw backward for a few short strokes to start the cut. Keep the saw rubbing against the 2 x 4. (Illus. 3).
4. After the cut is started, continue sawing. Move the saw slowly back and forth. Use little or no downward pressure on the saw.

Using a 2 x 4 and C-clamp Saw Guide

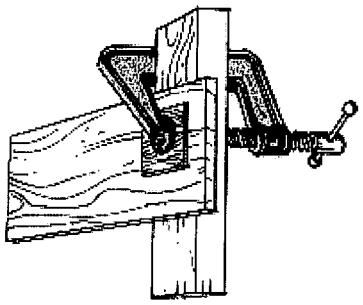
Are you having problems keeping your hand steady enough to make an accurate cut all the way through the wood? Would something to guide your saw help to improve your cuts? Maybe a piece of 2 x 4 held in position along your line would help you make a better saw cut. Clamp this piece of 2 x 4 to a board, and make a saw guide. Directions and illustrations on how to make a saw guide are featured on this page. Or ask your leader or your parent to help you make a **jig**.

You also could make an accurate square cut using a **miter box**. Ask your leader to show you this tool. If you work with a miter box, hold the piece of wood to be cut tightly against the back of the miter box. Do not try to twist the saw. Let it slide back and forth freely. If the miter box has metal saw guides, keep the saw teeth from touching them.



C-clamp

To prevent clamps from denting the wood, place a thin piece of scrap lumber between your good board and the clamps, as shown below.



Thin piece of scrap under clamp

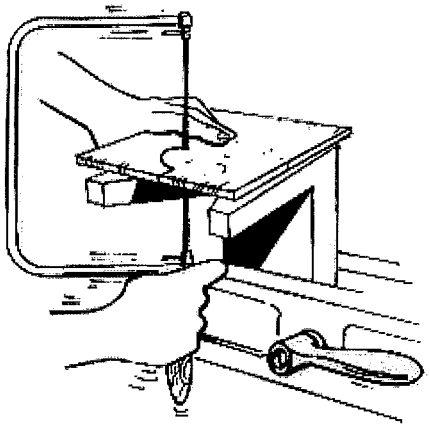
Safety Notes

- **Do not let the C-clamps fall on your feet.**
- **After use, place your saw where it will not be bumped by other tools.**
- **Do not touch the C-clamps with the saw.**

Cutting Curves

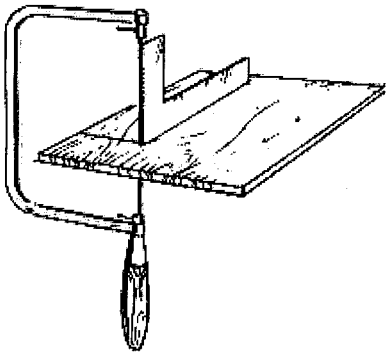
The coping saw is used commonly for cutting curves in wood. It is a small, inexpensive saw with a narrow blade.

The blade is held in place by spring action of the frame. You bend the frame of some saws to put in the blade. On other saws you loosen or tighten the blade by turning the handle.



Coping saw in upright position

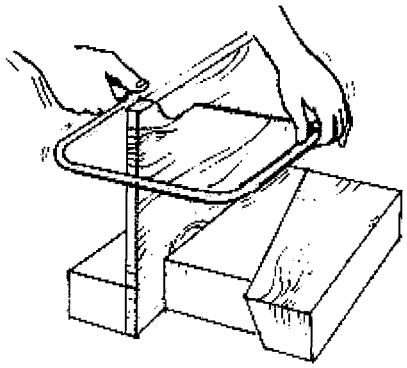
As the saw cuts, it tears and breaks fibers on one side of the board. This happens where the teeth come out of the wood on the cutting stroke. Place your pencil mark on the good side of the board. The wood fiber tears will be on the back side. The fiber tearing can be reduced by firmly pressing transparent or masking tape over the area where the teeth come out of the wood.



Saw square with the surface

If you position the blade with the teeth pointing toward the handle of the saw, you will be less likely to break your blade. It will be cutting on the pull stroke instead of the push stroke.

For wood that is ¼" or less in thickness, use a blade with 15 or 20 teeth per inch. This is called a fine tooth blade. On wood ¾" thick, use a blade that has 10 teeth per inch. This blade is a coarse tooth blade.



Coping saw in horizontal position

The coping saw can be used to cut a hole in a small piece of wood. The frame of the saw must go around the outside of the board to do this. Have your leader help you bore a hole through the wood with an auger bit or a twist drill. Remove the saw blade from one end of the saw. Put the saw blade through the hole, and then put the saw blade into the handle again. A utility saw, compass saw, or keyhole saw is used frequently for this purpose.

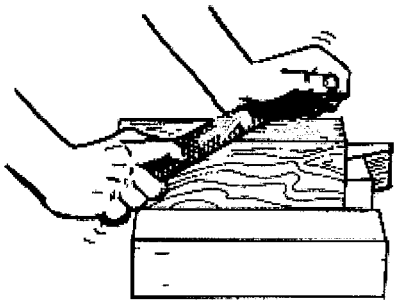
Things you can do

- Saw two pieces of wood, one with the saw straight up and down, the other with the saw at a 45-degree angle. Use your square to check your cuts. Write down in your notebook how the two cut pieces are different, and which cut looks better.
- Make a saw guide, as shown in the illustration on page 9.
- If you have a coping saw, show how you can cut out a curved section in a piece of wood or how you can cut a hole from the center of a board. When cutting a hole, remember to bore a hole through the wood with a bit or drill. Take the saw blade off the handle and put it through the hole by itself before reattaching the handle
- See "Coping Saw Puzzle" in the Working Plans.

Sanding and Smoothing

Sometimes when you are sawing curves, they become off-square across the length of the wood. They are rough on the edges and need to be smoothed. You can use a round file, a half-round wood rasp, or sandpaper on a dowel to do the job.

You also may want to smooth out a straight, square, crosscut saw cut. For this type of cut, you can use multi-blade wood-forming tools, rasps, or sandpaper. You also can smooth the saw cuts of the pieces in a kit or pre-cut unit.

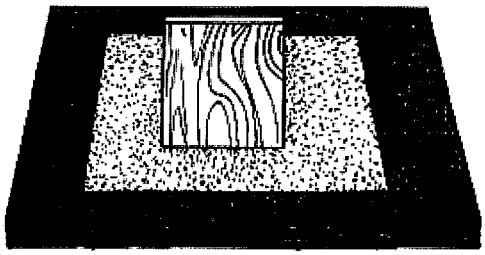


Crosswise and lengthwise stroke

When you use a **rasp**, move the tool lengthwise and diagonally. If you move it crosswise, you will be more likely to break off the edge of the wood.

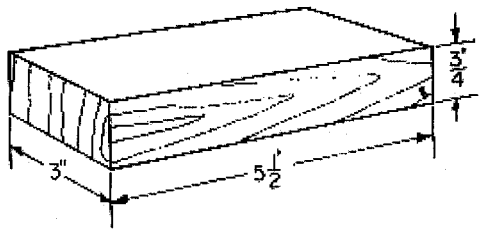
When sanding the edges or sides of the wood, sand in the direction of the grain of wood. If you sand across the grain, scratch marks will show.

Use either a part of a sheet of sandpaper on a block of wood, or glue a full sheet of sandpaper to a piece of flat plywood. Move your piece of wood across the full sheet of sandpaper that you attached to the plywood. For rough cutting, use coarse grit **flint paper** or 50-grit **garnet paper**. For easy smoothing, use fine grit paper or 150- to 200-grit garnet paper.

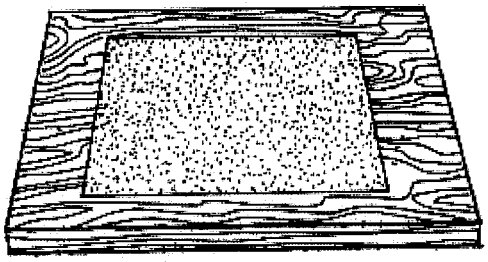


Keep board straight up and down

Tools you will need:



Sanding block to hold your sandpaper (commercial type may be used)



Sandpaper, available in various grades of fine, medium, and coarse grit. (Garnet paper is good, especially for hardwoods. It costs more than flint paper, but cuts faster and lasts longer.) Shown above is a full sheet of sandpaper glued to plywood.

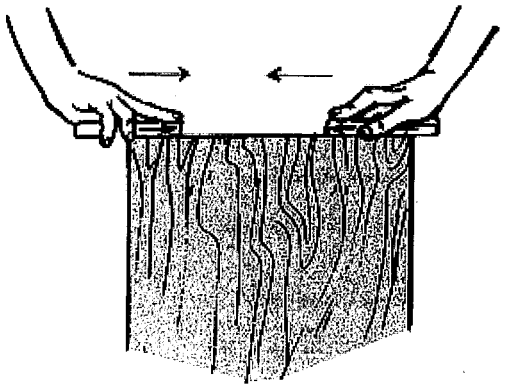
Wood rasp

Shoe or utility rasp

Multi-blade wood-forming tool to smooth and improve saw cuts

Smoothing Wood for a Finish

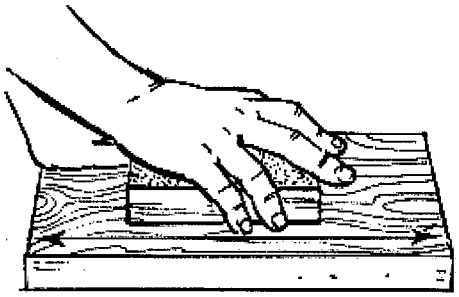
Smooth the ends, edges, and sides of your pieces prior to putting together your project. Then it will be ready for a finish. You may have to do a little touch-up sanding after assembling it. This depends upon how you intend to use the article you have made.



Prevent corner chipping.

To smooth an end grain with sandpaper or rasp, work from both edges towards the center to prevent the grain from chipping off the corners.

For most exterior use, lumber and plywood as they come from the lumberyard are good enough for finishing. But if the wood is dirty or oily, clean these spots either by sandpapering or washing them with a damp cloth that is not too wet.



Sand with the grain.

If you are making a toy, a game, or an article for the home, you may want to sand it. Some plywood is sanded at the factory and requires only a small amount of additional sanding with fine sandpaper. Lumber is not factory sanded. If you look carefully, you may see straight lines or small ridges going across the board, which were made by the planing mill. Your sanding will cut these ridges, producing a flat surface when they are sanded away. You can remove these marks using medium and then fine sandpaper.

Prior to completion, always finish with fine sandpaper. Then carefully wipe off the dust with a clean cloth.

Safety Notes

Remember...

Use special care with rasps and files. Handles that are fastened securely will keep sharp ends from jabbing into your hands.

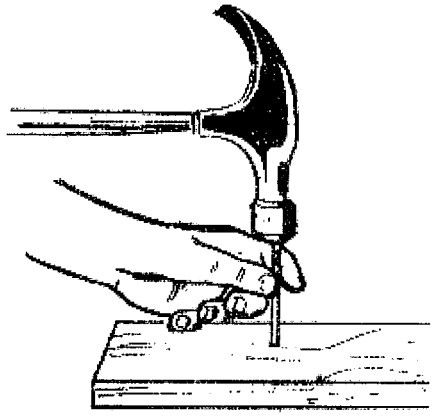
Things you can do

- Name some tools that are used in smoothing and sanding, and show these in an exhibit.
- Show what motion should be used when filing with a rasp, and when rubbing with sandpaper or a sander.
- See "Sandpaper Block" in the Working Plans.

Driving and Pulling Nails

There are many kinds and lengths of nails. Each is designed to do a special job. There are shingle nails, roofing nails, carpet tacks, and ring-shanked nails. Common nails, box nails, and wire nails have flat heads and are used where neatness is not important. Wire brads and finishing nails are used where neatness is important.

Most nails are ordered by "penny" size. The letter "d" is usually written instead of the word penny. One pound of six-penny nails may be written as 1 lb, 6d nails. The length of 2d to 10d nails can be figured out by multiplying the "d" number times ¼ inch and then adding ½ inch to that number. How long is a 6d nail? To find out, we multiply 6 times ¼, which equals 1½. To that we add ½, which gives us 2. So a 6d nail is 2 inches long.



Grasp nail near the head

To drive nails, we generally use a hammer. A hammer also can be used to pull and straighten nails.

See if you can drive several nails into some scrap wood without bending them, and without making hammer marks on the wood. If you do not strike the nail squarely each time with your hammer, what will happen?

If you had to show someone who has never held a hammer before how to drive a nail, how would you teach him or her?

Most beginners start off holding the hammer near the head, and then move their hand further back as they gain experience.

Tools you will need:

A curve claw hammer with a small handle to pull, drive, and straighten nails. (You could also use a tack hammer.)

Safety goggles

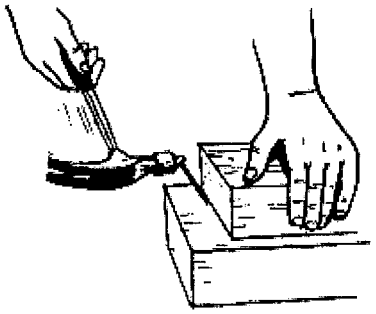
Wire and common nails

Brads and finishing nails

Nail set to drive nails into surface of the wood without leaving hammer marks

Bent nails may be straightened by holding a hammer or a block against the nail and pounding the leaning side of the nail against the object with another hammer.

Sometimes a short nail can be straightened without holding anything against it.



Straightening a long nail

Safety Notes

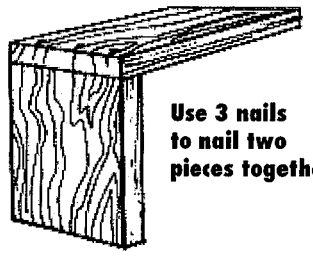
Remember...

- **Keep your fingers out of the hammer's way.**
- **Hit the target flat.**
- **Make sure the hammer head is on tight.**
- **Throw away damaged hammers.**

Nails that are too large, too close to the end of the board, or driven into lumber that is too thin can split the wood. If you must nail near the end of the board or into thin wood, use a small nail or drill a hole a little smaller than the nail.

Things you can do

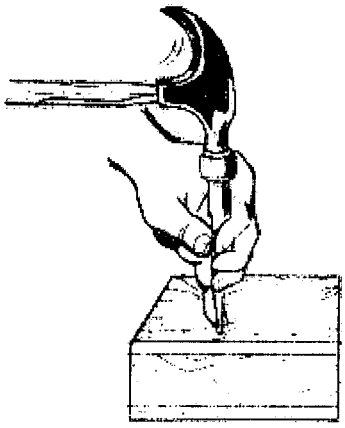
- Practice driving nails into scrap wood. Keep the nails straight and the wood free of hammer marks. Also practice driving in nails that are near the end of the block of wood.
- Drive nails of different lengths into a block of wood. Stop hammering before the head of the nail reaches the surface of the wood. Then practice pulling out the nails without bending them.
- See "Nail Point Design" and "Letter Holder" in the Working Plans.



Use 3 nails to nail two pieces together.

Using a Nail Set

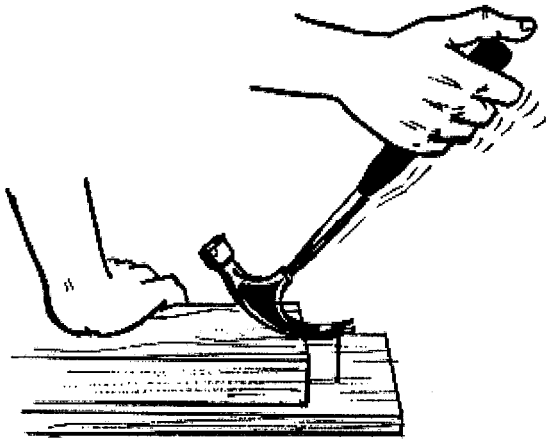
To drive down the nail so that it is even with the board, you may use a **nail set**. It often is used to drive or set the head of the nail below the surface of the wood. Use a nail set smaller than the head of the nail. Place the nail set directly over the head of the nail. Tap it with a hammer rather gently, especially if the nail is a small-sized one.



Using a nail set

Pulling Nails

The claws on the hammer are designed to pull nails. Slide the claws under the nail head, then grasp the hammer handle near the opposite end and apply a firm, steady pull until the nail is out.



Pulling a long nail

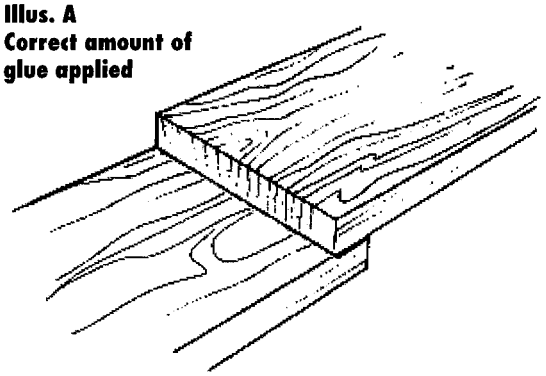
When pulling long nails, put a block of wood under the hammer head close to the nail.

Using Glues and Wood Finishes

Working with glue is an interesting and important part of woodworking. The advanced units of the 4-H Wood Science Program have information on several different kinds of glue. For now, you will do well to use the polyvinyl-resin glues. People know them as "white" or "yellow" glues, which you can buy in a hardware store in plastic squeeze bottles. Although they work well indoors, most of these kinds of glues fail to hold if they remain outdoors in humid weather. For wood materials that will be used outdoors, use a special glue that is prepared for that purpose.

Make sure always to read the directions on the label and follow them carefully.

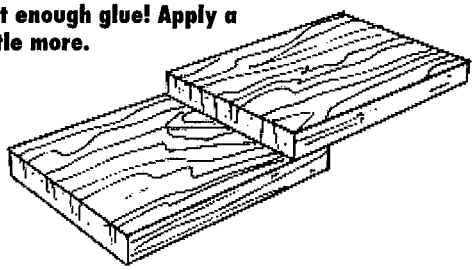
Illus. A
Correct amount of glue applied



Apply the proper amount of glue, as shown in Illustration A. When the joint is fastened together, a small amount of glue should squeeze out at the edges. No squeeze-out indicates a shortage of glue (B). Too much squeeze-out indicates a waste of glue (C). Wood covered with glue will not accept stain and finish in the same way as the natural wood, and it looks sloppy.

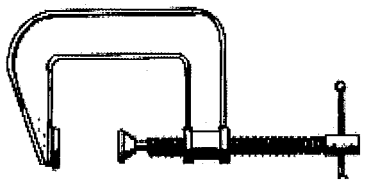
The pieces to be glued must be held together firmly while the glue is still drying. Do you have anything to hold together the pieces of wood while the glue is drying? Many woodworkers use C-clamps, pipe glue clamps, or a vise. Sometimes, nailing the pieces together will work. If you do this, leave the nails in the wood after the glue is dry.

Illus. B
Not enough glue! Apply a little more.

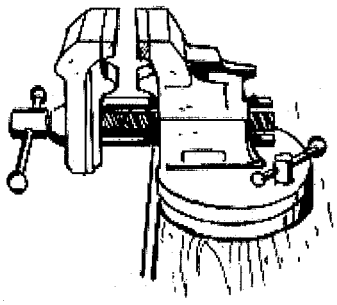


Tools you will need:

A 1-inch paintbrush to apply interior or exterior finishes



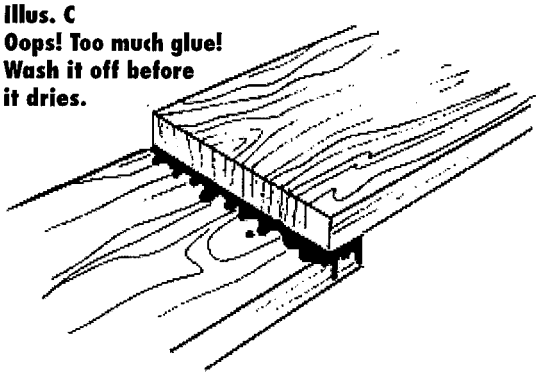
One or two 3-inch C-clamps to hold pieces of wood together for glueing, or to clamp boards together when boring holes



A homemade bench vise or a factory-made vise

Outdoor Wood Finishes and Stains

Illus. C
Oops! Too much glue! Wash it off before it dries.



Finishes made for outdoor use are stronger than the finishes that are made for indoor use. This is why articles made for outdoor use require different finishes than those for indoor use. Some finishes are more difficult to apply than others.

Water repellent or waterseal is the simplest exterior wood finish. Apply it with a brush or dip the article in the finish. To give it a little color effect, you may tint the article lightly with color in oil, with the help of your leader or parent. Articles that have been treated with this material should be retreated each year for several years.

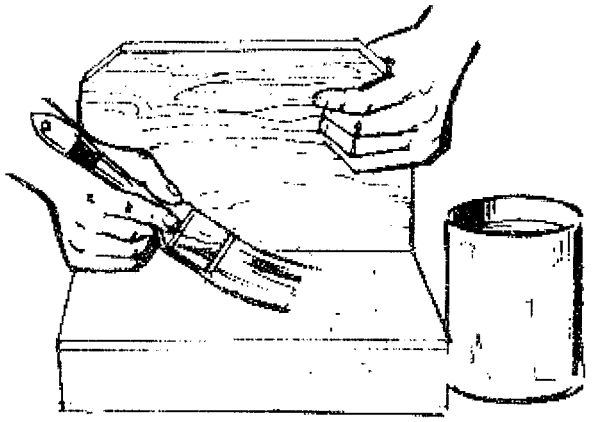
Outdoor wood stains soak into the wood without forming a film on the surface, and so will not peel off. They are easy-to-apply finishes that will make many of your projects look great! You can buy both oil base and latex stains of this type.

Apply the oil-base stain with a brush. Most of the stain will soak into the wood and give it color. One coat usually is enough on smooth wood. If it looks as though some of the stain is going to dry on the surface instead of soaking into the wood, wipe off the excess stain with a cloth. Remember that a cloth soaked in an oil-base stain can easily catch fire. When you are finished, be sure to spread the cloth out to dry in an open place where it would not damage anything should it happen to catch fire.

On rough surfaces, make a second application of the stain before the first application is totally dry.

Latex stain should be applied with a brush in two coats. Apply the second coat after the first one dries, which takes about 2 hours. You can make small batches of latex stain yourself. Just mix 1 cup of exterior latex house paint with 2 cups of water.

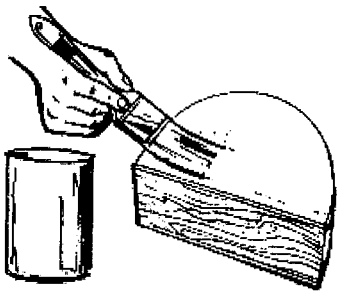
In addition to the above materials, you also may want to use outdoor paint by itself. This type of finish covers the entire surface of the wood with a dark material. Outdoor paints also come in oil base and latex. The oil-base paint should be cleaned with a paint thinner or similar material, while the latex may be cleaned with water.



Applying exterior stain for outside use

Special Hints

- **Follow the instructions carefully when using water repellent solution, waterseal, and stain.**
- **Always use a brush, except where you use the dip method of waterseal.**
- **Do not breathe the vapors.**
- **Do not splash the materials on your skin.**
- **Dry any rags soaked with oil. Such rags can start burning by themselves.**
- **Wash the paint brush used to apply the oil-base stain in paint thinner. Then wash it in water and detergent. Wash latex-stain brushes in cool water with detergent.**



Indoor Finishes

There are two common types of clear indoor finish materials. Oil finishes soak into the wood. Varnish-like materials form a layer of plastic on top of the wood. For the present, the oil finishes will give you the greater success. In more advanced units, you will learn how to use varnish-like finishes.

Oil finishes are sold at many paint stores. You can even mix your own batch. Either (1) dilute varnish at the rate of one part of varnish to two parts of paint thinner, or (2) dilute linseed oil at the rate of one part linseed oil to four parts of paint thinner.

Here's how to apply an oil-based finish:

1. Start with clean equipment and materials. Avoid dust in the air or on the wood. Wipe off all the sanding dust.
2. Apply the first coat of finish with a brush onto wood that is dry and clean.
3. Fifteen minutes later, wipe the wood with a dry, clean cloth. This removes the finish that has not soaked into the wood. Remember to dry or dispose of any oil-base rags in order to prevent fire.
4. After 24 hours, sand with 220-grit sandpaper or other material. Wipe off the dust with a clean cloth.
5. Apply the second coat of finish with a brush. Let the finish soak in for 15 minutes. Then, wipe it with a clean, dry cloth to remove the finish material that has not soaked into the wood.
6. After 24 hours, sand again. Then polish with furniture polish or wax if you wish.

Special Hints

The oil-base finish can be purchased with color in it so that you can stain the wood at the same time you apply the finish. If you mix your own finish, you can color it by adding either color in oil or universal color.

Wash your paint brush in paint thinner. Then wash it in warm water and detergent. This way, your brush with be ready for you to use again when you need it and will last a long while.

Safety Notes

You are going to be painting and varnishing now. Most paints contain chemicals that could explode around fire or that could be poisonous to you.

- **Keep paints away from an open flame. Do all your painting in a room with lots of fresh air.**
- **Put your clean-up rags into a covered metal can. KEEP THE LID ON IT! Otherwise, "spontaneous combustion" can take place and cause a fire.**

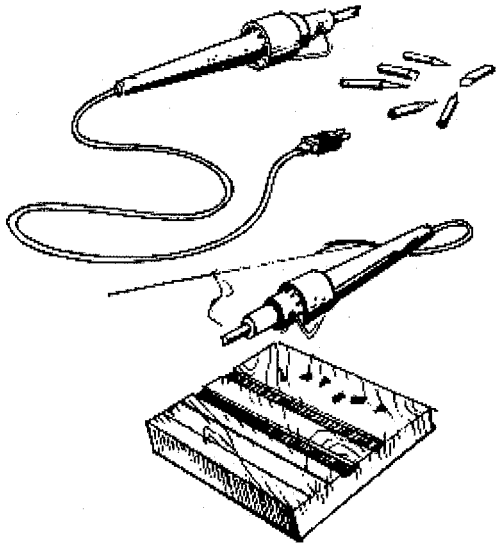
Things you can do

- Give a talk on the proper way to apply and store glue.
- List the different ways pieces of wood can be held together while glue is drying. Experiment with some of these ways as time permits.
- As a group, exhibit your wood-stain projects in a public place. Be prepared to explain to your audience how outdoor and indoor finishes are applied.
- See the other fun ideas of things to make in the Work Plans section.

Electric Wood Burning

Tools and materials you will need:

- **A wood burning tool (see picture)**
- **A scrap piece of wood at least 3 inches on each side for practice**
- **A pattern or your own design for a wall plaque or hot pad**
- **A good piece of wood about 5½ inches on a side or whatever size your own design needs**



Practice Burning Wood!

- Plug in your burning tool. Let it heat 3 to 5 minutes. Keep your fingers away from the hot tip!
- Touch your practice wood with the tip to see if it is hot enough to burn the wood.
- When it is hot enough to burn the wood, try this on your practice wood:
  a. Make a line from corner to corner of the wood by slowly moving the tool with very little downward pressure.
  b. Make a shorter line. Move the tool very slowly with more pressure.
  c. Place the sloping side of the tip on the wood. Move it very slowly for ¼ inch.
  d. Touch the wood with the pointed tip several times.

Check Your Work

- What movement of the tip made shallow, narrow lines?
- What movement made deep, wide lines?
- What kind of mark did the pointed tip make?
- What did the sloping side of the tip do?

Keep your hot woodburning tool out of the reach of your brothers and sisters. It might burn their fingers!

Now, for the Real Thing!

- Burn your design into the wood you chose for a wall plaque, hot pad, or other item.

Check Your Work Again

- Are the lines free of breaks or gaps?
- Is each line uniform in width?
- Is every line the same width?

Remember These Facts About Wood

- Some woods work better than others for wood burning. The best ones are balsa, basswood, poplar or aspen, white pine, sugar pine, or close-grain hardwoods. Other good woods include redwood, cedar, and ponderosa pine.
- It is easier to burn a good, uniform line into wood whose grain is not so obvious.

Working Plans

You can make any of the following items, or some of your own. Change the drawings or use other materials if you like. Your project leader will have some ideas, too.

There are several ways to make each article. Use the skills you have learned to experiment a little, or ask your project leader for advice on how to proceed. The most important thing is that you have fun, and do your woodworking safely!

Coping Saw Puzzle

Materials needed

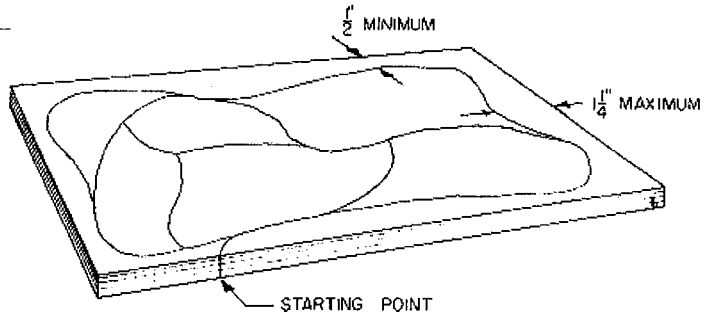
- A piece of ¼" plywood or paneling or ¼" medium-density hardboard about 6" x 8"
- One plastic or paper bag or large envelope to hold the completed puzzle

Tools needed

- Square
- Pencil
- Saw for square cuts
- Coping saw or a jigsaw for curved cuts

Instructions

1. Draw a wavy line around the piece near the edge. Keep the line at least ½" and not more than 1¼" from the edge.



2. Cut along this line to cut out the center piece.
3. Draw more wavy lines on the center piece for the puzzle.
4. Cut along these lines to make your puzzle. Put each piece in the paper bag or envelope. Do not lose any of the puzzle.

Sandpaper Block

Use

Holds ¼ sheet of sandpaper. Most sandpaper is 9" x 11". Sandpaper held on a block lasts much longer than the same paper ruffled up in your hand. The block can be improved slightly by gluing a piece of felt or thin rubber on the sanding side of the block.

Materials needed

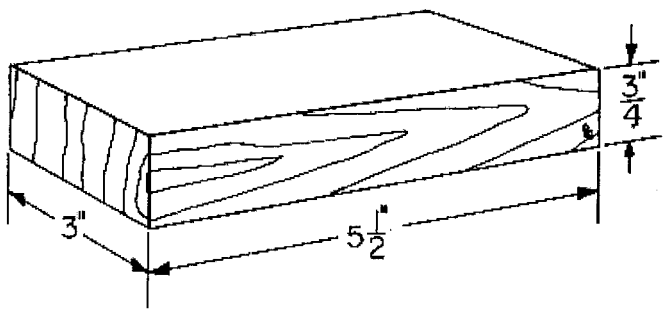
- One piece of wood 2½ to 3" wide and 5½" long (this can be either ¾ or 1⅛" thick).
- Finish materials described in this publication
- Felt or foam rubber if desired

Tools needed

- Square
- Pencil
- Saw
- Sandpaper (80-grit for rough lumber and 120-grit for smooth lumber)

Instructions

Apply a penetrating finish to all surfaces of the sandpaper block, unless you plan to glue on a piece of felt or thin foam rubber. Do not apply finish to areas to be covered with these materials.



Nail Point Design

Use

Made from ¾" or thinner lumber, the design can be used as a hot-pad or wall plaque. Made from a piece of material 1½" thick, or thicker, it can be used as a paperweight or a decorative object for a shelf.

Materials needed:

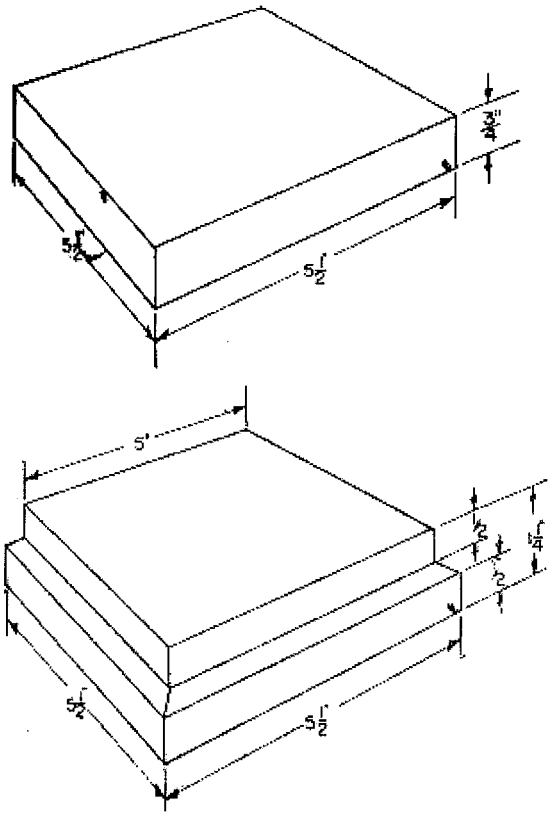
- A piece of lumber about ¾" x 5½" x 5½"
- Smoothing or sanding materials

Tools needed

- Saw
- Square
- Pencil
- Hammer
- Plane, wood-forming tool, wood rasp, or coarse sandpaper if you plan to slope or bevel the edges
- 1" wire nails to form a fine line of nail point holes
- Six-penny nails to form a medium line of nail point holes
- Ten-penny nails to form a heavy line of nail point holes
- Sandpaper (80-grit for rough wood and 120-grit for smooth wood)

Instructions

1. Use your hammer and nails to make lines of nail point holes to replace your pencil lines.
2. Use the sandpaper to sand off the pencil lines. Brush the dust out of the nail point holes.



Letter Holder

Materials needed

- One piece of 1 x 2 (actual dimension approximately ¾" x 1½") 6" long
- Enough plywood or paneling to cut two pieces each 4" x 6"
- Eight 1-inch wire brads
- Glue
- Smoothing or sanding materials described in this manual

Tools needed

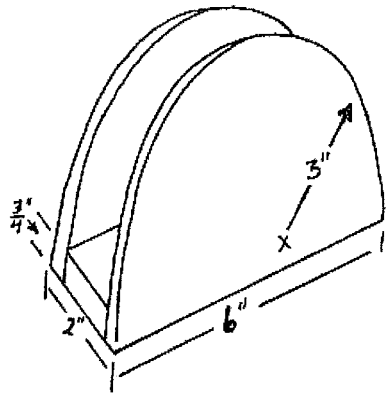
- Square
- Pencil
- A saw for square-cuts
- A coping saw or jigsaw for curve cuts
- Pencil compass
- Hammer
- Nail set
- Sandpaper (80-grit for rough wood and 120-grit for smooth wood)

Instructions

1. Cut the center piece to measure 6" long.
2. Mark the cutout lines for the side pieces. Remember, most plywood and paneling has one side better than the other side. Arrange your pieces so the best side of the plywood will be the outside of both the front and back piece. You may want to nail both pieces together and cut them at the same time.

Other ideas

- Add designs or decals to the side pieces.
- Use different material and change the shape.
- Make it larger so it can serve as a napkin holder.



Wire Wiggley

Use

Your wire wiggley can have many uses. It can be a table decoration or a paperweight. It can be a decorative ornament to place on a shelf. You also can make it a pencil holder.

Materials needed

- A piece of wood about ¾" thick and 2½" x 2½" for base
- About 2 feet or so of 19-gauge bright or annealed iron wire
- Sanding and smoothing materials described in this publication

Tools needed

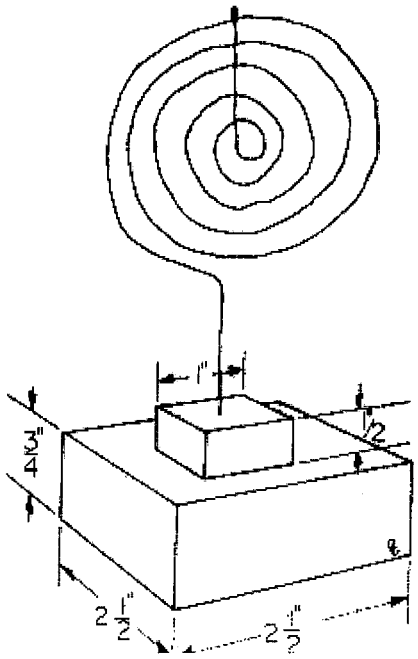
- Square
- Saw
- Pencil
- A wire brad, or a wire nail of the same wire gauge as the wire used, to punch a hole in the block to insert the end of the wire.
- Hammer
- Sandpaper (80-grit for rough wood and 120-grit for smooth wood)

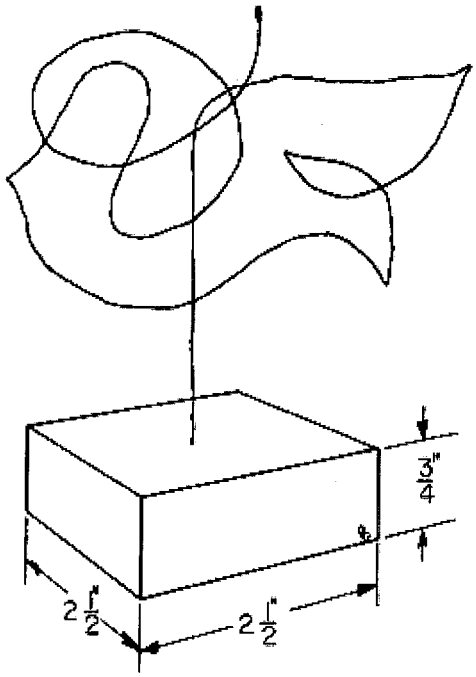
Instructions

1. Bend your wire to the desired shape.
2. Decide where you want one or both ends of the wire to stick into the wooden base. Make a hole for the wire about ⅜" deep into the wood using your hammer and wire nail. Be careful not to mar the wood when you pull out the nail.

Consider making changes in this plan

1. Use two or more pieces of wood of different sizes for the base.
2. Slope or gauge out different areas of the end of the base.
3. Use fine aluminum or brass welding rod as a wire. You may have to use a pair of pliers to bend the rod.





Stilts

Materials needed

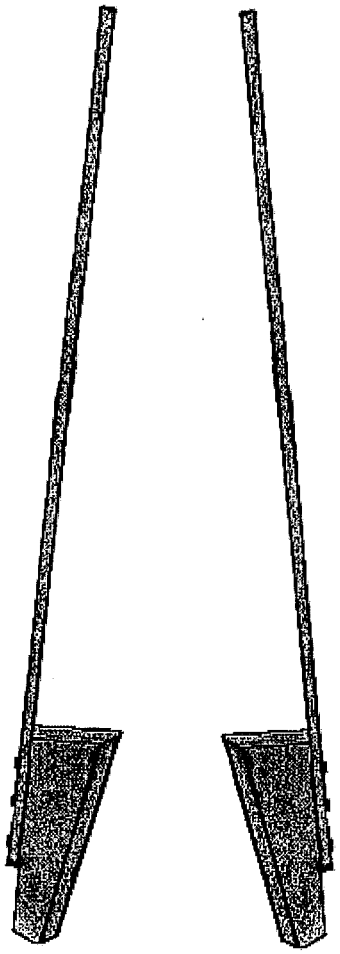
- A 1 x 6 at least 10" long
- Two pieces of 1 x 2s (pine, fir, or other wood) around 5' long
- Six 2-inch nails
- Paint or varnish (optional)

Tools needed

- Square and pencil
- Cutting saw
- Hammer

Instructions

1. Saw two pieces from a 1" x 6" board as shown in the diagram. Your final pieces should each measure 3½" and 2" across, and 10" long on the side that touches the pole.
2. Nail these parts to the 5' poles with 6-penny finish nails 2" long. Place each nail 4" apart, the first and last nail being 1" from the edge of the wood. Drive the nails up tight and flush with the surface.
3. A finish is not necessary, but paint or varnish will protect the wood and improve appearance.
4. The length of stilts and height of steps may be changed to suit your size.



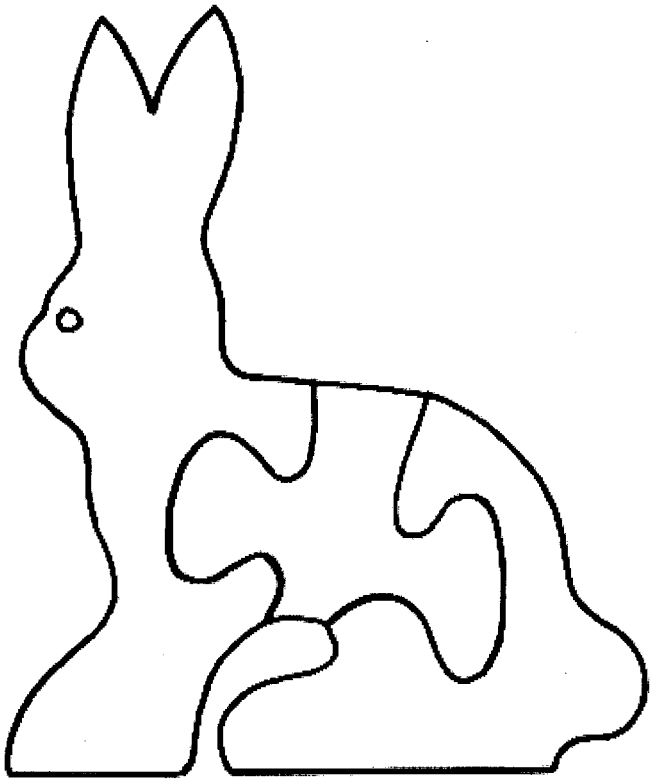
Rabbit Puzzle

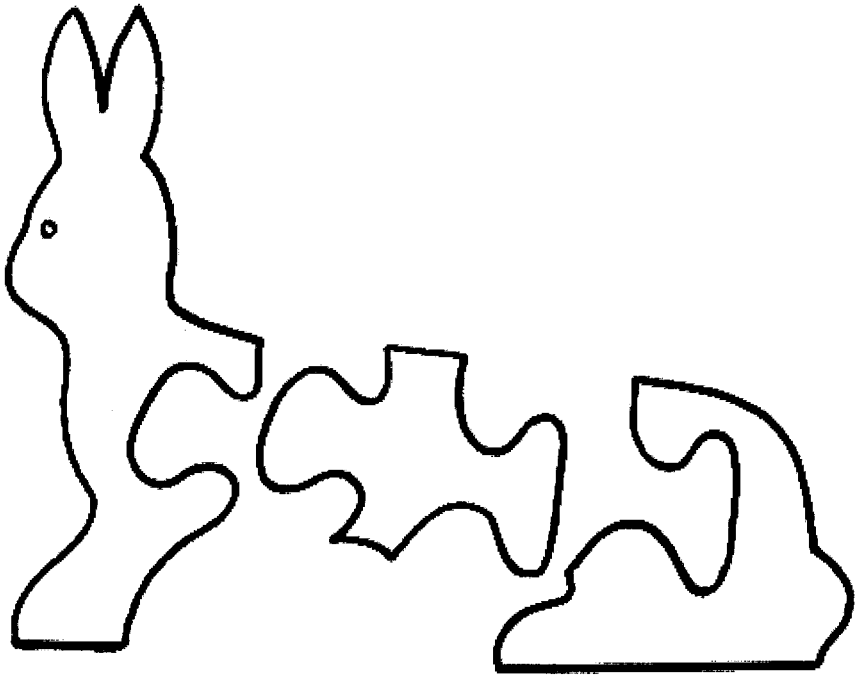
Use
Makes a great present for your brother or sister!

Materials needed
- A piece of 5/4 or 2 x 4 wood about 3½" long (the 5/4 material is about 1⅛" thick and the 2 x 4 is about 1½" thick)
- Carbon paper
- Whatever finish materials you select

Tools needed
- Pencil
- Coping saw with coarse teeth, or jigsaw with narrow blade
- Sandpaper (80-grit for rough surfaces and 120-grit for smooth surfaces)

Instructions:
1. Copy the drawing onto your section of wood, using the pencil and carbon paper.
2. Use your special saw to cut out the pattern from the wood.
3. Rub over the edges with various grades of sandpaper.
4. If you care to decorate your rabbit puzzle, make a design with your wood burning kit or use a wood finish.





Picture Frames

Materials needed

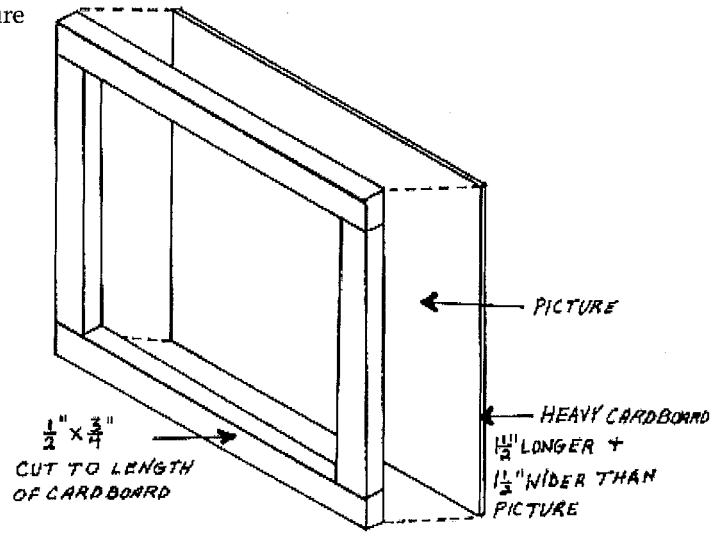
- ½" x ¾" stock—size will depend on size of picture
- Heavy cardboard—size will depend on size of picture
- Glue
- 1" brads

Tools needed

- Square and pencil
- Utility knife
- Saw
- Hammer
- Sandpaper
- Stain and varnish

Instructions

1. Cut the cardboard 1½" longer and 1½" wider than the picture to be framed.
2. Cut two pieces of stock the same length as the cardboard. Cut two more pieces the width of the picture.
3. Glue and nail the frame together.
4. Sand and finish.
5. Glue the picture to the cardboard, leaving a ¾" margin all around.
6. Glue the frame to the cardboard.
   NOTE: A piece of string may be glued or fastened on small tacks in back of picture to hang on wall. (Tacks should be put into frame.)



Note Holder

Materials needed

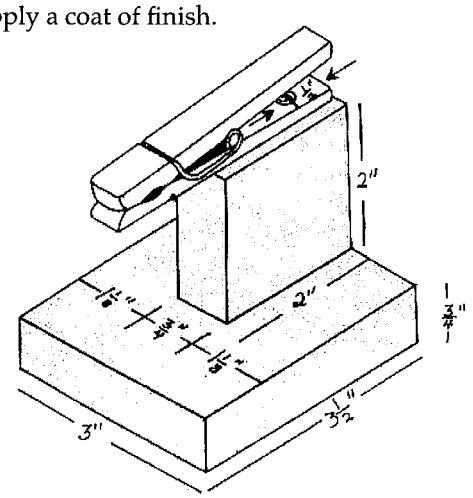
- One piece of wood ¾" x 2" x 2" (actual dimensions)
- One piece of wood ¾" x 3" x 3½"
- One clothespin
- Two 1½" nails
- One ½" woodscrew
- Glue
- Shellac

Tools needed

- Square and pencil
- Saw
- Drill
- Sandpaper
- Brush
- Hammer
- Screwdriver

Instructions:

1. Cut the pieces to size.
2. Sand the pieces smooth.
3. Drill a hole in one side piece of the clothespin, about ½" from the open end.
4. Glue the clothespin to the end of the ¾" x 2" x 2" piece.
5. When the glue dries, screw the pin down.
6. Glue the ¾" x 2" x 2" piece to the ¾" x 3" x 3½" piece. The assembly should be on center and flush with the back.
7. Apply a coat of finish.



Nest Shelf for Robins

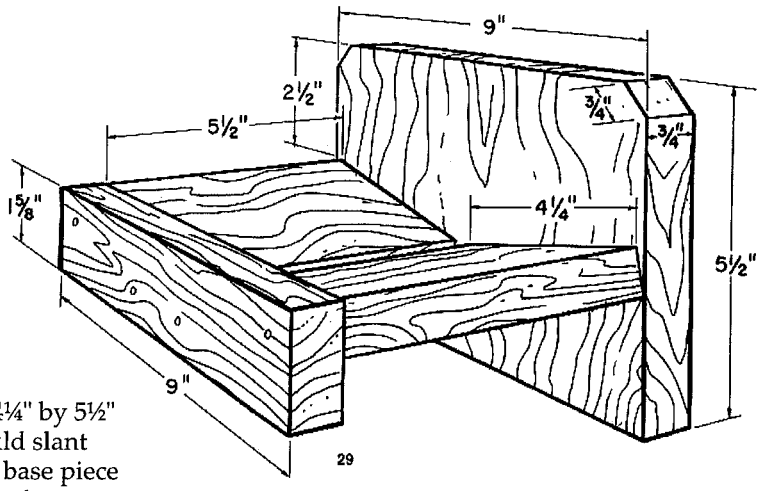
NOTE: Mount the nest shelf on the side of a building in the shelter of the eaves. Allow 6 or 7 inches between the shelf and the overhang. The shelf also may be mounted on the trunk or main branches of a tree, 10 to 12 feet above the ground.

Materials needed

- One piece 1" x 6" x 18"
- One piece 1" x 2" x 10"
- Eight 6d nails (preferably galvanized)
- Exterior finishing materials

Tools needed

- Square and pencil
- Saw
- Hammer
- Brush



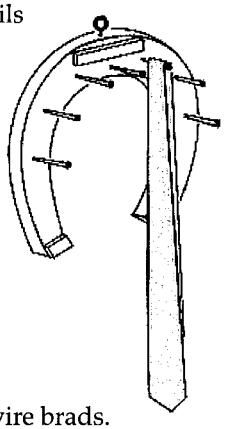
Instructions:

1. Cut pieces to size as indicated.
2. Nail the 1⅝" x 9" front piece and the two 4¼" by 5½" base pieces together. The base pieces should slant upward from the center. No part of either base piece should extend above, below, or beyond the front piece. The gap between the base pieces will serve as a drain.
3. Nail the back piece to the assembled unit. Have the upper corners of the base pieces 2½ inches from the top of the back
4. Apply finish.

Horseshoe Tie Rack

Materials needed

- One piece of lumber or plywood 6" x 6" about ¾" thick
- One piece of wood ⅛" x ⅜" x 4"
- Seven 2" horseshoe or cut iron nails
- One small screw eye
- ½" wire brads
- Interior finish materials

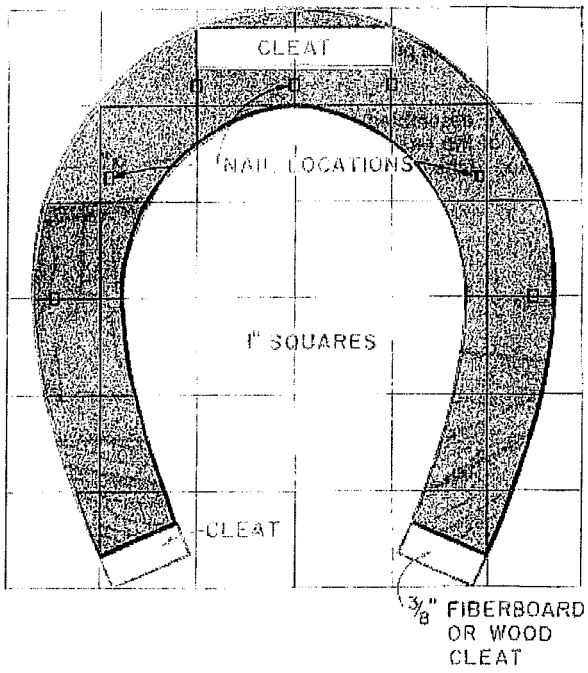


Tools needed

- Pencil
- Saw
- Drill
- Sandpaper
- Hammer
- Brush

Instructions

1. Cut out the horseshoe and cleats.
2. Attach the cleats with glue and wire brads.
3. Drill pilot holes for the horseshoe or cut iron nails.
4. Sandpaper smooth.
5. Apply finish.
6. Drive in nails to equal height.

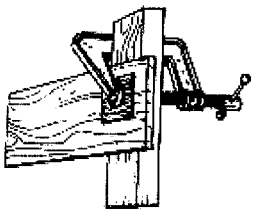


Tool Glossary

Auger
A tool with a central feed screw, a pair of cutting lips, and a crosswise handle used for boring holes in wood

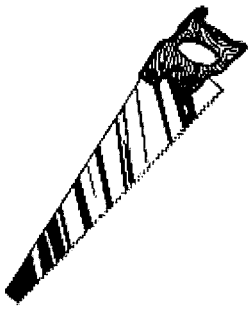
Awl
A pointed instrument that makes small holes in wood for marking

C-clamp
An instrument used to hold an object tightly together, made in the form of a "C"



Coping saw
A saw used for cutting curves in wood

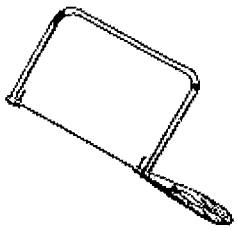
Crosscut saw
A saw used to cut easily across the fibers of wood



Garnet paper
A type of sandpaper that uses the mineral garnet as its rubbing material

Jig
A tool used to keep the correct position between a piece of wood and the tool used to work with it

Jigsaw
A saw with fine teeth used for cutting odd-shaped articles



Miter box
A device for guiding a hand saw at the proper angle

Nail set
An instrument used to drive nails into wood without leaving hammer marks

Penny
The size of a nail, indicated by the letter "d"

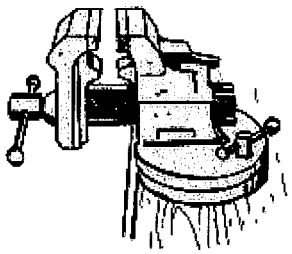
Rasp
A coarse file made with cutting points

Trace pattern
A picture plan that has a full-size outline of the desired shape of the object to be made

Twist drill
An instrument with an edged end that makes holes in wood by revolving into it

Utility square
An L-shaped rule that forms a 90-degree angle

Vise
An instrument that holds your work close together by squeezing with two mechanical jaws



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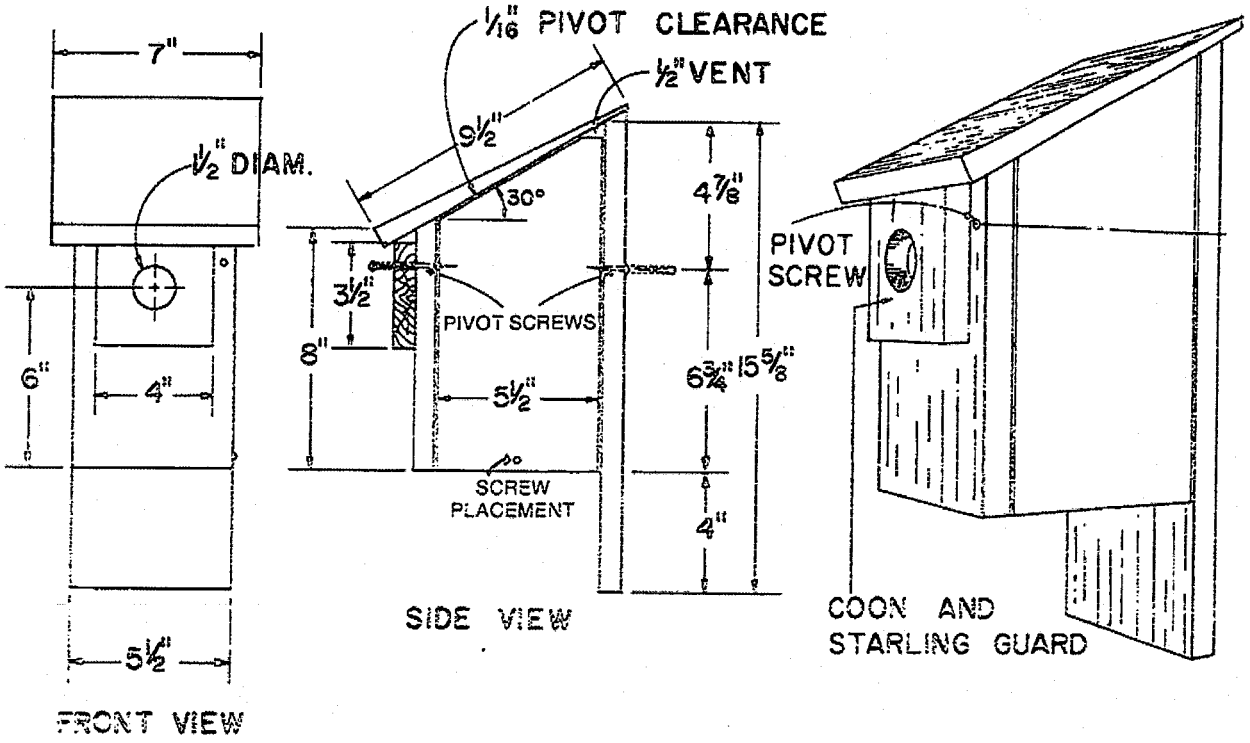

The Wonderful World of Wood

Unit II Member Manual

National 4-H Wood Science Series

4-H 4422
Reprinted September 2006

Oregon State University | Extension Service

Working with Wood & Tools

Acknowledgment

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Contents

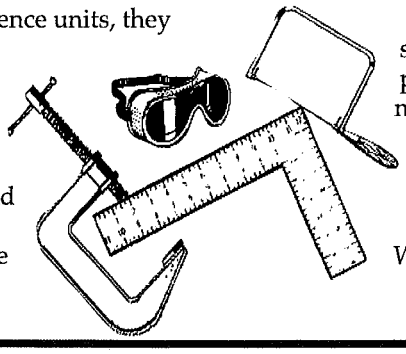
Note to Parents and Home Helpers

You as parents and home helpers are the key to your children completing Wood Science Unit II, *The Wonderful World of Wood*. Even though 4-H leaders help guide and direct your children's work, as parents you should be involved in the planning stages, and also work with your children throughout this project.

Get involved! Make woodworking a family activity. Wood science provides one of the best "learn by doing" opportunities in 4-H. Members have almost an unlimited scope of interesting, educational challenges including designing, constructing, and finishing wood. However, in order for them to complete the activities in the wood science units, they need your help.

In Unit II, your children will be introduced to power tools. For safety purposes, it is recommended that power tools not be used by children younger than 10 years old, and then only with the supervision of a leader or parent. Leaders can supervise your children only while at meetings, so it is up to you to help at home. Make this a safe and enjoyable experience for your children. Help them get the most out of this project by:

- Making this a family project.
- Helping to plan and select woodworking projects that suit your children's ages and abilities.
- Working with them to decide what tools, equipment, and supplies will be needed.
- Helping them set goals they can realistically meet so that they don't get frustrated with the project.
- Planning time that you can work with your children on wood-working projects and activities.



For safety purposes, remember to supervise whenever they are using power tools. Be there to lend a hand, if needed, and to show them that you are interested in the work they are doing, but DON'T DO THE WORK FOR THEM.

It's a challenging world, THE WONDERFUL WORLD OF WOOD!

Introduction

Welcome to Unit II of Wood Science, THE WONDERFUL WORLD OF WOOD!

This is the second in the series of 4-H Wood Science manuals. If you have completed Wood Science I, you probably are asking, "Now what?" Wood Science can be so interesting and challenging that you never really finish. Making beautiful and useful things of wood is limited only by your interest and imagination.

Unit II and subsequent units will help you continue to grow in your ability to create and assemble items of wood. You will learn more about wood itself—how to identify wood, how to measure wood, and how to buy wood.

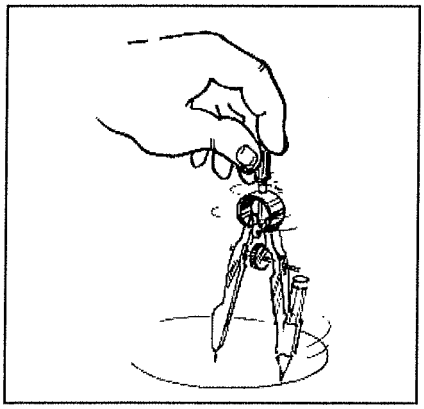
In the back of this manual are plans for some woodworking items you may wish to make; however, you also are encouraged to make items from other plans. Before you start, make sure you can get the necessary materials and make certain that you have, and can use, the right tools. Ask your parent or leader to help you select a woodworking project that is suited to your ability.

You may do your project work at home, or you may be invited to your leader's home or shop. You will enjoy the project more if you have your own work area in the shop, basement, or garage. Be sure to have a place to store your woodworking tools. The tools described in Wood Science Unit I make a good start on a tool set, and you may also want to add some of the tools that are discussed in this unit.

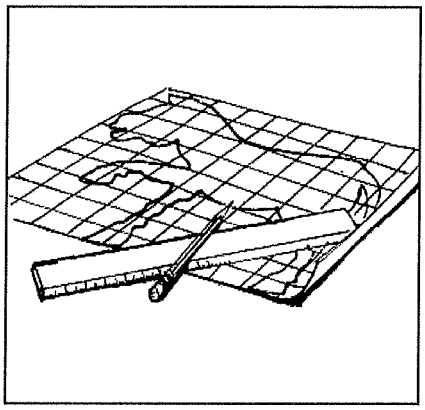
You will be using some power tools now: an electric drill, sander, saber saw, maybe a jigsaw, and others. These tools are powered by electricity to provide more force so you can do your woodworking jobs more easily and more accurately.

Considering your age and beginning skills, use power tools only when being supervised by a leader or parent. Be sure to read and obey the safety warnings provided by Woody Wise.

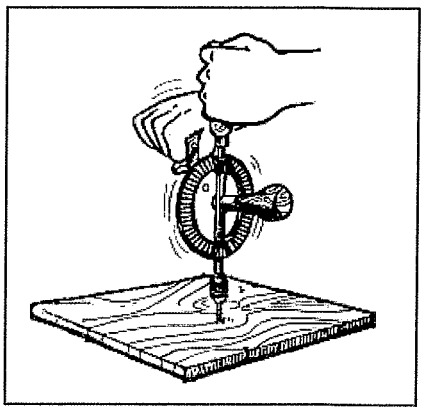
In Unit II, learn how to construct fun woodworking projects using different tools.



Measure and Mark



Use a Grid



Drill Holes

Opportunities for Learning and Doing

In Wood Science, there are many different things you can do and things you can make. There also are many opportunities to learn while doing.

A list follows. These are merely suggestions. There may be other things you wish to add. Also, there may be things on the list you may not want to include.

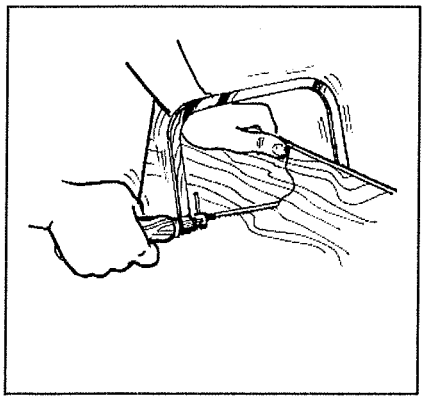
1. Make a wooden toy or gift as a holiday gift or birthday present.
2. Learn to enlarge irregular-shaped drawings using the grid system.
3. Add to your tool set.
4. Build a tool box or storage area for your tools.
5. Start a collection of various-size wood screws.
6. Give a demonstration on the correct use of a hand drill, electric drill, or any other woodworking tool. Consider other possible demonstrations that are related to woodworking.
7. Learn the differences between hard and soft woods.
8. Make a list of different jobs that are related to the wood industry.
9. Talk to some of the people who work in those jobs. Find out what they do.
10. Make a list of products obtained from wood. Write a speech or give a club demonstration on products obtained from wood.

Power Tool Users

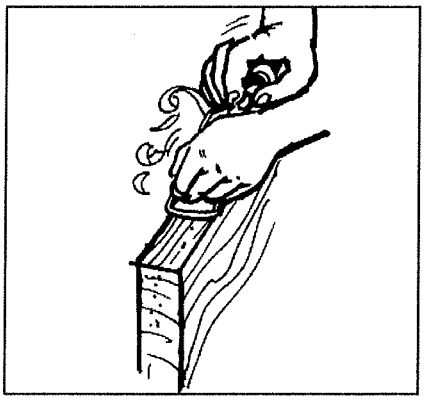
Since moisture conducts electricity, never use an electric tool in wet or moist conditions.

Power tools put out quite a lot of force, but they can't think! They depend on you to think. So, stay alert all the time you are using them.

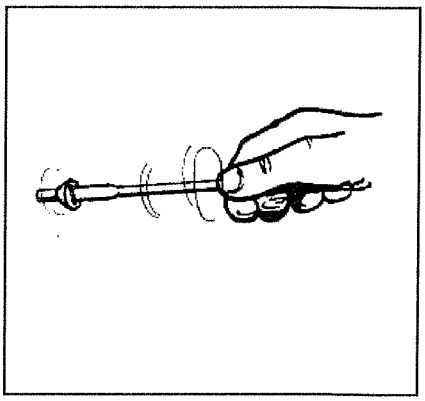
Wear safety goggles when driving nails and when using power tools. They protect the eyes from sawdust and chips.



Sand Wood



Build Things

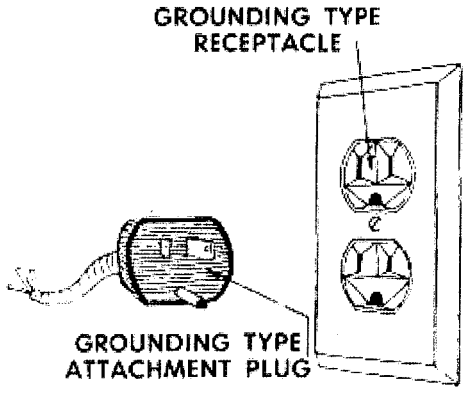


Use glue and finishes

Work Safely

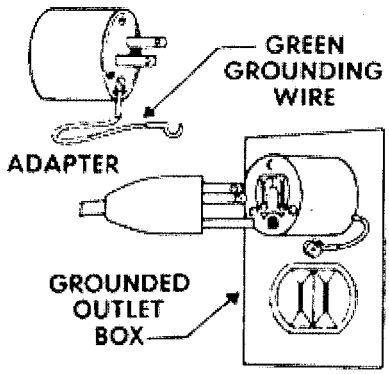
1. When working in the shop area, wear comfortable clothes. Avoid loose-fitting or dangling clothing, which might get caught in a machine.
2. Avoid carrying sharp or pointed tools in your pocket. They may cut or scratch you or somebody else, or tear a chair or auto cushion.
3. Be sure every electric tool you use, such as a jig saw, electric drill, or sander, is double insulated or properly grounded to protect you from electrical shock.

   Many manufacturers are now making portable electric tools with a specially insulated motor and switch housing. Since the housing provides a second layer of insulation to protect the operator, it is referred to as "double insulated" and does not require a third wire or prong to ground the tool. These units have a two-wire cord and should be identified as "DOUBLE INSULATED" and bear the (UL) label on the unit rather than just on the cord.



4. All tools that are not marked as double insulated should be properly grounded for protection against electrical shock. This can be done by connecting the tool to the power source with a cable or extension cord that has three conductors. The wire that attaches to the third blade of the plug safely grounds the tool. **This wire usually is green.**

Caution: A three-prong plug must always be plugged into a three-hole receptacle.



A grounding adapter used with a grounded outlet box.

Adapters are available for use with two-prong electrical outlets, but they should be used with caution. **Use an adapter only if the outlet box is grounded and the green grounding wire is properly attached.** (See illustration above.) If the above precautions are followed, you can then plug the three prongs of your tool into the adapter and use the tool safely.

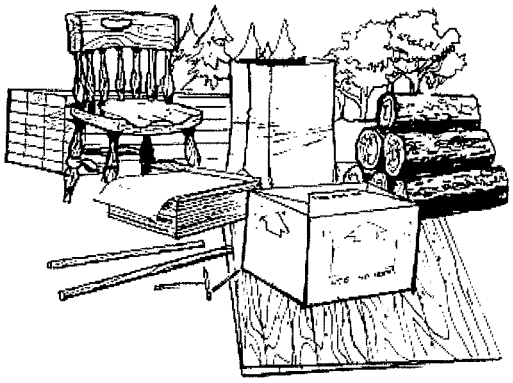
Be sure to read your instruction manual before using your power tools. If your manual has been lost, ask your leader or parent for help ***before*** using the tool.

Trees, Forests, and Forest Products

Take a look around you. No matter where you are—in your home, at school, at church, on a farm, or in your yard—you will see wood being used. Wood is an important natural resource, and it's renewable.

Since the United States was first colonized, billions of board feet of timber have been used to build homes, farm and industry buildings, and other wood products, too many to mention. Yet it is estimated that there is still two-thirds as much land in forests as there was when America was discovered.

Trees and forests not only provide wood products for us, they also provide other benefits such as recreational areas for picnicking, hiking, camping, hunting, and fishing. They provide homes and shelter for wildlife. Trees help keep the soil from washing away and protect our valuable water supply. They also help to purify our air and give us fresh, clean air to breathe.



Our forests are called a "multiple-use" resource because they provide so many benefits. Trees, and the wood from trees, are important resources. They provide more than 5,000 beneficial products useful to humans. How many ways can you think of in which wood is used? Remember that paper products also come from wood.

Trees must be harvested to obtain wood products. Through proper forest management and harvesting methods, we can have the wood products we need as well as the many other benefits of the forest.

From Trees to Wood Products

The forest products industry is a large and complex industry. Forest resources are converted into usable wood products. This industry is an important part of our nation's economy.

Some regions of our country are almost totally dependent on it for income and employment. About 1 out of every 20 people who work is employed in some part of the forest products industry. Let's take a look at this industry to see how we get our wood products.

Growing the Timber

The first step in the forest products industry is growing the timber. This is called **forestry**. Professional foresters manage the forests to increase growth and to protect them from fires, insects, and diseases. Keeping forests healthy ensures their usefulness to humans.

To learn more about our forests and growing timber, you may want to enroll in the 4-H forestry project.

Harvesting and Transporting the Timber to the Mills

Harvesting and transporting the timber to the sawmill is the next step in the forest products industry. Harvesting actually involves several steps. Before reaching the mill, trees are cut down, limbs are removed, then the trees are cut into logs. This is called **harvesting**. These steps are sometimes done by one person using a chain saw and a truck. However, large operations employ many persons and use large machines to cut the trees and haul the logs to the mill.

Processing

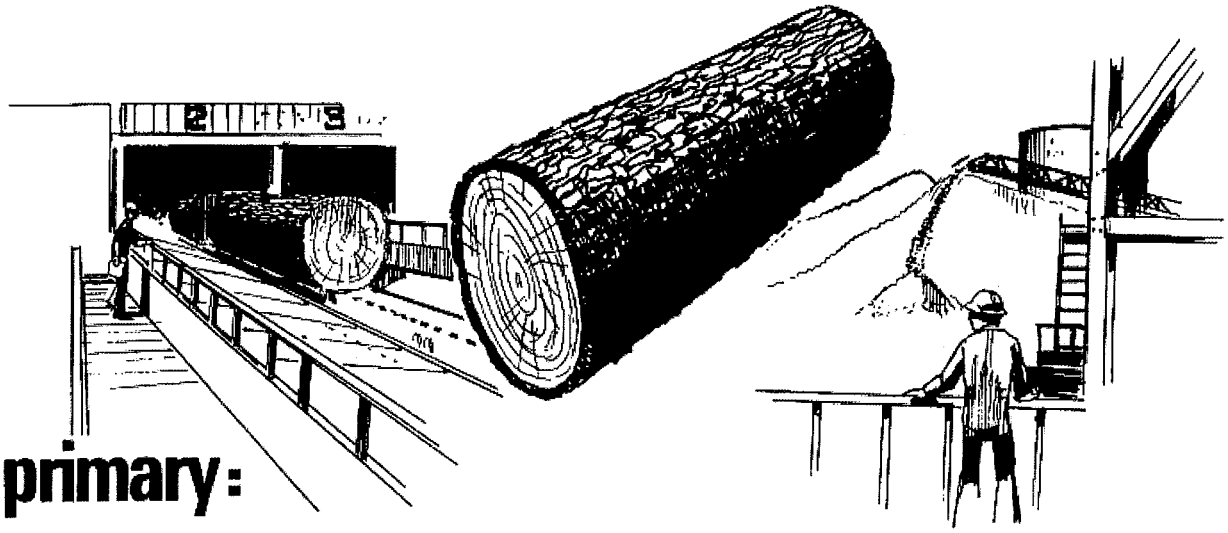
Processing is the third phase. It is divided into two segments: (1) primary processing, and (2) secondary processing. **Primary processing** is the sawing, chipping, or slicing of the log to convert it into lumber or other raw wood products. Examples of primary processing would be sawmilling to produce pulp and paper, veneer, plywood, or particleboard.

Some products need additional manufacturing before use, such as making furniture from lumber, particleboard, and plywood. Other examples include producing cardboard boxes or bags from paper, or making flooring from lumber. This is called **secondary processing**.

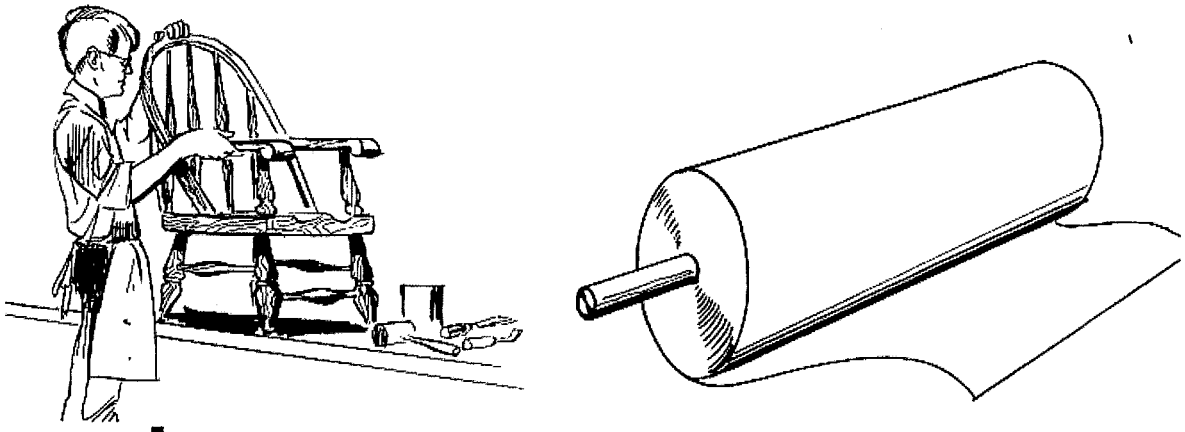
Marketing Wood Products

Marketing forest products also is important to the industry. Many individuals handle the products from manufacturer to user. Much of the lumber is delivered to the lumber yards or building supply stores where customers choose what they need. This is where you may find materials for your woodworking project. Other forest and wood products are sold at commercial and retail outlets, such as office supply stores, furniture stores, hardware stores, etc.

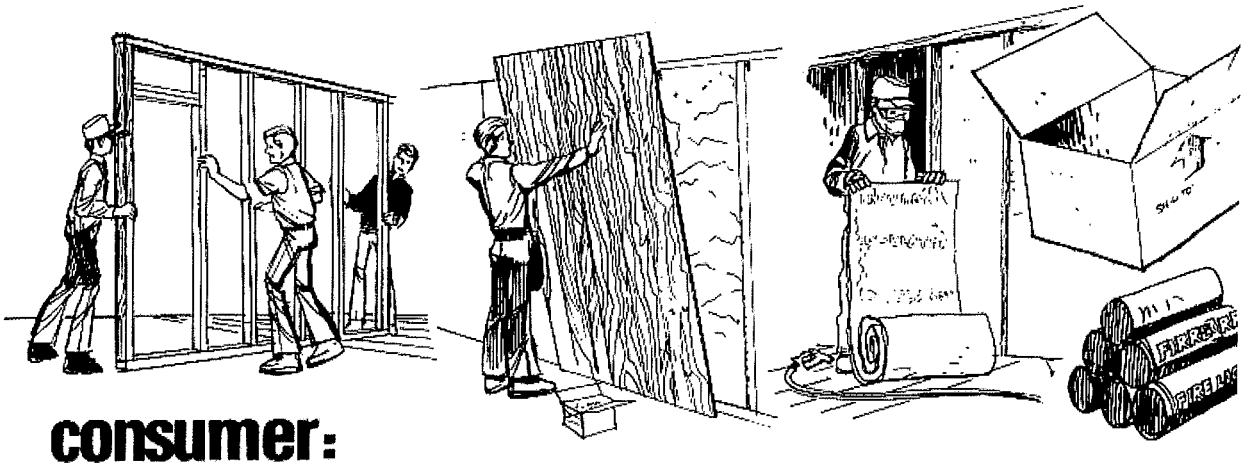
Wood construction and building trades also are part of the forest products industry. Much wood is used in homes and other buildings. Some homes are partially or totally built from lumber in factories, while others are built by carpenters on the site.



primary:



secondary:



consumer:

Learning to Use Wood

How do trees become the wood we use for making things? For some products, the logs can be used almost as they come from the tree. Telephone poles, fence posts, and firewood need little manufacturing. For most of the wood we use, the logs are cut into lumber or made into plywood, particleboard, or fiberboard. The type of tree the wood comes from, how it is cut, and how it is treated after cutting affect how it can be used—and even whether it can be used—for a particular project.

You learned in Unit I that trees can be divided into two basic groups. We call these **hardwood** and **softwood** trees. Hardwoods have broad, flat leaves; examples are oak, maple, and cottonwood. They usually turn color and lose their leaves in the fall. Softwoods have needle-like or scale-like leaves; examples are pine, cedar, and fir. They usually keep their leaves through the entire winter.

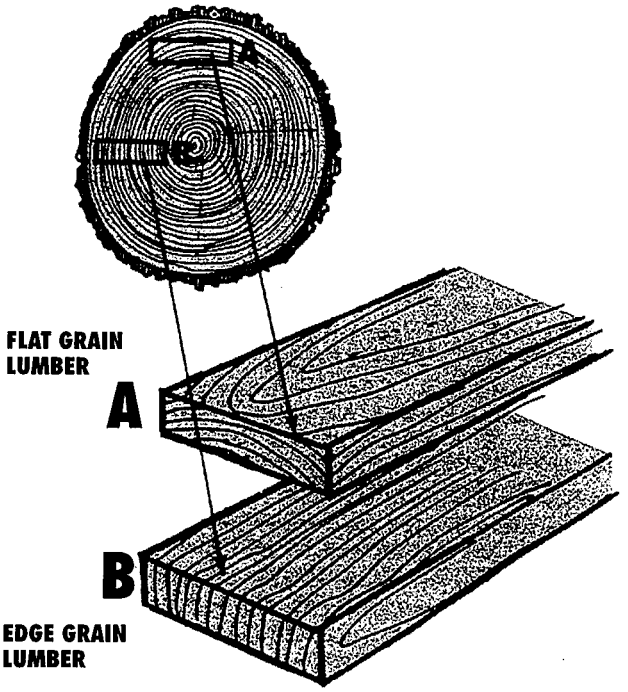
These names may fool some people into thinking that the wood from a hardwood tree is always hard, and the wood from a softwood tree is always soft. In fact, this is not always true, but the names remain because it is true in many cases.

The wood from hardwoods and softwoods is used for different things. Hardwoods are often used to make furniture, flooring, and paneling because of the attractive grain and colors. Softwoods are more often used as lumber or plywood for general building construction. For your project, you probably will use softwoods because they are usually available at local lumberyards. Hardwoods may be harder to find. Discuss with your leader or helper the various woods that are available and have them help you select the best wood to use in your project.

Let's look at wood to see how other things might affect its use. If we look at the cut end of a branch, log, or stump, we will see rings surrounding the center. They look like a target or bullseye. Each year a tree grows, it adds a new ring. This is why they are called **annual rings**. You also can see the annual rings on the cut ends of lumber.

The annual rings not only show on the ends of lumber, but they continue up the length of the board and appear on the faces and sides. They will appear as bands, lines, or other patterns. It is these annual rings that give wood its attractive patterns when cut and finished. On the faces and sides of wood, we call the annual rings and their patterns the "grain" of the wood. Look at a piece of lumber and see how the annual rings form patterns on the surface.

When a sawmill cuts a log into lumber, it may be cut in several ways. If you cut the log off center, closer to the edge like "A," you get **flat grain** lumber. The



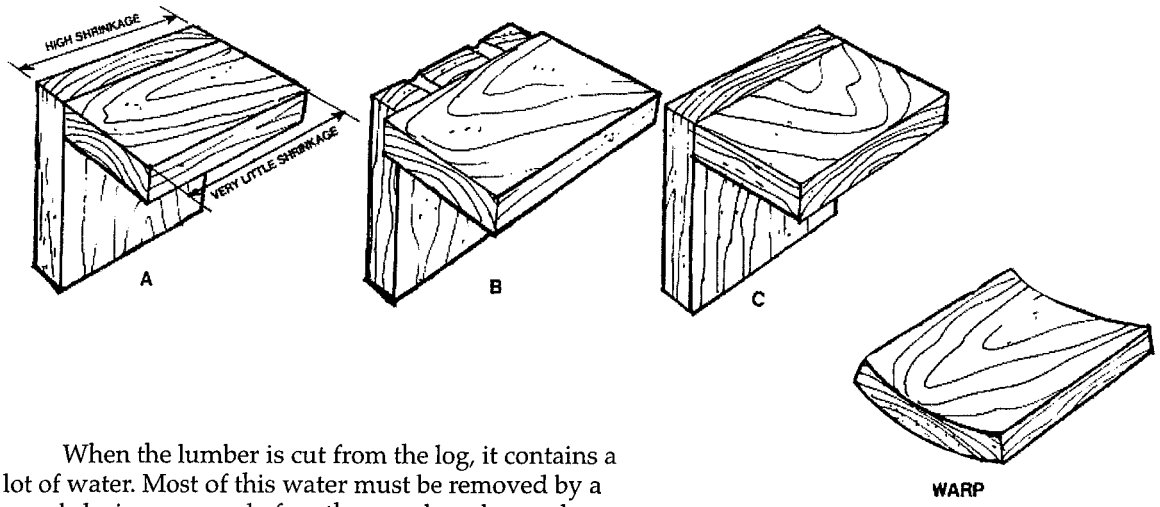
grain on the wide face of the board will be large, flat bands; long, wavy arches; or long patches, depending on how the saw cuts through the annual rings of the log. The grain on the edges will be narrow stripes or lines.

If the log is cut through the center like "B" in the drawing, you get **edge grain** lumber. In edge grain lumber, the grain goes nearly straight across the board from top to bottom and gives a pattern of stripes or lines on the wide face of the board. Lumber cut near the center of the log has edge grain.

Something for You to Do

Find a tree stump or a round piece of firewood, or ask your parent or leader to help you cut a piece from the end of a log or tree branch. Count the annual rings to see how old that piece of wood was when it was cut.

Remember that the rings go all the way around the trunk, so count only from the center to the bark. If the stump or log is old enough, you may even be able to find rings corresponding to some of the important dates in your life, the life of your family, or the history of your community. You may also want to use annual rings and the history they tell as a demonstration in your 4-H club meeting.



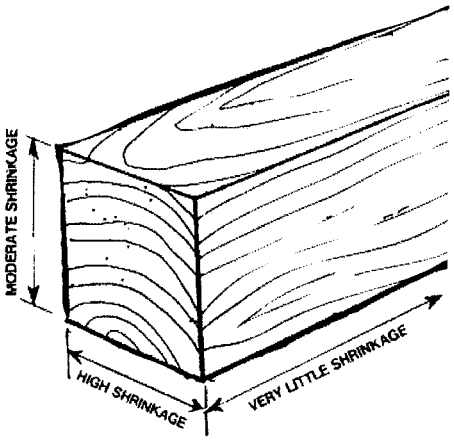
When the lumber is cut from the log, it contains a lot of water. Most of this water must be removed by a wood-drying process before the wood can be used, or the water eventually will evaporate, causing the wood to shrink. Some sawmills stack the lumber outdoors to let the water evaporate. This is called **air drying**. When complete, the lumber is called **air-dried** lumber. Others put the lumber in special buildings called dry kilns and heat the lumber to speed dry. Lumber dried like this is called **kiln-dried** lumber.

Some of the water in lumber evaporates without changing the size or shape of the wood. The amount of water that remains in the wood depends on the temperature and the **relative humidity** of the air around the lumber. Relative humidity is a measure of the moisture that is in the air. If the relative humidity of the air increases, the wood slowly gains moisture from the air, which causes it to swell. If the relative humidity of the air decreases, the wood loses moisture to the air and shrinks. These changes are always taking place, but if the wood has been dried properly and is protected and used correctly, the changes will be small and should not affect your project.

When wood shrinks and swells, the change in size is not the same in all directions. Wood shrinks and swells most in the direction along the annual rings. Along the grain or lengthwise to the piece of lumber, shrinkage is very small. Wide and thick boards shrink more than thin and narrow boards.

When we build projects, we must be careful to use wood correctly so that shrinkage and swelling do not hurt our finished product. Pieces put together like "A" (above) end up split and of different sizes (like "B") because the wood did not shrink the same amount. The proper way of joining these two pieces is shown in "C." Here the two pieces of wood will shrink and swell about the same.

When wood loses moisture or picks up moisture, it sometimes changes shape. This is called **warp**. Edge-grain lumber does not warp as much as flat-grain lumber.



Lumber that has been dried is better to work with than lumber that is **green** or wet, because it does not shrink or warp as much as green or wet lumber. Green lumber is lumber that has not been dried.

For projects that will be kept inside a house or building, drier lumber is needed than if the project is to remain outside. Check with your leader or parent for help.

The size of lumber is called its **dimensions** or measurements. The dimensions tell you the rough size of lumber when it was originally sawn at the sawmill. A 1 x 4 (one by four) is 1" thick and 4" wide when cut. As you know, lumber shrinks when it dries. Some material is also removed when the wood is planed smooth. As a result, most lumber cut 1" thick will end up being about ¾". A board cut 4" wide will be only 3½" wide after drying and planing. The original sawn size is still used to describe the piece, so it is called a 1 x 4.

The same thing happens to a 2 x 8 (two by eight). It is 2" thick and 8" wide when sawn. After drying and planing, it will be 1½" x 7¼", but it still is called a 2 x 8.

Plywood

You were introduced to plywood in Unit I. Plywood is made by gluing together three or more thin layers of wood called veneer and laying the grain of each piece at right angles to adjacent pieces. This gives the plywood extra strength and reduces shrinking and swelling.

Plywood is normally sold in sheets 4 feet by 8 feet (4 x 8). It comes in many thicknesses. It is measured in inches and sold by thickness. (For example, plywood called ¾" plywood is ¾-inch thick.) Unlike lumber, 1" plywood is 1 full inch thick.

Plywood is made in two types: (1) exterior type, and (2) interior type. The type refers to the glue used between the plies. If your item is going to be used outdoors, be sure to get exterior-type plywood, or the plies will come apart when the plywood gets wet. For indoor use, buy interior type plywood because it is less expensive for the same grade surface.

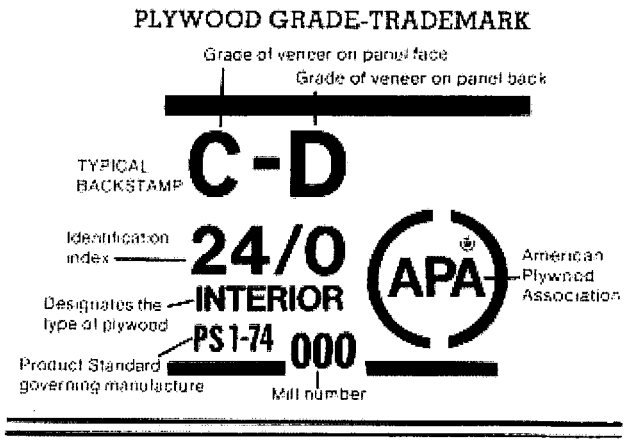
Many different species of trees are used to make plywood. Most of the softwood plywood comes from either Douglas-fir or southern pine.

The grades of softwood plywood are based on the quality of the veneer. The standard grades of veneer are A, B, C, and D, with A being the highest grade and D being the lowest. In the lower grade, more knots and defects will be present; however, these defects have little effect on strength.

Both sides of the plywood sheets are graded and do not have to be graded the same. If a sheet of plywood is graded A-D, the face will be A grade and the back will be D grade. In this manner, we can get greater use out of the high-grade logs than we could if all plies were required to be grade A throughout.

Interior-type plies usually have D veneer on the inside plies. Exterior-type plies must have C or better veneer throughout.

If you are building a project where both sides will show, you want to use an A-A plywood. If only one side will show, you can use A-C or A-D panel. You sometimes can cut pieces with clear faces from lower grade plywood by cutting between the defects.



Mill-Certified or Shop Grade Plywood

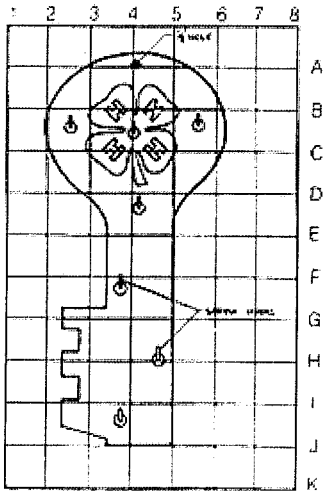
Some plywood is sold as mill-certified plywood. It also may be called shop plywood or shop cutting panels. This is plywood that has some defects that keep it from being sold as a standard grade. Mill-certified or shop plywood is found most often in areas where plywood is made. This is in the southern and western coast states. It may not be available in areas that are a long way from plywood plants. Mill-certified and shop plywood costs less than standard-grade panels. Many good, small pieces of plywood can be cut from mill-certified panels. These can be used for your woodworking projects.

How to Use the Grid System

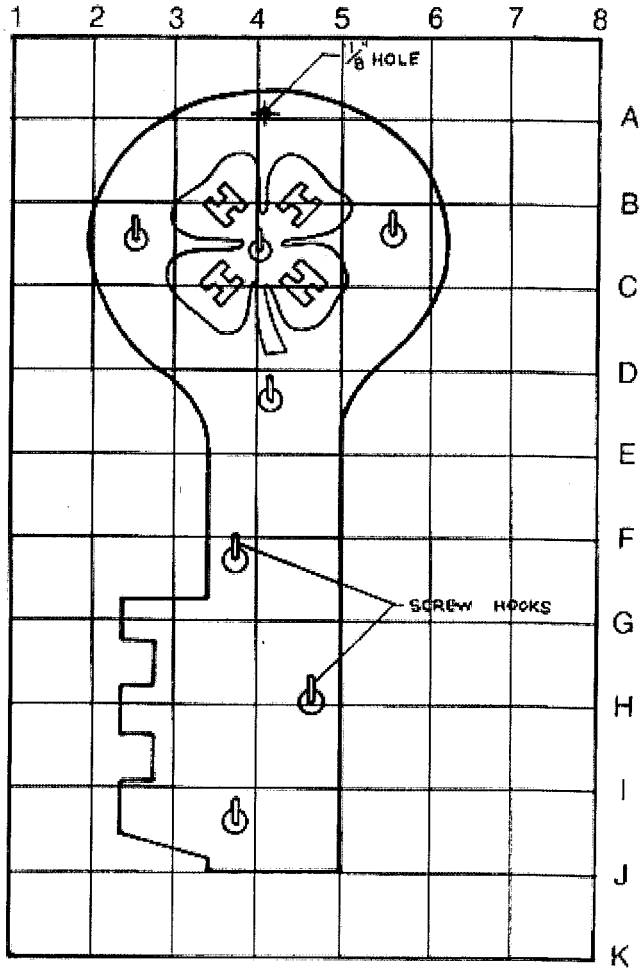
You may want to learn how to use the grid system to make drawings of irregular-shaped articles. The grid system is used to enlarge irregular-shaped drawings that are too small for a trace pattern.

For instance, if you had a 2" x 2" drawing of this key hook holder and you wanted to make it larger, you would follow these steps:

1. Decide on the size you want your pattern to be.
2. Draw a grid on your original article, and draw a grid the size you want your pattern to be on a clean piece of paper or wood. Both grids must have an equal number of squares, but the larger the drawing the larger the squares. The new drawing will then be your pattern.
3. Along one side number the lines. Place letters of the alphabet along the other. Remember, the squares on both grids must be identified the same.
4. Now you are ready to draw. On your original drawing, place dots where the outline of the picture crosses the grid lines. Transfer these dots to your new grid pattern, plotting the points one by one and connecting them in order as if you were trying to draw the picture free-hand. Use straight lines and curved lines where appropriate. As you connect the dots, your new pattern should be the same shape as your original, only larger.
   - To make a 12" x 12" drawing, use 12 rows of 1" squares.
   - To make a 16" x 16" drawing, use 16 rows of 1" squares or 8 rows of 2" squares.
   - To make a 24" x 24" drawing, use 24 rows of 1" squares or 16 rows of 1½" squares.



Original Pattern.



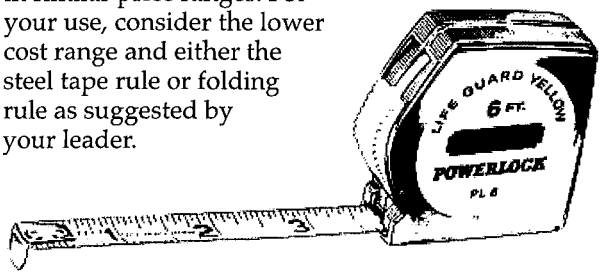
New Enlarged Pattern.

Woodworking Tools

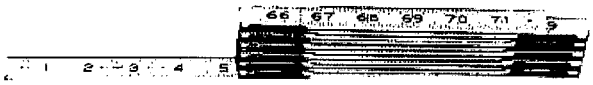
Wood Science Unit I contains information about a group of tools and some equipment you should have for your use. This unit contains information about more tools. You may want to add some of them to your tool set.

Steel Tape and Folding Rule

In this unit, you will be making bigger things than before. Therefore, you may desire a steel tape rule or a folding rule. Both are available in similar price ranges. For your use, consider the lower cost range and either the steel tape rule or folding rule as suggested by your leader.



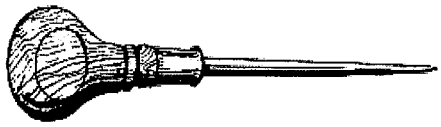
The steel tape rule is available in many lengths: 6, 8, 10, and 12-foot lengths. The 6-foot length probably is adequate for your use.



Folding rules are available with either standard inside reading or outside reading. The numbers on the inside-reading rule begin on the inside face. Thus the markings are close to the work when the rule lies on the work with the unfolded portion up.

Scratch Awl

Now that you are doing more exact and accurate work than before, you may need a scratch awl for marking. It gives a very clean, sharp, distinct line for accurate cutting. It can be used to make a center point in wood for drilling.



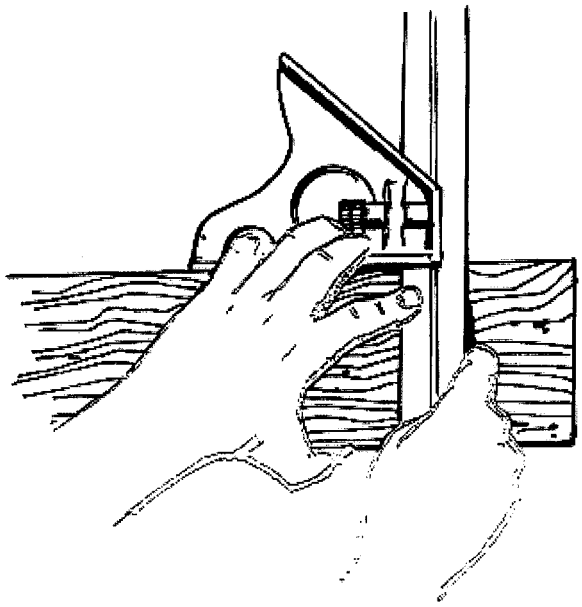
Attention Awl Users

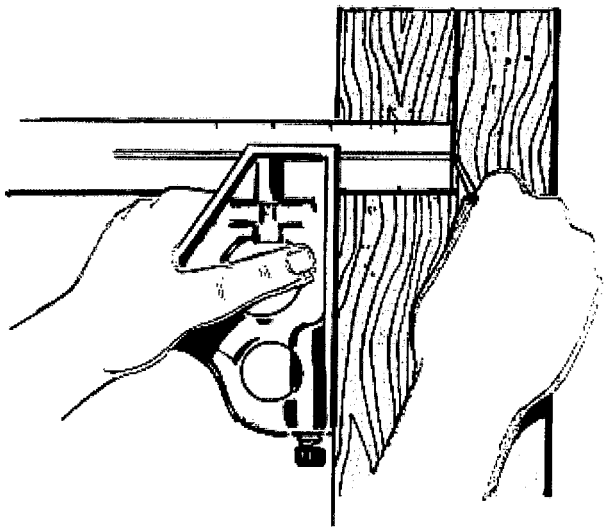
An awl is sharp-pointed like an ice pick. It is used for marking lines or piercing small holes in wood. Because of its sharpness, it must be handled carefully at all times so it won't pierce your skin.

Combination Square

A steel combination square and a scratch awl marker or pencil can be used to make a line of uniform distance from one edge of the wood piece.

Set the blade of the square in the desired position and securely tighten the adjusting nut. Hold the square firmly against the edge of the wood. Slide the handle along the edge of the wood piece with one hand while marking at the end of the blade with the other hand. Slant or slope the marker in the same direction as you are moving the square.

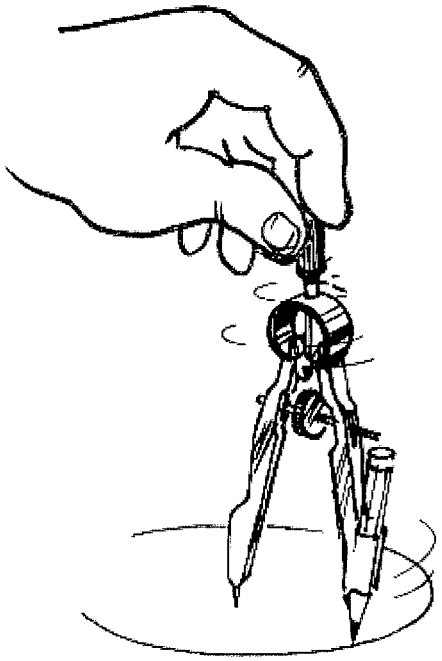




Pencil Compass

A moderately priced pencil compass works well for drawing circles or parts of circles. The pencil should be adjusted so that when the compass is closed, both the pencil point and the needle-like point of the leg are the same length. To use the compass, push the needle-like point into the center spot of your circle and move the compass in a circular motion. Slightly lean the compass in the direction you are moving.

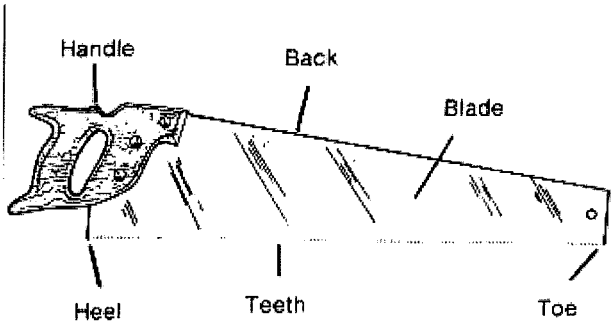
When drawing a circle on a piece of paper, place a piece of cardboard or wood under the paper. Otherwise, the needle point may go through the paper and harm a nice tabletop.

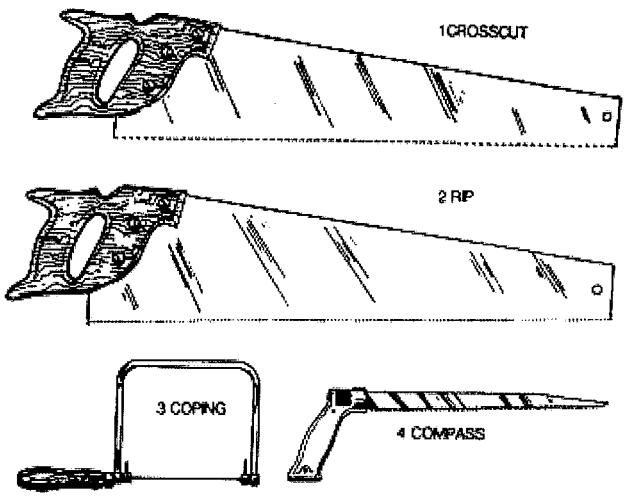


Hand Saws

Saw size is determined by the length of the blade in inches. Some popular sizes are 20", 22", 24", and 26". The coarseness or fineness of a saw is determined by the number of teeth points per inch.

There are different types of hand saws, each suited for a particular job.





Crosscut Saw

This saw is used frequently by woodworkers. Crosscut saws cut across the grain of wood, and they cut on both the forward and backward strokes. They are available with coarse teeth or fine teeth. The teeth have knife-like points.

A coarse, crosscut, 8-point saw works well for fast work and for green wood. A fine saw, 10 to 14 teeth points per inch, is better for smooth, accurate cutting and for cutting dry wood.

Rip Saw

Rip saw teeth are shaped like chisels. They cut like a gang of chisels in a row. The rip saw cuts mostly on the forward stroke and is used for cutting with the grain of the wood.

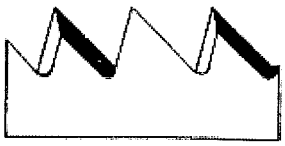
Coping Saw

This saw is used commonly for cutting curves in wood. It is small with a narrow blade and cuts better on wood that is not too thick, such as ¼" to 1" thick. As the saw cuts, it tears and breaks the wood fibers, cutting in the direction that the teeth are pointing. For example, if the blade is placed in your saw with the teeth pointing toward the handle, the saw will be cutting on the pull stroke.

Compass Saw

This saw is small with a short, narrow blade. It is used to saw curves in wood too thick for a coping saw. To start an inside cut with the saw, you must bore one or more holes large enough to admit the point of the saw. Insert the saw point in the hole and cut with smooth, even strokes.

Crosscut Saw Teeth



Rip Saw Teeth

Attention Power Saw Users

Wear safety goggles whenever using electric saws.

Keep a firm grip on the saw so it does not jump out of your hands.

Turn the saw off and unplug it when cutting is finished.

Do not let the blade touch any part of your body. It can inflict serious damage.

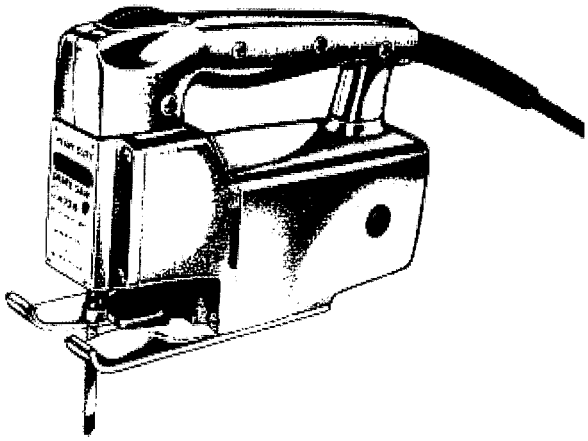
Use with supervision.

Power Saws

Saber Saw and Jig Saw

These power saws cut straight lines, curves, circles, and irregular shapes. Blades are available for these saws that can be used to cut metal, plastics, composition board, rubber, etc.

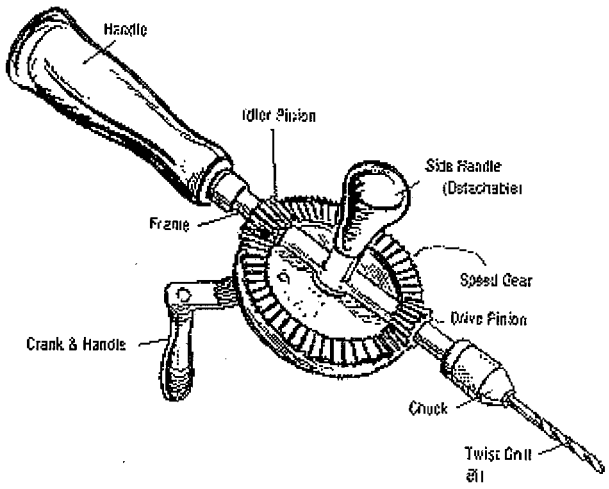
It would take many pages to explain in detail the operations of these saws. If you have one of them, study the instruction book you received. Operate power saws only with the supervision of a leader or parent.



Tools for Boring Holes in Wood

Hand Drill

The hand drill is used with removable drill bits of different sizes. It is used to make small pilot holes up to ¼" for nails and screws. This prevents splitting the wood. Use it also to drill a starting hole for the coping saw blade.



Before you start drilling, make a small starting hole in the wood with a scratch awl or a nail and hammer. The hole prevents the drill point from slipping or sliding. Always make sure you have the right size drill bit properly placed in the chuck before you start to work.

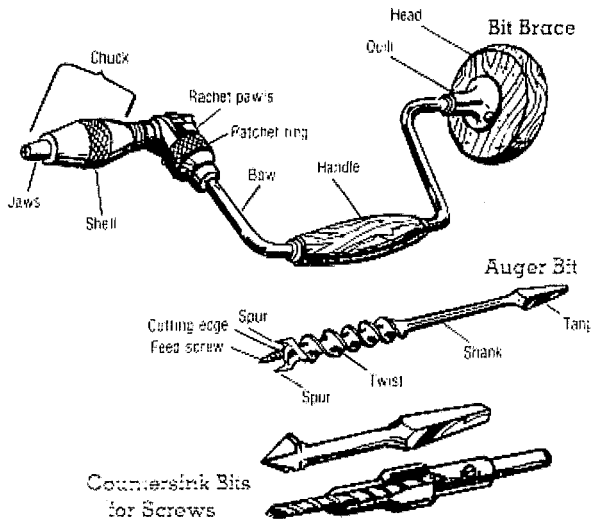
To put the drill bit in the chuck, hold the crank handle and frame with one hand and turn the chuck to the left with the other. Open the jaws only a little more than the size of the drill bit. This helps to center the bit. Turn the chuck back to the right to tighten and hold the bit in place. The drill is used by holding it straight up and down. Hold the handle in your left hand and turn the crank with the right hand.

Proper Use of Hand Drills

Be careful. The drill may be jerked out of the wood and injure you. The gears also can pinch.

Bit Brace and Auger Bits

To bore large holes ¼-inch and larger, use your bit brace and auger bit or electric drill and appropriate bit. The bit brace is used for turning such tools as wood auger bits, screwdriver bits, twist drill bits, and countersink bits. Braces are made either with or without the ratchet device. The ratchet makes it possible to bore holes where the handle cannot be turned all the way around, as in corners. The size of a bit brace is designated by its sweep. The sweep is the diameter of the circle through which the handle swings. A brace with an 8- to 10-inch sweep is suitable for average work.



Can you see the similarity between the hand drill and this tool? They are both used to bore holes. However, on the hand drill the part that makes the hole is called the **twist drill bit**. On this tool it is called an **auger bit**. You can use either for making small holes, but it is easier to make large holes with an auger bit.

The bit and brace is used by pressing down on the head and turning the handle. As the feed screw starts to break through your item, turn the item over and finish boring the hole from the other side. This prevents splitting and splintering.

Most hardware stores sell auger bits individually or in sets. The number usually stamped on the tang (shank) indicates the size of the bit by 16ths of an inch. For example, 4 indicates 4/16" or ¼".

Brace and Bit Safety

This is a fairly safe tool, but accidents can happen. Hands have been pinched where the handle or head bearing became worn. Don't use the brace if it is badly worn.

Make sure the tang of the bit fits correctly and the chuck jaws firmly hold it. Be sure the ratchet won't slip and scrape your knuckles.

Stay away from the back side of the piece being bored. The bit can break through accidentally with great force. If possible, put a board on the back side of the piece you are drilling to keep your project piece from breaking.

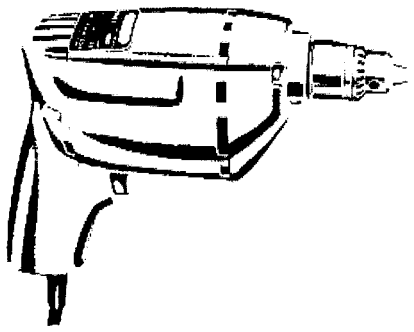
Electric Drill

The electric drill can be used for all sizes of holes, depending on its size and your ability to safely use it. A small electric drill is a very handy tool for drilling holes up to ¼ inch, and larger electric drills using special bits can drill holes up to 1 inch in diameter.

When using the electric drill, make a pilot hole in the wood the same as you would when using a hand drill. Always make sure you have the right size drill bit properly placed in the chuck before you start to work.

Drills are available in the light-duty, inexpensive range, medium-duty, heavy-duty, or industrial class. Electric drills also are available with varying speeds.

Electric drills run at a very high speed. When using the electric drill, grasp the handle firmly. The drill develops a twisting force called **torque** when in motion. If the bit suddenly became stuck, the torque of the drill could jerk your arm enough to strain a muscle.



Electric Drill Users

Always make sure the key is removed from the chuck before pressing the switch.

There may be a sudden twisting force on the drill handle should the bit become stuck. You must have a firm grip on the drill handle at all times.

Never use the electric drill where there is the possibility of touching water or in damp conditions.

Any slight break in the electric-cord insulation could give you a severe shock.

The wood being drilled should be clamped or held securely.

Keep the tool in good condition at all times.

Carbon steel drill bits work well in wood, but high-speed drill bits are necessary for drilling in metal. Metal is considerably harder than wood; therefore, carbon steel bits become dull very quickly when used in metal. The higher quality steel used in high-speed bits makes them more durable than carbon steel bits.

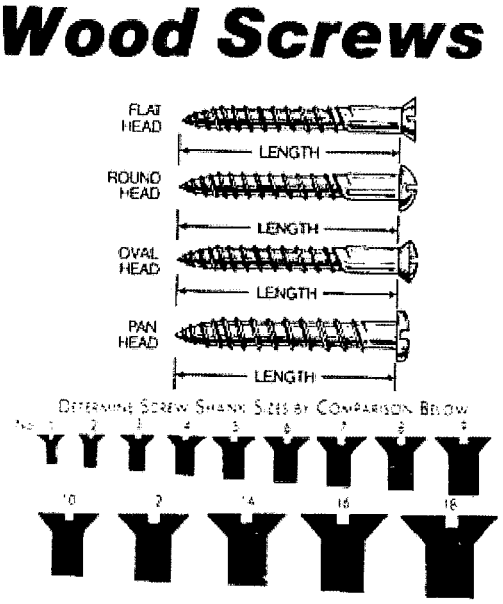
Wood Screws

There are various kinds and sizes of screws. The flat-head screw is used most commonly in woodworking, although the oval-head and the round-head screws are sometimes used, mainly for ornamental effect. The pan-head screw also is used.

The size of wood screws is designated by:
(1) Size of the shank
(2) Length

You may use screws to assemble some of the things in your woodworking project. Remember to drill pilot holes to prevent splitting and to make the screws turn more easily.

To make pilot holes, find the proper drill size from the table. Drill the first hole as deep as the length of the screw from the head to the beginning of the threads. Then drill the second hole inside the first hole and drill as deep as the screw length. Instead of using two different-size drills to make pilot holes, you can buy combination pilot hole drill bits in a variety of sizes to fit the different-size screws.



Sizes of Bits or Drills to Bore Holes for Wood Screws

Number of Screw		1	2	3	4	5	6	7	8	9	10	12	14	16	18
Body Diameter of Screw		073	086	099	112	125	138	151	164	177	190	216	242	268	294
		5/64	3/32	3/32	7/64	1/8	9/64	5/32	11/64	11/64	3/16	7/32	15/64	17/64	19/64
First Hole	Twist Drill Size	5/64	3/32	7/64	7/64	1/8	9/64	5/32	11/64	3/16	3/16	7/32	1/4	17/64	19/64
	Auger Bit Number							3	3	3	3	4	4	5	5
Second Hole	Twist Drill Size		1/16	1/16	5/64	5/64	3/32	7/64	7/64	1/8	1/8	9/64	5/32	3/16	13/64
	Auger Bit Number												3	3	4

Using the Screwdriver

Turn the screw in until the two pieces of wood fit tightly together. If you turn the screw too much, the wood around the screw threads will break out. Then the strength of the screw is lost.

The screwdriver should be the same width as the slot on the screwhead. It should be thick enough so it fits snugly into that slot.

Screwdriver Users

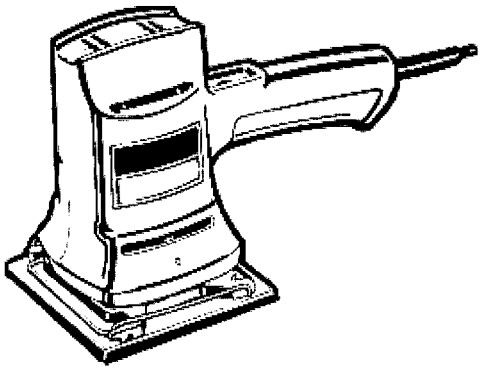
Imagine! Some people have been seriously hurt while using screwdrivers when the screwdriver slipped and struck them in the palm of the hand.

Objects you are working on should always be placed on the work surface. Never hold the object in the palm of your hand.

Screwdrivers must fit the slots of the screws properly.

Oscillating Sander

Oscillating electric sanders can be used in the shop and home. They can be used for paint removal, refinishing furniture, finishing wood and smoothing wood, wallboard, or plaster wall joints. The sanding action is provided by a rectangular piece of sanding paper attached to a sanding pad. The pad oscillates either back and forth or in a circular motion. A sander that oscillates in a circular motion may not be satisfactory for fine work, because it may leave circular scratches on the wood surface. If you are not sure whether to use this sander, ask your leader or parent for help.



Using the Sander

Be sure the sander is properly grounded through a three-wire grounding cord. Check to see that the switch is in the OFF position before connecting the electric plug to the outlet. Lift the sander off the work before starting or stopping it. Hold it firmly with little or no downward pressure. The weight of the sander is enough in most cases.

To smooth a rough surface, start with a coarse sandpaper because it cuts faster. Change to medium and then to fine sandpaper as the surface becomes smooth. Remember to sand along the grain (along the length of your wood piece), never across the grain.

Lubricate the sander according to recommendations of the manufacturer.

Using the Electric Sander

Because moisture conducts electricity, never use the electric sander in wet conditions. You can get shocked!

Unplug the sander when changing the sandpaper.

Never let the moving sandpaper touch the power cord. It can quickly ruin the insulation, which can then shock you.

Woodworking Plans

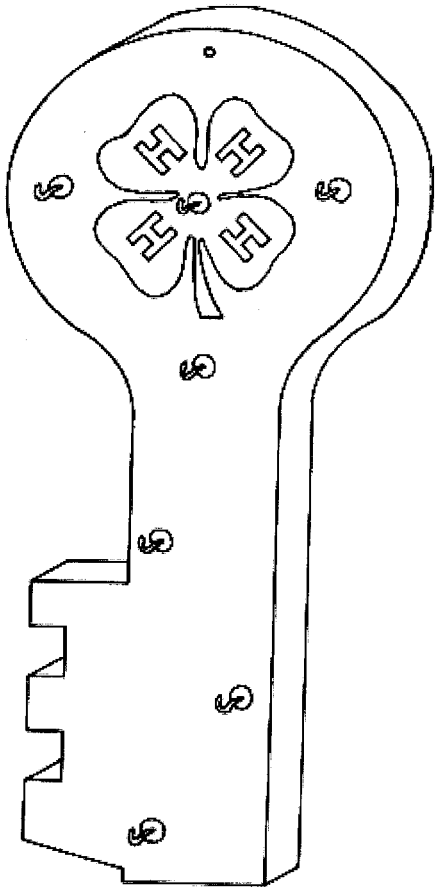
4-H Key Holder

Materials needed

- 1 piece of 1 x 6 lumber (actual size ¾" x 5½") x 11" long
- 7 — ½" cup hooks
- Carbon paper
- Sandpaper (medium and fine grit)
- Paint (green and white)
- Stain
- Varnish

Tools needed

- Coping saw or saber saw
- Boring tool with ⅛" bit
- Woodburning tools (optional)



Instructions:

1. Trace pattern onto wood using carbon paper. (See instructions for grid enlargements on page 11.)
2. Cut out the key using the saw.
3. Drill ⅛" hole at top for hanging.
4. Sand the wood piece thoroughly.
5. Stain the piece.
6. Take the pattern and re-mark your wood for the 4-H Clover design and cup hooks.
7. Paint the clover green and the H's white. (Instead of using paint, you can burn the clover design into the wood with a woodburning tool.)
8. Varnish the entire item.
9. Install the hooks.

Cutting Board

Materials needed

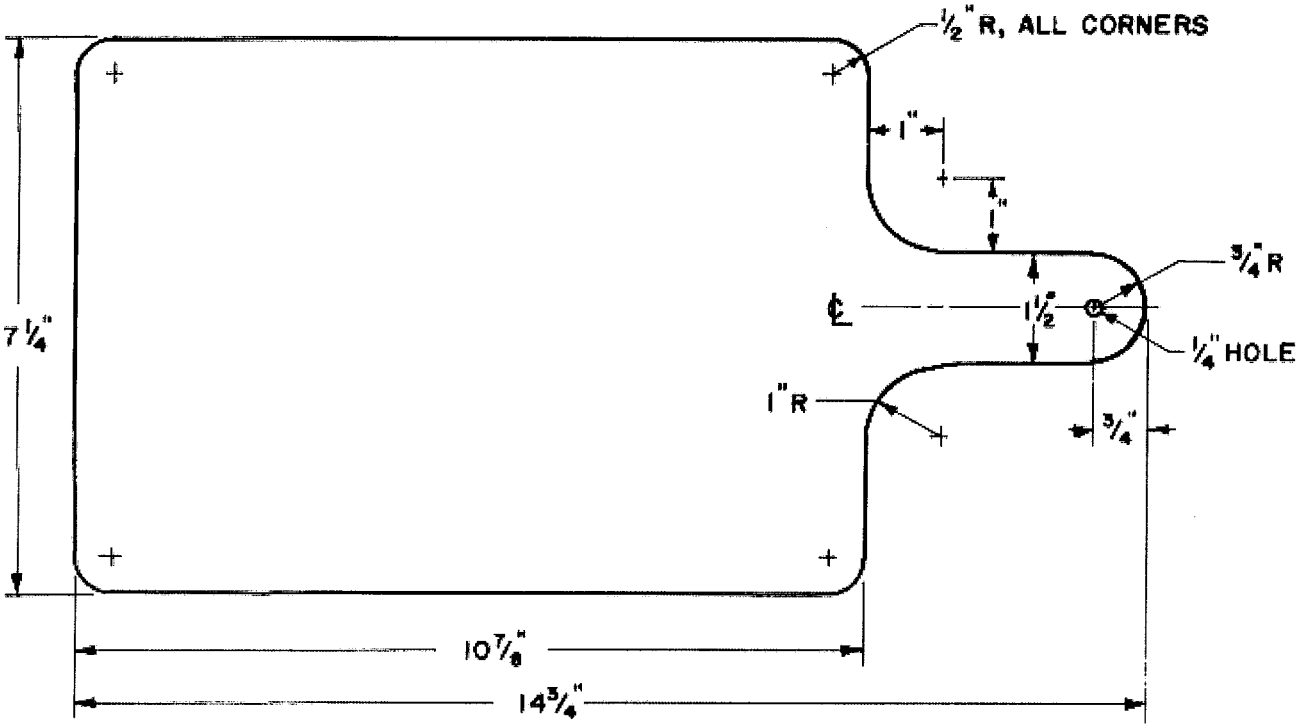
- 1 piece of 1 x 8 hardwood (actual size ¾" x 7¼") x 15" long
- Sandpaper (medium and fine grit)
- Varnish

Tools needed

- Pencil compass
- Square
- Saw (coping, jig, or saber saw)
- Boring tool with ¼" bit

Instructions

1. Using the pencil compass, lay out curves and the hole in the handle on your wood piece. Use the square to make straight lines on the sides and end.
2. Cut out the curves and drill hole.
3. Sand both sides.
4. Finish with two or three coats of varnish, on one side only. (This process is optional.)



The Shifting Pyramid Game

Materials needed

- 1 piece of ¾" x 8" x 8" A-D or better plywood, or use a piece of lumber 1 x 10 (actual size ¾" x 9¼") x 8" long (base)
- 1 piece of ¼" x 6" x 6" A-D or better plywood, or use a piece of lumber 1 x 8 (actual size ¾" x 7¼") x 6" long (game pieces)
- 1 piece of ¼" dowel stock, 12" long (pegs)
- Glue
- Sandpaper (medium and fine grit)
- Finishing material (optional)

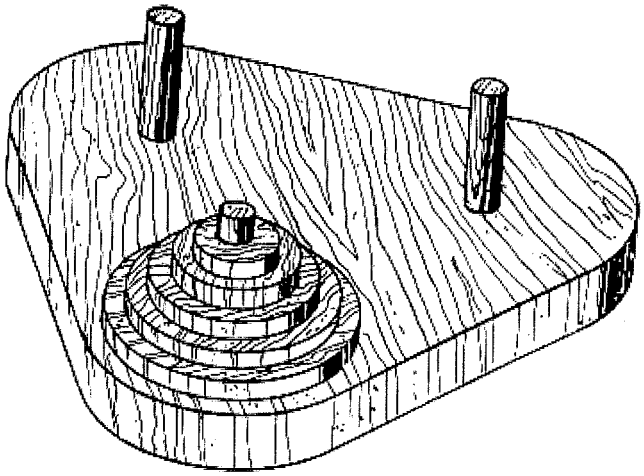
Tools needed

- Saw (coping, saber or jig saw)
- Boring tool with ¼" and ⅜" bits

Instructions

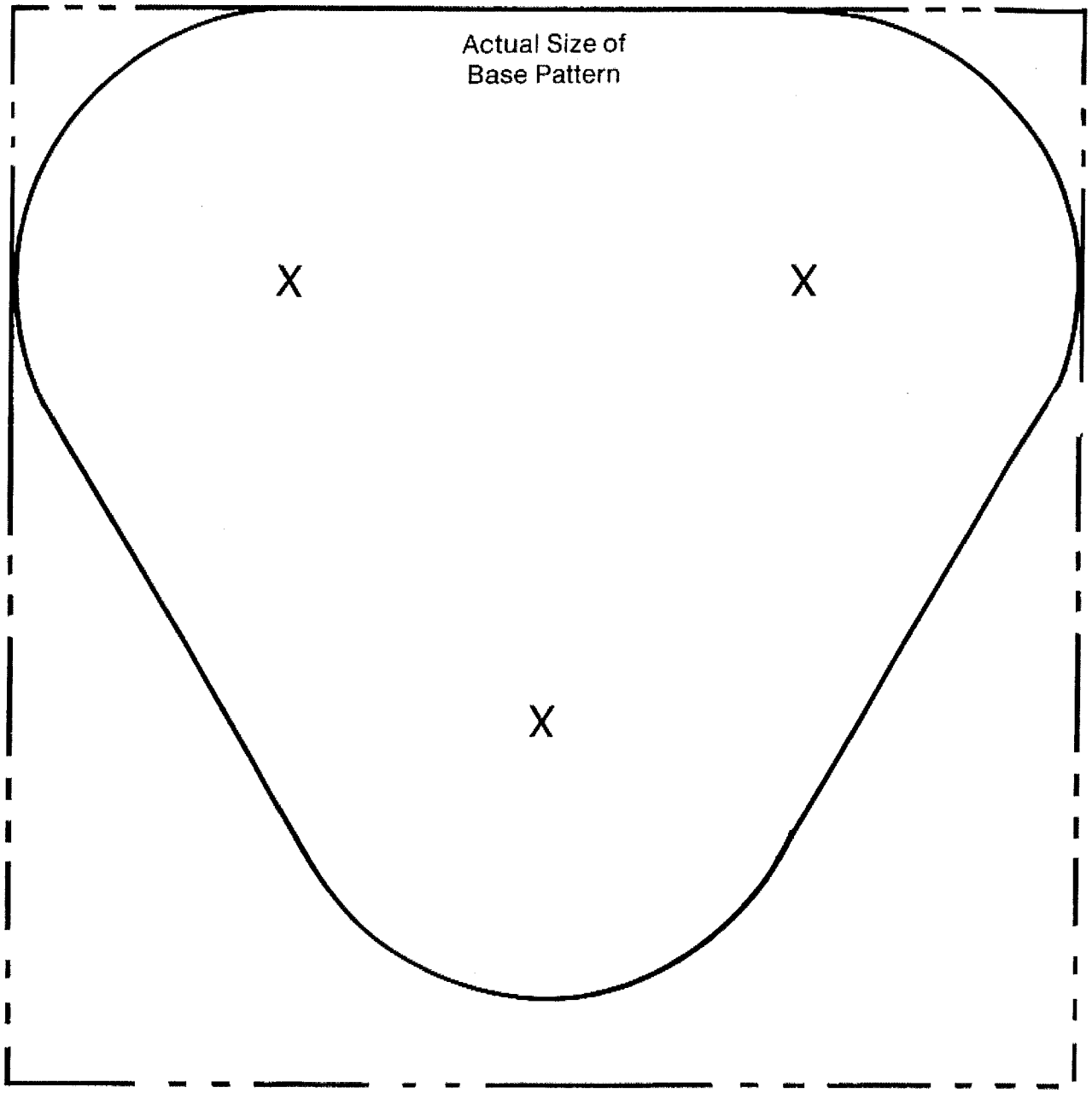
1. Trace the pattern for the base using carbon paper between your piece of wood and the pattern. Use the pattern on page 22.
   NOTE: If your saw cuts on the pull stroke, trace your pattern on the back side of your wood piece so that the front face of the piece does not get damaged during cutting.
2. Cut out the base using a saw.
3. Mark and drill ¼" peg holes, ½" deep in the base at the locations marked with an X.
4. Sand the surfaces and edges of the base.
5. Cut three pieces of the ¼" dowel stock, 3" in length.
6. Sand the dowel pegs, rounding the top ends.
7. Apply glue to the sides of the holes with a small stick, then place the pegs in the holes.
8. Mark and cut the five movable pieces from the ¼" plywood. Dimensions of the pieces are (3 x 3"), (2½" x 2½"), (2" x 2"), (1½" x 1½"), and (1" x 1"). These pieces can be cut round or square.
9. Mark the centers of each individual piece, and drill a ⅜" hole completely through the piece.
10. Sand each piece and finish with a material of your choice. Painting the pieces different colors adds eye appeal.

How to Play:



Place five pieces on one peg in pyramid formation. The object is to shift the entire pyramid (5 pieces) to another peg, moving one piece at a time and at no time having a larger piece above a smaller one. Can you do it in 31 moves (that's perfect)?

To make the puzzle more challenging, use seven blocks instead of five.



Bird House

Materials needed

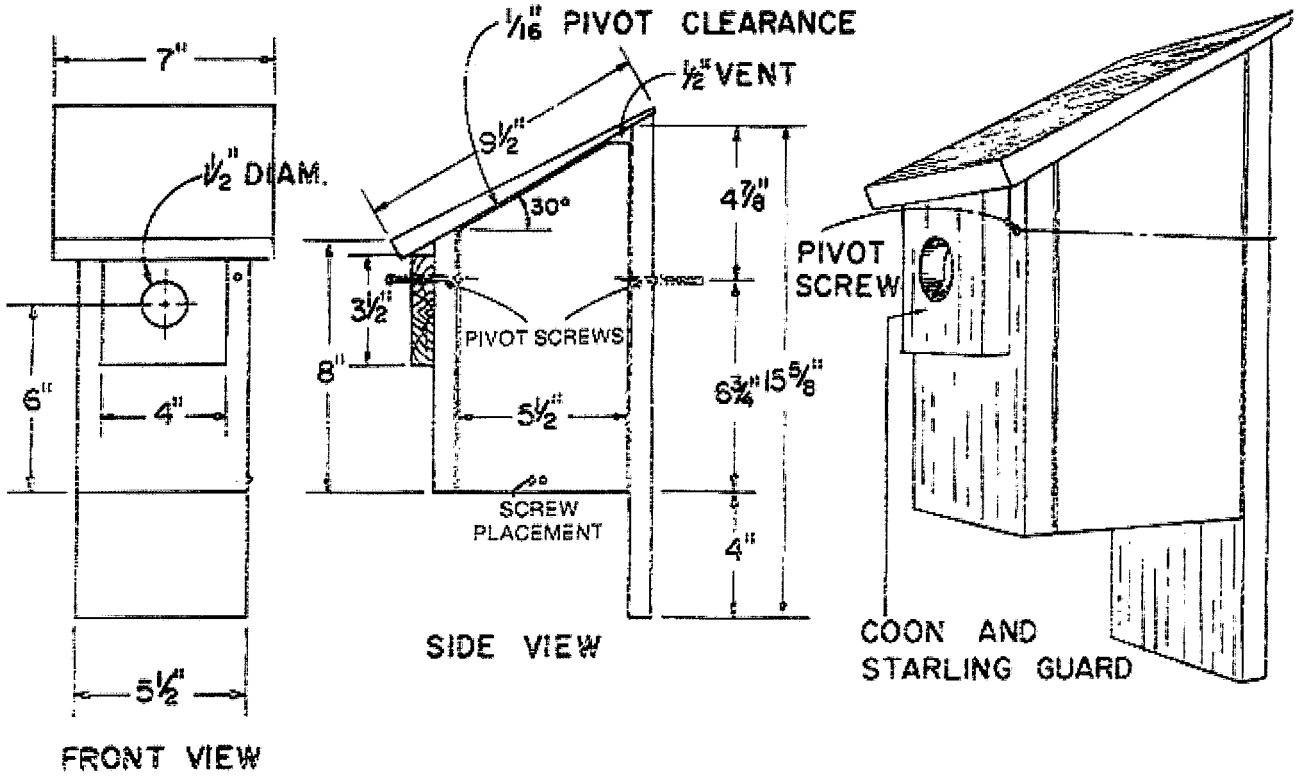
- 1 piece of lumber 1 x 6 (actual size ¾" x 5½") x 54" long
- 1 piece of bevel siding or other material for roof ¾" x 10" x 8"
- 1 piece of lumber 1 x 4 (actual size ¾" x 3½") x 4" long for coon and starling guard
- 3 — No. 10, 1½" round-head wood screws
- 1¼" galvanized or aluminum nails for roof and guard
- 1¾" to 2¼" galvanized or aluminum nails
- Sandpaper (medium and fine grit)
- No finish is necessary for the bird house

Tools needed

- Square
- Hand saw
- Hammer
- Boring tool with ⅜" and 1½" bits (bird hole can be cut with a compass saw or saber saw instead of using a drill)
- Pilot hole bits to fit the screws
- File

Instructions

1. Mark and cut pieces as shown in the diagram below. NOTE: One side of the house is hinged to pivot on screws for easy access for annual cleaning. Removal of the screw at the bottom of the side allows the top of the side to be pushed inward. The hinged side should be 1/16" shorter than the other side.
2. Sand pieces smooth.
3. Drill a ⅜" drain hole in each corner of the bottom.
4. Drill holes in the front and back pieces to accommodate the screws.
   NOTE: Follow the instructions on page 17 for making pilot holes.
5. Assemble all pieces using nails, except for the hinged side.
6. Install hinged side using screws.



4-H Book Ends

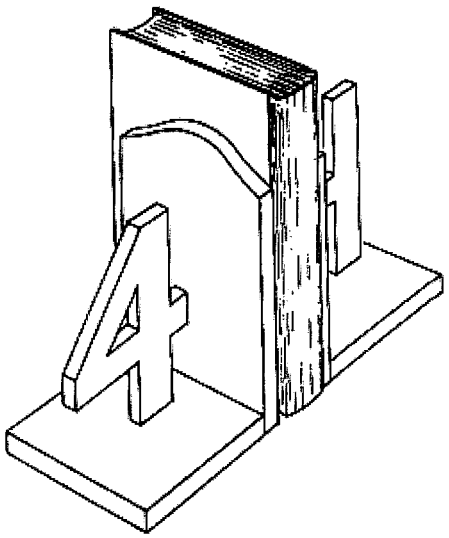
Materials needed

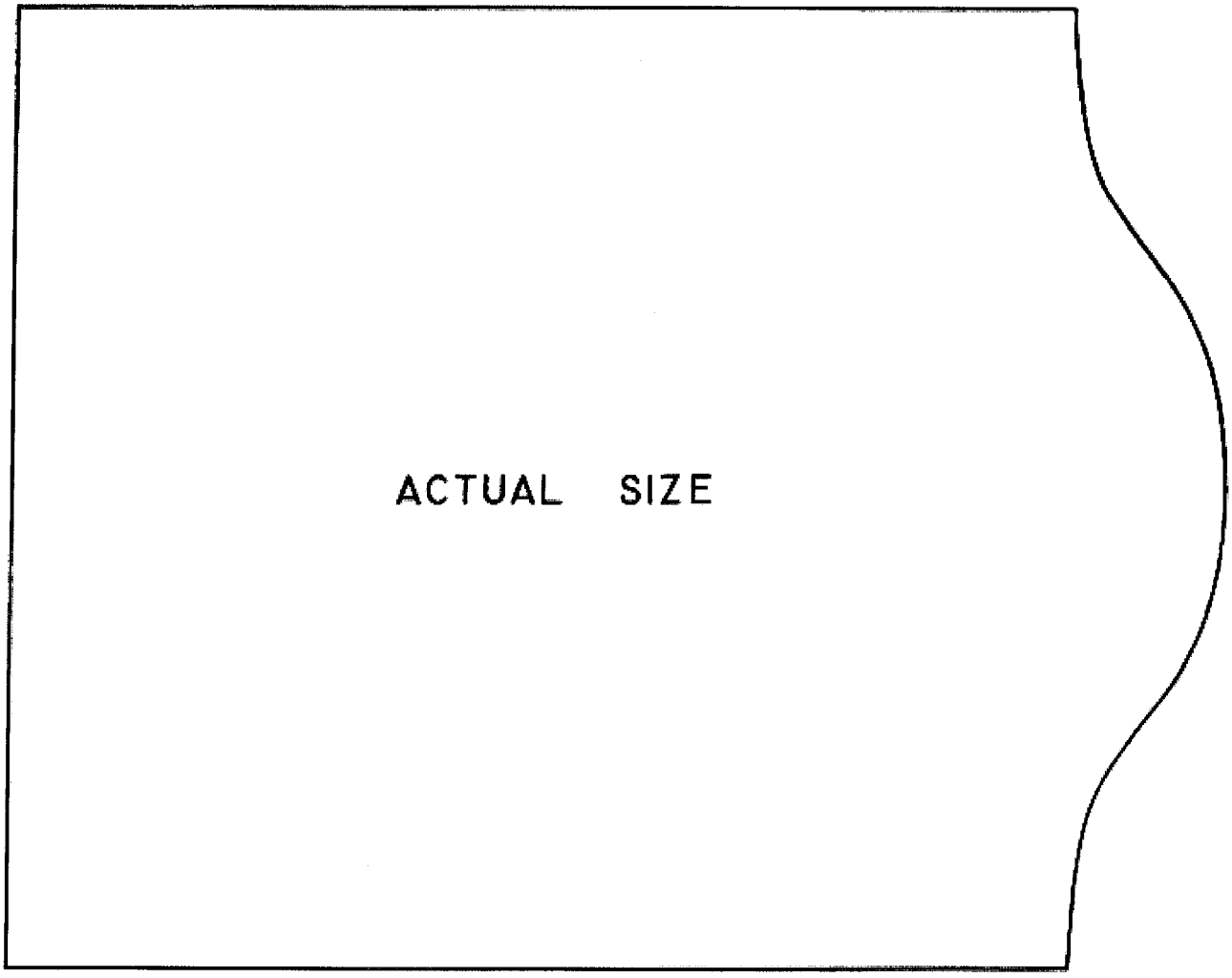
- 1 piece of 1 x 6 lumber (actual size ¾" x 5½") x 36" long, or you can use interior-type plywood (¾" A-C grade or better)
- 10 — 1½" finishing nails
- Sandpaper (medium and fine grit)
- Glue

Paint and varnish, optional

Tools needed

- Saw (coping, jig, or saber)
- Hammer

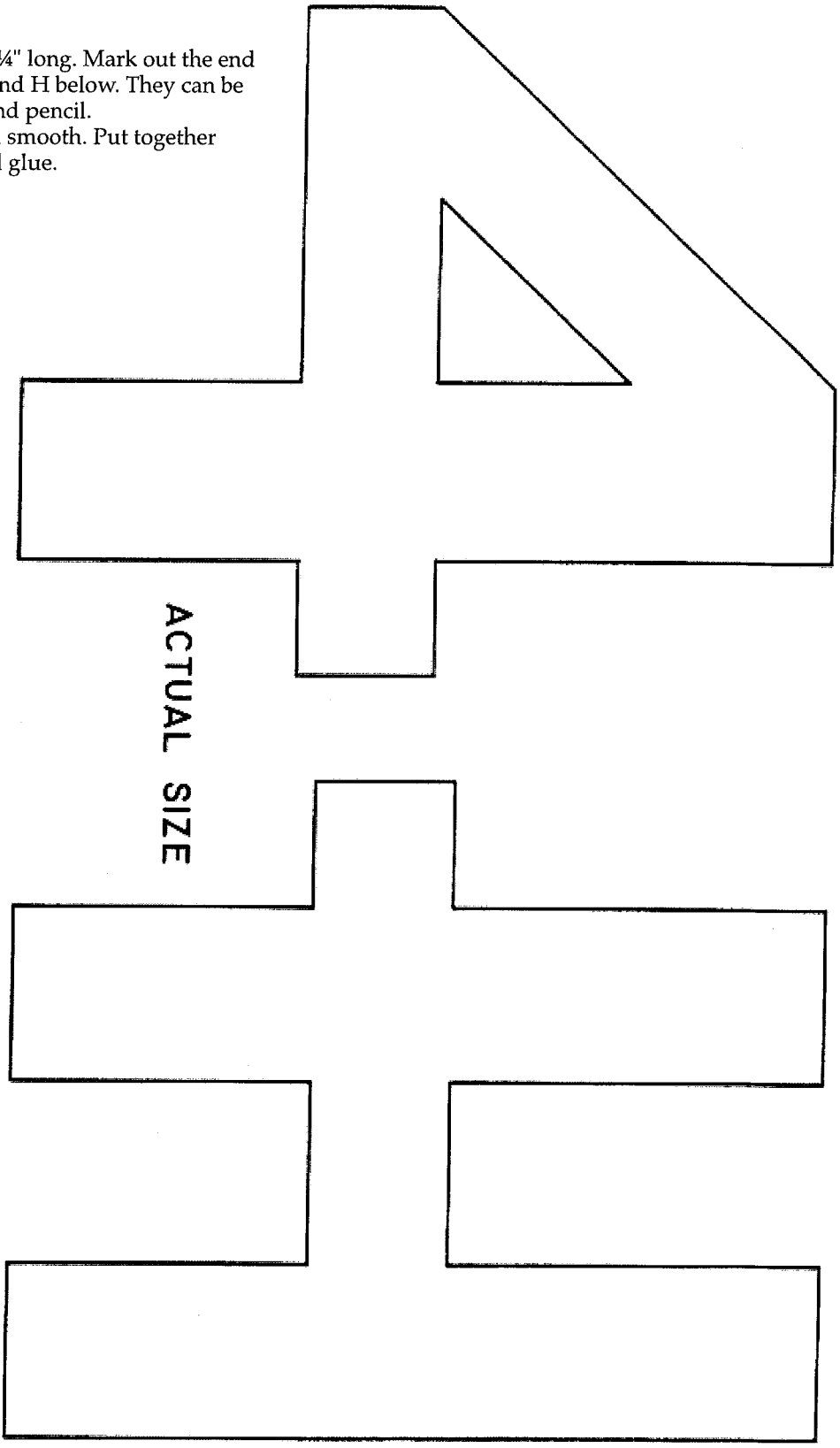




4-H Book Ends (continued)

Instructions

1. Mark out two base pieces 5¼" long. Mark out the end pieces (page 24) and the 4 and H below. They can be traced with carbon paper and pencil.
2. Cut out the pieces and sand smooth. Put together with 1½" finishing nails and glue.
3. Apply finish.



Foot Stool

Materials needed

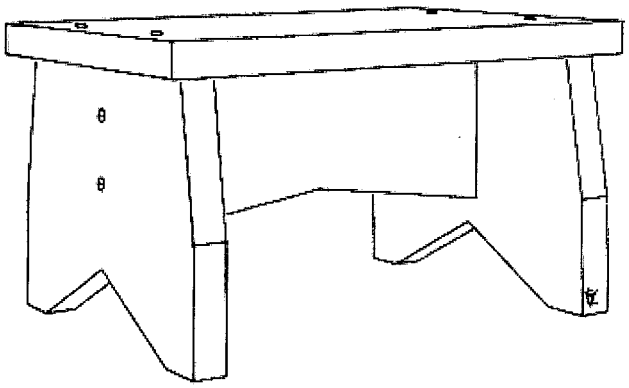
- 1 piece of 1 x 8 lumber (actual size ¾" x 7¼") x 24" long—for top and legs
- 1 piece of 1 x 4 lumber (actual size ¾" x 3½") x 12" long—for stretcher
- 8 — No. 8, 1½" flathead wood screws
- Sandpaper (medium and fine grit)
- Glue

Tools needed

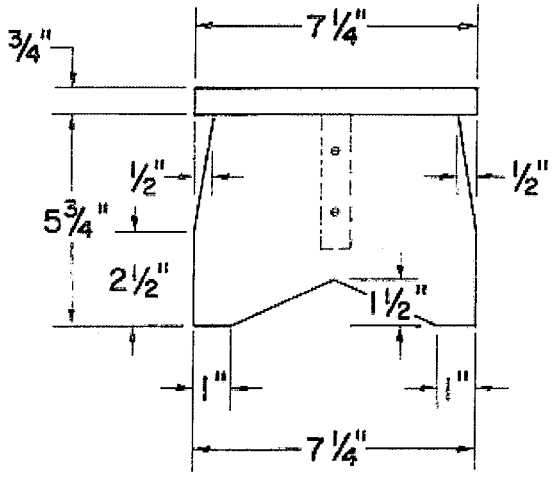
- Hand saw
- Screwdriver
- Boring tools
- Pilot hole bits to fit the screws and countersink

Instructions

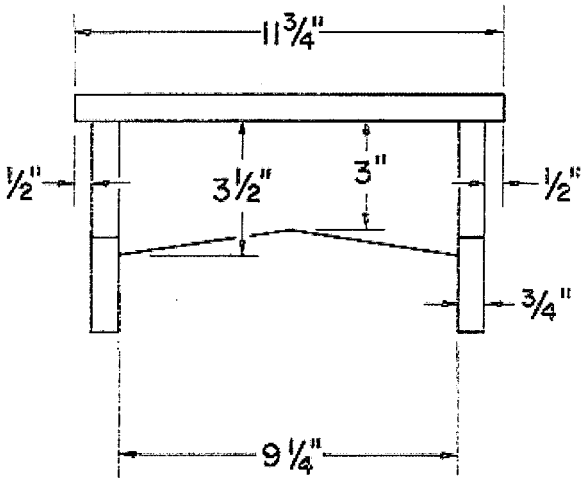
1. Measure and mark the pieces for the footstool.
2. Cut out the pieces.
3. Drill holes for the screws and countersink them so that the screwheads are just below the wood surface.
4. Sand the pieces.
5. Assemble with glue and the screws.
6. Finish as desired.



END VIEW



SIDE VIEW



Book Rack

Materials needed

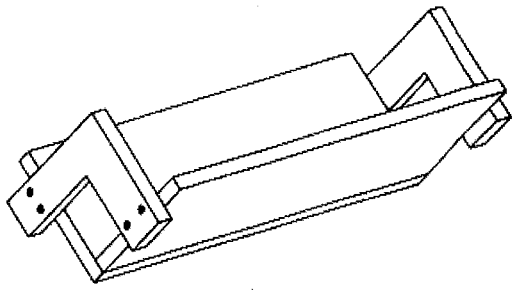
- 1 piece of 1 x 8 lumber (actual size ¾" x 7¼") x 18" long (bottom)
- 1 piece of lumber 1 x 6 (actual size ¾" x 5½") x 18" long (back)
- 1 piece of 1 x 8 lumber (actual size ¾" x 7¼") x 16" long (L-shape ends)
- 13 — No. 6, 1¼" flat-head wood screws
- Stain and varnish (optional)

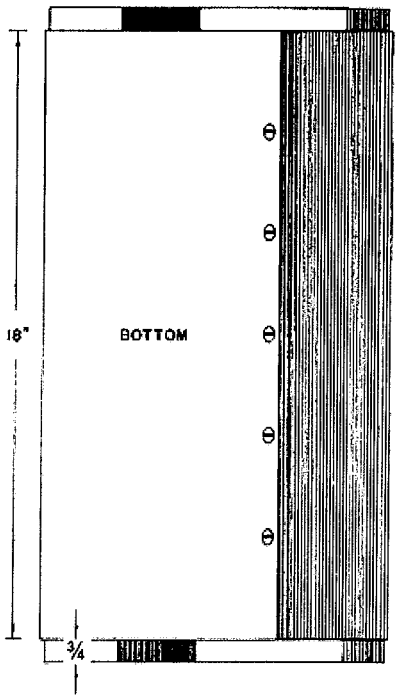
Tools needed

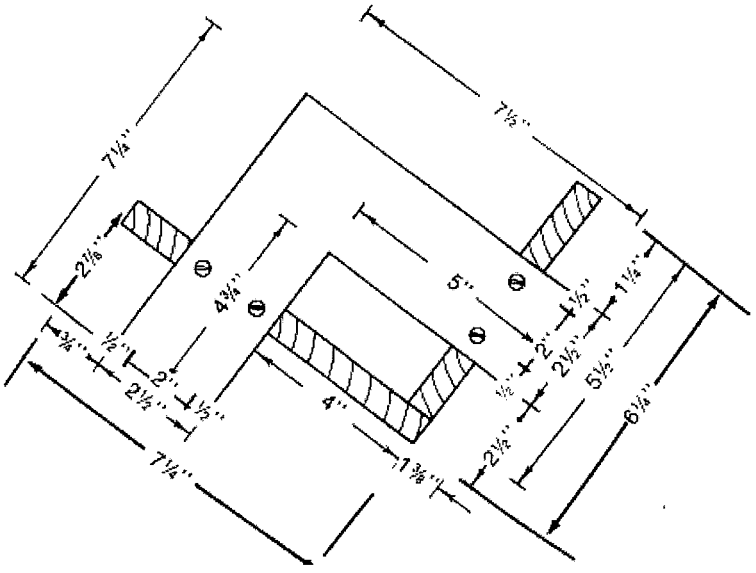
- Hand saw
- Screwdriver
- Boring tool with a ⅛" bit and countersink

Instructions

1. Cut pieces to size, including the two L-shaped ends.
2. Sand pieces smooth.
3. Drill and countersink five holes, 3 inches apart, ⅜" from the edge on a long edge of the 1 x 8 x 18" piece.
4. Screw the 1 x 6 x 18" piece to the 1 x 8 x 18" piece using five of the wood screws.
5. Mark, drill, and countersink the four holes in each L-shape end.
6. Screw the L-shape ends to the ends of the shelf assembly using two screws on each end.
7. Stain and varnish or finish as desired.







Tool Box

Materials needed

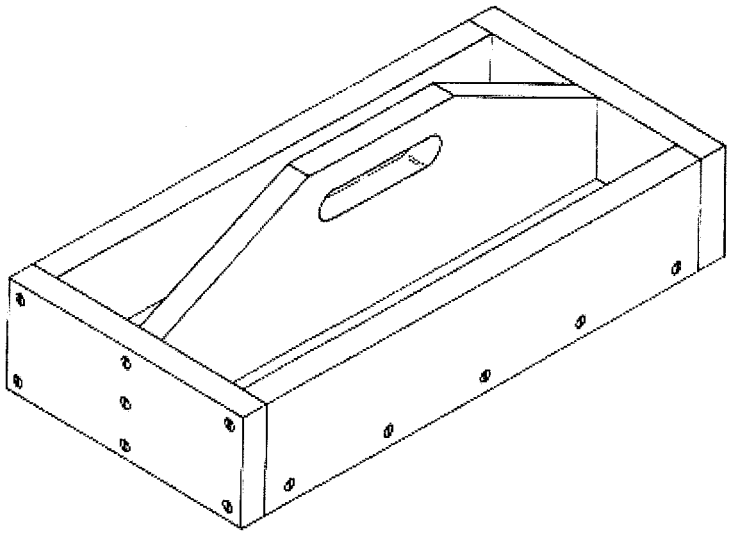
- 2 pieces of 1 x 4 lumber (actual size ¾" x 3½") x 18" long—sides
- 2 pieces of 1 x 4 lumber (actual size ¾" x 3½") x 10" long—ends
- 1 piece of 1 x 8 lumber (actual size ¾" x 7¼") x 18" long—bottom
- 1 piece of 1 x 6 lumber (actual size ¾" x 5½") x 18" long—handle
- 4 — No. 8, 1½" flat-head wood screws
- 25 — No. 8, 2" flat-head wood screws
- Sandpaper (fine grit)

Tools needed

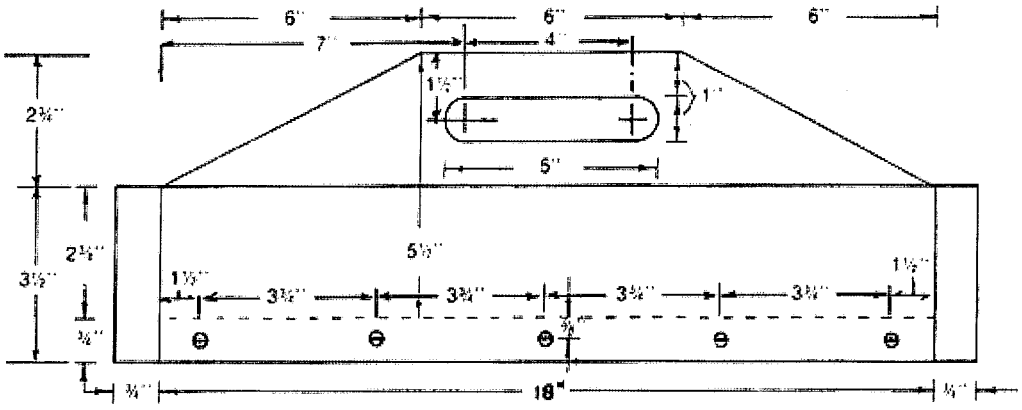
- Saws (hand saw and coping, jig, or saber saw)
- Screwdriver
- Round wood rasp or file
- Boring tool with a 1" bit
- Pilot hole bits to fit the screws and countersink

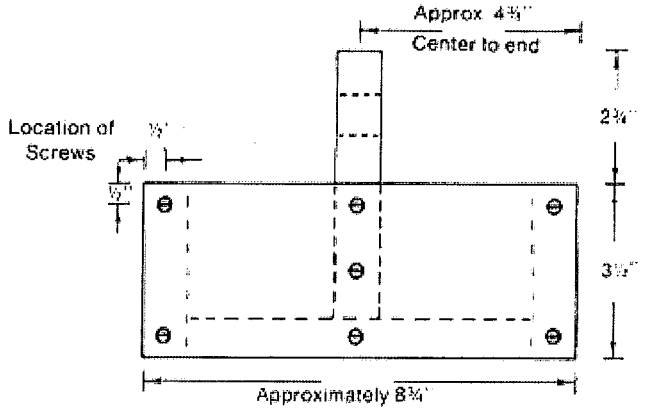
Instructions

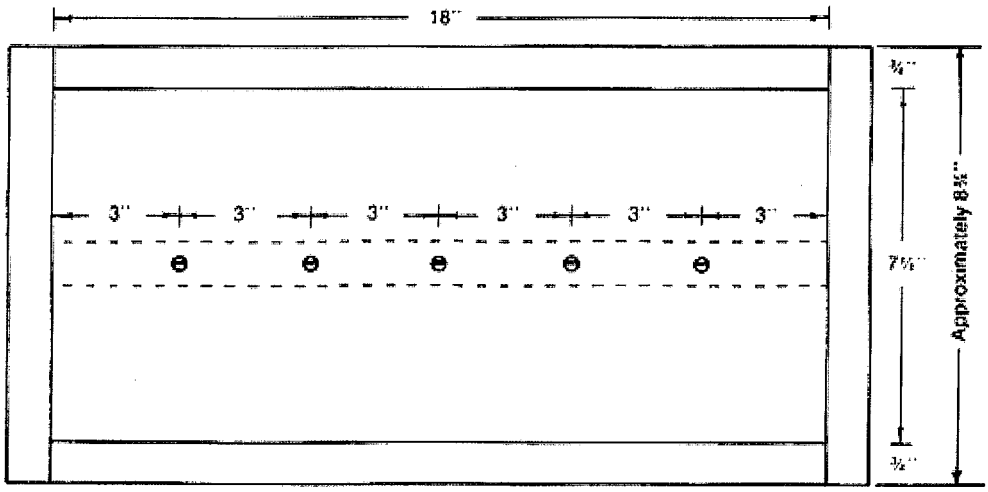
1. Cut pieces to size. (See diagram on page 29.)
2. Mark the angled cuts on the handle as shown in the diagram. Cut the angles with the saw, leaving 1/16" or so for sanding.
3. Mark the handle hole. Bore a 1" hole at each end of the mark and remove the rest with a coping saw. Use a round wood rasp or file to even the handle edges. Sand the handle smooth.
4. Draw the center line lengthwise on the 1 x 8 x 18" bottom piece. Drill and countersink holes every 3 inches on that line and screw the handle to the bottom using 2" wood screws.
   NOTE: Follow the instructions for drilling pilot holes on page 17. Countersink the holes on the outside of the tool box so the heads of the screws are slightly below the surface of the wood. A careful craftsman lines the slots of the screws so that they are all in the same direction.
5. Drill and countersink holes in the two 1 x 4 x 18" side pieces, ⅜" from the bottom edge. Space the holes as shown in the diagram. Now screw both sides to the edges of the bottom piece using 2" screws.
6. Add the ends in the same manner, except use 1½" screws in the bottom corners of each piece.
7. For added strength, drill and countersink three holes in each end piece to hold the handle. Space them as shown in the diagram, and insert a 2" screw in each hole.
   NOTE: This tool box is approximately 8¾" wide. This measurement may need to be adjusted to the width and thickness of your bottom and side pieces.



Tool Box (continued)







Wonderful World of Wood Glossary

Annual rings
Rings or circles seen on the cut end of a branch, log, or stump. They resemble a bullseye and actually are showing the layer of wood produced by a single year's growth of the tree.

Bevel siding
A wedge-shape board or piece of wood, thicker along one edge than the other. One board edge has been cut and trimmed to an angle.

Board foot
A measurement of wood that is 1 foot long by 1 foot wide by 1 inch thick. It also can be other sizes that have the same total amount of wood. For example, a piece of wood 2 feet long, 6 inches wide, and 1 inch thick or a piece of wood 1 foot long, 6 inches wide, and 2 inches thick also is 1 board foot of wood. To get the number of board feet in a piece of lumber, measure your lumber and multiply Length (feet) x Width (inches) x Thickness (inches) and divide by 12. The formula is written

$$\frac{L' \times W'' \times T''}{12}$$

Countersink
A tool used to make a tapered hole for the head of screws to fit into.

Grain
The lines, bands, or patterns that appear on the ends, faces, and sides of lumber. The grain is formed from the annual rings.

Grid
A graph-like square consisting of horizontal and vertical lines placed equal distances apart. It is used for plotting points to change the size of irregular-shape drawings. Drawings can be increased or decreased in size.

Kerf
A slit or notch made by saw teeth.

Kiln
An oven used to dry wood. The temperature and relative humidity are controlled to minimize shrinkage and warping.

Particleboard (chipboard)
A panel of wood, usually 4 x 8 feet and of several thicknesses, made of wood chips bonded together under pressure. It has a very high resistance to warping, shrinking, and expanding.

Pilot hole
The starting hole placed in wood to prevent a drill or auger bit from slipping, or to accommodate a screw. Pilot holes help prevent the wood from splitting when boring holes into wood. Pilot holes can be made with an awl or a hammer and nail when used to start a drill or auger bit, but should be drilled to proper size to match a screw.

Plane
A tool for smoothing and leveling wood.

Plywood
A building material consisting of wood glued or cemented together with the grains of the wood laying adjacent to each other at right angles.

Primary processing
The sawing, chipping, or slicing of the log into lumber or other raw wood products. Examples of primary processing are sawmilling to produce pulp and paper, veneer, plywood, or particleboard.

Secondary processing
Additional manufacturing of wood beyond the primary processing stage before the wood can be used, such as making furniture from lumber, particleboard, and plywood. Other examples include producing cardboard boxes and paper bags from paper or making flooring from lumber.

Torque
A turning or twisting force felt when using power tools. The motion is caused by the electrical force.

Veneer
A thin slice of wood cut from a log with a knife or saw.

Vise
A device for holding wood stationary while you work on it at the workbench.

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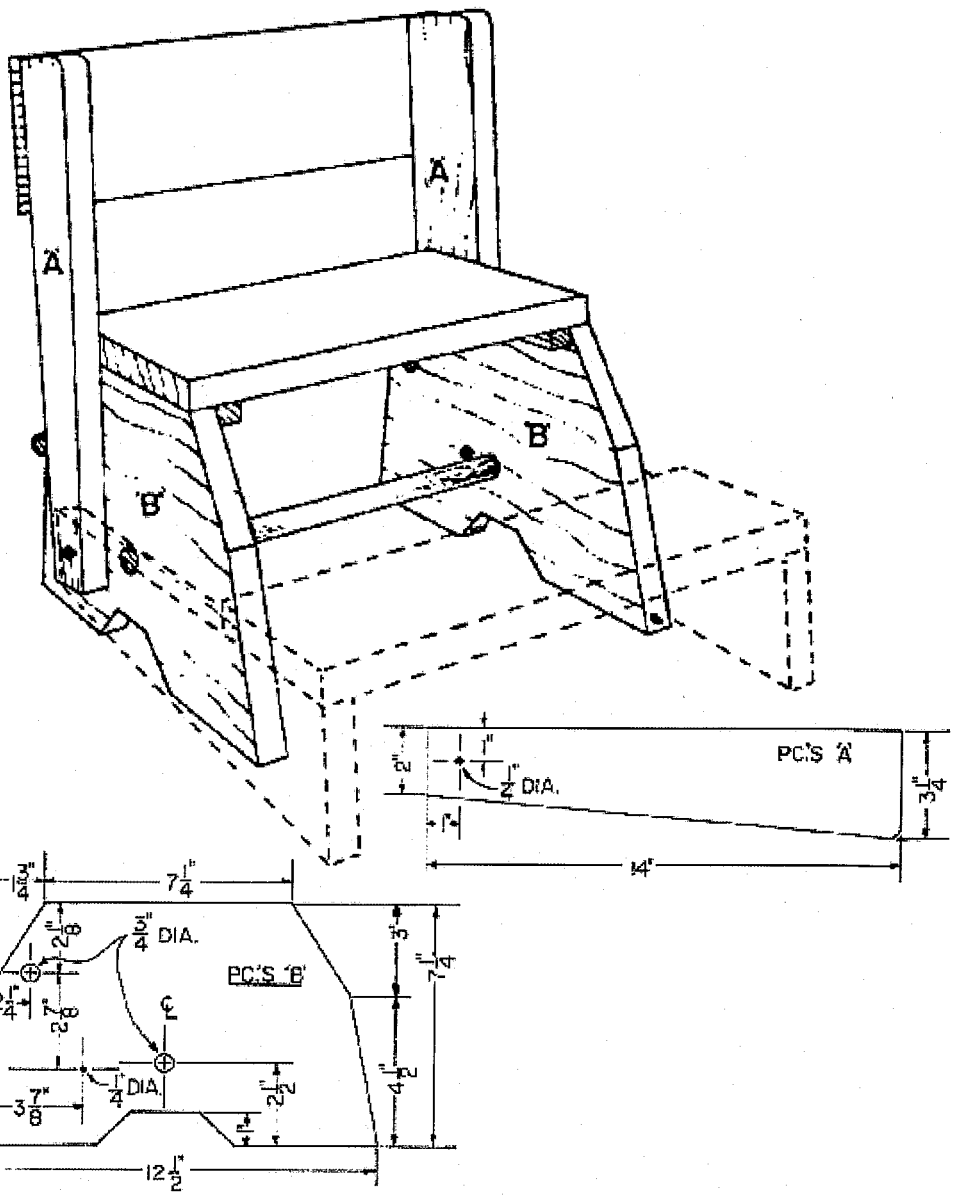

Building Bigger Things

Unit III Member Manual

National 4-H Wood Science Series

4-H 4423
Reprinted September 2006

Oregon State University | Extension Service

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Contents

Note to Parents and Home Helpers

Your 4-H'er is now moving into the third unit of the 4-H Wood Science project series, "Building Bigger Things." Through your support, this member has been able to participate in woodworking projects and activities that helped him/her learn about wood as a product and to construct items from wood.

At this point, your 4-H member is probably continuing in Wood Science because of personal interest, positive experiences, or because of the enthusiasm that you, club leaders, or other members have generated. You can help your 4-H'er keep up his/her initiative by continuing to be personally involved and interested in the project.

In this unit, new concepts of wood science are introduced. Activities and experiments are provided that can help youth better understand these concepts. In addition, youth learn how to use new tools and machinery for constructing items from wood. The provided learning experiences, woodworking tools, and plans for constructing items from wood are now becoming more sophisticated, so your 4-H'er is going to depend on you for help. You can see that he/she has positive experiences in this unit by:

- Helping the 4-H'er understand new concepts being taught
- Assisting, when needed, in completing the activities and experiments provided within
- Helping to locate wood samples
- Helping select items for their personal woodworking projects that they can realistically complete
- Working with club leaders to plan, supervise, and chaperone group activities, as needed, and to help provide transportation
- Being available to lend a hand, if needed, while your 4-H'er is working on his/her project

Remember, 4-H'ers learn by doing, so DON'T DO THE WORK FOR THEM, but give all the support you can to your 4-H'ers and leaders!

Introduction

This is Unit III of the 4-H Wood Science project series, "Building Bigger Things."

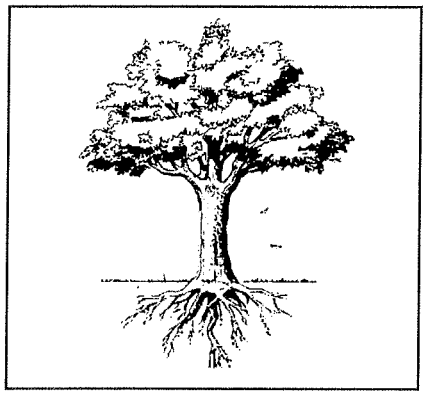
In the previous two units you learned a variety of things: how to measure, mark, cut, sand, and smooth wood; how to use wood finishes; how to buy and use lumber and plywood; and how to use a variety of woodworking tools in constructing items from wood. You also learned how wood is harvested and processed into usable wood products. But there are still many things that you need to learn about wood in order to use it properly when building your projects.

Science is learning about things — why things are the way they are and how we can change them to make them better or easier to use. Wood Science is learning about wood.

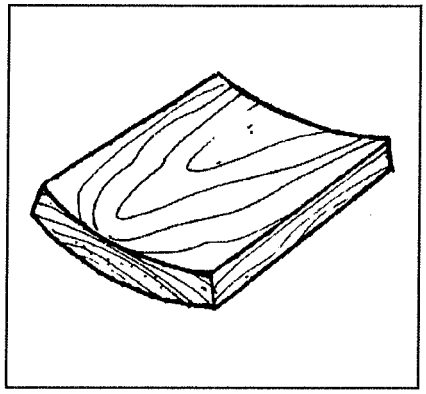
In this unit you will learn more about wood itself. You will learn how woods are named and classified, more about the physical characteristics and properties of wood, and why one wood works better than another for a specific woodworking project. You will learn about economics of the wood products industry and how various products are made. You will be introduced to more woodworking tools and machinery, allowing you to gain new skills in constructing items from wood. You'll learn all these things through your participation in individual and group activities, by completing the activities and experiments in this manual, and through the items you choose to make as your own personal woodworking projects.

Set goals for what you want to accomplish this year in the Wood Science project, keeping in mind your abilities and skills. Several woodworking plans are included in the back of this manual. Select items to make from these plans; but, you are also encouraged to use plans from other sources.

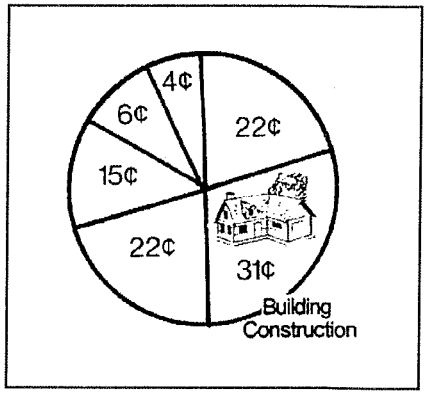
In Unit III you will learn more about...



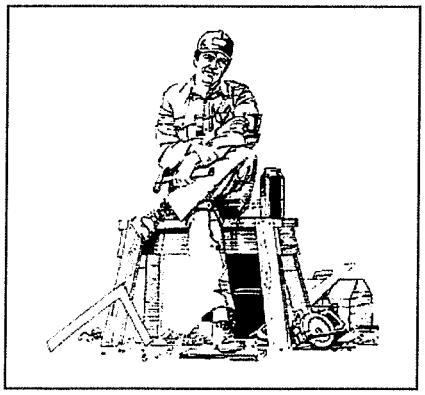
Wood Species



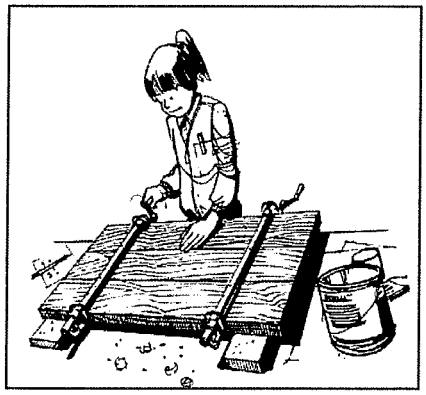
Structure and Properties



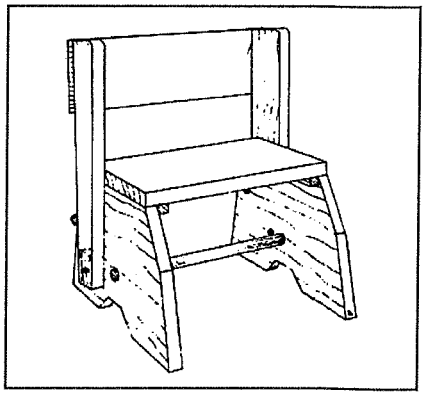
Economics



Careers



Tools



Woodworking/Plans

Learning More About the Forest Products Industry

The forest products industry is made up of many different types of companies. Some are very large with factories all over the world that produce a wide range of wood products. Others are very small and may only produce one type of product in one location. Some companies do everything, from growing the trees to selling the product to you at a local lumber yard or building houses with the products. Others may only be involved in one part of the process of getting wood from the tree to its final use.

As part of your project work, activities are suggested that will help you learn more about how we get wood products — some of the processes, costs, and people involved. Local libraries, wood products companies, forest products trade associations, and other forest products companies are good sources of information, too.

Activities: Exploring the Forest Products Industry

A. Learn all you can about the manufacturing and marketing of one or more wood products. This could be a piece of lumber, plywood, paper, or a piece of furniture. Visit your local lumber yard. Find out what kinds of wood products they sell and where the products come from. Visit a furniture store. Find out what woods are used to make furniture. If you have a sawmill, pulpmill, furniture plant, or other wood processing plant nearby, find out how specific products are made. Report what you have learned to your club, or plan a special presentation for another club.

B. Sketch a diagram of the wood processing plant you visit, so that you can teach other club members how the manufacturing plant works. This can be a group activity.

C. Learn more about career opportunities in the forest products industry and also in woodworking.

D. Help your club plan tours of industries and places in your local area that process and market wood products, such as lumber yards, sawmills, furniture manufacturers, processing plants, cabinet makers, etc.

E. Ask your leader or parent to help you organize a "Wood Bowl" contest for your club. The competition can be between individuals within your club, or your club can compete as a team against other clubs. Use what you have already learned to help you develop questions for the Wood Bowl.

Economics of the Forest Products Industry

America is a timber-using country. The average volume of timber used per person each year in the United States is about 65 cubic feet. This is the amount of wood that is in a tree 22 inches in diameter with a 40-foot trunk. It takes a forest nearly the size of a football field to grow that much wood. Since we use so much lumber, let's take a look at the cost of each process involved in getting the timber from the forest to the consumer.

Growing timber is only a small part of the total cost of wood products. Out of each dollar spent on producing and distributing wood products, the cost of growing and caring for the trees is about 4 cents.

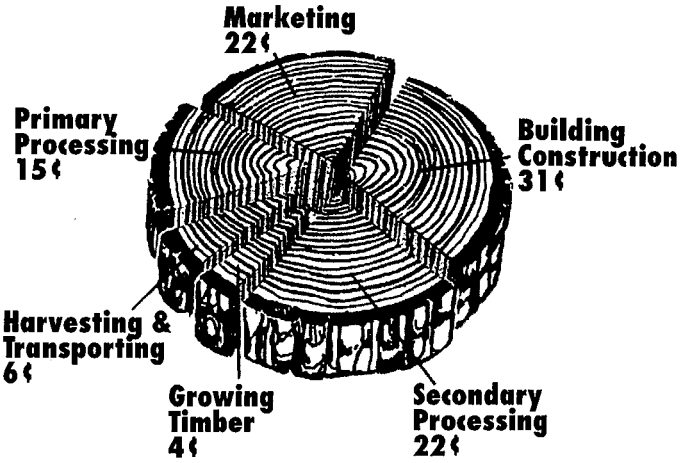
Many different people are involved in growing trees. Professional foresters manage timber lands for private companies, for the U.S. Government, and for states. They also help farmers and landowners manage their timber. It takes college training to become a professional forester. Many foresters have forestry technicians working with them. You can learn to be a technician in a 2-year program after high school.

Almost 60 percent of our timber is grown by farmers or other private individuals, so anyone can be a part of the timber growing phase of forest products.

Harvesting and transporting timber is the second step. The cry of "timber" rings out in the forest and a tree crashes to the ground. This begins a tree's long trip toward becoming the wood in the project you build, the paper on which this page is written, or the pencil you use at school.

Harvesting and transporting the logs require many types of employees, many very skilled in their particular jobs. Truck drivers, equipment operators, and maintenance men are needed in addition to skilled fellers and buckers. Harvesting and hauling the timber from the woods costs about 6 cents out of each dollar spent on the final wood product.

Processing is the third step. It begins with "primary processing." Primary processing activities include sawmilling, pulp and paper production, and plywood and particleboard manufacturing. Primary processing costs about 15 cents out of each dollar spent on the final wood product.



Dollar Value of Wood Products

Users don't always want to buy lumber or other primary processed products. They may want products that have been further manufactured, such as furniture, cabinets, and flooring from lumber; book cases; corrugated boxes from paper; and other items from wood. This is called "secondary processing," and it accounts for 22 cents of every dollar spent on the final wood product.

Marketing wood products is the fourth step. Many people are needed to make and sell the products consumers want. Much of the lumber is sold by building supply stores and lumber yards where consumers choose what they need. Other forest products are sold at specialized stores, such as office supply stores, furniture stores, and hardware stores. (Think of the stores in your town that sell wood products.) Getting the wood from the factory to the consumer costs about 22 cents out of every dollar spent on the final product. This not only includes shipping costs, but it also includes the cost of wholesalers, distributors, and retailers.

Building Bigger Things

Building construction is another large part of the forest products industry. Most homes and small buildings are made from wood. The average home being built in the U.S. today contains the equivalent of about 1,500 board feet of wood. It takes about 24 good sized trees (22 inches in diameter with a 40-foot trunk) or many more small trees to make this much wood. The building industry is active in all areas of the country and offers many job opportunities for people who enjoy working with wood. The building construction industry accounts for the remaining 31 cents.

As you can see, a lot has to happen to a tree before it becomes a wood product. The tree in the forest makes up only a very small part of the value of the final product. Each additional step makes the wood more valuable. The values shown in the illustration on page 5 are averages for the whole wood products industry. Each individual product would be divided differently. For example, the wood in a fine carving would naturally cost more than a similar amount of wood in a fence post.

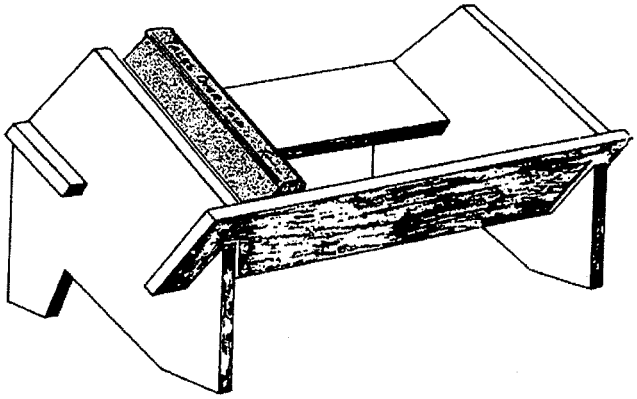
Careers in the Wood Products Industry

There are many job opportunities in the wood products industry. This industry employs about one out of every 20 working Americans. Some of the job opportunities have previously been mentioned. It takes a lot of mill managers, lumber graders, kiln operators, wood chemists, salesmen, equipment operators and servicemen, and many others to bring wood products to customers.

For more information on careers in wood science and technology, write to the Society of Wood Science and Technology, One Gifford Pinchot Drive, Madison, Wisconsin 53726-2398.

Activity: Trace The Flow of Wood Products You Use

Give a report on how one wood product (lumber, plywood, hardboard, etc.) you use to build a woodworking project was produced. Design a flow chart to help you illustrate the steps. You may also want to learn how other wood products are made. For instance, if you want to build the book rack shown here, you will need two types of wood products—lumber and plywood. When the book rack is completed, it holds another wood product—books; and books are printed on paper. So your flow chart could show how the wood product gets from the tree to lumber or plywood; from the tree to book rack; or from the tree to book.



Book Rack

Learning More About Wood Itself

Now that you know a little about how the wood was manufactured for your woodworking projects, you may want to learn more about the wood itself—the structures and properties of wood, how to identify different kinds of wood, and which type of wood works best for a particular woodworking project. If you learn this, you will know more about wood than many people who have spent a lifetime working with it but never bothered to learn anything about it.

Wood is divided into two groups, "hardwoods" and "softwoods." When magnified, hardwoods look different than softwoods. Each group also has different properties which may make one group of wood better for a particular wood product than another. For example, hardwoods are usually heavier and harder than softwoods, and might be better for flooring than a softwood. There are many other properties, as you will learn later, that make a particular wood more appropriate for a particular product than another.

Within the hardwood and softwood groupings, different kinds of trees are further identified by name. Let's see how each group of trees gets its name.

Names of Woods

There are more than 100 different kinds of woods (trees) in the United States. Approximately 60 are widely used for wood products. Your lumber yard may only sell a few of the different kinds. Each different kind of wood is called a "species." Each species has at least two names: a **common name** and a **scientific name**. The common name, such as white oak or eastern white pine, may vary in different parts of the country because a number of different woods have the same common name. Some woods may even have several common names.

One scientific name is given to each species, and this name is always the same. The scientific name has two parts. For example, the scientific name of white oak is *Quercus alba.* The first part, which always begins with a capital letter, is kind of like your last name—the family name. It is the same for closely related woods. All oaks are given the first name *Quercus*. The second part of the scientific name is like your first name. It tells which oak it is. *Quercus alba* is white oak, and *Quercus rubra* is northern red oak. Likewise, the scientific name for eastern white pine is *Pinus strobus.*

The scientific name is handy to know when discussing wood products with technical people, but don't expect the clerks at the lumber yard to know the scientific name of the lumber they sell you.

Activity: Wood Sample Collection

Start a collection of wood samples. It will help you learn more about the different types of woods that are available and what they look and feel like. It will also make a very good 4-H demonstration; or, you can use it to show some younger club members how they can tell the differences between woods. The collection can also be used in displays and exhibits.

A 1" x 3" x 5" piece of wood is a good sample size for your collection. Label each sample. Some of the things you might include on the label are: the common name, scientific name, whether it is a hardwood or softwood, where the wood grows, and some of its common uses.

Each time you work with a new kind of wood, add a sample of it to your collection. Your leader may have some woods that you do not have, so you can exchange samples.

Other sources for wood samples are lumber yards, cabinet shops, sawmills, and woodworking shops. Products that can be included in your collection are plywood, particleboard, fiberboard, edge grain and flat grain lumber, and treated wood. **Treated wood** is wood that contains a chemical that makes the wood resistant to decay and insect damage. The other terms were discussed in Unit II. Do you remember what they mean?

Structure of Wood

Knowing more about the structure of wood will help you know how to use it. In the first two units, you learned a little about the structure of wood. You learned that a tree has annual rings; one for each year that the tree has grown. Let's look at a tree to learn more about its structure.

A tree can be divided into three parts — the crown, trunk, and roots. The crown contains the branches, twigs, and leaves, and it is the "food factory" in the tree. The roots anchor the tree to the ground and absorb water and nutrients from the soil. The trunk of the tree holds the crown up to the sun. It also conducts water and nutrients up to the leaves and distributes the manufactured food to points of growth.

The trunk of the tree is the major source of the wood we use. The wood in the branches and the wood in the roots is similar but not often used, because branches and roots are usually not long enough nor straight enough to make lumber.

The trunk is divided into many parts. There is the bark, sapwood, heartwood, pith, and rays. Take a look at each part. Get a piece of tree trunk to look at when identifying these parts and refer to the illustration shown. Even a small tree will have all of these parts, except that some small trees may be too young to have developed heartwood.

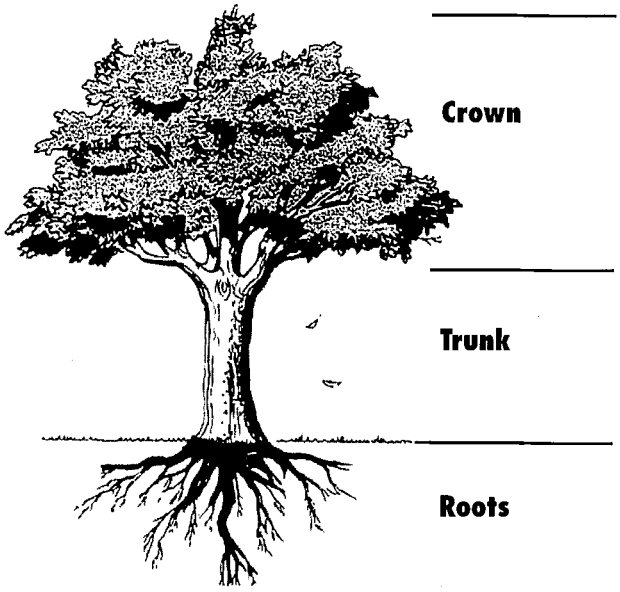
On some trees, the bark is thick and chunky, and on others, it is thin and smooth. Tree bark is made up of inner bark and outer bark. The **inner bark** ("B") on a living tree is soft and moist. It is a living part of the tree and carries food from the leaves down the trunk. The **outer bark** ("C") is dry and crumbly. It protects the growing areas from outside injury.

The **sapwood** ("D") is the living part of the wood. The sapwood layer may be very narrow or it may be wide. It carries water from the roots to the leaves and also serves to store food.

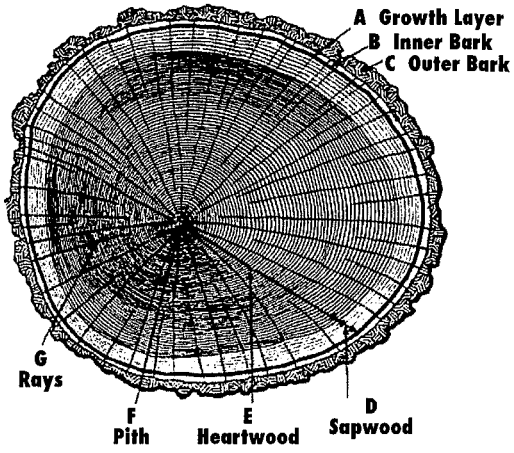
The **heartwood** ("E") is generally darker or more brightly colored than sapwood. Early in the life of the tree, the heartwood was sapwood; but, as the tree grew older, the inner sapwood died and turned to heartwood. The major function of heartwood is to help support the tree, but heartwood is important for another reason — it sometimes makes the wood decay resistant.

The very center of the tree is called the **pith** ("F") and was formed when the tree was very young. Wood close to the pith may have properties very different from the wood that is formed later on in the life of a tree.

Between the bark and the wood in the tree trunk is the **cambium layer** ("A"). The cambium is the growth layer. It allows the tree to grow larger in diameter, adding new wood just inside the cambium layer and new bark just outside the cambium layer. In other words, the tree grows two ways at once: an inner layer of tree trunk and an outer layer of bark. The additional inner layer of wood makes the tree bigger, so the cambium layer has to stretch. At the same time, each year the bark gets thicker by the additional layer of bark grown. In fact, the reason that the bark of older



Parts of a Tree



Parts of a Tree Trunk

trees is rough with ridges is that the bark you see is old bark, which was grown when the tree was small, and it cannot stretch enough to smoothly cover the now larger tree. There are a few exceptions to the rule. For example, older beech trees, aspen, and red alder have smooth bark. It's a characteristic of these trees.

Wood is a very complex material. It is made up of millions of small fibers or **cells**. These long hollow tubes are connected together with a gluelike substance. If you look at the end of a piece of wood that has been cut with a very sharp knife, you may be able to see the open ends of some of the cells.

Most of the cells in the trunk of the tree are aligned up and down the trunk. This is what gives the wood its grain direction along the trunk. A tree also has cells that are aligned from the bark to the pith. These are called **rays** ("G").

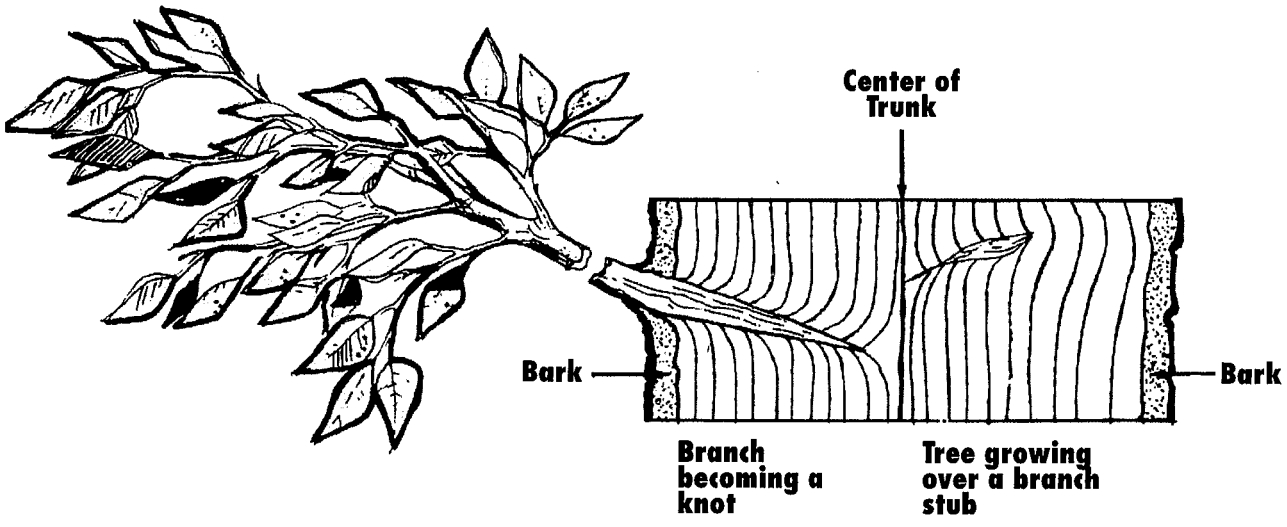
As a tree grows, it produces branches as well as a vertical stem. As the tree trunk grows in diameter, it grows over the branches. An overgrown branch is called a **knot**. If a branch remains on the tree throughout its life, the knot will extend from the center of the trunk out through the bark where it becomes a visible branch (left side of illustration). However, many times the lower branches on the tree die and fall off, or they are cut (**pruned**) from the tree. When this happens, the tree grows over the stub, and the knot ends in the wood at the point where the branch stub becomes overgrown with clear wood (right side of illustration). This is how it becomes possible to have a board which has a knot on one surface and no knot on the opposite surface—if the board happened to be cut so that the knot ended within the board. The grain direction in the knot will be perpendicular to the trunk and the grain in the wood that surrounds the knot will have to curve around the knot. These changes in grain direction, and the knots themselves, can give wood a very attractive appearance or detract from its appearance; and knots usually reduce the strength of wood, because the grain direction is different than in clear, knot-free lumber.

As long as the branch is alive, the wood and knot grow together. Lumber cut from these trees has tight knots which stay in the wood. If the branch dies but remains on the tree, the trunk still grows around the knot, but the wood of the knot and the wood of the tree will not actually grow together. Such a knot will be loose; and, when cut into lumber, the knot may fall out leaving a **knot hole**. Loose knots and knot holes weaken wood; therefore, knots are referred to as defects in wood.

Activity: Compare Tight and Loose Tree Knots

Find a piece of wood that has a loose knot and a piece of wood of the same species that has a tight knot. Examine the area around the tight knot to see if you can tell how solidly the wood in the branch and trunk are grown together.

Compare this with the loose knot. Do you see any differences? Could you knock the loose knot out, leaving a knot hole? Add these two pieces to your wood sample collection.



Identifying Hardwoods and Softwoods by Structure and Appearance

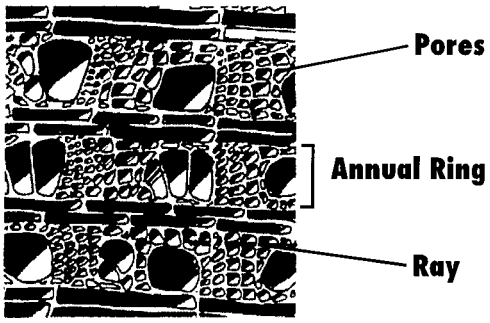
Wood identification is not easy. It is both an art and a science. The art cannot be taught in a book. It comes from handling different woods. The science can be taught, and the first step is learning the characteristic differences between hardwoods and softwoods. Start learning the differences by trying the following activity.

Activity

To help you in identifying woods, you will need a hand lens or magnifying glass and a sharp knife. You will also need a piece of hardwood and a piece of softwood. Oak (a hardwood) and white pine (a softwood) work best.

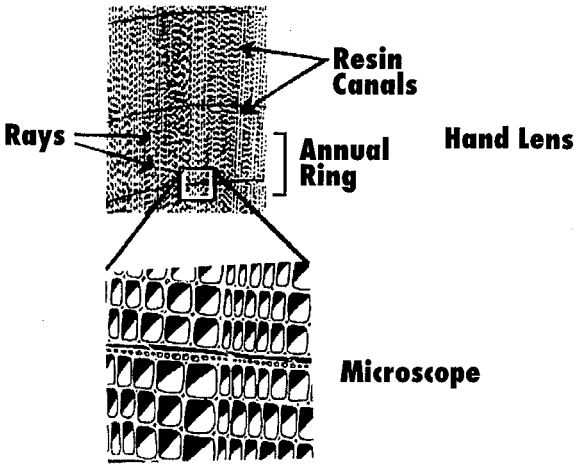
Make a small, clean cut on the ends of the wood samples. Look at the cut surface with the hand lens or magnifying glass. (It may help if you wet the cut surface.) What do you see? Do you see any differences in the two pieces? If you have samples of other woods, examine them also. Do you see any similarities? Differences? Are there similarities in the softwoods? Are there similarities in the hardwoods?

Your oak sample will look similar to this:



Hand Lens

Your pine sample will look similar to this:



The first major difference that you should notice is that the oak has large open cells at the start of each annual ring. These are called **pores**. All hardwood species have pores, but the pattern and number of pores varies. This is one way of telling different hardwood species apart.

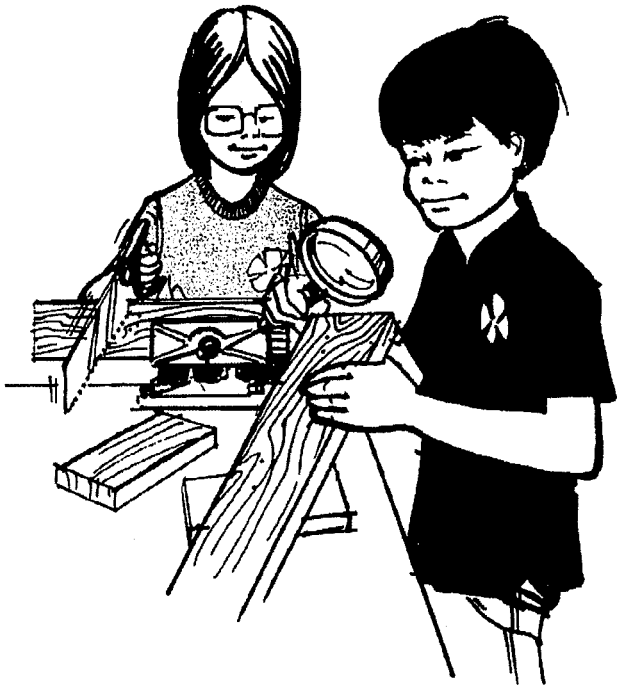
Pine does not have pores. It does have a few scattered openings that are called **resin canals**, but they are not all located along each annual ring, as pores are. Look at the pine sample again. If you have a good, clean cut and look real close, you can see the tiny cell openings. They are shown in the magnified pine sample illustration. These cells are lined up in a very uniform pattern from the center of the tree to the bark. The cells in oak are not lined up in straight rows like the pine.

Therefore, the most accurate method of separating hardwoods and softwoods is the presence of pores and lack of cell alignment in hardwoods, as compared to the lack of pores and obvious cell alignment in softwoods.

In the end view of the oak, you will also see large bands of lighter colored wood material that cross the annual rings. These are the **rays**. Both the oak and pine have rays, but they are larger in the oak and much finer in the pine. All wood species have rays, and their size and spacing can be used to help identify different species.

Activity: Compare Wood Structures

Look at some wood samples other than oak or pine. Look for patterns of cells, pores, or rays that are different from the oak and pine. List some of the things that are different, such as the presence of resin canals, size and spacing of rays, patterns of pores, coloration, odor, etc. Some of these may be used to identify woods. Others may be used to separate woods into smaller groups. Later you will learn how pores and rays affect the use of wood. Your leader may have a book which shows magnified sections or cross sections of different woods which will help you identify your samples. If not, go to your local library for help.



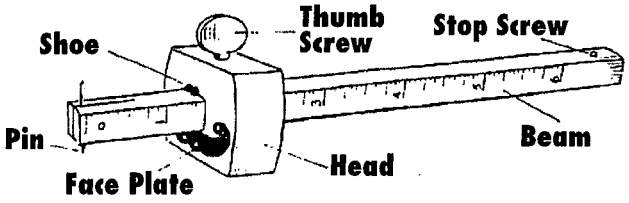
How Moisture Affects Wood

Wood in its natural state always contains some moisture (water). Wood is nearly saturated with water when it is growing, and, although it may feel dry, some of this water is still present in the normal use of wood. Only wood that has been dried at temperatures above the boiling point has no water in it. Even if water is removed by drying, the wood will begin to regain moisture when exposed to the atmosphere, because even the driest climates have some relative humidity (moisture) in the air.

When wood picks up a lot of moisture or becomes saturated with water, it changes in some ways. It gets heavier. It changes shape. And, it can even become deformed. These properties affect how we can use wood, and, in some situations, what we must do to finish and protect the wood from moisture and water.

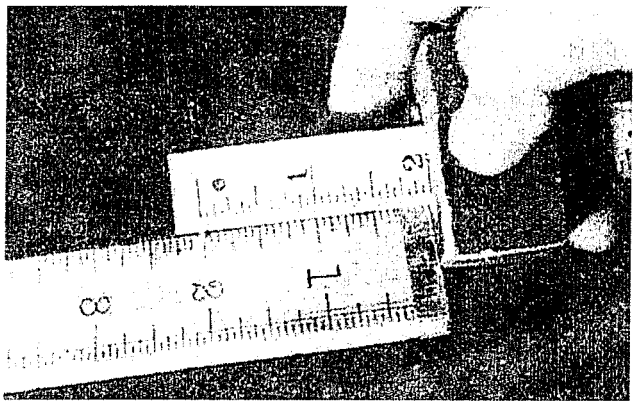
The suggested experiment on page 12 for observing what happens when wood gets wet requires some assistance from your leader or parent, so be sure to ask an adult to help. To conduct the experiment, you need five small blocks of wood from the end of a 2 x 4 or 2 x 6. It is best to get your leader or parent to help you cut these with a power saw. You might find some scraps of wood to use in the scrap bin at your local lumber yard.

Woodworking Tools and Machinery



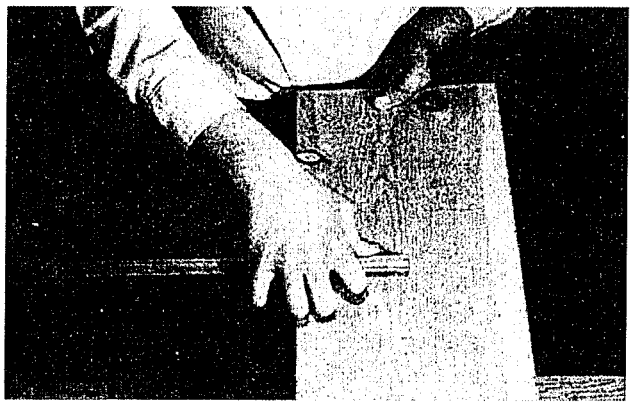
Marking Gauge

A marking gauge is used to mark a uniform width on a board. The steel combination square discussed in Unit II can be used for the same purpose.



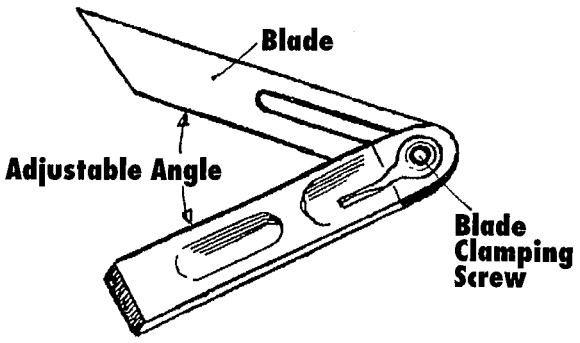
To use the marking gauge, set the pin the desired distance from the face of the head and check with a rule. It is better not to rely upon the measurements on the gauge, because the pin may become bent, which will alter the measurement. When the correct dimension is found, tighten the thumb screw and measure again. The pin must be kept sharp.

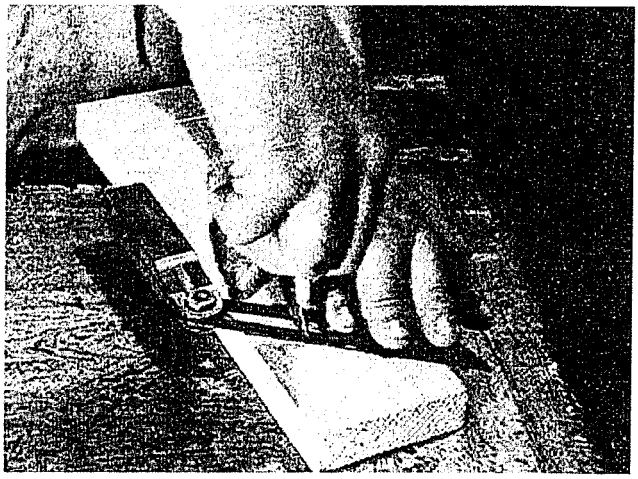
When marking, push the gauge forward. Roll the gauge slightly clockwise so both the beam and pin point touch the wood. Held in this manner, you can observe the point at all times. The head must be held tightly against the work edge of the wood. Hold the gauge as you would a ball, then move the thumb toward the pin to distribute the pressure between the pin and head. Some people use the gauge by drawing it toward the body. In either case, be careful to keep the face firmly against the edge of the wood.



T Bevel

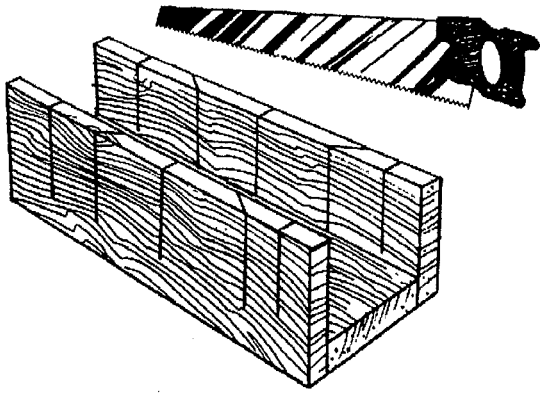
The T bevel is used for laying out miters; testing mitered ends, beveled or chamfered edges; or duplicating lines drawn at some angle. Mitered corners of picture frames and bevel siding are examples of ways the T bevel can be used for measuring and cutting angles.





Miter Box

This simple miter box is used to cut wood stock accurately at 45- and 90-degree angles. Other miter boxes can be adjusted to any angle. The wood is placed in the bottom of the box, then the saw is placed in the saw cuts. This gives a rapid and accurate method of cutting.



Clamps

Clamps are essential tools to many woodworking operations. They are used to hold wood pieces together while you work on them and they are used in gluing, to hold your wood pieces under pressure while the glue dries.

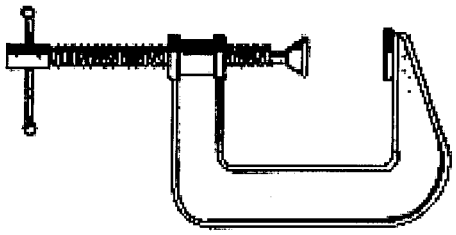
There are several different kinds of clamps:

C-Clamps were discussed in Unit I. They are rather small, c-shape devices with an adjustable bolt at one end. They are commonly used to clamp boards together when boring holes, gluing wood pieces together, or making a saw guide. To hold two pieces of wood together or to apply pressure to wood for gluing, tighten the bolt. It is possible for wood to become dented when using the c-clamp, so remember to use a piece of scrap material between your good board and the clamp to prevent dents.

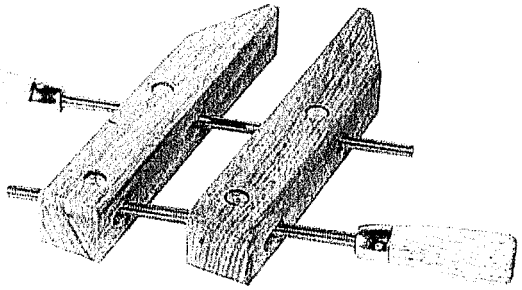
Handscrew Clamps are designed to do jobs too large for the c-clamp to do. They have two long, parallel bolts which are adjusted separately. To hold two pieces of wood together or to apply pressure for gluing, screw the bolts in opposite directions.

Pipe Bar and **Adjustable Clamps** vary in length according to intended use. These clamps adjust to fit the size of your wood by moving the adjustable stop back and forth along the bar. Pressure is applied by the crank screw.

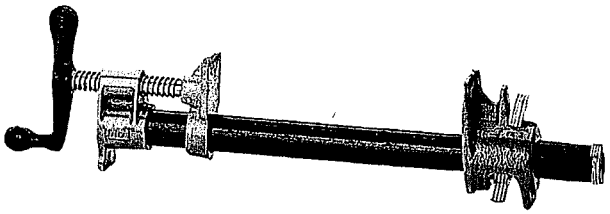
The **Adjustable Bar Clamp** is commonly called a cabinet clamp. It may be used for the same purposes as the pipe bar clamp.



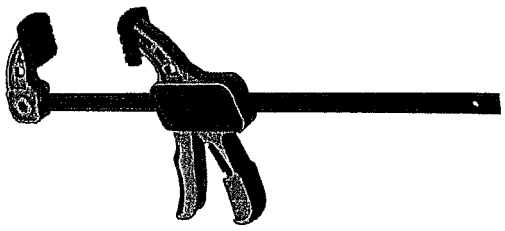
C-Clamp



Handscrew Clamp



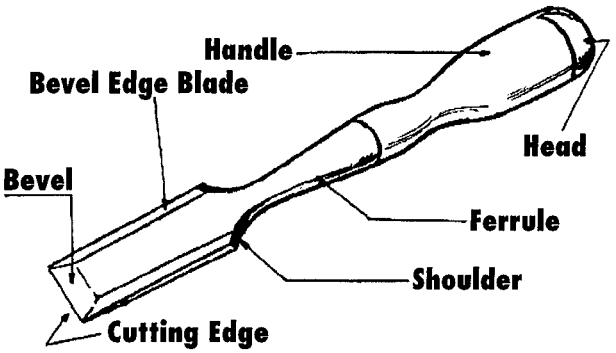
Pipe Bar Clamp

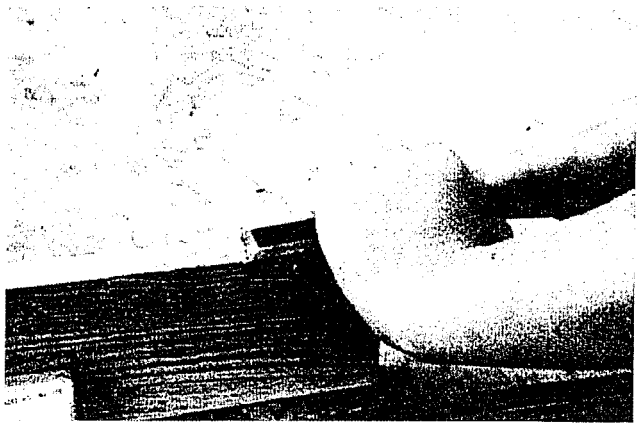


Quick Clamp

Wood Chisel

Chisels are used for removing unwanted strips of wood. They are made in various blade widths, ranging from ⅛ to 2 inches, and there are different types of chisels available at various prices.





Always push the chisel away from you. Keep both hands behind the cutting edge.

Depending on the density of the wood and the cut being made, chisels are operated either entirely by hand pressure or by pounding the end with a mallet or hammer. Hand pressure may be adequate when there is little material to remove and a good, smooth cut is needed. Pounding pressure is applied when making marking cuts and when removing large chunks of wood material. When pounding a chisel head, it is advisable to use a wooden, rubber, rawhide, or plastic mallet. When possible, chisel cuts should be made with the grain of wood. Cutting across the grain tears the wood away, leaving uneven areas and splinters.

Buy a chisel made of good steel. A chisel made of poor metal cannot hold an edge and becomes a dangerous tool. Chisels purchased in sets of varying sizes are economical, but if you can buy only one chisel, buy a ⅜ " because it is suitable for most woodworking jobs you will be doing.

Using the Wood Chisel

Guide the chisel with one hand, and apply the moving power with the other. Always push the chisel away from you, keeping both hands behind the cutting edge.

To cut with the grain of the wood, hold the chisel with the beveled edge up for a fine cut and with the beveled edge down for a rough, heavy cut.

To cut across the grain of the wood, grasp the blade of the chisel between the thumb and the first two fingers of one hand to guide the chisel and act as a brake while pushing with the other hand.

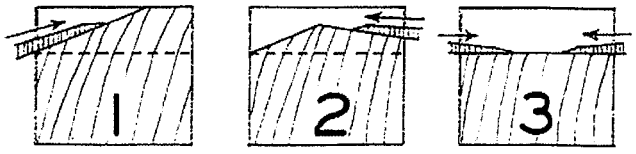
To avoid splintering the corners, cut from each edge toward the center. Remove the center portion last.

Safety Notes for Using Chisels

Keep chisel edges sharp. Dull chisels are hard to use and can slip and cause dangerous accidents.

Always push the chisel away from your body, never toward you.

Place all work on a table or workbench. Never hold it in your hand.



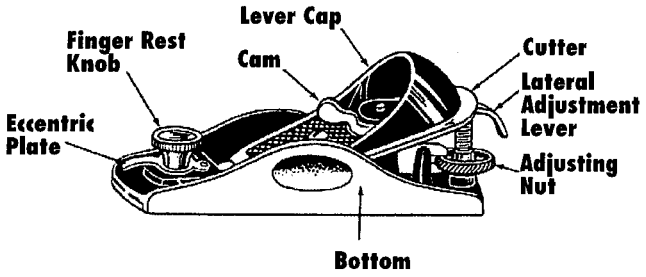
Woodworking Tools and Machinery (continued)

Planes

Planes are used for smoothing wood surfaces so that little or no sanding is necessary. They are available in two materials, wood and metal. There are several different kinds of planes, each serving a different function. Five common ones are discussed in this unit. They are the **block**, **jack**, **smooth**, **fore**, and **jointer** planes. The two most important to the home shop woodworker are the block and jack planes, because they can serve many functions. Remember, the cutting edge is very sharp so BE CAREFUL!

Block Plane

The block plane is the smallest and the most practical plane for the young woodworker. It is 4 to 5 inches long, which makes it easy to hold, and can easily be carried about in a tool box, which makes it handy. It can be used for almost any job but is an ideal tool to finish work. Because of the low blade angle, the block plane also is used for fine work and cutting across end grain. It also works well to cut chamfers and bevels.



To assemble the plane, place the plane iron (cutting blade) in the body of the plane, bevel side up. Position the lever cap and tighten the screw.

Adjusting the Block Plane

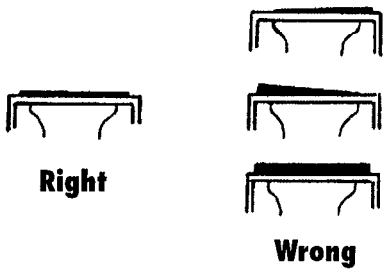
To check the adjustment, turn the plane upside down and sight along the bottom. The blade should project through evenly and just about the thickness of a sheet of paper.

Turn the adjusting knob clockwise to push the plane iron out. To pull the plane iron in, turn the knob to the left until the blade is in proper position. Then turn it clockwise until it starts to push the plane iron out. The plane iron will stay in the right place when the plane is used.

To adjust for an even blade, loosen the lever cap screw. Turn the plane over and sight along the bottom. Press the plane iron to the right or left until it is even. Tighten the lever cap screw.

Smooth Plane

This is a short plane, usually 5½ " to 10" long, used for cutting smooth, glasslike surfaces. It stays adjusted to produce an extremely thin and fine shaving.

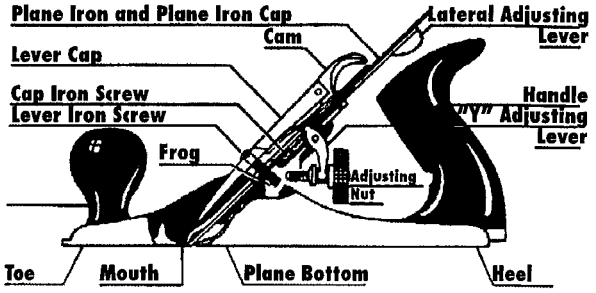


Notice how the plane bottom ends at the heel. This is a characteristic of smooth planes.

This tool works well for rough or preliminary planing as well as for planing end grain, chamfers, and other edge shaping.

Jack Plane

This medium-size plane, about 11" to 15" long, can be used for almost any job. It can be used for planing a door, trueing a wood surface, or beveling the edge of a surface. Because of its longer bottom, the plane does less riding up and down on uneven surfaces, therefore cutting off the top of high, uneven spots until the surface becomes straight and even.



Fore Plane and Jointer Plane

These planes are ideal for cutting an edge or a surface perfectly straight. Fore planes are usually 18" long and the jointer plane 22" to 24" long. Their long lengths enable them to ride over bumps and hollow places, producing a smoothly cut surface.

Assembling Smooth, Jack, Fore, and Jointer Planes

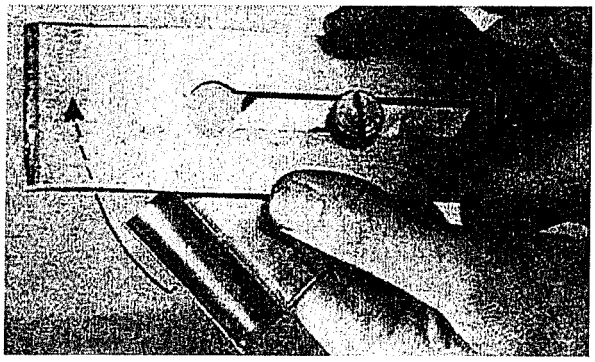
In assembling the block plane, the plane iron (blade) was placed in the plane with the bevel up. These planes are different. First, they have a plane iron cap. Second, the plane iron (blade) is placed in the plane with the bevel down. To assemble these planes, hold the plane iron cap crosswise the plane iron, bevel down. Slip the cap screw through the round hole in the plane iron and slide it up the slot (A). Then rotate the cap so it is straight with the plane iron.

Move the plane iron cap forward to a position about 1/16" from the cutting edge (B). Be very careful. Do not let the cap slip over the cutting edge. This will dull the blade.

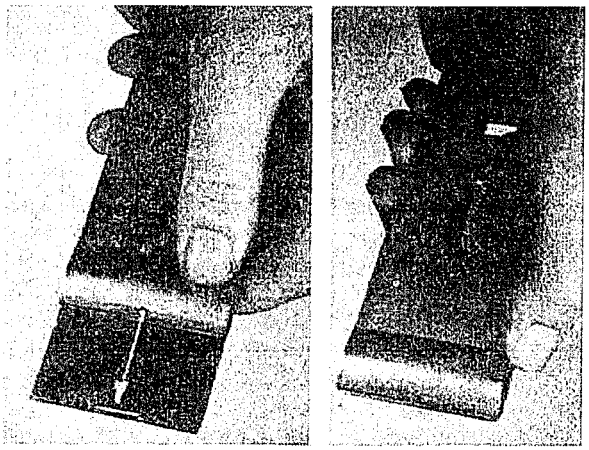
After making this adjustment, use a screwdriver or lever cap to tighten the cap screw to hold the pieces together (C).

Carefully place the plane iron and cap, with the cap side up, in position over the cap iron screw (D).

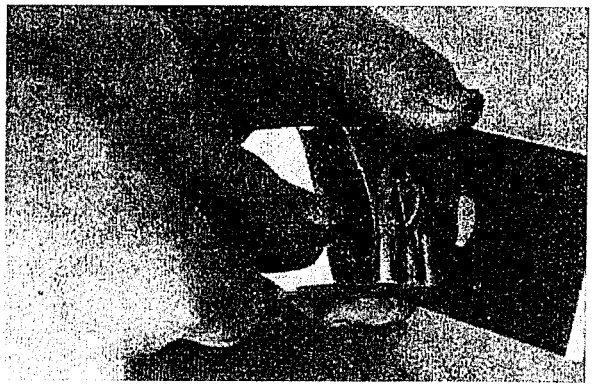
Place the lever cap in position and lock it in place using the cap cam (E). If too loose or too tight, adjust the cap iron screw slightly.



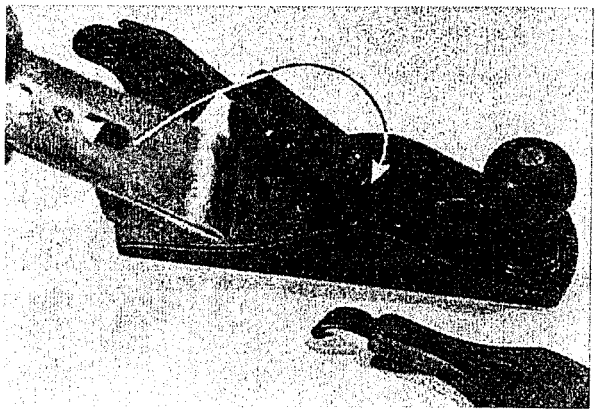
A



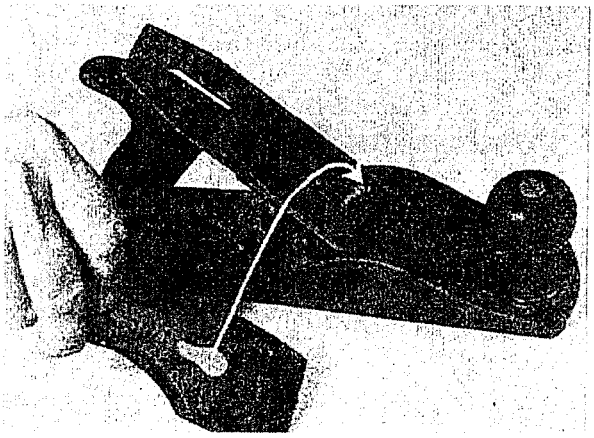
B



C



D

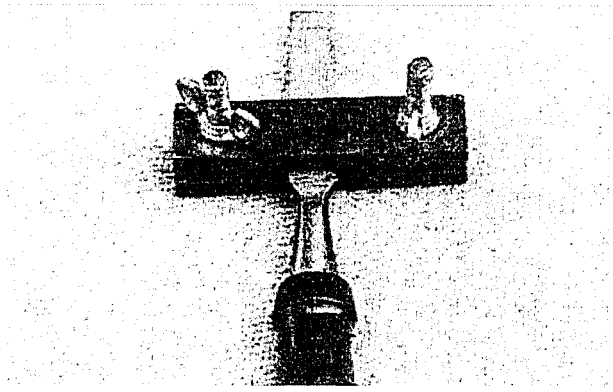


E

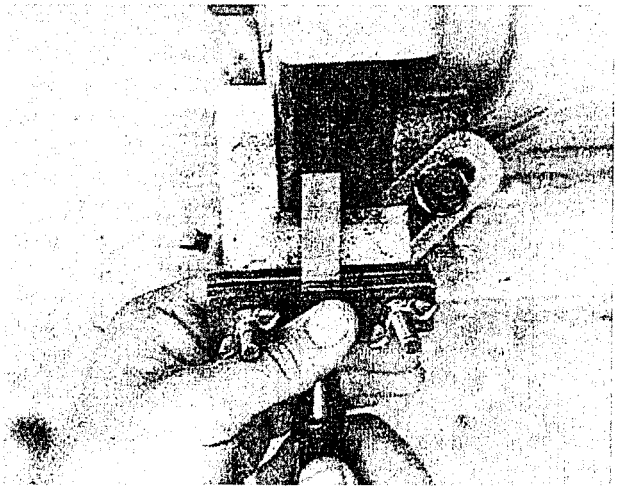
Sharpening Wood Chisels and Plane Irons

Wood chisels and plane irons are whetted on the oil stone to give a very sharp cutting edge. When the cutting edge is nicked or the angle is incorrect, it is time to grind it. A grindstone is desired for this, but a fine grit emery wheel can be used. In either case, the grinding wheel should turn toward the chisel. Dip the chisel or plane iron frequently in water to prevent overheating.

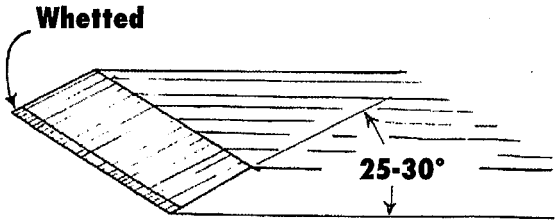
The cutting edge should be straight and square with the sides of the chisel or plane iron. You may desire a clamp to grip the chisel and rest against the grinder guide for accurate positioning.



A clamp to hold the chisel or plane iron for grinding.



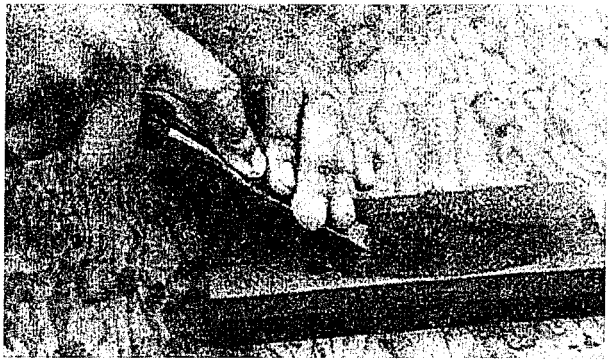
Chisel in position on grinder. Move chisel or plane iron across the face of the wheel from side to side. Caution: wear goggles unless wheel is guarded with eye shields.



A bevel too short and thick will not enter the wood easily. A bevel too long and thin is weak and will nick easily.

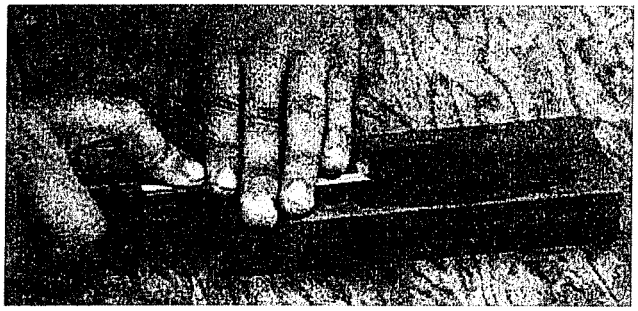
After proper grinding, whet the chisel or plane iron on the oil stone for a very sharp cutting edge.

Apply enough oil to the stone surface to keep it moist. The oil prevents particles of steel from filling the pores of the stone. When the pores are filled, the stone does not cut well. Wipe off the oil before putting the stone away.



Place the chisel or plane iron on the fine grit oil stone with the bevel flat on the surface. Raise the handle slightly 5 degrees or less, so you whet only the forward part of the bevel.

Move the chisel or plane iron with a circular motion back and forth lengthwise on the oil stone several times. The circular motion permits you to use the entire top of the stone so it wears evenly.



Safety Notes for Using Plane Irons

Make sure the cutting edge on plane irons stays sharp. Dull blades can be dangerous.

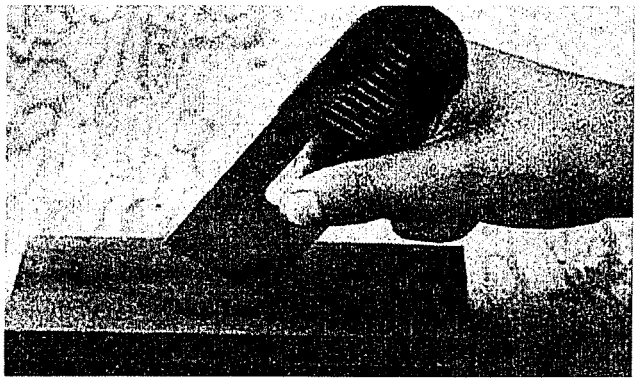
Make sure the work to be planed is securely fastened or held with a clamp to avoid slippage.

After whetting the bevel edge on the oil stone, remove the wire or feather edge. Turn the chisel over and hold the flat side flat on the oil stone. Move the chisel back and forth a couple of times in this position.

Now look at the cutting edge. If you see a nick or a shiny edge of bluntness, whet both sides again. Make a small cut in a piece of wood before taking a final look.

Use dulls the cutting edge. When it becomes dull, sharpen by whetting as described. The whetting process can be repeated until the bevel becomes too short and thick. Then, grind for the correct angle.

Plane marks show less on a finished surface if the corners of the plane iron are slightly rounded. This can be accomplished by additional honing at the edges or just stroking the corner in a circular motion as illustrated.



Power Tools

Bench Grinder

The bench grinder is used for sharpening woodworking tools. Chisels, plane irons, and screwdrivers can all be sharpened on the bench grinder. The simplest kind of grinder is turned by hand, but most of today's grinders are operated by electricity. This grinder is mounted on a bench and is equipped with a grinding wheel, wire brush wheel, and buffing wheel.

There are several different types of grinders. Your parent or leader may be able to explain them in further detail. Anyone interested in buying a grinder should compare cost, size, and quality of the various types. Ask your parent or leader for help. Be sure to look for sturdy construction, guards for the grinding wheels, adjustable tool rests, and safety eye shields.

Grinder Wheel Dressing

The grinding wheels should be dressed regularly to keep the wheels round, grinding surface flat or even, and to remove glaze. Either a steel cutter wheel dresser or carbide wheel dresser can be used.

Support the dresser on the tool rest and hold it firmly against the grinding wheel while it is operating at full speed. Move the dresser back and forth across the surface. Do not remove more of the grinding wheel than is necessary. Exert just enough pressure on the steel wheel dresser so that the dresser is cutting the wheel. If you see sparks when using the steel dresser wheel, apply more pressure. When the proper pressure is exerted on a carbide wheel dresser, there are sparks at the area of contact between the dresser and the wheel.

Grinder Operation and Safety

- It is important to protect your eyes when operating a high speed grinder. Pieces of metal and abrasive wheel particles fly from the grinding wheel when it is in use. These particles may injure unprotected eyes. Provide yourself with a pair of safety goggles and use them.

- Operate the wheel only at speeds recommended by the manufacturer.
- Keep the tool rest adjusted and close to the grinding wheel. The distance from the wheel should not exceed ⅛".
- Keep the grinding wheel round with the proper shaped working face by frequent dressing.
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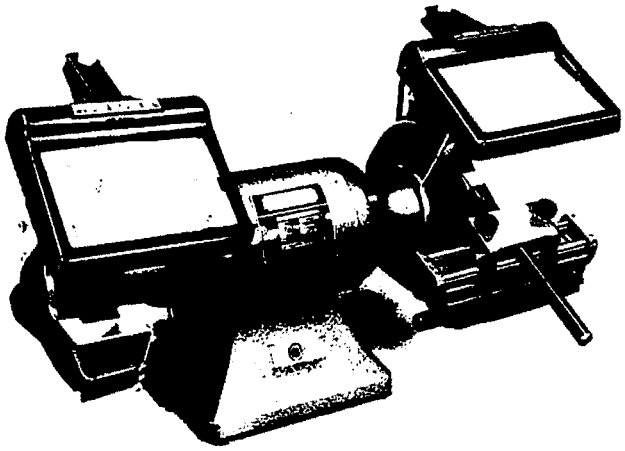
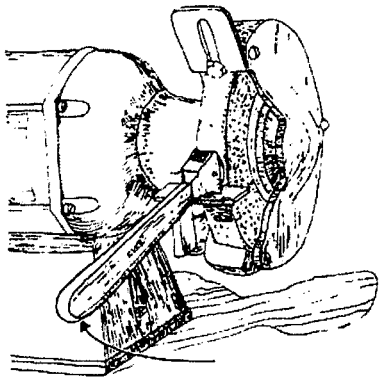


Bench grinder self-contained



Dressing a grinding wheel

Drill Press

The drill press is a power machine that has many uses. With proper attachments, it can be used for drilling, routing, sanding, mortising, shaping, carving, cutting dovetails, buffing, wire brushing, and grinding.

There are two basic types of drill presses: the **bench** type and the **upright** type. These are basically the same, the difference being in the mounting. As the name suggests, the benchtype drill press is mounted on a work bench and the upright type is mounted on a pedestal which stands on the floor.

Drill presses come in a number of sizes and use a wide variety of bits. Those most commonly found in shops have the capacity to drill holes up to 1 inch in diameter, using the proper bits.

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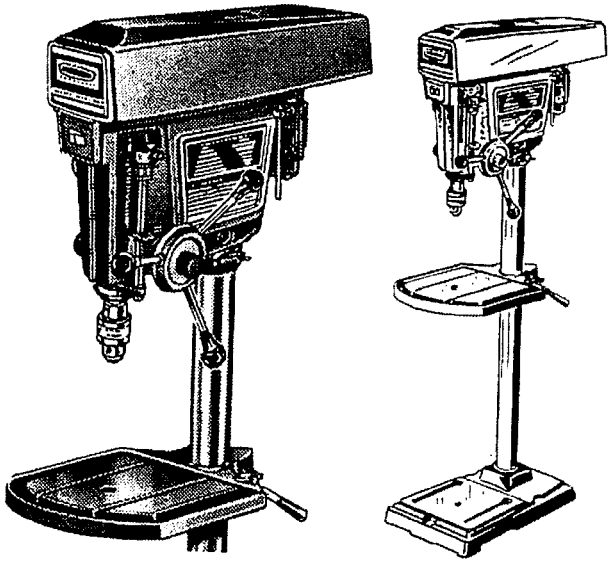

Belt Sander

A belt sander quickly sands large surfaces such as floors, walls, and planks. It can erase scratches or smooth uneven workmanship. The belt sander also works well on furniture made of solid lumber, but it is not suited to sanding furniture made from veneer plywood.

The cutting action is done by a sanding belt which runs over two pulleys. The work capacity of this sander depends upon its size and belt speed. These are either noted on the machine itself or in the literature that accompanies the machine. For very small pieces of wood, the belt sander may not be a safe tool to use.

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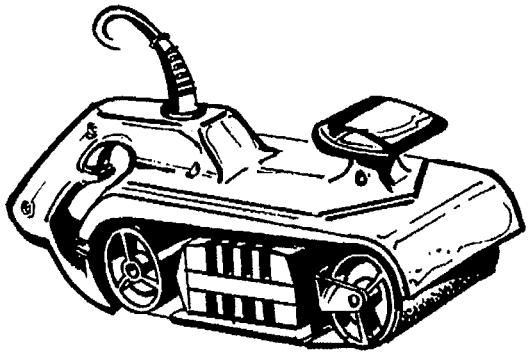

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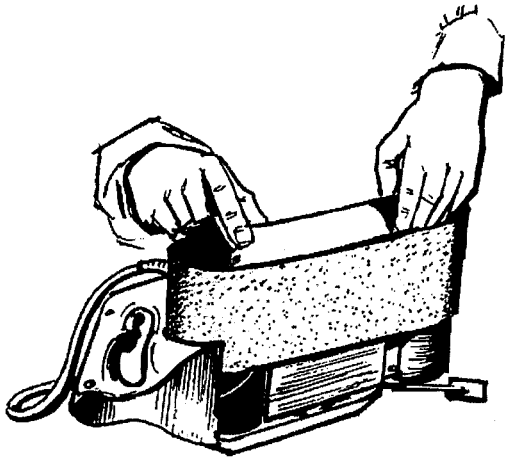
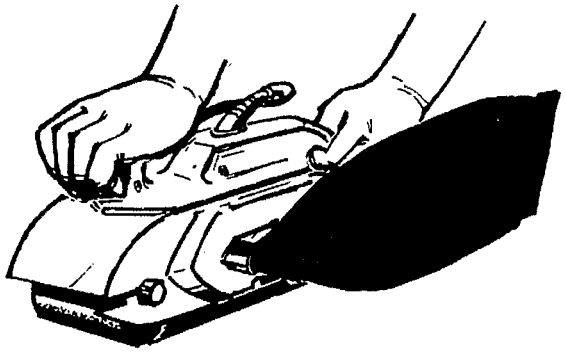
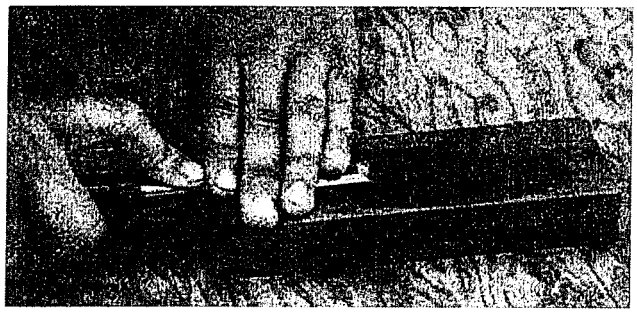


Changing the Belt



Accessory Dust Bag



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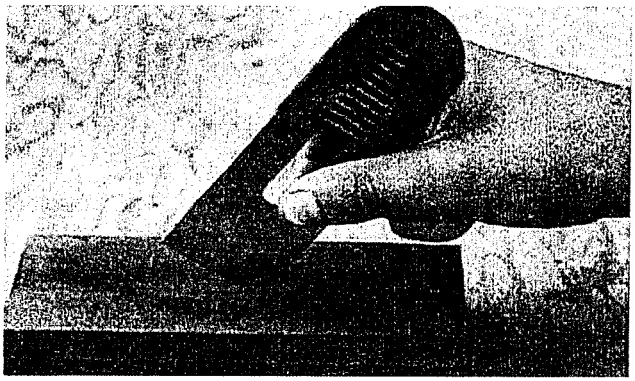

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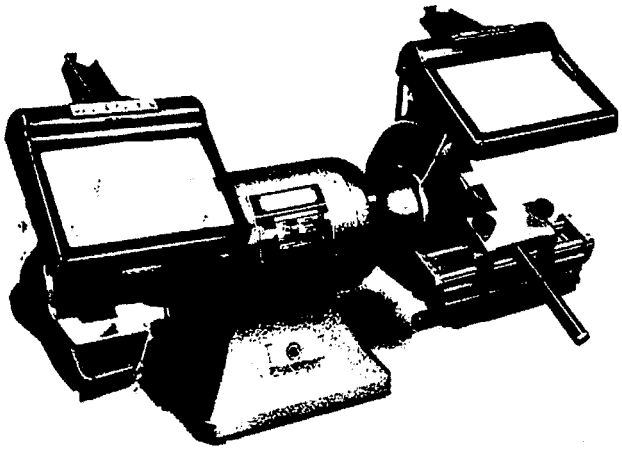

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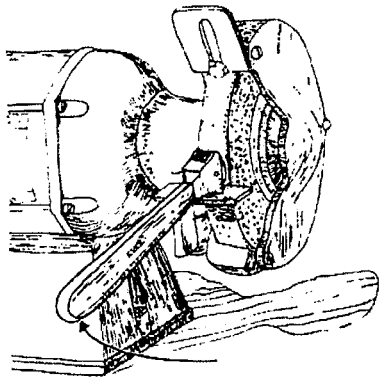

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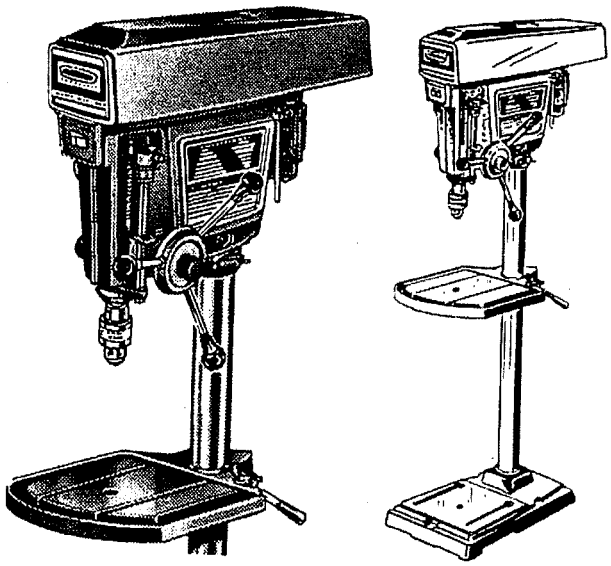

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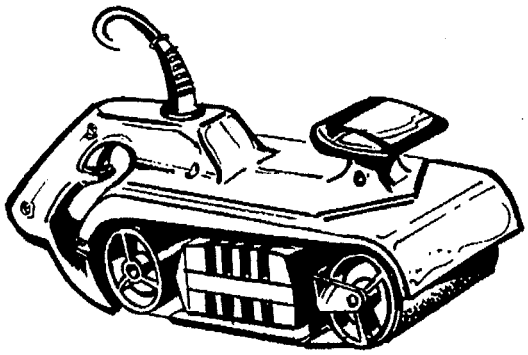
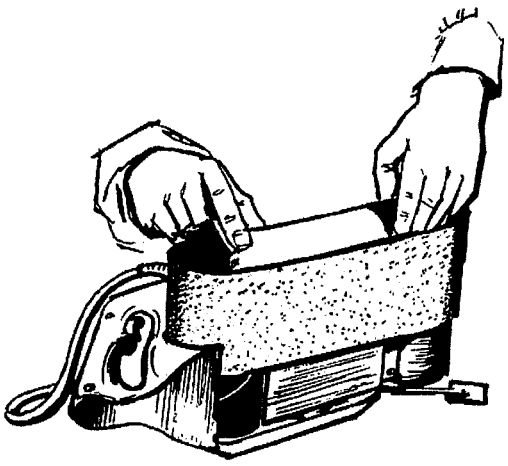
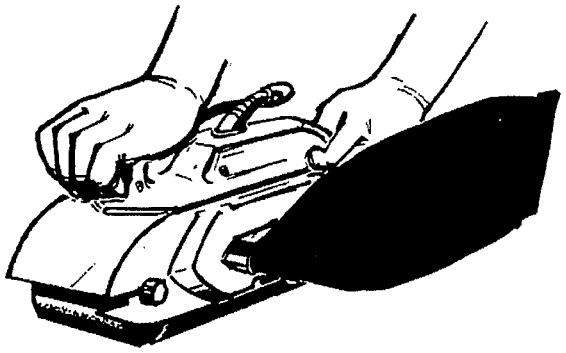


Belt Sander



Changing the Belt



Accessory Dust Bag

Woodworking Plans

Get Along Little Doggie

Materials needed

- 1 piece of 1 x 2 lumber (actual size ¾" x 1½") and 11" long — axles
- 1 piece of ¾" x 10" x 22" A-C or better plywood — body*
- 1 piece of ⅜" x 6" x 8" or ½" x 6" x 8" A-C or better plywood — wheels*
- 2 — 10d finishing nails
- 8 — 1½" wire nails
- Cloth or leather — ears
- Glue
- Finish, optional

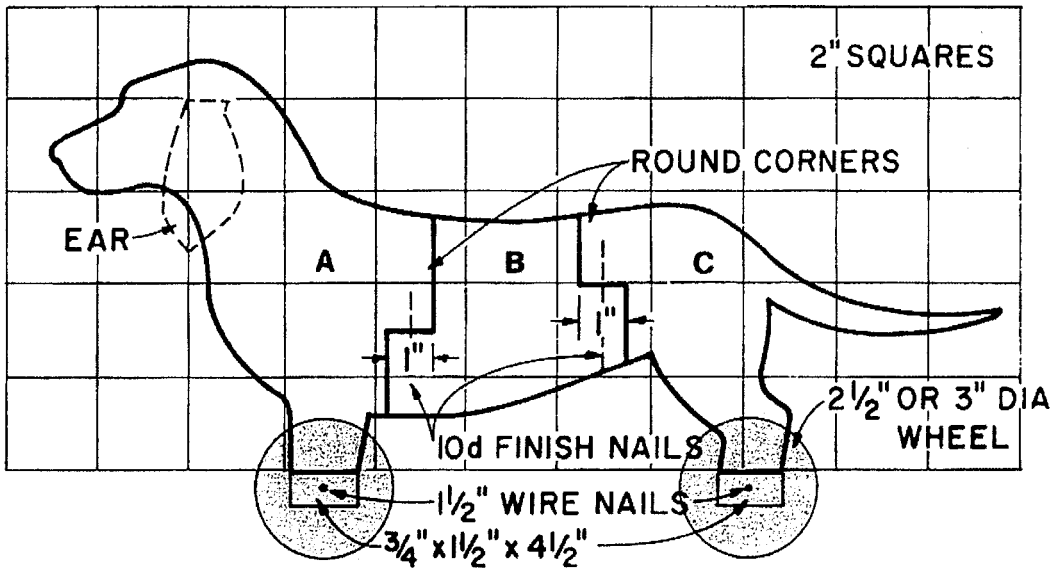
Tools needed

- Coping saw
- Hammer
- Rasp or file
- Drill press or other boring tool with appropriate bits
- Pencil compass
- Oscillating sander (or sandpaper)

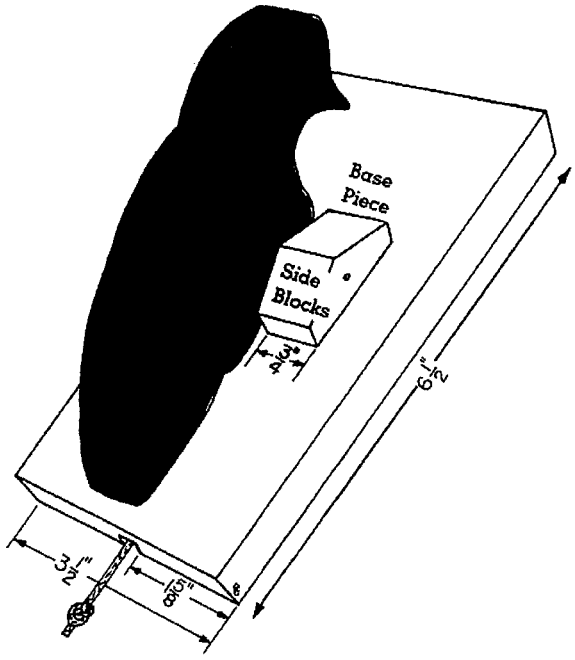
***Note:** If the toy will be used outdoors, use A-C exterior plywood. For best appearance on front and back, use A-A plywood (A-A exterior for outdoors). See the discussion on plywood grades in Unit II.

Instructions

1. Make a trace pattern using the grid system. Trace pattern onto wood.
2. Cut out body, wheels, and axles.
3. Cut body into A, B, and C pieces. Round the cut edges with a rasp or file so that the dog can twist and turn.
4. Drill loose fitting holes for hinge nails in bottom part of B piece. Drill tight pilot holes for hinge nails in top part of A and C pieces.
5. Sand all pieces smooth.
6. Drill loose fitting holes for nail hub in wheels. Attach axles to A and C pieces with glue and nails.
7. Assemble sections of dog with nails.
8. Attach ears.
9. Apply finish, if desired.



"Pecky" the Door Knocker



Instructions

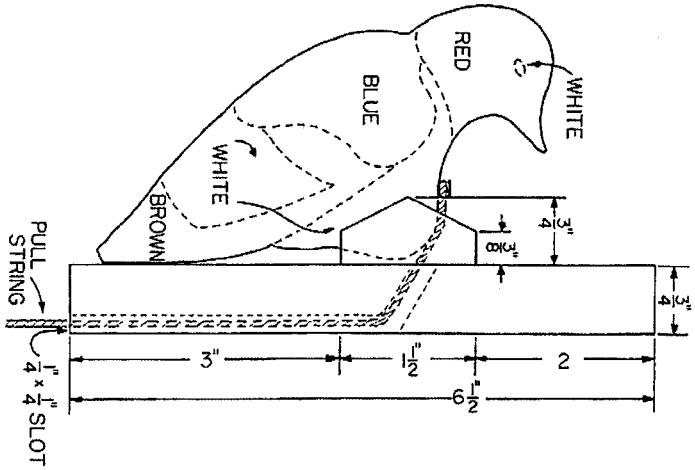
1. From one end of your wood piece, cut out the base to size.
2. Using the grid system, make a trace pattern of Pecky's body size 3½" x 5½". Trace onto wood.
3. Mark the two side blocks, each ¾" x 2" long.
4. Cut out all three pieces.
5. Mark and drill nail hinge or pivot holes in side blocks. (The hole in Pecky must be larger than the nail you will use as a pivot.)
6. Drill a ¼" hole through the base piece for the string. Chisel a ¼" recess on the bottom edge for the string as seen in the illustration.
7. Sand all pieces. Finish as desired.
8. Attach the side blocks to the base piece using the wire brads.
9. Attach pull string to Pecky's breast using the wire nail.
10. Attach Pecky to the base.

Materials needed
(Hardwood preferred)

- 1 piece of lumber 1 x 4 (actual size ¾" x 3½") and 14" long
- 1 — 6d finishing nail
- 12" of strong cord, cloth or leather shoe lace
- 1 — ⅝" wire nail
- 4 — 1" wire brads
- Finish, optional (weather proof, if needed) or paint

Tools needed

- Hand saw
- Coping saw
- Drill press or other boring tool with appropriate bits
- Hammer
- Rasp or file
- Chisel
- Oscillating sander or sandpaper



Sandbox

Materials needed

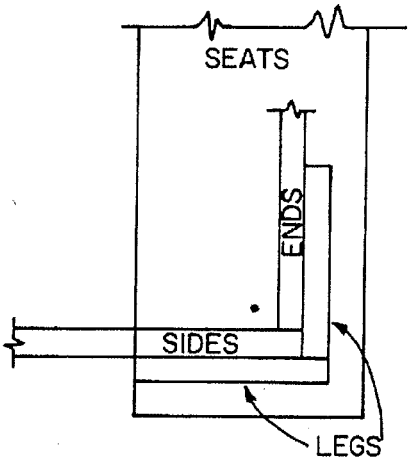
- 3 pieces of 1 x 8 lumber (about ¾" x 7¼") and 8 feet long for ends, sides, and seats
- 1 piece of 1 x 6 lumber (about ¾" x 5½") and 8 feet long for legs
- 1 piece of 1 x 4 lumber (about ¾" x 3½") and 4 feet long for support cleat
- 1 piece of ¾" x 47¾" x 38" exterior grade plywood for bottom
- 7d galvanized siding nails
- Penetrating semi-transparent oil base stain (free of penta) for finish

Tools needed

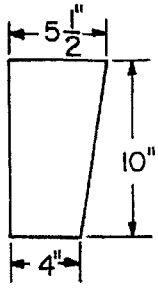
- Crosscut saw
- Coping saw
- Pencil compass
- Square
- Countersink
- Claw hammer
- Drill with ¼" bit
- Oscillating or belt sander
- Paint brush

Instructions

1. Check the thickness of material used for sides. The thickness will affect the length of the end pieces.
2. Drill a drain hole ¼" in diameter near each corner.
3. Slightly round all corners of seats.
4. Finish.



CORNER DETAIL



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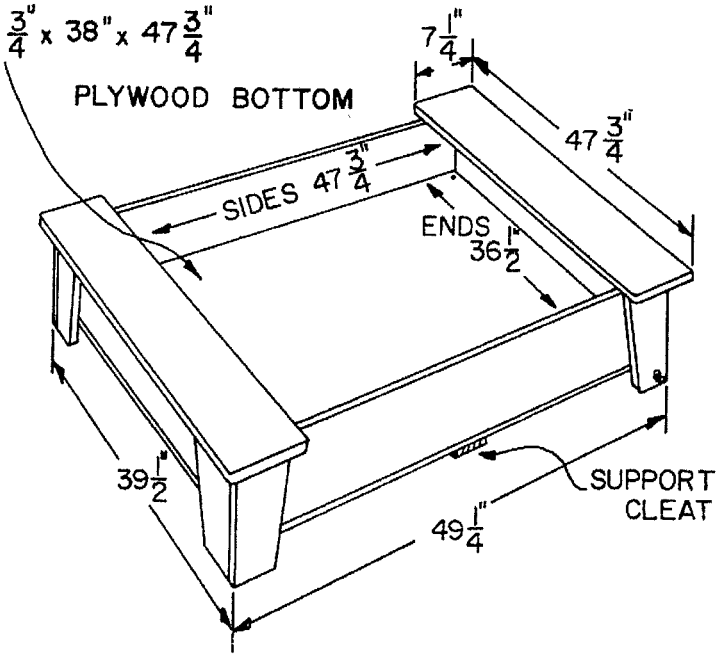
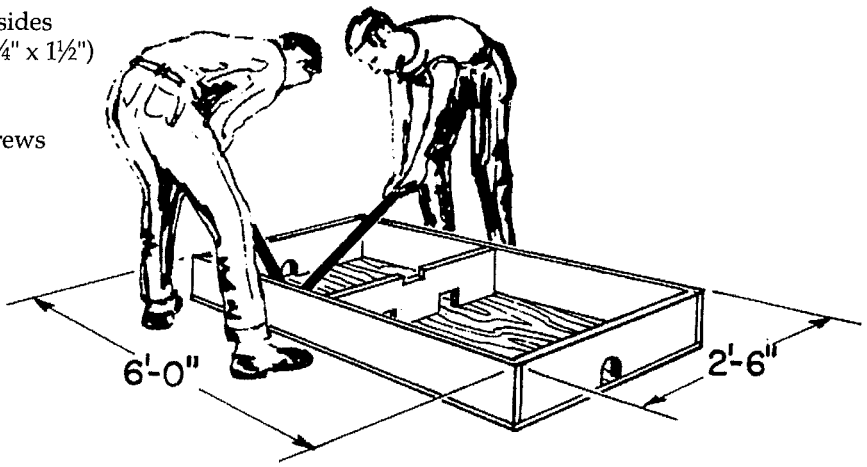


Box Hockey

Materials needed

- 1 piece of ⅝" x 30" x 6 feet exterior grade plywood for floor
- 1 piece lumber 2 x 6 (actual size 1½" x 5½") and 8 feet long for ends and partition
- 2 pieces lumber 1 x 6 (actual size 3/4" x 5 1/2") and 6 feet long for sides
- 2 pieces lumber 1 x 2 (actual size ¾" x 1½") and 30" long for sticks
- 1 puck — 1" thick, 2" diameter
- 12 — No. 6, 1¼" flathead wood screws
- 36 — 1½" finishing nails
- Paint or varnish

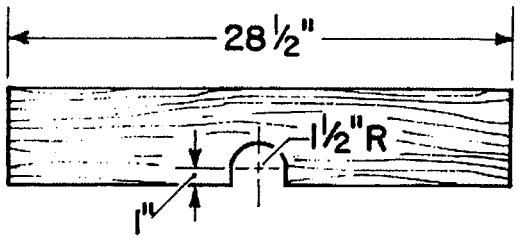


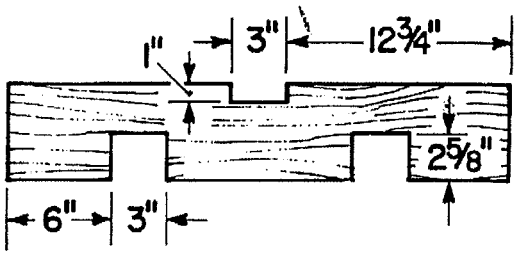
Tools needed

- Crosscut saw
- Coping saw
- Pencil compass
- Square
- Countersink
- Claw hammer
- Drill with ⅛" bit
- Oscillating or belt sander
- Paint brush

How to play Box Hockey

Players stand on opposite sides of the box, which is placed on the floor. Each player has a hockey stick and holds it at the end. The puck is placed in the notch in the center partition. To start the game, the players "shinny off." (i.e., They touch the bottom of the box and then each other's stick three times, counting 1-2-3 go.) The object of the game is to knock the puck out of the box through the end opening to the player's own left. When the puck goes through opening, the players start over. Best two out of three goals win.





Shoe Shine Box

Materials needed

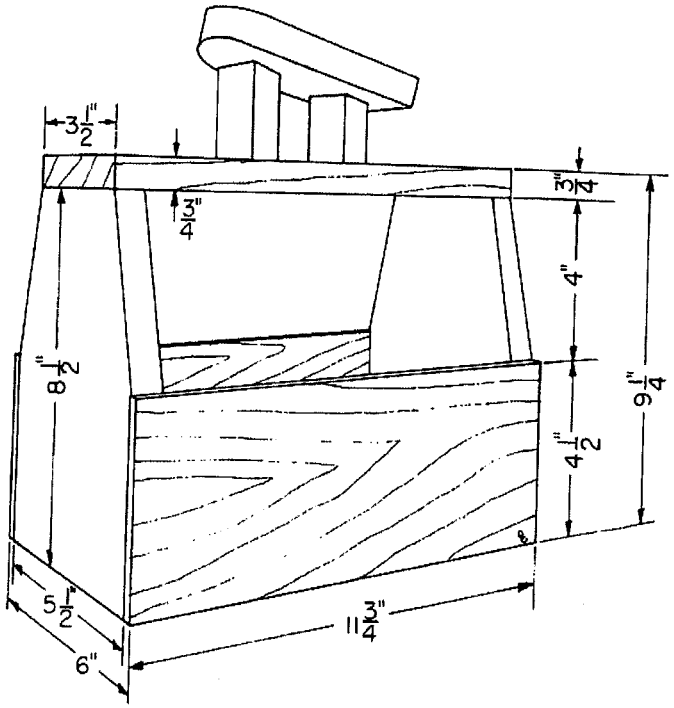
- 1 piece of 1 x 6 lumber (actual size ¾" x 5½") and 30" long—bottom and ends
- 1 piece of 1 x 4 lumber (actual size ¾" x 3½") and 24" long—top and footrest
- 1 piece of 1 x 2 lumber (actual size ¾" x 1½") and 6" long—footrest supports
- 1 piece of plywood ¼" x 4½" x 24"—sides
- 6d finishing nails
- 1" wire brads
- Glue
- Finish, optional

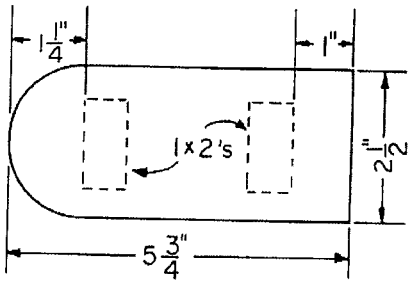
Tools needed

- Hand saw
- Coping saw
- T bevel
- Square
- Hammer
- Bar clamp or adjustable clamp
- Plane
- Belt or oscillating sander (or sandpaper)

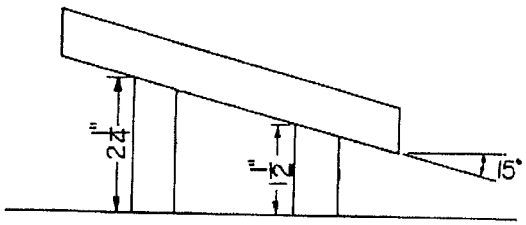
Instructions

1. Cut out pieces to size, as illustrated.
2. Plane all edges smooth and sand pieces before assembly.
3. Attach ends to bottom using glue. Hold with a clamp until dry, then nail.
4. Assemble the footrest and attach it to the top.
5. Attach the top to the ends using glue and nails.
6. Now, attach the plywood sides using glue and the wire brads. Nail into the ends and bottom pieces.
7. Finish as desired.





TOP VIEW



SIDE VIEW

Step Stool/Chair

Materials needed

- 1 piece of lumber 1 x 8 (actual size ¾" x 7¼") and 6 feet long. Out of this piece cut:
  - Two A pieces
  - Two B pieces
  - One seat, 7¼" x 12"
  - One back rest, 4¼" x 13¾"
  - Two corner blocks, each ¾" x 1" x 6½"
- 1 piece of ¾" x 16" dowel stock. Out of this piece cut:
  - Two stops, ¾" x 1½"
  - One spacer, ¾" x 12"
- 2 — ¼" x 2" machine bolts
- 6 — ¼" steel washers
- 6d finishing nails
- Glue
- Finish, optional

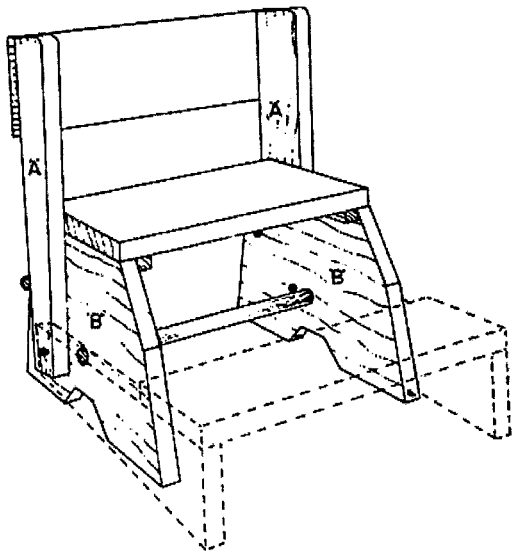
Note: Place a steel washer between piece A and piece B, as well as at each end of the bolt.

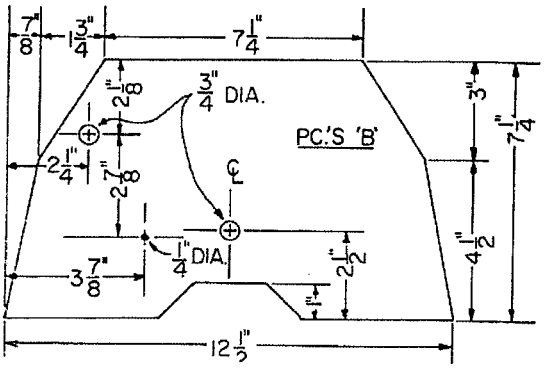
Tools needed

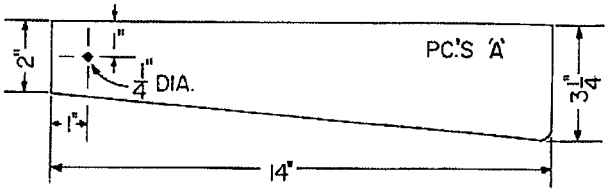
- Hand saw
- Hammer
- Drill press or boring tools with appropriate bits
- Coping saw
- Belt or oscillating sander (or sandpaper)
- Clamp (if gluing pieces together)

Instructions

1. Cut all pieces to size as illustrated.
2. Drill ¼" and ¾" holes in B pieces as illustrated.
3. Nail the corner blocks to B pieces.
4. Place dowels for stops and spacer through B pieces, gluing together.
5. Attach seat to B pieces.
6. Drill holes in A pieces as illustrated.
7. Attach A pieces to backrest.
8. Attach A pieces to B pieces using machine bolts and washers on each end of B pieces.
9. Finish as desired.







Medicine Cabinet for Barn

Materials needed

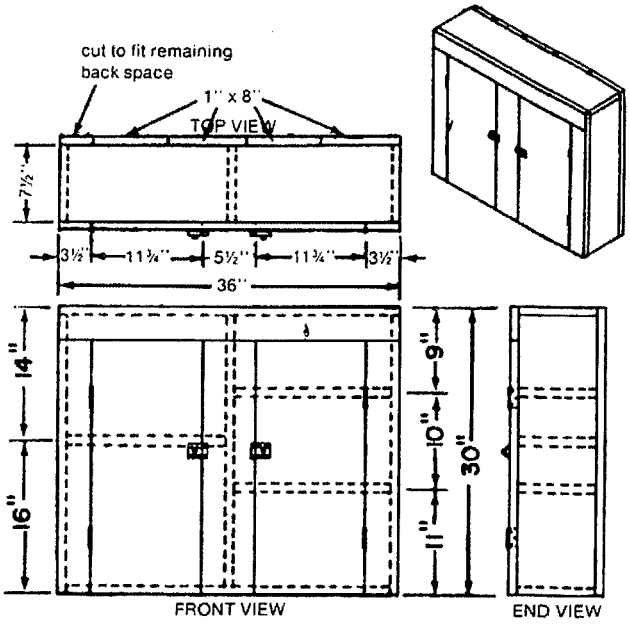
- 2 pieces 1 x 8 lumber (actual size ¾" x 7¼") and 10 feet long
- 1 piece 1 x 8 lumber (actual size ¾" x 7¼") and 12 feet long
- 1 piece 1 x 4 lumber (actual size ¾" x 3½") and 8 feet long
- 1 piece 1 x 6 lumber (actual size ¾" x 5½") and 3 feet long
- 2 pieces A-C or better interior plywood ¾" x 11" x 26½"
- 2 pairs small butt hinges
- 2 cupboard turns (or locks)
- Paint
- Screws
- Nails
- Finish, optional

Tools needed

- Hand saw
- Plane
- Screwdriver
- Chisel
- Hammer
- Oscillating or belt sander
- Square
- Paint brush

Instructions

1. Cut top, bottom, and sides from 1" x 8" x 12' piece.
2. Assemble with screws, keeping corners square.
3. Cut 4 back boards from one 1" x 8" x 10' piece.
4. Cut remaining back board to length from other 1" x 8" x 10' piece. Cut to fit width of remaining back space using a rip saw.
5. Assemble back to frame with nails keeping corners square.
6. Cut center divider and shelves from 1" x 8" x 10'.
7. Install with nails.
8. Cut door frame from 1" x 4" x 8'.
9. Install with screws.
10. Slightly bevel latch side of plywood doors.
11. Notch door and door frame with chisel to receive butt hinges.
12. Install hinges with screws.
13. Install cupboard turns (or locks).
14. Sand and finish inside and out.



Saw Horse

Materials needed
(for horse with 24" legs)

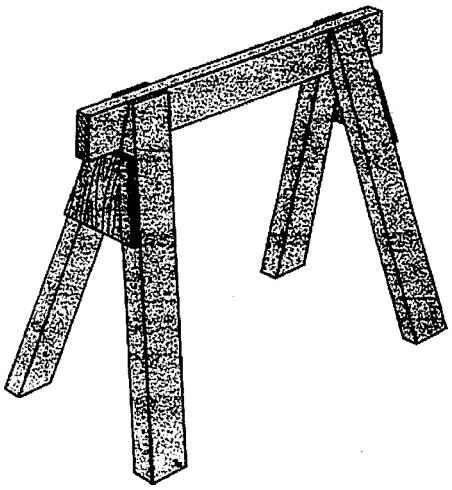
- 1 piece 2 x 4 lumber (actual size 1½" x 3½") 12 feet long, sound wood, free from cross grain, shakes, or other defects which will reduce the strength
- 1 piece 1 x 6 lumber (actual size ¾" x 5½") 2 feet long
- 8 — No. 14, 3" flathead wood screws
- 20 — No. 12, 2" flathead wood screws
- 20 — 4d finishing nails
- Colorless penetrating wood finish, such as boiled linseed oil or varnish with paint thinner or commercial wood seal

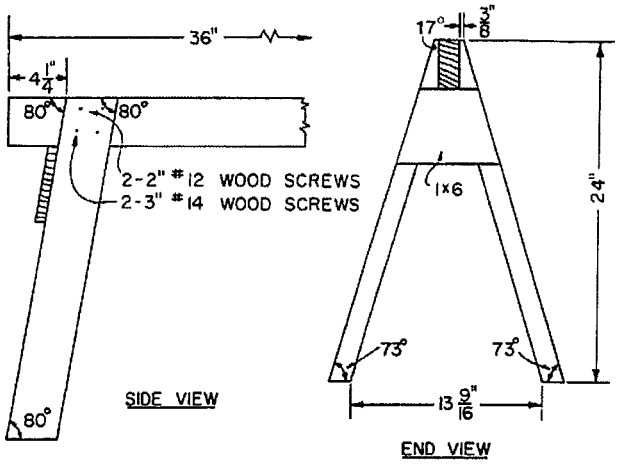
Tools needed

- Hammer
- Crosscut saw
- Screwdriver
- Countersink
- Combination square
- Sandpaper
- Tape rule
- T bevel
- Plane

Instructions

1. Lay out and cut all pieces.
2. Assemble saw horse as shown with nails.
3. Drill pilot holes and install screws.
4. After the legs are marked and cut out, 1¼" is cut off the tapered end to give a narrow, flat end section. The flat end section will be flush with the top of the beam.





Suggested Construction Dimensions

Horse height	Leg distance (top) from beam end	Layout leg length	Trimmed leg length
18"	3⅛"	20⅝"	19⅜"
20"	3½"	22⅝"	21⅜"
24"	4¼"	26¾"	25½"

Garage Creeper

Materials needed

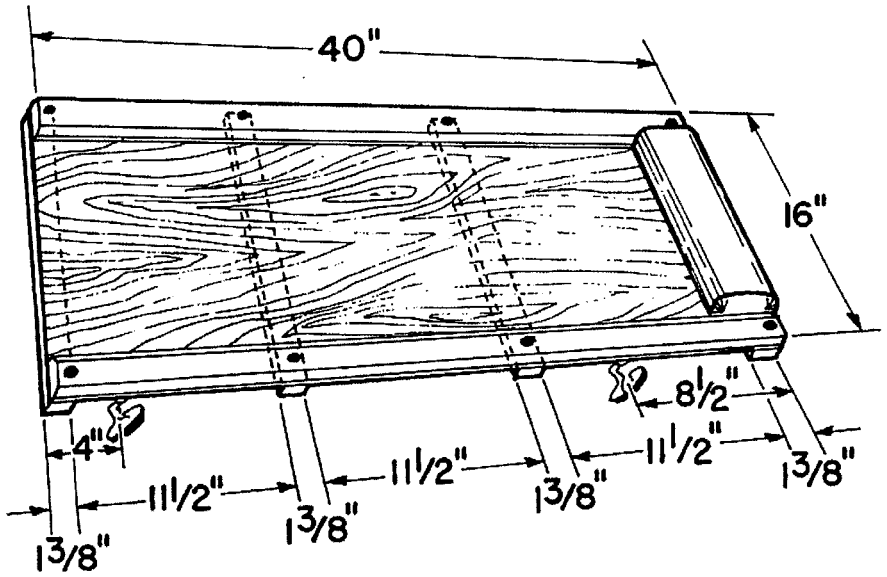
- 2 pieces of 1 x 2 lumber (actual size ¾" x 1½") and 40" long
- 4 pieces of 1 x 2 lumber (actual size ¾" x 1½") and 16" long
- 1 piece of ¼" x 16" x 40" exterior grade plywood
- 4 swivel casters or rollers for creeper. These are available from some mail order houses and most auto supply houses.
- 16 — No. 10, ¾" flathead wood screws
- 8 — ¼" x 2" carriage bolts with nuts
- 8 — ¼" washers
- 1 piece 1" x 12" x 18" plastic foam to fold for headrest covering
- ⅓ yard vinyl plastic upholstery for headrest covering
- Upholstery nails
- 24 — ⅝" wire brads
- Waterproof glue
- Enamel or wood sealer finishing material

Tools needed

- Saw
- C-Clamp
- Screwdriver
- Wrench
- Drill and ¼" bit
- Sandpaper
- Square
- Paint brush
- Plane

Instructions

1. Cut hardwood strips to size.
2. Round upper inside corner of the 1" x 2" x 40" side pieces with plane.
3. Glue these side pieces to plywood sheet. Use ⅝" brads about 5" apart to serve as glue clamps.
4. To attach 1" x 2" x 16" strips: Clamp in place and drill bolt holes. Release clamps and apply glue. Insert bolts and tighten. Use 3 brads across plywood area to hold plywood to strip while the glue dries.
5. Attach casters or rollers. Check to see that they have clearance to swing in a full circle.
6. Finish.
7. Fold and attach headrest.



Glossary

Bucking
Cutting the log into lengths.

Chamfering
To remove the sharp corner along the edge of a board by planing it at a 45-degree angle. The resulting surface is called a "chamfered edge."

Chipping
Cutting wood into small pieces using mechanical knives.

Cubic Foot
A cube of wood 12" on a side.

Dovetailing
To fit together interlocking joints having rectangular ends, such as for drawers, cabinets, and furniture frames.

Featheredge
A very thin, sharp edge on a plane iron; especially one that is easily broken or bent over.

Felling
Cutting down trees.

Honing
Sharpening with a fine grit stone or whetstone, usually with oil.

Grindstone
A flatsided circular stone that revolves on an axle and is used for grinding and sharpening woodworking tools.

Joint
The area where two pieces of wood are attached, fitted, or joined together. There are different ways of doing this in woodworking.

Knots
The remains of branches covered over by the tree trunk as the tree grew. Knots reduce the strength of lumber and sometimes detract from the appearance of wood, therefore they are referred to as defects in wood.

Limbing
Removing limbs and branches from trees.

Lumber
Any wood that is suitable for carpentry construction.

Miter
To cut two pieces of wood at corresponding angles so that they can be fitted together into a neat and secure joint.

Mortising
Cutting a hole in a piece of wood to receive another piece of wood, a lock, or any other wood fastener.

Plane Iron
The blade or cutting edge of wood plane.

Prune
To cut off or cut back parts of a tree or plant to help its growth and shape.

Pulping
Chemical or mechanical separation of wood into fibers.

Resin Canals
The tubular, cell-like spaces found in softwoods.

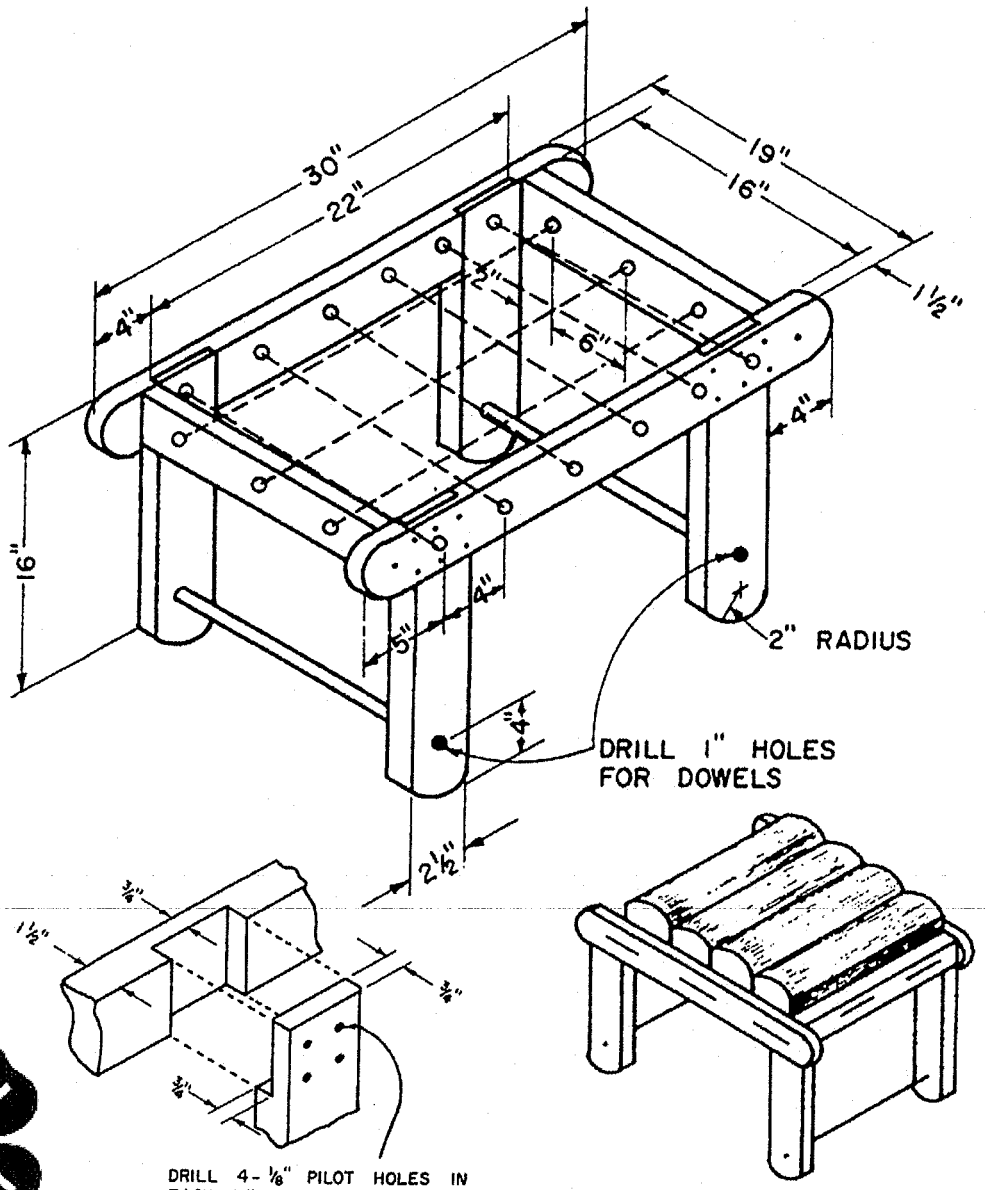
Species
A class of trees and woods having common characteristics and a common family name.

Treated Wood
Wood that contains a chemical that makes wood resistant to decay and insect damage.

Trueing
To make level or square.

Whetting
Sharpening by rubbing on or with something, such as a stone.

Reprinted July 2001 from the National 4-H publication *Building Bigger Things* (Unit III Member Manual). Reprinted September 2006.



DRILL 4-⅛" PILOT HOLES IN EACH LEG FOR #12 SCREWS

4-H Wood Science

Leader Guide

4-H 442L
Reprinted September 2006

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Table of Contents

Introduction

Congratulations! You are embarking on an adventure in working with wood and tools. The experience can be fun and educational for you and for your members. This guide has been designed to introduce you, the leader, to the exciting world of wood science and woodworking.

As a leader in the 4-H Wood Science Program, you hold a key position in the lives of your 4-H'ers. You may start a child toward a noble career or help develop an avocation in woodworking or wood science that will last throughout his or her lifetime. If you enjoy working with young people and like woodworking and wood science, you will find the time and effort spent as a 4-H leader most rewarding.

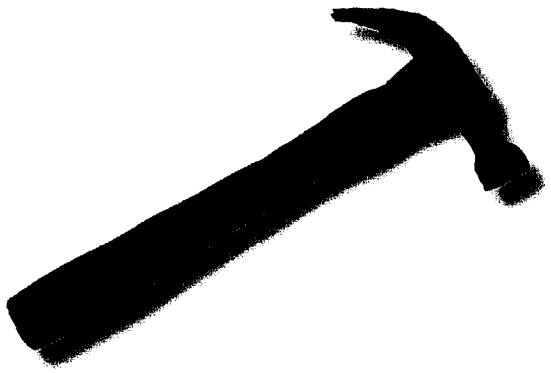
Objectives

The objective of the 4-H wood science program is to help boys and girls develop leadership skills, character, and citizenship responsibilities by sharing woodworking experiences. Realizing that youth have their own individual backgrounds, talents, experiences, and aspirations, the aim of this program is to accept boys and girls where they are in terms of woodworking knowledge and skills, and to help them build upon their current levels of attainment until they are able to achieve personal goals, which they have set for themselves, in the wood science project.

Woodworking provides one of the best "learn by doing" opportunities in 4-H. Members almost have an unlimited scope of interesting, educational challenges including designing, constructing, finishing and refinishing, analyzing, identifying, and experimenting with numerous woods, tools, processes, and materials. Many youngsters, especially senior 4-H'ers, can build or design their own work areas; procure tools, machines, and equipment; design and build their own work benches and tables; and make tool panels, too. 4-H'ers can have many positive experiences while making useful articles for home, school, and/or recreational use. With the help of this guide, you will be able to plan and conduct enjoyable, educational activities and experiences for youth.

The 4-H wood science program gives youth opportunities to:

- Develop leadership abilities, build character, and assume citizenship responsibilities
- Develop an understanding and appreciation of the many products from the forest
- Acquire knowledge and develop skills in the selection and appropriate use of various types of wood and wood products
- Acquire knowledge and develop skills in the selection, care, and safe use of woodworking tools and machinery
- Explore career opportunities associated with the manufacture and utilization of forest products
- Develop an awareness for business and economics of the forest products industry



Working with Young People

How can the wood science program be tailored to the needs of boys and girls at different levels of maturity? In general, young people at certain ages have identifiable characteristics. The subject matter and style of presentation can usually be tailored to meet the needs of various age groups. Some of the characteristics of three groups are identified:

9–12 Year Olds

- Are active
- Are interested in tangible ideas, not abstract
- Have short attention span
- Need and accept guidelines from adults and teens
- Like group activities
- Are easily motivated, eager to try new things
- Need recognition and praise
- Like to be with members of their own sex

13–15 Year Olds

- Like to explore community beyond immediate neighborhood
- Have a broadened span of interests
- May find it hard to accept help from older people
- Are beginning to think of what they'll do when they grow up
- Are often questioning
- Are often self conscious

16–19 Year Olds

- Look toward adulthood and career
- Have longer attention span
- Are developing selected interests; choose a few and study fully
- Handle abstractions; understand principles behind ideas
- May understand that there are no simple answers
- Work cooperatively with adults
- May be ready to give leadership to younger club members
- Need guidance regarding vocations
- Desire and need a strong voice in planning own activity
- Are interested in traveling

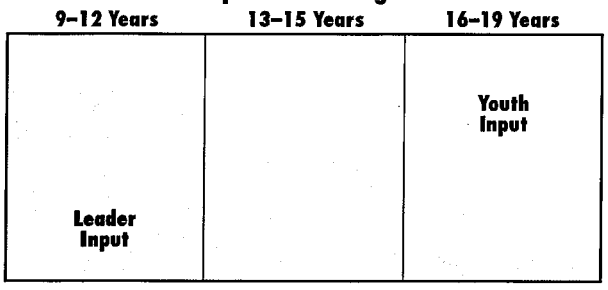
These characteristics are only generalizations and should be used as a base for dealing with youth. Each 4-H'er has his or her own unique qualities.

Hints for Working With Young People

As an effective leader, you want to remember that at each age level there is a need to emphasize different skills and provide different degrees of leader input. As members grow older or progress in projects, the need for leader guidance decreases.

You will want to be aware of your members' development and reinforce positive attitudes. The characteristics listed here for the various age levels may help you in planning your role as a 4-H leader.

Proportions of Leader Input and Youth Input at Three Age Levels



Your Challenge

An effective 4-H leader is an adult or teen who makes it possible for 4-H'ers to get together as a group to learn to do things they would not do alone. A successful leader offers security, suggestions, and support; has the confidence of the members; understands their viewpoint; is tolerant, patient, and sympathetic. A leader makes friendly suggestions that will encourage members to broaden their educational experiences, and the wise leader recognizes work well done in such a way that 4-H'ers will be encouraged to do even better. The group is only meaningful when the individual members are the doers and the learners. 4-H teaches "learning by doing." Remember, members' mistakes can actually be helpful learning experiences. The "leader" is really a helper, and leadership is "helpership." As your 4-H'ers grow and develop in their wood science program, they too can become helpers of others.

Tips for Helpership in Wood Science and Woodworking

1. Read the section called "Basic Information About Wood" found in this leader guide.
2. Obtain a set of the member manuals that accompany this guide and study them together. Become familiar with all the project materials.
3. Familiarize yourself with available resources and use them. (See the "Resources" section in the back of this manual.)
4. Help members set goals they can realistically meet. Help them plan and select woodworking projects that suit their age and abilities.
5. Don't do project work for members.
6. Familiarize yourself with the woodworking tools, materials, and machinery being used in this project.

Supervise members whenever using tools and machinery, especially power tools.
7. Avoid comparing the progress of one member with that of another.
8. Praise members for a job well done.
9. Help members get to know themselves, including their strengths and weaknesses.
10. Don't determine or direct all of the group's activities. Let the members share in the planning.
11. Solicit the help of parents, families, and friends, when needed.

Program Division

The national 4-H wood science program literature is divided into three units. Units are planned as 1-year projects. After Unit I, each additional unit becomes more difficult than the preceeding one. Ideally, a 9- to 12-year-old member will enroll in Unit I the first year and in a new unit each of the following years.

Every member should have the program manual that corresponds to the unit in which he or she is enrolled. As a 4-H wood science program leader, you should have copies of all manuals used by your members.

Unit I "Working With Wood and Tools" presents elementary information about wood structures. It explains how to buy and use lumber and plywood. It tells how to measure, mark, cut, sand, and smooth wood, how to use glues and finishes, and how to use a variety of beginner woodworking tools, such as crosscut and coping saws, C clamps, and electric woodburning tools. Woodworking plans are included for making simple items from wood.

Unit II "The Wonderful World of Wood" is designed to help 4-H members continue to grow in their ability to create and assemble items of wood. It discusses more sophisticated processes and tools than those found in Unit 1. It tells the steps involved in converting trees into wood products. It discusses grains, how warping and swelling affect the use of wood, how to use the grid system to make patterns of irregular shaped objects, and introduces additional woodworking tools. The combination square, pencil compass, hand drill, bit brace and auger, and rip and compass saws are included. Electric tools and safety rules for using them are introduced. The electric drill, jig and saber saws, and oscillating sander are presented. Woodworking plans are provided for utilizing these tools.

Unit III "Building Bigger Things" covers the physical structure, properties, and characteristics of wood, and helps members better understand how the properties of wood affect its use. It tells how woods are named and classified, discusses economics of the forest products industry, and introduces more woodworking tools and machinery. Simple activities and experiments are included to help members learn more about wood.

Project Records

The 4-H project record is important. It helps the 4-H'er remember what has been done, and it serves as a kind of measuring stick. The recorded information keeps both the member and leader informed of progress being made in the project. A record form is available for this project. Record forms may be supplied by the local Extension office or State 4-H office. Contact your local 4-H office for further information.

Your Job as a Leader

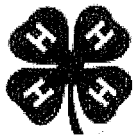
Leader Liability

The question of liability is very difficult to answer. Generally speaking, the 4-H leader is not liable unless proven negligent. The liability clause of homeowners' insurance policies will give protection in some cases. It is wise to ask your insurance representative for details. Some 4-H leaders subscribe to a group accident insurance. If you are interested in a policy of this type, ask your insurance representative, or contact the person in charge of 4-H in your local area.

Budgeting Your Time

The time you devote as a wood science program leader will vary with the number of members in your group and the extent of your involvement with them, the type of activities you provide, and the goals you and your 4-H'ers establish. It is important that sufficient time be devoted by both adult and teen leaders to operate a safe, effective, educational program. In budgeting your time, consider the following:

1. Beginning leaders should plan to attend leader-training meetings held in their area.
2. Plan adequate time for studying both the leader's guide and the member manuals.
3. Provide sufficient time to plan thoroughly the organization of all meetings, including pledges, inspirational sessions, recreation, and refreshments, if they are appropriate.
4. Plan for "hands on" workshops in addition to other meetings. Ninety-minute workshop-type meetings may be ideal for younger members, while 120- to 150-minute sessions might be more acceptable for older 4-H'ers.
5. Provide sufficient time to help all members individually, particularly those with special needs. In the wood science area, "shortcuts," missing procedural steps, and limited instruction are dangerous and educationally limiting.



6. Provide sufficient time for both leaders and members to exhibit at local fairs, 4-H congresses, conferences, and wherever they have the opportunity.

Schedule meeting times so that members will have an opportunity to plan and participate in "learning" and "doing" experiences. Put forth a special effort to meet the goals of members, teen leaders, and other adult leaders. Finally, plan time with individual members to evaluate their accomplishments and the achievements of the club or group.

Facilities for Meetings

The facilities necessary for 4-H wood science meetings will vary according to the number in the group, the type of meeting planned, the time of year, and weather conditions. Developing "learning" and "doing" goals can be accomplished in any number of informal, leisure type situations; for example, while sitting in the shade of a tree or in a leader's basement. Activities such as nail driving contests can be held in similar places. Learning situations such as demonstrating how to drive, pull, and straighten nails with a hammer can be conducted on an old table out-of-doors, or in a garage or basement area.

Ideally, the workshop area should be maintained for 4-H wood science club meetings. It should include work and storage space for materials and equipment for as many youngsters as are in the club. Safety, of course, is foremost in determining the amount of space needed. Younger members working on small items may need only limited space. As both 4-H'ers and their projects grow throughout the year, it may be necessary to expand the work area.

Temporary work benches may be constructed by attaching homemade vises to pieces of plywood securely fastened to the top of sawhorses. One 4' x 8' area should provide adequate space for six people by making one station at each end and two on each side. Stop blocks and bench hooks should be provided as holding devices. The bench vises may be attached directly to the plywood. However, many leaders prefer to attach a vise to a smaller piece of plywood and then fasten the assembled unit to the plywood with screws.

Planning Program Meetings

Initiative, enthusiasm, and organizational ability are good attributes in planning meetings. Many leaders will have grown far beyond the need for the detailed instructions which follow. However, a new wood science program leader may find these suggestions helpful for starting and conducting meetings.

First Meeting

Preparation

1. Obtain a list of club or group members, a set of wood science literature for each member, and tools and materials to be displayed in the work area to help generate interest.
2. Decide on the date and time of the meeting (both starting and ending), location of the meeting, method or plan for conducting the meeting, and items the members should provide.
3. Notify members and other project leaders by one or more of the following methods:
   - Announcement at a general club meeting
   - Announcement in the club newsletter
   - Send a card or letter to members and leaders
   - Telephone, with the assistance of junior leaders or older members.

   A communications committee will save you many hours of work.

Conducting the First Meeting

1. Meet the members in a friendly manner. Help everyone involved get acquainted.
2. See that the group is orderly before starting the meeting. After the group has settled, describe the project and activities. Have the members look over the literature.
3. Physical activities provide a good beginning. Consider a nail-driving relay contest. Select two members as team captains and have the 4-H'ers divide into two groups. One hammer to each team and two nails per person is adequate.
4. Regroup the members. Lead them to develop goals for themselves and for the group. Put special emphasis on goals for "learning" and "doing."
5. Another brief activity might be appropriate. A repeat of the nail-driving contest or some other physical activity will keep the members interested, lively, and help develop their enthusiasm.
6. If the group is to be developed formally, lead the members into electing officers. If the members are strangers, it may be important to have "get acquainted" games and maybe a "biographical" session in order that members may learn leadership qualities of others.
7. Prepare for the next meeting. Invite a few older members to give short informational demonstrations. Have the 4-H'ers and leaders outline what they would like to do at the second session.
8. Set the date and location of the next meeting.
9. Adjourn the meeting.

Suggestions for Demonstrations and Educational Activities

1. Demonstrate one or more ways to use trace patterns.
2. Illustrate the nomenclature of various tools, including the coping saw, framing square, crosscut and rip saws, wood rasps, multi-blade forming tools, claw hammer, nail set, and other appropriate instruments, such as mitre box or jig.
3. Demonstrate how to saw to a line with a coping saw. Include information on how to select proper blades and to set tension.
4. Show how to square to a mark for sawing.
5. Explain how to read inches and fractions of inches. A yardstick, foot rule, carpenter's tape or zigzag rule would be helpful. If appropriate, discuss the conversion of measures to the metric system.
6. Demonstrate the correct procedure for cutting to a line with a crosscut saw and a rip saw.
7. If a mitre box is available, demonstrate how to adjust the clamp and saw to a line with a mitre saw. A homemade jig may be substituted here.
8. Demonstrate how to form shapes on wood with a rasp, woodfile, or similar tool.
9. Demonstrate how to drive, set, and pull nails with a claw hammer.
10. Provide tools, materials, and equipment for members to begin to experience the procedures shown above. If the club session is brief, 4-H'ers may be instructed to practice their beginning skills at home. If this is an expanded club period, members may begin their tracing, squaring, and sawing during the meeting.

Home Produced Visuals, Tours, and Speakers

Teach with wood product samples. Secure the help of a forester, carpenter, or wood products salesman. Prepare visuals to show:

- Variety of wood samples from your area or state to help teach wood identification
- Other wood products
- Samples of pulp products (paper types and grades)
- Samples of hardwood products
- Samples of different types of composition, paneling, fiberboard, particleboard, etc.
- Samples of different lumber sizes, species, grades
- Samples of different plywood species and grades, with stamps.

Activities, Events, and Exhibit Ideas

The creative leader will find an almost inexhaustible source of activities, events, and exhibit ideas for the wood science program. The appendices contained within this leader's guide will provide several possibilities for your consideration.

Recognition and Awards

4-H'ers, like everyone else, appreciate a pat on the back, a sincere "thank you," and material rewards. They like to earn ribbons, medals, trophies, certificates, savings bonds, scholarships, and other kinds of recognition. In 4-H, such opportunities abound for members, clubs and county groups.

Many people working together through common goals of 4-H make possible this recognition. Among them are parents, 4-H leaders, Extension agents, specialists, state 4-H leaders, and donors of local, state, or national awards. Their interests and personal involvement as well as financial assistance motivate 4-H'ers to achieve even greater accomplishments.

Achievement considered when selecting winners includes: member's participation and accomplishments in the respective program leadership experiences, personal development, community and civic responsibilities, and participation in other 4-H projects or activities.

Selecting and certifying winners of awards, at all levels, is the responsibility of the Cooperative Extension Service, with each state determining its selection process and dates for submitting required materials.

You can help your 4-H'ers get an early start on those all-important 4-H records by having them build a file of project pictures, news clippings, ribbons, correspondences, and other items showing their progress. These will be useful when compiling and submitting records for county and state recognition. Who knows? You may have a future national winner of an educational scholarship.

For current information on national awards that are available in the 4-H wood science program, contact your local or state 4-H office, or write to National 4-H Council, Program Services Division, 7100 Connecticut Avenue, Chevy Chase, Md. 20815.

Basic Information About Wood

What should you, as a leader, know about wood that will help your 4-H'ers better understand it and its use?

Where Does Wood Come From?

We all know that wood comes from trees, but where in the trees, and how does it get there? Most of the wood that you and your 4-H'ers will use in your wood science projects will come from the trunks of trees. However, wood from large branches is similar in structure.

Wood, itself, is composed of woody tissue, which is made up of individual wood fibers. An individual wood fiber is very, very small. Tear a piece of paper and look at the torn edge. You should be able to see an individual wood fiber. (You can see it better when magnified.) Paper is made of wood fibers which have been separated from each other and then matted together in a rather random fashion. The original wood grows with these fibers all attached to each other and all aligned in one direction, parallel with the trunk.

If you could look at the end of a piece of wood magnified to 1,000 times its actual size, you would see something that looks quite similar to a box full of soda straws. Each individual straw resembles a wood fiber. Each straw is hollow; so is each individual wood fiber. If you dumped the soda straws out of the box, scattered them about and flattened them, they would look like the magnified surface of paper. Then, if you tore them apart, you could look at one individual straw, just as when you tore the paper, you looked at one individual wood fiber.

What does this have to do with wood science, you may be asking? It is important because so many of the properties of wood are best understood by understanding wood structure.

Wood structure helps explain the strength and weakness of wood. If you wanted to support a concrete block using a couple of boxes of soda straws, you could if you set the soda straws on end. Similarly, you could support a loaded box car with two pieces of wood on end. If you try to support the concrete block with soda straws on their side, you would probably crush them. Similarly, if you tried to support the loaded box car with the wood on its side, you would probably crush it. The point is that wood, like the soda straws, is very strong in the direction of the wood fibers and less strong in the other direction. Many other wood properties depend upon the direction of the wood fibers.

Before leaving the soda straw illustration, there is one additional point which needs to be made. If you took just a few soda straws and stood them on end, they would not support very much weight. If you glued a few together and stood them on end, they would support more weight, but they would probably bend before they compressed. If you glued many straws together and stood them on end, the structure would be strong enough for you to stand on. You can likewise support a very heavy load with a short section of 2×4 (on end) but a full length 2×4 will not support that same load because it will bend. (If you can somehow keep the 2×4 from bending throughout its length, it will support the heavy load.) This demonstrates that the ultimate strength of wood in its strongest direction often cannot be utilized because of a number of factors.

Where Wood Fibers Come From

Now that you know wood is composed of fibers, which are essentially parallel to each other and held together, you might wonder how they get that way. Obviously, they grow that way when a tree is forming wood. In temperate climates, trees grow only during the warmer part of the year. The trunk and branches of trees are covered with a layer of bark. All growth of wood fibers takes place at the junction between the wood and the bark. This junction is called the cambium layer. The cambium is the growth layer, and it allows the tree to grow larger in diameter. Each year a sheath of new wood is formed that completely covers all of the older wood in the trunk and branches. Each new sheath fits snugly over the layer of wood formed the year before.

The wood formed during the early part of each growing season (called springwood or earlywood) is usually lighter in weight and coarser in texture than the summerwood or latewood, formed near the end of the growing season. After most trees have reached a moderate age, the wood near the center of the trunk and branches undergoes further changes. It changes from sapwood into heartwood. Sapwood is usually light in color while heartwood is usually darker in color. Early in the life of the tree, the heartwood was sapwood; but, as the tree grew older, the inner sapwood died and turned to heartwood. Heartwood may be more resistant to decay than sapwood. Often a decayed log in the woods will contain all heartwood, the sapwood having rotted away. Very young trees may be all sapwood. But in most species, the band of sapwood which surrounds the heartwood accounts for a relatively small proportion of the total trunk. The rich colors of furniture woods, like cherry and walnut, are the colors of the heartwood of these species.

(Refer to the Unit III 4-H member manual, *Building Bigger Things*, "Structure of Wood.")

Annual Rings

If a tree is cut by sawing through the trunk just above the ground, the surface of the stump reveals the tree's history. The center of the cross section is called

the pith. It was formed when the seedling sprang up. In concentric rings around the pith, there are alternate layers of springwood and summerwood. Each ring is made up from the springwood and summerwood formed during one growing season, and the total ring formed in one season is called the annual growth ring or the annual ring. If the tree is cut during the growing season, the last annual ring will not be complete. If the tree is cut early in the growing season, the ring will contain only springwood fibers, since the cambium layer is still producing springwood fibers at that time. If the tree is cut later in the growing season, the cambium layer may or may not have already switched to growing summerwood fibers. However, if the tree is cut in the winter, the outermost annual ring will be complete, having both springwood (earlywood) and summerwood (latewood) fibers present.

The number of annual rings accurately tells the age of the tree. The relative thickness in the proportion of springwood to summerwood can tell much about the local climate during the life of the tree. Fast growing trees have wider rings than slow growing trees. Some fast growing trees have rings up to an inch thick, while some slow growing trees take 100 years or more to grow an inch. In general, wood from fast growing trees, which produce mostly springwood, is weaker than wood with more summerwood.

You cannot tell the age of a tree by counting the rings on a cross section of a cut which is some distance above the ground, because you have no way of knowing how many years it took the tree to reach the height at which the cut was made.

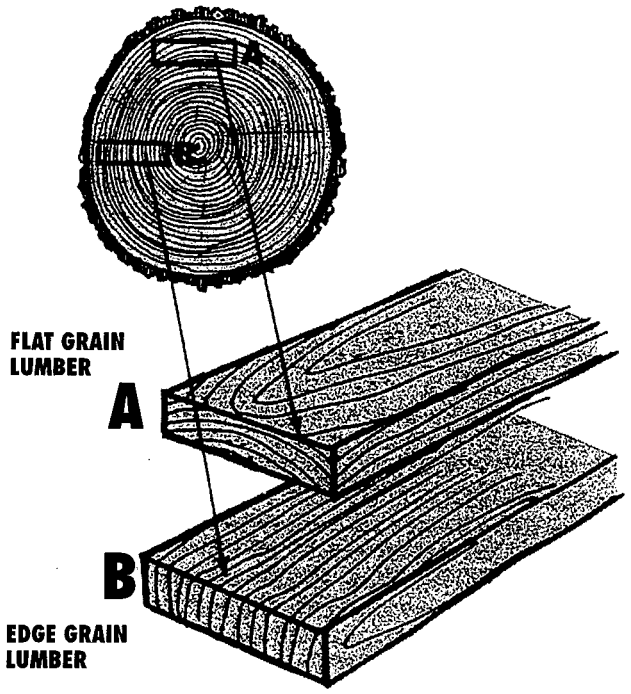
(Refer to the Unit II 4-H member manual, *The Wonderful Wood of Wood,* "Learning to Use Wood"; and to Unit III, *Building Bigger Things,* "Structure of Wood.")

Boards Cut From Logs

When a tree is cut into logs and the logs cut into boards, it may be cut in several ways. If you cut the log off center, closer to the edge like "A," you will get "flat grain" lumber. The grain on the wide face of the board will be large flat bands, long wavy arches or long patches, depending on how the saw cuts through the annual rings of the log. The grain on the edges will be narrow stripes or lines.

If the log is cut through the center, like "B" in the drawing, you will get "edge grain" lumber. In edge grain lumber the grain goes nearly straight across the board from top to bottom and gives a pattern of stripes or lines on the wide face of the board. Lumber cut near the center of the log will have edge grain.

Knowing this about edge grain and flat grain lumber, you will soon realize that most boards will be something other than pure edge grain or pure flat grain. Few trees are so large that a board cut from the edge will have growth rings that run parallel to the



surface of the board. There may be trees which have a nearly flat surface, but growth rings generally curve because the tree is round, so true flat grain is so rare as to almost not exist. True edge grain is relatively easy to obtain from any tree but only in very limited quantities. You could get additional edge grain by first cutting a log into pie shaped pieces and then cutting these into boards. In actual practice, logs are seldom cut this way because it wastes too much wood and would produce more lower grade boards since defects, such as knots, are most common near the center of the tree (and edge grain boards more likely contain wood from the center of the tree). Generally, logs are sawn so that flat grain boards are cut first.

(Refer to the Unit II 4-H member manual, *The Wonderful World of Wood,* "Learning to Use Wood.")

Knots

A knot is a section of a branch embedded in the wood. The wood in the trunk of a tree must curve around the wood of the tree's branches. When the trunk and a branch are both living, a sound knot is formed. If the branch dies and the trunk continues to grow around it, the knot and the trunk will not actually grow together, even though the trunk has grown tightly around the knot. This results in a loose knot in a board. Loose knots sometimes become knot holes. Both loose knots and tight knots cause reduction in strength in wood, but loose knots are generally more objectionable. In fact, tight knots are favored for some special uses, such as in knotty pine paneling or furniture.

As a tree grows, the lower branches are shaded by the upper branches and often die, and eventually drop off. As the tree continues to grow in diameter, clear wood grows over the broken off stubs of the branches so that, after time, a tree may have a clear trunk where once there were branches. Even though the surface of the trunk is clear, the wood underneath the surface still contains branch wood from when the tree was smaller. Clear boards are more valuable than boards with knots. Every log contains some knots near the center of the cross section, and some logs contain knots on all surfaces. The grain of the wood in and around knots is irregular and may interfere with woodworking processes.

(Refer to the Unit III 4-H member manual, *Building Bigger Things*, "Knots."

Softwoods and Hardwoods

Softwood lumber comes from trees which have needles. Hardwood lumber comes from trees which have leaves. Generally, softwood lumber is actually softer than hardwood lumber but there are many exceptions. Softwoods, such as southern yellow pine, are harder than hardwoods, such as cottonwood and yellow poplar. A heavier wood, be it softwood or hardwood, is generally harder and stronger than a lighter wood. Most houses are built from softwood. Most furniture is made from hardwood.

(Refer to Unit II, *The Wonderful World of Wood*, "Learning to Use Wood"; and to Unit III, *Building Bigger Things*, "Identifying Hardwoods and Softwoods.")

Why Wood is an Important Material

Wood comes in many species, sizes, shapes, and conditions. It has a high ratio of strength to weight and a remarkable record for durability and performance. Dry wood has good insulating properties against heat, sound, and electricity. It can absorb and dissipate vibrations. And, it is used in fine musical instruments, such as violins. Because of the variety of grain patterns and colors, wood is also an aesthetically pleasing material. Its appearance may be easily enhanced by stains, varnishes, lacquers, and other finishes. It is easily shaped with tools and fastens easily with adhesives, nails, screws, bolts, and dowels. When wood is damaged, it is easily repaired. Wood structures are easily remodeled or altered. Wood resists oxidation, acid, salt water, and other corrosive agents. It has a high salvage value. It can be made decay and insect resistant with preservatives and can be treated to resist fire.

Moisture Content of Wood

Moisture content of wood is defined as the weight of water in wood expressed as a fraction, usually as a percentage of the weight of oven dried wood. Weight, shrinkage, strength, and other properties depend upon moisture content of wood. In living trees, moisture content may range from 30 percent to more than 200 percent of the weight of wood.

Moisture exists in wood as water or water vapor in the hollow portion of the wood fiber, or as water "bound" chemically within the cell wall. Green wood is wood in which the cell walls are completely saturated with water. Waterlogged wood is wood in which the cell walls and the hollow fibers are completely filled with water. The water contained in the hollow wood fibers adds to the weight of wood but does not affect the other properties very much. The water which is contained within the cell wall greatly influences wood properties. The cell walls in a growing tree are saturated with moisture, and there often is additional moisture inside the hollow wood fibers. Most of the changes that take place in wood due to drying begin to take place as wood dries below 30 percent moisture content, which is the approximate point at which only the "bound" water remains. This is called the fiber saturation point. At moisture contents below the fiber saturation point, wood begins to shrink and gain strength as it loses moisture.

Equilibrium Moisture Content

The concept of equilibrium moisture content is perhaps the most important wood science concept for a woodworker to know. Equilibrium moisture content is defined as that moisture content at which the wood is neither gaining nor losing moisture. In other words, the wood is in equilibrium with the atmosphere. In actual use, wood almost never reaches a true equilibrium with its surrounding atmosphere, because air temperatures and relative humidities in which wood is used are continually changing.

Wood is constantly either drying or gaining moisture. If you started out with a wet piece of wood and a dry piece of wood of any species and kept them inside an average home, the wet piece of wood would slowly dry to about 8 percent moisture content, and the dry piece of wood would slowly gain moisture to about 8 percent average moisture content. (For the dry Southwest, the figure is closer to 6 percent, and for the humid South and Southeast, it is closer to 11 percent.) The point is that a woodworker should know why it is important to use wood which is already near the moisture content that it will reach while in service or use. This practice should reduce wood shrinkage and swelling by minimizing the change in moisture content of the wood.

Shrinkage

Wood starts to shrink at moisture contents below 30 percent. It swells until it reaches 30 percent. This shrinking and swelling may result in warping, checking, splitting, or performance problems that

WOODWORKING

Sonoma County 4-H

Name: _____ Date: _____

Guidelines for Project Proficiency Award

Beginning:

	Date Completed	Leader's Initials
1. Name some safety precautions to observe when working with or around power tools.	_____	_____
2. Tell why safety glasses and protective ear plugs are an important part of safety when working with power tools.	_____	_____
3. Explain how you gathered ideas and items needed for one wood project that you completed.	_____	_____
4. Explain the different uses for several different grits of sand paper.	_____	_____
5. Demonstrate how to use a tape measure. Show 1", 3/4", 1/2" and 1/4".	_____	_____
6. Name two different power tools. Explain what they are used for.	_____	_____
7. Explain/demonstrate the proper way to sand a piece of wood. Explain why you chose to sand that way.	_____	_____
8. Explain/demonstrate what the "GRAIN' is on a piece of wood.	_____	_____
9. Name different hand saws. Explain their uses.	_____	_____
10. Identify and name two types of wood screws.	_____	_____
11. Identify and name two types of screwdrivers.	_____	_____
12. Explain why cleaning up when finished with a project is important.	_____	_____
13. Explain why workmanship is important when creating a project.	_____	_____

ACTIVITIES

1. Exhibit your project(s) at a craft fair, show.	_____	_____
2. Give a demonstration at County level.	_____	_____
3. Make a still exhibit for County level.	_____	_____

Project Leader's Signature of Completion: _____ Date: _____

Club Leader's Signature of Completion: _____ Date: _____

I'm a 4-H Project Leader: Now What Do I Do?

How do I know who is in my project?

- Your club organizational leader will provide you with the names, addresses and phone numbers of the members enrolled in the project for which you are the leader.
- If you are working on the county level, contact the UCCE for the list of project members.
- The organizational leader may indicate to you if any of the youth have special needs. At your first project meeting, note any other youth that may have special needs.
- You may wish to consult with the parent or your 4-H Youth Development Agent as to how to work with a special needs child.

How often should I hold project meetings?

It is recommended you hold 4-6 meetings that each last 1½ to 2 hours in length. Some projects require more meetings or a longer meeting time to accomplish your goals. Some projects, such as leathercraft, may lend themselves to individual project work as members progress on their projects. In this case, you should hold several introductory meetings for all members and then set up a schedule of time for them to sign up for individual help.

When do I start?

Get started as soon as possible! Members' interest in a project is most keen when they are signing up for a project and when they get their project books.

How do I cover the cost of project meetings?

- There is a wide variety of means for covering the cost of project meetings. Some methods used include:
- Each member pays for their share of the expenses or provides a portion of the supplies.
- The club agrees to cover expenses using funds from their treasury. Approval in advance is needed for this.
- Members and leaders can solicit donations/supplies from area businesses.
- Sometimes funds from sources outside your club may be available to cover your project meeting costs.

How do I establish a project meeting schedule?

First, determine when you are available to work with project members. Then determine an initial project meeting date by consulting with your project members.

Thanks to 4-H Youth Development Programs, UW-Extension, Cooperative Extension for use of these materials.

Publicize the date using one of the following means:

- County and/or club newsletter
- Club meeting or leader association meetings
- Postcards or phone calls to project members

You may not be able to schedule an initial meeting that everyone can attend. Establish a time to meet with those unable to attend before you hold your second project meeting.

Where do I hold project meetings?

Typically project meetings are held at project leader homes, schools, or community buildings. For more information on facility adaptability and liability concerns contact your 4-H Youth Development Agent.

What safety precautions do we need to consider?

Consider the type of safety issues your particular project involves. Request and secure necessary safety items such as ear protection, eye protection and head protection.

How do I let others in my club or other clubs know I am a project leader?

Prior to enrollment ask for time on your club's meeting agenda to let families in your club know you're a project leader and to share some things the kids could do in the project if they enrolled in it. When the project materials are handed out, take the opportunity to inform or remind members that you are their project leader and set an initial meeting date with the group. If no one in your club is in your project, you may wish to offer your services to a neighboring club. Talk to your club organizational leader or county 4-H Youth Development agent about this opportunity.

How do I prepare for the first meeting?

You may want to establish a 4-H resource box where you keep your project materials and any additional resources you will be using. Take time to become familiar with your project literature and talk to others who were project leaders for this project to find out what activities the members enjoyed.

What should I do at the initial project meeting?

- At the initial project meeting, here are some ideas of what you might want to cover:
- Find out what the members want to learn and accomplish in the project. The project literature is an excellent source of ideas.
- Review the safety practices that members will need to follow.

Thanks to 4-H Youth Development Programs, UW-Extension, Cooperative Extension for use of these materials.

- Do an introductory activity related to the project so the members get to know one another
- Have a small project the members can complete and take home
- Talk about how the project meeting supplies will be paid for. Experienced leaders have found it easiest to charge a small fee to cover the cost of the expenses.
- Assess when members are available for additional meetings. You may wish to ask the parents or members to bring along their calendars of family activities.
- Encourage parents to participate in project meetings, especially the initial meeting.

What does a typical project meeting look like after the initial orientation?

Use the experiential learning model (found in the introductory pages of your Helper's Guide) to plan your project meeting. The project helper's guide will provide suggestions for designing a project meeting. Here are some suggestions for each section of the model:

Do

- Plan an activity to focus the project members on what they'll be doing today. Work on the project for that meeting.

Reflect

- Review the process completed
- Discuss what worked and didn't work.
- Talk about how any problems that arose were solved.
- Assist members in documenting their project work for inclusion in their record books/portfolios.

Apply

- Ask the project member the following questions:
- What else have you seen that is similar to this?
- How can you apply what you learned today to other situations?

What resources are available to help me?

- 4-H Project Literature – You will receive project literature through your 4-H club or the UW-Extension office. Typically there is a helper's guide and member literature for three to four levels.
- Other People in my Club & County – There are a number of people in your county who would be willing to share project ideas and tips with you.

Thanks to 4-H Youth Development Programs, UW-Extension, Cooperative Extension for use of these materials.

These include:

- Project leaders in other clubs
- County Staff
- Older youth who have been involved in the project

- Media Collection & Public Libraries – Additional resources can be obtained from the Cooperative Extension Media Collection. They have videos, skillathons, displays and resource packages available to support a variety of projects. There is a user fee per item you or your club will be responsible for. You can view their catalog at their website http://www.uwex.edu/ces/media/. Check with your local public library to find out what resources they may have or that you can obtain through inter-library loan.
- 4-H Website – Wisconsin 4-H is continually adding more information and activities to their website. Visit this site at www.uwex.edu/ces/4h/onlinepro/. You may wish to check out websites from other state 4-H programs also.
- Volunteer Leaders Conferences – Review each issue of your county's newsletter to learn about training sessions for project leaders offered by your county, district or at statewide events. Sessions focusing on new project literature are typically offered at the State 4-H Volunteer Leader Conference held every other year. Periodically statewide conferences focusing on specific project areas are offered in addition to sessions at the volunteer conferences. You can also exchange ideas with other leaders at statewide Field Day.
- Field Trips – Youth always enjoy the opportunity to see firsthand how things are done and how they work. Consider taking your project group on a field trip or tour of a local business or company to enhance their project experience. An example would be taking your dairy members to a cheese factory or your foods group to a local bakery.
- Local Experts – Bring in a local "expert" to share their ideas and experiences with your group. One example would be asking a Master Gardener to share information on choosing perennial or trimming shrubs at one of your project meetings.
- Magazines – Many leaders have found creative ideas to supplement those in the project literature in magazines they have or those at the public library.

Thanks to 4-H Youth Development Programs, UW-Extension, Cooperative Extension for use of these materials.

How can I incorporate activities not included in the project guide?

We encourage you to use the ideas in the project literature as they have been successfully used with youth. If you have some additional activities you would like to incorporate, consider the following criteria:

- Of interest to kids
- Developmentally appropriate
- Incorporate the experiential learning model
- Youth and adults are involved in determining what will be done
- Enhances the development of member life and project skills
- Research based source of content utilized

What is the relationship between project work and the county fair?

The County Fair is an opportunity for an independent evaluation of life and project skills a member learned through completing a project. County fair entries typically match the activities included in the project literature and may include other activities that are being emphasized in your county. One of your roles is to help maintain the focus of members and parents on the goal of 4-H, which is to develop blue ribbon kids. Talk with members about what they learned about each of their fair entries from the judging process. Help members celebrate their accomplishments regardless of the color of ribbon each project member received at the fair. This may be done through individual encouragement or at a meeting following the fair. While entering and displaying a project at the County Fair is the traditional method of public affirmation, there may be other means of exhibition such as a club tour, open house, community celebrations or others.

Who can I go to if I need someone to help me during the project meetings?

If you are leading beginning level project meetings, ask older members in the project to help you. This is a great leadership experience for them! Parents are another excellent source of help. Don't hesitate to ask them to stay for the meeting and be actively involved in their child's project work.

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