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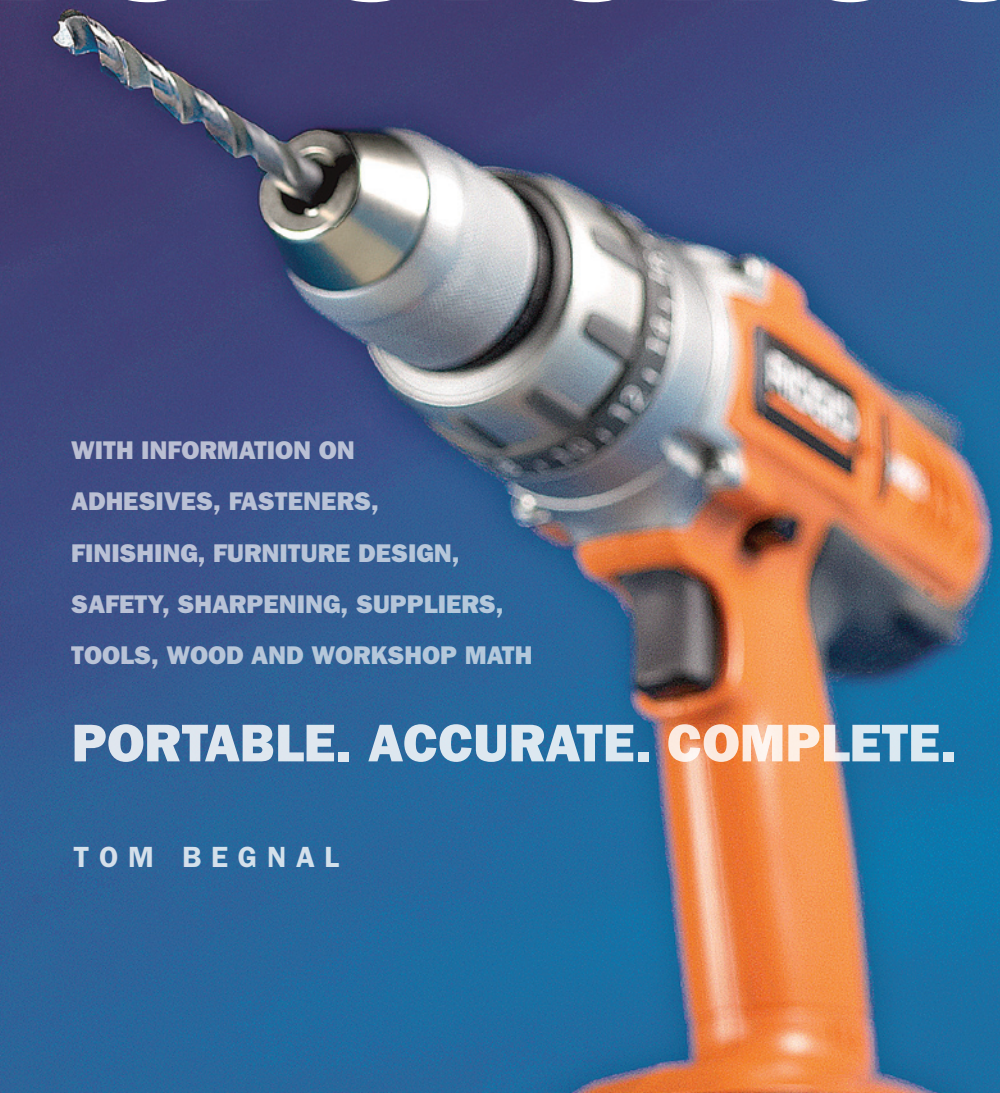
pocket shop reference



WITH INFORMATION ON
ADHESIVES, FASTENERS,
FINISHING, FURNITURE DESIGN,
SAFETY, SHARPENING, SUPPLIERS,
TOOLS, WOOD AND WORKSHOP MATH

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To prevent accidents, keep safety in mind while you work. Use the safety guards installed on power equipment; they are for your protection. When working on power equipment, keep fingers away from saw blades, wear safety goggles to prevent injuries from flying wood chips and sawdust, wear ear protectors, and consider installing a dust vacuum to reduce the amount of airborne sawdust in your woodshop. Don't wear loose clothing, such as neckties or shirts with loose sleeves, or jewelry, such as rings, necklaces or bracelets, when working on power equipment. Tie back long hair to prevent it from getting caught in your equipment. People who are sensitive to certain chemicals should check the chemical content of any product before using it. The authors and editors who compiled this book have tried to make the contents as accurate and correct as possible. Plans, illustrations, photographs and text have been carefully checked. All instructions, plans and projects should be carefully read, studied and understood before beginning construction. Due to the variability of local conditions, construction materials, skill levels, etc., neither the author nor Popular Woodworking Books assumes any responsibility for any accidents, injuries, damages or other losses incurred resulting from the material presented in this book. Prices listed for supplies and equipment were current at the time of publication and are subject to change. Glass shelving should have all edges polished and must be tempered. Untempered glass shelves may shatter and can cause serious bodily injury. Tempered shelves are very strong and if they break will just crumble, minimizing personal injury.

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to convert	*to*	*multiply by*
Inches	Centimeters	2.54
Centimeters	Inches	0.4
Feet	Centimeters	30.5
Centimeters	Feet	0.03
Yards	Meters	0.9
Meters	Yards	1.1

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DEDICATION

To my wife Susan, for all her love and kindness

about the author

Tom Begnal was managing editor of *The Woodworker's Journal* magazine for more than fifteen years. He has written or edited woodworking and how-to books for several publishers including F+W Publications (Popular Woodworking Books), McGraw-Hill, Rodale Press and Sterling Publishing. Currently an associate editor at *Fine Woodworking* magazine, he lives in Kent, Connecticut.

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table of

contents

12 INTRODUCTION

CHAPTER ONE
14 **woodworking math**

CHAPTER TWO
54 **furniture design**

CHAPTER THREE
84 **wood**

CHAPTER FOUR
124 **manufactured woods**

CHAPTER FIVE
144 **adhesives**

CHAPTER SIX
152 **tools**

CHAPTER SEVEN
170 **sharpening**

CHAPTER EIGHT
176 **fasteners**

CHAPTER NINE
194 **finishing**

CHAPTER TEN
204 **safety**

CHAPTER ELEVEN
220 **suppliers**

240 INDEX

topic index

CHAPTER ONE

14 **woodworking math**

15 Basic Geometry for Woodworkers
32 Fractions to Decimal Equivalents
33 Fractions to Metric Equivalents
34 Metric to Decimal Equivalents
35 U.S. Weights and Measures
36 Metric Weights and Measures
37 U.S. and Metric Equivalents
38 Conversion Table
45 Miter Angles for Polygons
47 Determining Side Lengths for Polygons
48 Compound Angles
51 Enlarging Grid Patterns Using a Photocopy Machine
53 Circle Templates Around the House

CHAPTER TWO

54 **furniture design**

55 Common Woodworking Joints
60 General Rules for Joinery Design
62 Standard Furniture Dimensions
69 Understanding a Shop Drawing
70 Common Woodworking Abbreviations
72 Common Woodworking Symbols
73 Particleboard Shelf Spans
76 Factory-Made Pine Mouldings
80 Wood Screw Shank and Pilot Hole Drill Sizes
81 Lag Screw Shank and Pilot Hole Drill Sizes
82 Threaded Insert (Rosan Nut) Pilot Hole Drill Sizes
82 Clear Glass
83 Acrylic Sheet
83 Plastic Laminate

CHAPTER THREE

84 **wood**
85 Commercial, Common and Botanical Names for Domestic Commercial Hardwoods
88 Standard, Forest Service and Botanical Names for Domestic Commercial Softwoods
89 Common and Botanical Names for Some Imported Hardwoods
92 How to Calculate Board Feet
93 Board Footage Chart
94 Softwood Lumber Grades
98 Softwood Lumber Standard Sizes
100 Typical Softwood Lumber Grade Stamp
102 Examples of Softwood Lumber Grade Stamps
103 Pressure-Treated Lumber Retention Levels
104 Typical Quality Mark for Pressure-Treated Lumber
105 Hardwood Lumber Grades
106 Standard Thicknesses for Hardwood Lumber (Rough and Surfaced)
107 Recommended Average Moisture Content
108 How to Determine Wood Moisture Content
109 Equilibrium Moisture Content
111 Wood Shrinkage
115 Time Required to Air-Dry Lumber To 20% Moisture Content
118 Hardness
120 Working Properties of Some Hardwoods
121 Approximate Relative Heartwood Decay Resistance
123 Steam Bending Table

CHAPTER FOUR

124 **manufactured woods**
125 Softwood Plywood
131 Hardwood Plywood
140 Particleboard
141 Medium Density Fiberboard (MDF)
142 Hardboard

CHAPTER FIVE

144 **adhesives**
145 Wood Bonding
147 Surface Preparation Guidelines
147 Glue Guidelines
148 Commonly Used Wood Adhesives
150 Properties of Common Woodworking Adhesives

CHAPTER SIX

152 **tools**
153 Drill Speeds
154 Suggested Wood Lathe Speeds
155 Band Saw Blade Minimum Cutting Radius
156 Band Saw Blade Tooth Styles
157 Determining Band Saw Blade Length
158 Scroll Saw Blades
160 Saber Saw Blades
161 Pulley Formulas
162 Common Router Bit Profiles
164 Common Moulding Head Cutter Profiles
166 Table and Radial-Arm Saw Blades
168 Table-Saw Coving Cuts

CHAPTER SEVEN

170 **sharpening**
171 Sharpening Angles
174 Types of Bench Sharpening Stones
174 Comparison of U.S. and Japanese Grits
175 Selecting a Bench Sharpening Stone

CHAPTER EIGHT

176 **fasteners**
177 Wood Screw Head Options
177 Wood Screw Shank Diameters
178 Wood Screw Lengths and Commonly Available Screw Numbers
179 Drywall (Sheetrock) Screws
179 Particleboard and Medium Density Fiberboard (MDF) Screws
180 Converting Penny Size to Nail Length
181 Nail Gauges and Equivalent Diameters
182 Nails Per Pound
183 Standard Machine Threads
184 Machine Bolts
184 Machine Screws
185 Hanger Bolts
186 Dowel Screws
186 Lag Screws
188 Carriage Bolts (Square Necked)
189 Brads
190 Plain Washer Dimensions (for Lag Screws and Bolts)
191 Common Butt Hinge Sizes
192 Knockdown Hardware

CHAPTER NINE
194 **finishing**
195 Coated Abrasives
200 Steel Wool Grades
200 Thinning Shellac
201 Choosing a Stain
202 Choosing a Top Coat
203 Top Coat Dry Times
203 Making a Tack Cloth

CHAPTER TEN
204 **safety**
205 General Safety Rules
207 Safe Extension Cord Wire Gauges and Lengths
208 Noise in the Workshop
211 Working With Pressure-Treated Wood
213 Hazardous Woodworking Chemicals

CHAPTER ELEVEN
220 **suppliers**
221 Hard-to-Find Woodworking Supplies
226 General Woodworking Suppliers
228 Hardware Suppliers
229 Hardwood Suppliers
231 Wood Finishing Suppliers
232 Clock Parts Suppliers
233 Manufacturers' Customer Service Telephone Numbers and Web Sites
236 Comprehensive Index

As we enjoy an evening in the workshop, it is easy to forget that the craft of woodworking encompasses a surprisingly large body of information. Much of that information is learned only through considerable practice and experience. And, once learned, it is usually applied to the task at hand with little thought or effort. An experienced woodworker knows, almost intuitively, what to do and how to do it.

But even veteran woodworkers understand that practice, experience and intuition are not always enough. Despite what seems to be second nature, it's often necessary to find an important bit of information in order to move a project forward. Usually, however, that bit of information is found only after a lengthy search through a pile of woodworking books, magazines, owner's manuals and shop-worn notes. And, of course, the search too often comes up empty.

This book is an effort to make that search considerably easier. Here, in a single volume, is an easy-to-understand compilation of the many facts, figures and formulas that are important to every woodworker. From shop geometry to lumber grades to drill press speeds, *Popular Woodworking Pocket Shop Reference* provides an extensive storehouse of valuable woodworking data.

This is a book to be used, not admired. Keep it near your workbench. My sincere hope is that you often find yourself reaching for it, and that it quickly provides you with all the information you need.

Have fun and work safely.

introduction

CHAPTER ONE

woodworking math

1

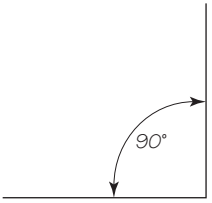
Basic Geometry for Woodworkers

An understanding of basic geometry is very useful to woodworkers. Indeed, when you consider that every woodworking project is made from parts that form straight lines, curved lines or a combination of the two, it is clear that geometry is very much a part of the workshop.

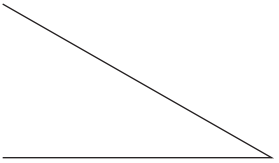
ANGLES

The space between two lines that meet is called an angle. An angle is usually measured in degrees.

Right Angle
The angle formed by a line perpendicular to another line. A right angle measures 90°.



Acute Angle
An angle measuring less than a right angle.



Obtuse Angle
An angle larger than a right angle, but less than 180°.

POLYGONS

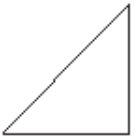
A polygon is a closed plane figure that has three or more sides and angles. A polygon with all angles equal and all equal-length sides is called a regular polygon. Some of the common polygons are:

POLYGON	NUMBER OF SIDES
Triangle	3
Quadrilateral	4
Pentagon	5
Hexagon	6

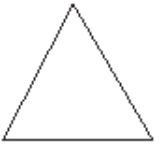
POLYGON	NUMBER OF SIDES
Octagon	8
Decagon	10
Dodecagon	12

TRIANGLES

A triangle is a polygon with three sides and three angles. The sum of the three angles is always 180°.

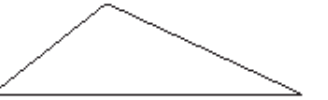


Right Triangle
A triangle with one angle at 90°

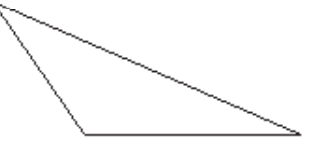


Equilateral Triangle
A triangle with all sides of equal length.

Isosceles Triangle
A triangle with two sides of equal length



Scalene Triangle
A triangle with all sides unequal



Obtuse Triangle
A triangle with one angle obtuse (greater than 90°)

QUADRILATERALS

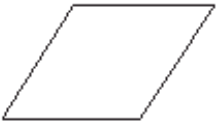
A quadrilateral is a polygon that has four sides and four angles. The sum of the four angles is always 360°.

Rectangle
A four-sided plane figure with four right angles

Square
A four-sided plane figure with four right angles and four equal-length sides

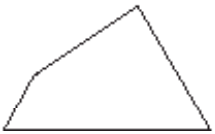
Rhomboid
A four-sided plane figure with all sides parallel, adjacent sides unequal, and usually having two acute angles and two obtuse angles

Rhombus
A four-sided plane figure with all sides equal-length and parallel, usually having two acute angles and two obtuse angles



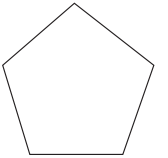
Trapezoid
A four-sided plane figure with two sides parallel and two sides not parallel

Trapezium
A four-sided plane figure having no sides parallel

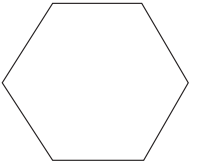


OTHER POLYGONS

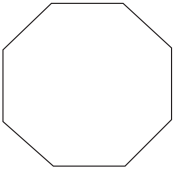
Regular Pentagon
A plane figure having five equal-length sides and five equal angles



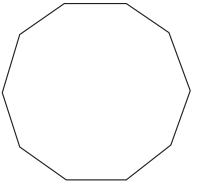
Regular Hexagon
A plane figure having six equal-length sides and six equal angles



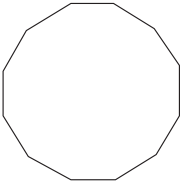
Regular Octagon
A plane figure having eight equal-length sides and eight equal angles



Regular Decagon
A plane figure having ten equal-length sides and ten equal angles



Regular Dodecagon
A plane figure having twelve equal-length sides and twelve equal angles

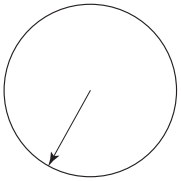


CIRCLES

A circle is a closed curve, with all points on the curve equally distant from the center.

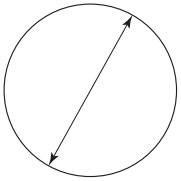
Radius

A straight line extending from the center of the circle to any point on the circle



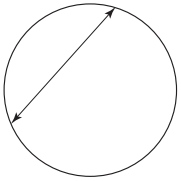
Diameter

A straight line that passes through the center of a circle and extends from one side of the circle to the other



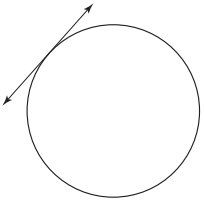
Chord

A straight line connecting two points on a circle



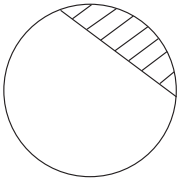
Tangent

A straight line that touches a circle at only one point



Segment

That part of a circle cut off by a straight line



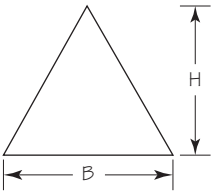
AREA FORMULAS

Area is a measure of the amount of surface of an object. Square units of measurement (square inches, square feet, square millimeters, square meters, etc.) are used to describe area.

Triangle

Area = $\frac{1}{2}B \times H$
where:
B = length of the triangle base
H = height of the triangle

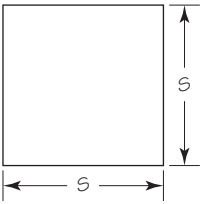
Example
B = 12" H = 8"
Area = $\frac{1}{2}(12) \times 8$
$= 6 \times 8$
= 48 square inches



Square

Area = S × S
where:
S = length of the sides

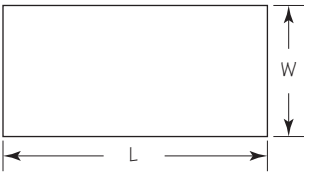
Example
S = 6"
Area = 6 × 6
= 36 square inches



Rectangle

Area = L × W
where:
L = length of the rectangle
W = width of the rectangle

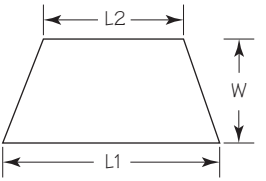
Example
L = 4" W = 2"
Area = 4 × 2
= 8 square inches



Trapezoid

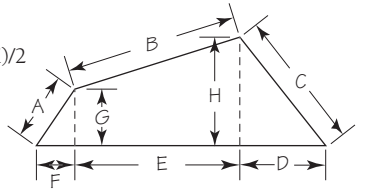
Area = $\frac{1}{2}(L1 + L2) \times W$
where:
L1 = long parallel side
L2 = short parallel side
W = width of trapezoid

Example
L1 = 12" L2 = 8"
W = 5"
Area = $\frac{1}{2}(12 + 8) \times 5$
$= \frac{1}{2}(20) \times 5$
$= 10 \times 5$
= 50 square inches



Trapezium

Area = (G + H)E + (F × G) + (D × H)/2



Example

A = 5" B = 11.75"
C = 10" D = 6"
E = 11" F = 3"
G = 4" H = 8"

Area = [(4 + 8)11 + (3 × 4) + (6 × 8)]/2
= [(12)11 + 12 + 48]/2
= [132 + 12 + 48]/2
= 192/2
= 96 square inches

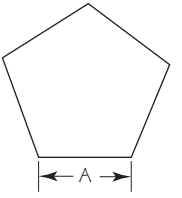
Regular Pentagon

(all sides equal)

Area = 1.7205 × (A × A)

where:

A = length of sides



Example

A = 6"

Area = 1.7205 × (6 × 6)
= 1.7205 × 36
= 61.938 square inches

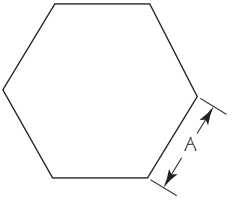
Regular Hexagon

(all sides equal)

Area = 2.5981 × (A × A)

where:

A = length of sides



Example

A = 2"

Area = 2.5981 × (2 × 2)
= 2.5981 × 4
= 10.3924 square inches

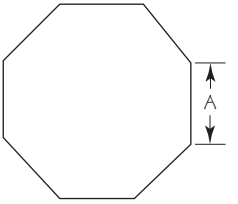
Regular Octagon

(all sides equal)

Area = 4.8284 × (A × A)

where:

A = length of sides



Example

A = 3"

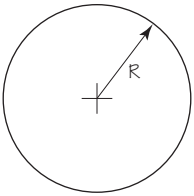
Area = 4.8284 × (3 × 3)
= 4.8284 × 9
= 43.456 square inches

Circle

Area = 3.14159 × (R × R)
where:
R = radius of circle

Example

R = 15"
Area = 3.14159 × (15 × 15)
= 3.14159 × 225
= 706.86 square inches



woodshop application

Using the Area Formula

Two coats of polyurethane varnish must be applied to the top and bottom surfaces of a round tabletop that has a 48" diameter. Is a pint of polyurethane enough to do the job?

1. Determine the area of the tabletop surface in square inches. 48" diameter means 24" radius.
   Area = 3.14159 × (R × R)
   = 3.14159 × (24 × 24)
   = 3.14159 × 576
   = 1810 square inches
   Multiply by 2 to get area for the top and bottom surfaces.
   1810×2 = 3620 square inches.

2. Convert square inches to square feet (see conversion table, page 35).
   3620 square inches × .00694 = 25.12 square feet. Multiply by 2 to get amount needed for two coats.
   25.12 × 2 = 50.24 square feet.

3. Check label on can for coverage of product.

A pint of polyurethane that can cover at least 60 square feet will be able to do the job.

PERIMETER FORMULAS

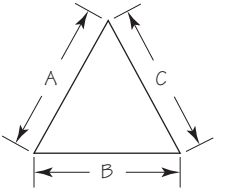
Perimeter is the distance around the outside of a geometric figure.

Triangle

Perimeter = A + B + C
where:
A, B and C = lengths of sides

Example

A = 5"
B = 8"
C = 12"
Perimeter = 5 + 8 + 12
= 25"

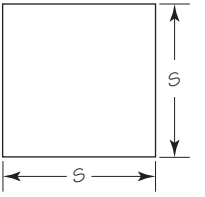


Square

Perimeter = 4 × S
where:
S = length of sides

Example

S = 9"
Perimeter = 4 × 9
= 36"

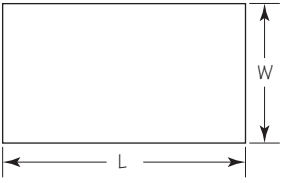


Rectangle

Perimeter = 2 × (L + W)
where:
L = length of the rectangle
W = width of the rectangle

Example

L = 6.5" W = 3.5"
Perimeter = 2 × (6.5 + 3.5)
= 2 × 10
= 20"

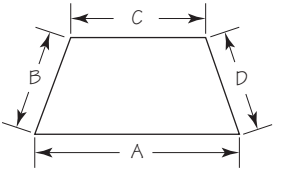


Trapezoid

Perimeter = A + B + C + D
where:
A, B, C and D = lengths of sides

Example

A = 5" B = 8"
C = 4" D = 6"
Perimeter = 5 + 8 + 4 + 6
= 23"

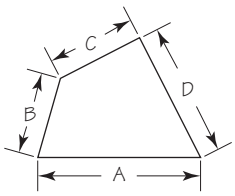


Trapezium

Perimeter = A + B + C + D
where:
A, B, C and D = lengths of sides

Example

A = 18.25"
B = 5.5"
C = 6.25"
D = 8"
Perimeter = 18.25 + 5.5 + 6.25 + 8
= 38"

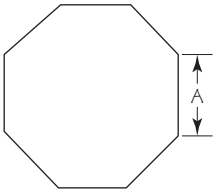


Other Regular Polygons

(hexagon is shown)
Perimeter = A × N
where:
A = length of sides
N = number of sides

Example

A = 4"
N (for hexagon) = 6
Perimeter = 4 × 6
= 24"



woodshop application

Using the Perimeter Formula

A cove moulding is to be added around the base of a blanket chest. The blanket chest measures 18" wide by 48" long. How much cove moulding must be routed in order to provide enough stock for the project?

1. Determine the perimeter of the rectangular blanket chest.

Perimeter = 2 (A + B)
= 2 (18 + 48)
= 2 (66)
= 132"

2. Convert inches to feet (see conversion table, page 35).

132" × .08333 = 11'

The blanket chest needs a minimum of 11 feet of routed moulding.

CIRCUMFERENCE FORMULA

The circumference is the distance around a circle.

Circle

Circumference = 6.2832 × R

where:

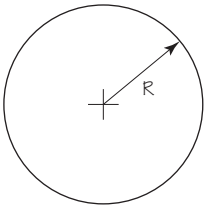
R = radius of circle

Example

R = 12"

Circumference = 6.2832 × 12

= 75.4"



woodshop application

Using the Circumference Formula

How much iron-on edging is required to edge to a 36"-diameter tabletop?

1. Determine the radius of the tabletop.

Radius = Diameter/2

= 36/2

= 18"

2. Determine the circumference of the tabletop.

Circumference = 6.2832 × R

= 6.2832 × 18

= 113"

3. Convert inches to feet (see conversion table, page 35).

113" × .08333 = 9.42′

The tabletop needs 10 feet of iron-on edging.

SOLVING RIGHT TRIANGLES

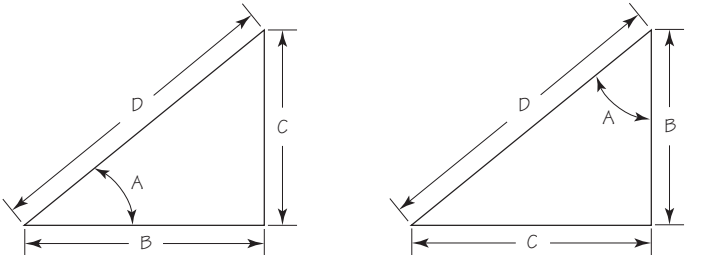
Right triangles (triangles with one angle at 90°) are found in many woodworking designs, so the ability to solve these triangles is very helpful when designing or building many types of projects. Solving a right triangle enables you to determine the angles and the lengths of the sides.

Using the formulas that follow, you can determine the unknown sides of a right triangle if you know one of the angles (other than the 90° angle) and the length of one side. You can also determine the unknown angles of a right triangle if you know the length of at least two of the sides.

In some cases it might be necessary to use two of the formulas to get the answer you need. The first formula solves for an unknown side or angle. Then the new information is applied to a second formula that can provide the final answer.

Keep in mind that when the location of the unknown angle (A) changes, the locations of sides B and C also change as shown below.

Finally, remember that the three angles in a triangle always equal 180°. If you know one of the angles (other than the 90° angle), you can get the unknown angle using the formula: 180 - (90 + known angle).



A = unknown angle (based on Angle Functions in Table I, II or III on the next page)
B = side adjacent to the unknown angle
C = side opposite the unknown angle
D = side opposite the 90° angle

ANGLE FUNCTIONS FOR RIGHT TRIANGLES — FOR USE WITH PAGES 28-29

ANGLE (A) *(degrees)*	TABLE I	TABLE II	TABLE III
0	.00000	1.00000	.00000
1	.01746	.99985	.01745
2	.03492	.99939	.03490
3	.05241	.99863	.05234
4	.06993	.99756	.06976
5	.08749	.99619	.08716
6	.10510	.99452	.10453
7	.12278	.99255	.12187
8	.14054	.99027	.13937
9	.15838	.98769	.15643
10	.17633	.98481	.17365
11	.19438	.98163	.19081
12	.21256	.97815	.20791
13	.23087	.97437	.22495
14	.24933	.97030	.24192
15	.26795	.96593	.25882
16	.28675	.96126	.27564
17	.30573	.95630	.29237
18	.32492	.95106	.30902
19	.34433	.94552	.32557
20	.36397	.93969	.34202
21	.38386	.93358	.35837
22	.40403	.92718	.37461
23	.42447	.92050	.39073
24	.44523	.91355	.40674
25	.46631	.90631	.42262
26	.48773	.89879	.43837
27	.50953	.89101	.45399
28	.53171	.88295	.46947
29	.55431	.87462	.48481
30	.57735	.86603	.50000
31	.60086	.85717	.51504
32	.62487	.84805	.52992
33	.64941	.83867	.54464
34	.67451	.82904	.55919
35	.70021	.81915	.57358
36	.72654	.80902	.58779
37	.75355	.79864	.60182
38	.78129	.78801	.61566
39	.80978	.77715	.62932

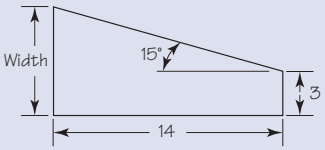
ANGLE (A) *(degrees)*	TABLE I	TABLE II	TABLE III
40	.8391	.76604	.64279
41	.86929	.75471	.65606
42	.90040	.74314	.66913
43	.93252	.73135	.68200
44	.96569	.71934	.69466
45	1.0000	.70711	.70711

SOLVING RIGHT TRIANGLES WHEN ONE SIDE AND ONE ANGLE ARE KNOWN

If you know the length of:	*And you want to know the length of:*	*Refer to pages 27-28 and use this formula:*
B	C	C = A (from Table I) × B
B	D	D = B/A (from Table II)
C	B	B = C/A (from Table I)
C	D	D = C/A (from Table III)
D	C	C = A (from Table III) × D
D	B	B = A (from Table II) × D

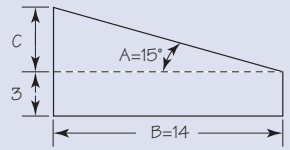
woodshop application

A lap desk to be built must have sides that are 14" long and have a 15° slant. If the front end of the sides measures 3", what is the overall width of the sides?



The desk side creates a right triangle with one known side (B) and one known angle (A). To determine the overall width of a side, calculate the length of side C, then add that length to 3".

A = 15°
B = 14"
C = unknown



From the formulas above:
C = A (from Table I) × B
= .26795 × 14
= 3.7513 (round to 3.75 = 3¾")
Width of sides = 3¾" + 3"
= 6¾"

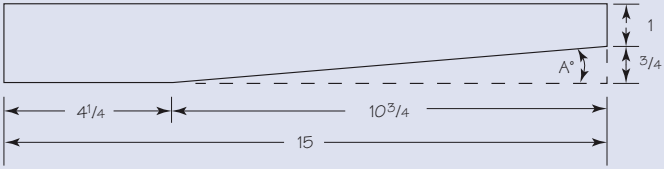
SOLVING RIGHT TRIANGLES WHEN TWO SIDES ARE KNOWN

If you know the length of:	*And you want to know the length of:*	*Refer to pages 27-28 and use this formula to find angle A:*
B	C	A (from Table I) = C/B
B	D	A (from Table II) = B/D
C	D	A (from Table III) = C/D

Once the angle function (A) is determined, convert the number to the corresponding angle.

woodshop application

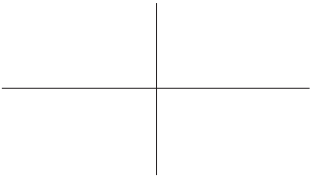
A coffee table is to have four 15"-long legs made from 1¾" square stock. The legs are to be tapered on two sides, with each taper starting 4¼" from the top of the leg. At the bottom of the leg, the taper reduces the thickness of the leg by ¾". You need to determine the angle of the taper so you can use a tapering jig to cut the tapers.



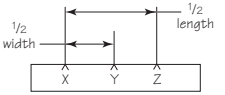
A = unknown
B = 10¾
C = .75
A (from Table I) = C/B
= .75/10.75
= .06977
From Table I: .06977 = about 4°

HOW TO DRAW AN ELLIPSE

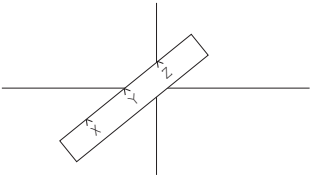
Various methods are used to create an ellipse. The method shown here, often called the trammel method, is relatively simple and you can use it to make an ellipse of just about any size.



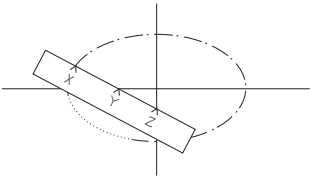
1. Draw a horizontal line slightly longer than the length of the ellipse, then draw a vertical line slightly longer than the ellipse width. Make sure the lines are perpendicular to each other.



2. Mark Points X, Y and Z on a straightedge made from cardboard, stiff paper or a thin piece of wood. XZ should be equal to one-half the length of the ellipse and XY should be equal to one-half the width of the ellipse.



3. Position the straightedge so that Point Z falls along the vertical line and Point Y falls along the horizontal line. Hold the straightedge in position, then mark Point X, which represents a point on the circumference of the ellipse.

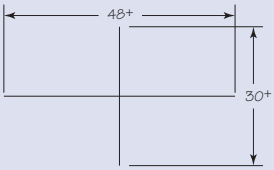


4. Continue moving the straightedge, always keeping Point Z on the vertical line and Point Y on the horizontal line. Mark a new Point X after each movement of the straightedge. Mark as many points as needed to create a smooth curve along the entire circumference of the ellipse.

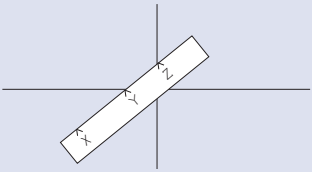
woodshop application

Drawing an Ellipse

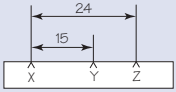
Draw an elliptical tabletop that measures 48" long by 30" wide.



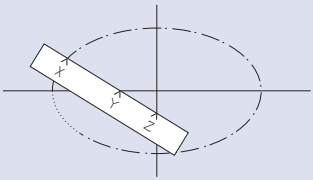
1. Draw a horizontal line at least 48" long on the glued-up stock for the tabletop. At the midpoint of the horizontal line, draw a vertical line at least 30" long. Make sure the lines are perpendicular to each other.



2. Mark Points X, Y and Z, using a straightedge, so that XZ equals 24" and XY equals 15".



3. Position the straightedge so that Point Z falls along the vertical line and Point Y falls along the horizontal line. Hold the straightedge in position, then mark Point X, which represents a point on the circumference of the ellipse.



4. Continue moving the straightedge, always keeping Point Z on the vertical line and Point Y on the horizontal line. Mark a new Point X after each movement of the straightedge. Mark as many points as needed to create a smooth curve along the entire circumference of the ellipse.

Fractions to Decimal Equivalents

FRACTION *(inches)*	DECIMAL EQUIVALENT *(inches)*	FRACTION *(inches)*	DECIMAL EQUIVALENT *(inches)*
1/64	.015625	33/64	.515625
1/32	.031250	17/32	.531250
3/64	.046875	35/64	.546875
1/16	.062500	9/16	.562500
5/64	.078125	37/64	.578125
3/32	.093750	19/32	.593750
7/64	.109375	39/64	.609375
1/8	.125000	5/8	.625000
9/64	.140625	41/64	.640625
5/32	.156250	21/32	.656250
11/64	.171875	43/64	.671875
3/16	.187500	11/16	.687500
13/64	.203125	45/64	.703125
7/32	.218750	23/32	.718750
15/64	.234375	47/64	.734375
1/4	.250000	3/4	.750000
17/64	.265625	49/64	.765625
9/32	.281250	25/32	.781250
19/64	.296875	51/64	.796875
5/16	.312500	13/16	.812500
21/64	.328125	53/64	.828125
11/32	.343750	27/32	.843750
23/64	.359375	55/64	.859375
3/8	.375000	7/8	.875000
25/64	.390625	57/64	.890625
13/32	.406250	29/32	.906250
27/64	.421875	59/64	.921875
7/16	.437500	15/16	.937500
29/64	.453125	61/64	.953125
15/32	.468750	31/32	.968750
31/64	.484375	63/64	.984375
1/2	.500000	1	1.00000

Fractions to Metric Equivalents

FRACTION *(inches)*	METRIC EQUIVALENT *(millimeters)*
1/64	0.396875
1/32	0.793750
3/64	1.190625
1/16	1.587500
5/64	1.984375
3/32	2.381250
7/64	2.778125
1/8	3.175000
9/64	3.571875
5/32	3.968750
11/64	4.365625
3/16	4.762500
13/64	5.159375
7/32	5.556250
15/64	5.953125
1/4	6.350000
17/64	6.746875
9/32	7.143750
19/64	7.540625
5/16	7.937500
21/64	8.334375
11/32	8.731250
23/64	9.128125
3/8	9.525000
25/64	9.921875
13/32	10.31875
27/64	10.71563
7/16	11.11250
29/64	11.50938
15/32	11.90625
31/64	12.30313
1/2	12.70000

FRACTION *(inches)*	METRIC EQUIVALENT *(millimeters)*
33/64	13.09688
17/32	13.49375
35/64	13.89063
9/16	14.28750
37/64	14.68438
19/32	15.08125
39/64	15.47813
5/8	15.87500
41/64	16.27188
21/32	16.66875
43/64	17.06563
11/16	17.46250
45/64	17.85938
23/32	18.25625
47/64	18.65313
3/4	19.05000
49/64	19.44688
25/32	19.84375
51/64	20.24063
13/16	20.63750
53/64	21.03438
27/32	21.43125
55/64	21.82813
7/8	22.22500
57/64	22.62188
29/32	23.01875
59/64	23.41563
15/16	23.81250
61/64	24.20938
31/32	24.60625
63/64	25.00313
1	25.40000

Metric to Decimal Equivalents

METRIC *(millimeters)*	DECIMAL EQUIVALENT *(inches)*
1	.03937
2	.07874
3	.11811
4	.15748
5	.19685
6	.23622
7	.27559
8	.31496
9	.35433
10	.39370
11	.43307
12	.47244
13	.51181
14	.55118
15	.59055
16	.62992
17	.66929
18	.70866
19	.74803
20	.78740
21	.82677
22	.86614
23	.90551
24	.94488
25	.98425
26	1.02362

U.S. Weights and Measures

LENGTH
1 mil = .001 inch
1000 mils = 1 inch = .08333 foot
12 inches = 1 foot = .33333 yard
3 feet = 1 yard = 36 inches
5½ yards = 1 rod = 16½ feet

SQUARE MEASURE (AREA)
1 square inch = .00694 square foot = .00077 square yard
144 square inches = 1 square foot = .11111 square yard
9 square feet = 1 square yard = 1296 square inches
30¼ square yards = 1 square rod = .00625 acre

CUBIC MEASURE (VOLUME)
1 cubic inch = .00058 cubic foot = .00002 cubic yard
1728 cubic inches = 1 cubic foot = .0370 cubic yard
27 cubic feet = 1 cubic yard = 46,656 cubic inches
128 cubic feet = 1 cord = 4.736 cubic yards

CAPACITY — LIQUID MEASURE
60 minims = 1 fluidram = .22559 cubic inch
8 fluidrams = 1 fluid ounce = 1.80469 cubic inches
4 fluid ounces = 1 gill = 7.21875 cubic inches
4 gills = 1 pint = 28.875 cubic inches
2 pints = 1 quart = 57.75 cubic inches
4 quarts = 1 gallon = 231 cubic inches
31½ gallons = 1 barrel = 7277 cubic inches

CAPACITY — DRY MEASURE
1 pint = ½ quart = 33.6 cubic inches
2 pints = 1 quart = 67.2 cubic inches
8 quarts = 1 peck = 537.6 cubic inches
4 pecks = 1 bushel = 2150 cubic inches

WEIGHT (AVOIRDUPOIS)
27.344 grains = 1 dram = .0625 ounce
16 drams = 1 ounce = 437.5 grains
16 ounces = 1 pound = 7000 grains
25 pounds = 1 quarter = 400 ounces
100 pounds = 1 short hundredweight = .05 short ton
112 pounds = 1 long hundredweight = .05 long ton
20 short hundredweight = 1 short ton = 2000 pounds
20 long hundredweight = 1 long ton = 2240 pounds

Metric Weights and Measures

LENGTH
1 millimeter = .001 meter
10 millimeters = 1 centimeter = .01 meter
10 centimeters = 1 decimeter = .10 meter
10 decimeters = 1 meter = 1 meter
10 meters = 1 dekameter = 10 meters
10 dekameters = 1 hectometer = 100 meters
10 hectometers = 1 kilometer = 1000 meters

SQUARE MEASURE (AREA)
100 square millimeters = 1 square centimeter = .0001 square meter
100 square centimeters = 1 square decimeter = .01 square meter
100 square decimeters = 1 square meter = 1 square meter
100 square meters = 1 square decameter = 100 square meters
100 square decameters = 1 square hectometer = 10,000 square meters

CUBIC MEASURE (VOLUME)
1000 cubic millimeters = 1 cubic centimeter = .000001 cubic meter
1000 cubic centimeters = 1 cubic decimeter = .001 cubic meter
1000 cubic decimeters = 1 cubic meter = 1 cubic meter

CAPACITY
10 milliliters = 1 centiliter = .01 liter
10 centiliters = 1 deciliter = .10 liter
10 deciliters = 1 liter = 1 liter
10 liters = 1 dekaliter = 10 liters
10 dekaliters = 1 hectoliter = 100 liters
10 hectoliters = 1 kiloliter = 1000 liters

WEIGHT
10 milligrams = 1 centigram = .01 gram
10 centigrams = 1 decigram = .10 gram
10 decigrams = 1 gram = 1 gram
10 grams = 1 dekagram = 10 grams
10 dekagrams = 1 hectogram = 100 grams
10 hectograms = 1 kilogram = 1000 grams
100 kilograms = 1 quintal = 100,000 grams
10 quintals = 1 ton = 1,000,000 grams

U.S. Equivalents and Metrics

LENGTH

1 inch = 25.4 millimeters = 2.54 centimeters = .0254 meter
1 foot = 304.80 millimeters = 30.48 centimeters = .3048 meter
1 yard = 914.40 millimeters = 91.44 centimeters = .9144 meter
1 millimeter = .03937 inch = .00328083 foot = .00109361 yard
1 centimeter = .39370 inch = .03280830 foot = .01093610 yard
1 meter = 39.37 inches = 3.28083 feet = 1.093611 yards

SQUARE MEASURE (AREA)

1 square inch = 645.16 square millimeters = 6.4516 square centimeters = .00064516 square meter
1 square foot = 92,903 square millimeters = 929.03 square centimeters = .092903 square meter
1 square yard = 836,127 square millimeters = 8361.27 square centimeters = .836127 square meter
1 square millimeter = .0015499 square inch
1 square centimeter = .154999 square inch = .001076 square foot
1 square meter = 1549.99 square inches = 10.7638 square feet = 1.19599 square yards

CUBIC MEASURE (VOLUME)

1 cubic inch = 16,387 cubic millimeters = 16.3871 cubic centimeters
1 cubic foot = 28,317 cubic centimeters = .0283168 cubic meter
1 cubic yard = .7645548 cubic meter
1 cubic millimeter = .000061 cubic inch
1 cubic centimeter = .06102 cubic inch
1 cubic meter = 35.314 cubic feet = 1.3079 cubic yards

CAPACITY

1 minim = .061610 milliliter = .0000616 liter
1 fluidram = 3.6967 milliliters = .0036967 liter
1 fluid ounce = 29.5729 milliliters = .0295729 liter
1 gill = 118.294 milliliters = .118294 liter
1 pint (liquid) = 473.176 milliliters = .473176 liter
1 quart (liquid) = 946.35 milliliters = .94635 liter
1 gallon (liquid) = 3785.4 milliliters = 3.7854 liters
1 milliliter = .27 fluidram = .06102 cubic inch
1 centiliter = .338 fluid ounce = .61020 cubic inch
1 deciliter = .21 pint (liquid) = 6.1020 cubic inches
1 liter = .057 quarts (liquid) = 61.020 cubic inches
1 dekaliter = 2.64 gallons (liquid) = 244.080 cubic inches

WEIGHT
1 grain = .0648 gram
1 dram (avoirdupois) = 1.77185 grams
1 ounce (avoirdupois) = 28.3495 grams
1 pound (avoirdupois) = .4536 kilogram
1 short hundredweight = 45.359 kilograms
1 long hundredweight = 50.848 kilograms
1 short ton = .90718 metric ton
1 long ton = 1.0161 metric tons

Conversion Table

Note: British imperial measure (liquid and dry measure) is not shown. The British imperial gallon equals 1.2009 U.S. gallons.

TO CONVERT FROM:	TO:	MULTIPLY BY:
centigrams	grains	.15432
	grams	.01
centiliters	fluidrams	2.705
	fluid ounces	.33814
	liters	.01
centimeters	feet	.03281
	inches	.3937
	meters	.01
	mils	393.7
cubic centimeters	cubic feet	.00003532
	cubic inches	.06102
	liters	.001
	cubic meters	.000001
cubic decimeters	cubic centimeters	1000
	cubic inches	61.0237
cubic feet	cubic centimeters	28,317
	cubic inches	1728
	cubic yards	.03704
	cubic meters	.02832
	gallons (liquid)	7.48052
	liters	28.31687

TO CONVERT FROM:	TO:	MULTIPLY BY:
cubic inches	cubic centimeters	16.3872
	cubic feet	.000579
	cubic meters	.00001639
	gallons (liquid)	.00433
	liters	.01639
	pints (dry)	.02976
	pints (liquid)	.03463
	quarts (dry)	.01488
	quarts (liquid)	.01732
cubic meters	cubic centimeters	1,000,000
	cubic feet	35.314
	cubic inches	61,023.4
	gallons (liquid)	264.17
cubic millimeters	cubic centimeters	.001
	cubic inches	.00006
cubic yards	cubic feet	27
	cubic inches	46,656
	cubic meters	.7646
cup (liquid)	gallon (liquid)	.0625
	ounce (liquid)	8
	pint (liquid)	.5
	quart (liquid)	.25
decigrams	grains	1.5432
	grams	.1
deciliters	fluid ounces	3.38
	liters	.1
decimeters	inches	3.937
	meters	.01
dekagrams	grams	10
	ounces (avoirdupois)	.3527
dekaliters	gallons (liquid)	2.64
	liters	10

TO CONVERT FROM:	TO:	MULTIPLY BY:
decameters	inches	393.7
	meters	10
drams (avoirdupois)	ounces (avoirdupois)	.0625
	grains	27.3437
	grams	1.7718
drams (liquid)	see fluidrams	
feet	centimeters	30.4801
	inches	12
	meters	.3048
	yards	.3333
fluid ounces	cubic inches	1.80469
	cups (liquid)	16
	fluidrams	8.0
	gallons (liquid)	.00781
	liters	.02959
	pints (liquid)	.0625
	tablespoon	2
	teaspoon	6
fluidrams	cubic inches	.22559
	fluid ounces	.125
	milliliters	3.69669
	minims	60
gallons (dry)	cubic feet	.1556
	cubic inches	268.8
	cubic meters	.0044
gallons (liquid)	cubic feet	.1337
	cubic inches	231
	cubic meters	.0038
	fluid ounces	128
	liters	3.7854
	pints (liquid)	8
	quarts (liquid)	4
gills	pints (liquid)	.25

TO CONVERT FROM:	TO:	MULTIPLY BY:
grains	drams (avoirdupois)	.03657
	grams	.0648
	milligrams	64.7989
	ounces (avoirdupois)	.00229
grams	pounds (avoirdupois)	.00014
	grains	15.432
	kilograms	.001
	milligrams	1000
	ounces (avoirdupois)	.03527
	pounds (avoirdupois)	.0022
hectograms	grams	100
	ounces (avoirdupois)	3.5274
hectoliters	gallons (liquid)	26.418
	liters	100
inches	centimeters	2.54
	feet	.08333
	meters	.0254
	millimeters	25.4
	mils	1000
	yards	.02778
kilograms	grains	15,432.36
	grams	1000
	ounces (avoirdupois)	35.274
	pounds (avoirdupois)	2.2046
kiloliters	gallons (liquid)	264.172
	liters	1000
kilometers	feet	3280.833
	meters	1000
liters	cubic centimeters	1000
	cubic feet	.035313
	cubic inches	61.02398
	quarts (dry)	.9081
	quarts (liquid)	1.0567
	gallons (dry)	.22702
	gallons (liquid)	.26417

TO CONVERT FROM:	TO:	MULTIPLY BY:
long tons	pounds (avoirdupois)	2240
meters	feet	3.2808
	inches	39.37
	kilometers	.001
	millimeters	1000
microinches	inches	.000001
	centimeters	.0001
	microns	.0254
microns	inches	.0000394
	meters	.000001
	microinches	37.370079
	mils	.03937
milligrams	grains	.01543
	grams	.001
milliliters	fluid ounces	.0338
	fluidrams	.2705
	liters	.001
millimeters	inches	.03937
	meters	.001
	microns	1000
	mils	39.37
mils	inches	.001
	microns	25.4001
	millimeters	.0254
minims	fluidrams	.01667
	milliliters	.06161
ounces (avoirdupois)	drams (avoirdupois)	16
	grains	437.5
	grams	28.350
	pounds (avoirdupois)	.0625
ounces (liquid)	see fluid ounces	

TO CONVERT FROM:	TO:	MULTIPLY BY:
pints (dry)	cubic inches	33.6003
	liters	.5506
	quarts (dry)	.5
pints (liquid)	cubic inches	28.875
	cups (liquid)	2
	fluidounces	16
	gallons (liquid)	.125
	quarts (liquid)	.5
	gills	4
	liters	.47318
pounds (avoirdupois)	grams	453.592
	grains	7000
	ounces (avoirdupois)	16
quarts (dry)	cubic inches	67.2006
	liters	1.10112
	pints (dry)	2
quarts (liquid)	cubic inches	57.75
	gallons (liquid)	.25
	liters	.94636
	pints (liquid)	2
square centimeters	square feet	.001076
	square inches	.1550
	square millimeters	100
square decimeters	square inches	15.5
	square meters	.01
square decameters	square meters	100
	square yards	119.599
square feet	square centimeters	929.0341
	square inches	144
	square meters	.0929
	square yards	.1111
square hectometers	square meters	10,000

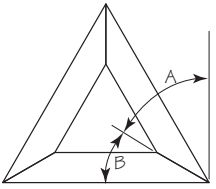
TO CONVERT FROM:	TO:	MULTIPLY BY:
square inches	square centimeters	6.4516
	square feet	.00694
	square millimeters	645.1625
	square yards	.00077
square meters	square centimeters	10,000
	square feet	10.7639
	square yards	1.196
square millimeters	square inches	.00155
	square meters	.000001
square yards	square feet	9
	square inches	1296
	square meters	.83613
tablespoon (liquid)	teaspoon (liquid)	3
teaspoon (liquid)	fluid ounce	.166666
	tablespoon (liquid)	.333333
yards	feet	3
	inches	36
	meters	.9144

Miter Angles for Polygons

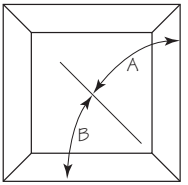
(WHEN ALL SIDES ARE EQUAL LENGTH)

For polygons not shown, use the Miter Angle Formula on page 47 to calculate the angle.

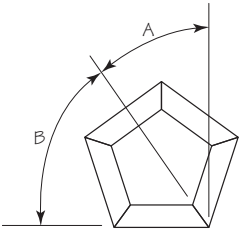
Equilateral Triangle
A = 60°
B = 30°



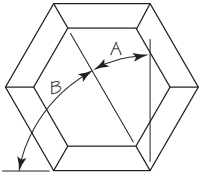
Square (also Rectangle)
A = 45°
B = 45°

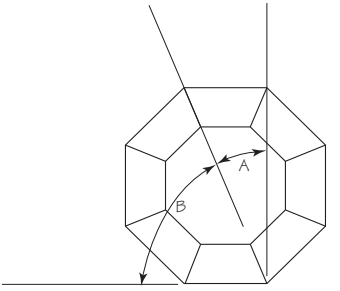


Regular Pentagon
A = 36°
B = 54°

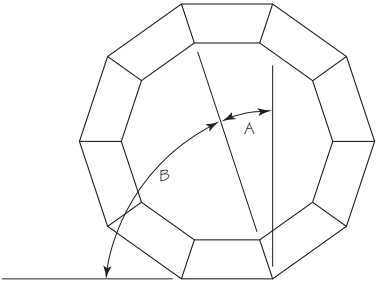


Regular Hexagon
A = 30°
B = 60°

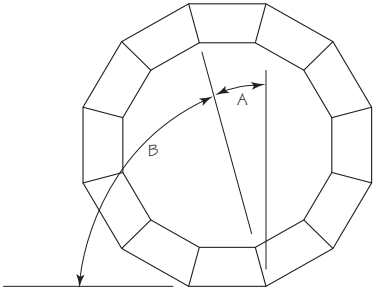




Regular Octagon
A = 22½°
B = 67½°



Regular Decagon
A = 18°
B = 72°



Regular Dodecagon
A = 15°
B = 75°

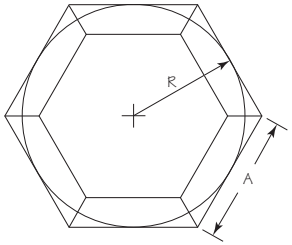
MITER ANGLE FORMULA

For any figure with sides of equal length, use the following formula to calculate the miter angle A:

A = 180/N where:
A = the miter angle (measured from vertical)
N = the number of sides

Determining Side Lengths for Polygons

For any figure with sides of equal length, use the following formula to calculate the lengths of the sides:
A = R × C
where:
A = length of side
C = constant
(from Constant Chart below)
R = radius



NUMBER OF EQUAL-LENGTH SIDES	CONSTANT
3 (equilateral triangle)	3.464
4 (square)	2.000
5 (regular pentagon)	1.453
6 (regular hexagon)	1.155
8 (regular octagon)	.828
10 (regular decagon)	.650
12 (regular dodecagon)	.536

Example: You are making an octagonal wall clock that must be 16" wide. What length do you cut each of the sides?
A 16"-wide clock has a radius of 8".

A = R × C
= 8 × .828
= 6.624" (use 6 5/8")

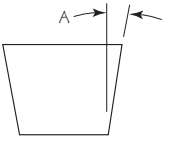
Compound Angles

A compound angle is created by cutting a workpiece at an angle using a saw blade that is also tilted at an angle. The compound angle is commonly used to create tapered-sided boxes and containers. The tilt angle (A) of the box side is measured from a vertical line. Compound angles can be cut on the table saw or the radial-arm saw. Keep in mind, however, that saw gauges are notoriously inaccurate, so it's always best to make test-cuts on scrap stock.

The saw blade angle (B) is measured from a vertical line for both the table saw and radial-arm saw. The angle of the table saw miter gauge (C) is measured from a line perpendicular to the saw blade. The angle of the radial-arm saw (C) is measured from a line perpendicular to the fence.

Not all manufacturers use the same points of reference when establishing the blade tilt and cutting angles shown on their saw gauges. Therefore, the angles marked on your saw gauge might not correspond with the angles shown in the table. To avoid confusion, always set the saw based on Angles B and C shown below.

Tilt Angle (A)



Side View of Box

Angle of Blade (B)

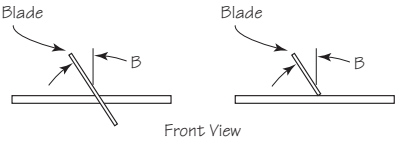
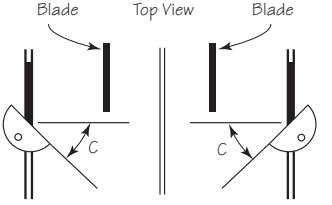
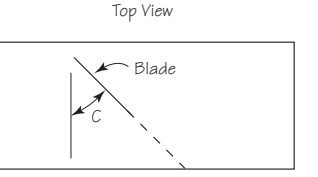


Table Saw **Radial-Arm Saw**



Angle of Miter Gauge (C)



Angle of Radial-Arm Saw (C)

TABLES FOR COMPOUND ANGLES

A = tilt angle of sides
B = blade angle of table or radial-arm saw
C = angle of table saw miter gauge or radial-arm saw

FOUR-SIDED FIGURE

A (degrees)	*B (degrees)*	*C (degrees)*
5	44.8	4.9
10	44.1	9.9
15	43.1	14.5
20	41.6	18.9
25	39.9	22.9
30	37.8	26.6
35	35.4	29.8
40	32.8	32.7
45	30.0	35.3
50	27.0	37.5
55	23.9	39.3
60	20.7	40.9

FIVE-SIDED FIGURE

A (degrees)	*B (degrees)*	*C (degrees)*
5	35.8	3.6
10	35.4	7.2
15	34.6	10.7
20	33.6	14.0
25	32.2	17.1
30	30.6	20.0
35	28.8	22.6
40	26.8	25.0
45	24.6	27.2
50	22.2	29.1
55	19.7	30.8
60	17.1	32.2

SIX-SIDED FIGURE

A (degrees)	*B (degrees)*	*C (degrees)*
5	29.9	2.9
10	29.5	5.7
15	28.9	8.5
20	28.0	11.2
25	27.0	13.7
30	25.7	16.1
35	24.2	18.3
40	22.5	20.4
45	20.7	22.2
50	18.8	23.9
55	16.7	25.3
60	14.5	26.6

EIGHT-SIDED FIGURE

A (degrees)	*B (degrees)*	*C (degrees)*
5	22.4	2.1
10	22.1	4.1
15	21.7	6.1
20	21.1	8.1
25	20.3	9.9
30	19.4	11.7
35	18.3	13.4
40	17.1	14.9
45	15.7	16.3
50	14.2	17.6
55	12.7	18.7
60	11.0	19.7

TEN-SIDED FIGURE

A (degrees)	*B (degrees)*	*C (degrees)*
5	17.9	1.6
10	17.7	3.2
15	17.4	4.8
20	16.9	6.3
25	16.3	7.8
30	15.5	9.2
35	14.7	10.6
40	13.7	11.8
45	12.6	12.9
50	11.5	14.0
55	10.2	14.9
60	8.9	15.7

TWELVE-SIDED FIGURE

A (degrees)	*B (degrees)*	*C (degrees)*
5	14.9	1.3
10	14.8	2.7
15	14.5	4.0
20	14.1	5.2
25	13.6	6.5
30	13.0	7.6
35	12.2	8.7
40	11.4	9.8
45	10.6	10.7
50	9.6	11.6
55	8.5	12.4
60	7.4	13.1

Enlarging Grid Patterns Using a Photocopy Machine

A photocopy machine can be a real time-saver when enlarging a grid pattern. The table on the next page requires the use of a photocopy machine that can enlarge at least 150 percent. If you don't have easy access to such a machine, your local copy center is likely to have one.

You'll need to determine the percentage of enlargement before you can use the table. To determine the percentage of enlargement:

1. Determine the desired full-size length of the pattern.
2. Measure the length of the pattern on the grid.
3. Divide the desired full-size length by the measured length of pattern on the grid, then multiply by 100.

Example: Plans for a hutch cupboard show a grid pattern for a curved bracket foot. The full-size curve must measure 6" long. On the pattern, the curve measures $1\frac{7}{8}$" long. How much must the curve be enlarged to produce a full-size pattern?

Percentage of enlargement = desired full-size length/measured length of pattern on grid × 100

= $6/1\frac{7}{8} \times 100$

= 3.2×100

= 320 percent

Once the percentage of enlargement is known, the table on the next two pages details how to enlarge the pattern using a photocopier.

TO ENLARGE ORIGINAL BY: (percentage of enlargement)	STEP 1 Copy original at this %	STEP 2 Copy 1st copy at this %	STEP 3 Copy 2nd copy at this %	STEP 4 Copy 3rd copy at this %
155	150	103	-	-
160	150	107	-	-
165	150	110	-	-
170	150	113	-	-
175	150	117	-	-
180	150	120	-	-
185	150	123	-	-
190	150	127	-	-
195	150	130	-	-
200	150	133	-	-
205	150	137	-	-
210	150	140	-	-
215	150	143	-	-
220	150	147	-	-
225	150	150	-	-
230	150	150	102	-
235	150	150	104	-
240	150	150	107	-
245	150	150	109	-
250	150	150	111	-
255	150	150	113	-
260	150	150	116	-
265	150	150	118	-
270	150	150	120	-
275	150	150	122	-
280	150	150	124	-
285	150	150	127	-
290	150	150	129	-
295	150	150	131	-
300	150	150	133	-
305	150	150	136	-
310	150	150	138	-
315	150	150	140	-
320	150	150	142	-
325	150	150	144	-
330	150	150	147	-
335	150	150	149	-
340	150	150	150	101
345	150	150	150	102

TO ENLARGE *ORIGINAL BY: (percentage of enlargement)*	STEP 1 *Copy original at this %*	STEP 2 *Copy 1st copy at this %*	STEP 3 *Copy 2nd copy at this %*	STEP 4 *Copy 3rd copy at this %*
350	150	150	150	104
355	150	150	150	105
360	150	150	150	107
365	150	150	150	108
370	150	150	148	111
375	150	150	150	111
380	150	150	148	114
385	150	150	150	114
390	150	150	148	117
395	150	150	150	117
400	150	150	148	120

Circle Templates Around the House

Looking for a circle template? As shown here, the template you need might be in your kitchen cupboard, workshop cabinet or even your pants pocket.

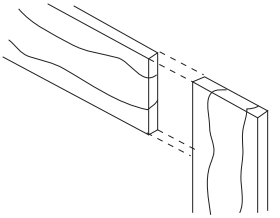
TEMPLATE	DIAMETER *(inches)*	RADIUS *(inches)*
penny	3/4	3/8
nickel	7/8	7/16
quarter	1	1/2
top end of 35mm film canister	1 3/8	11/16
lid from 1 gallon plastic milk container	1 1/2	3/4
bottom end of Old Spice shave cream (11 oz. can)	1 5/8	13/16
bottom end of WD-40 (9 oz. can)	2 3/4	1 3/8
bottom end of Minwax Wood Finish (1/2 pint can)	2 7/8	1 7/16
bottom end of Borden's condensed milk (12 oz. can)	3	1 1/2
bottom end of Minwax Wood Finish (1 pint can)	3 3/8	1 11/16
bottom end of Folger's coffee (12 oz. can)	4	2
bottom end of Butcher's Wax (16 oz. can)	4 1/4	2 1/8
compact disc	4 3/4	2 3/8
bottom end of Cabot's Wood Stain	6 3/4	3 3/8

CHAPTER TWO

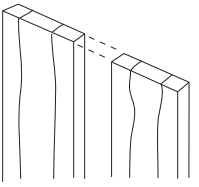
furniture design

2

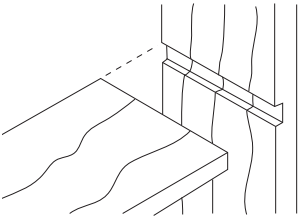
Common Woodworking Joints



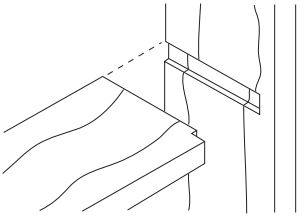
Butt (end to end)



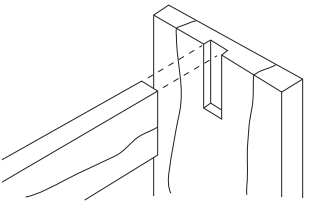
Butt (edge to edge)



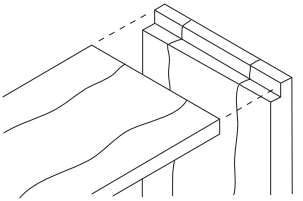
Through Dado



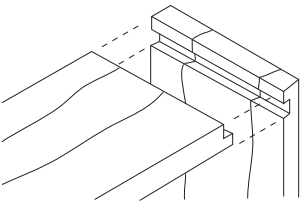
Stopped Dado



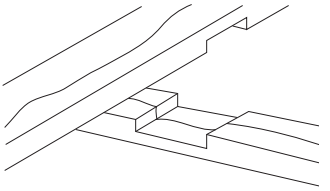
Groove



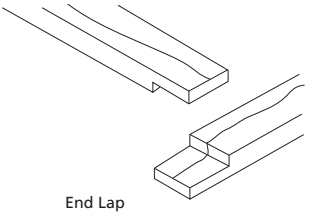
Rabbet



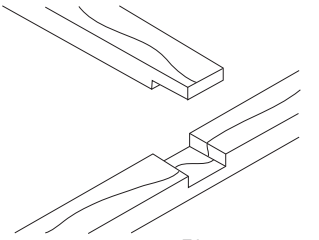
Rabbet and Dado



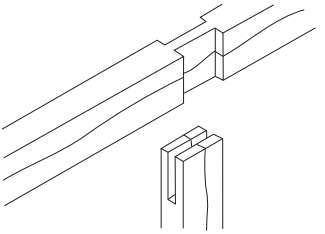
Cross Lap



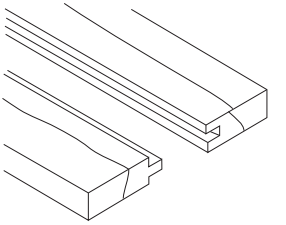
End Lap



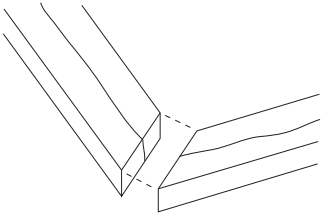
T-Lap



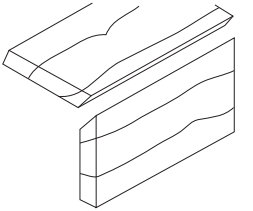
T-Bridle



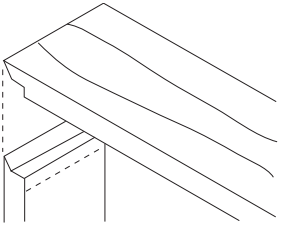
Tongue and Groove



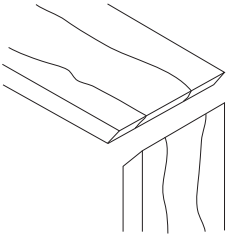
Flat Miter



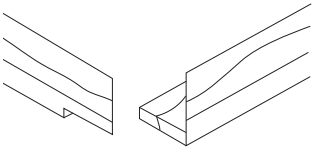
Edge Miter



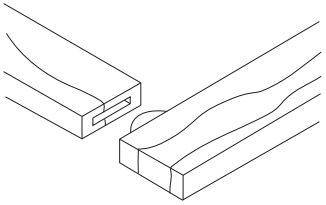
Rabbet Miter



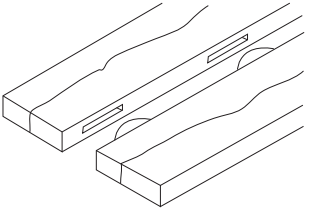
End Miter



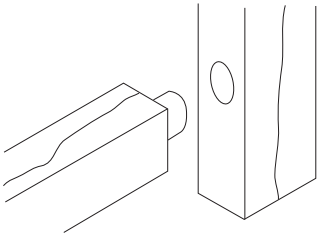
Lap Miter



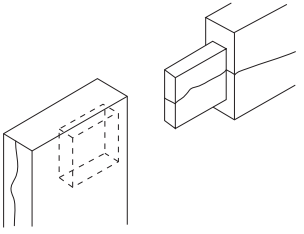
Biscuit (end to edge)



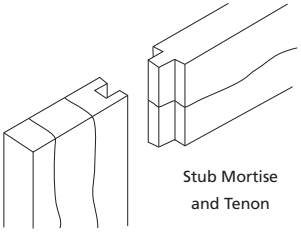
Biscuit



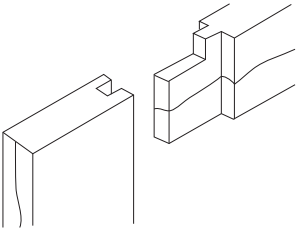
Round Mortise and Tenon



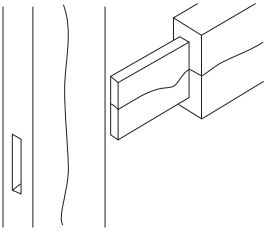
Blind Mortise and Tenon



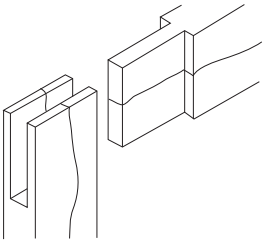
Stub Mortise
and Tenon



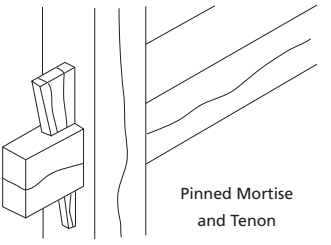
Haunched Mortise and Tenon



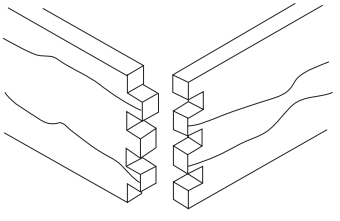
Through Mortise and Tenon



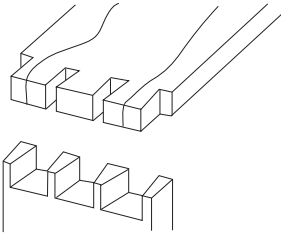
Open Mortise and Tenon



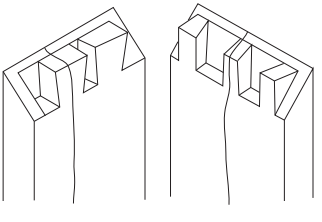
Pinned Mortise and Tenon



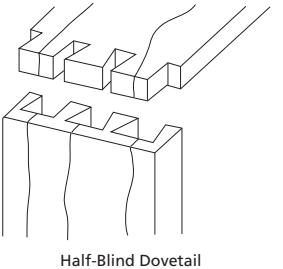
Finger or Box Joint



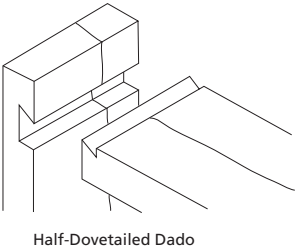
Through Dovetail



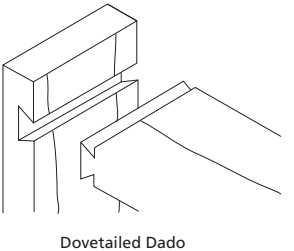
Blind Dovetail



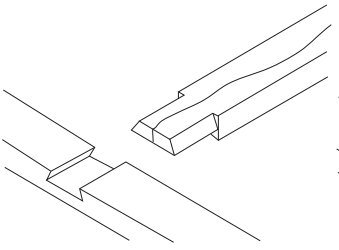
Half-Blind Dovetail



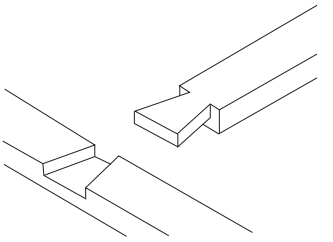
Half-Dovetailed Dado



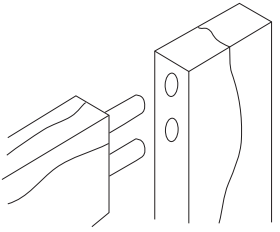
Dovetailed Dado



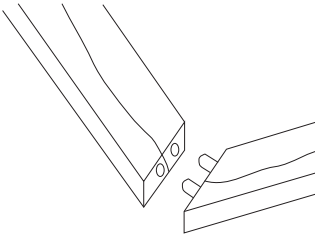
Keyed Dovetail Half-Lap



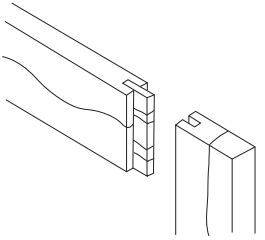
Dovetailed Half-Lap



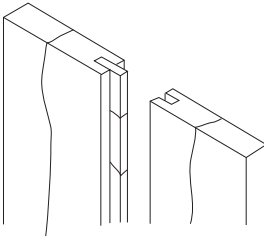
Dowel (end to edge)



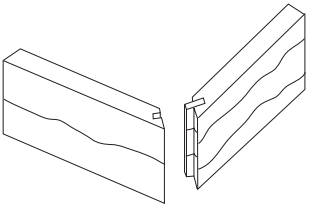
Doweled Miter



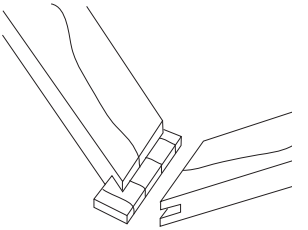
Spline (end to edge)



Spline (edge to edge)



Splined Miter



Miter With Spline Key

General Rules for Joinery Design

A number of general rules, or rules of thumb, apply to the design of woodworking joints. Although they work just fine for most applications, keep in mind that these rules are not absolute, so there will be occasional exceptions.

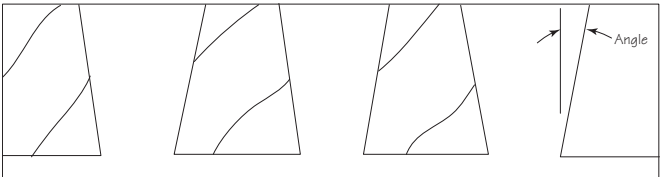
MORTISE-AND-TENON JOINTS

• When the mating parts are the same thickness, make the tenon about one-third the stock thickness.

• When cutting a blind mortise and tenon, make the mortise 1/16" to 1/8" deeper than the tenon length. The added space provides room for any excess glue to collect, allowing the joint to fully close when clamp pressure is applied.

DOVETAILS

• The dovetail angle affects both strength and appearance. Avoid a dovetail angle of less than 7° because the resulting joint offers minimal locking strength. Also, avoid a dovetail angle that's more than 14° as the resulting short-grain edges are more likely to shear off if the joint is heavily stressed. Any angle between 9° and 11° offers good strength and appearance. A 7° angle produces an attractive dovetail, but is a good choice only when a joint is subjected to little stress. Since dovetail angles are often specified as slopes, the chart below lists common dovetail angles and their approximate slopes.



DOVETAIL ANGLE *(degrees)*	APPROXIMATE SLOPE
7	1:8
8	1:7
9	1:6
11	1:5
14	1:4

DOWEL JOINTS

• Use a dowel diameter that's between one-third and one-half the stock thickness (for example use a 1/4", 5/16" or 3/8"-diameter dowel for 3/4"-thick stock).

• When boring dowel holes, add 1/16" clearance at each end to allow for excess glue.

• When using dowels to help align edge-to-edge joints, space the dowels 8" to 12" apart.

LAP JOINTS

• When the mating parts are the same thickness, the lap should be one-half the stock thickness.

NAIL JOINTS

• When nailing a thinner piece to a thicker piece, the nail length should be about three times the thickness of the thinner piece. Example: Use a 2 1/4"-long nail to attach a piece of 3/4"-thick stock to a piece of 3 1/2"-thick stock.

• When both parts are about the same thickness, the nail length should be 1/8" to 1/4" less than the combined thicknesses of the parts. Example: Use a 2 3/4"-long nail to join two pieces of 1 1/2"-thick stock.

• When nailing near the end of a board, drill pilot holes to prevent the stock from splitting. The pilot hole diameter should be about 75 percent of the nail diameter and bored to a depth of about two-thirds the nail length.

SCREW JOINTS

• About two-thirds of the screw (or the entire thread length) should enter the mating piece.

• When both parts are about the same thickness, the screw length should be 1/8" to 1/4" less than the combined thicknesses of the parts. Example: Use a 1 5/8"-long screw when joining a 3/4"-thick piece to a 1"-thick piece.

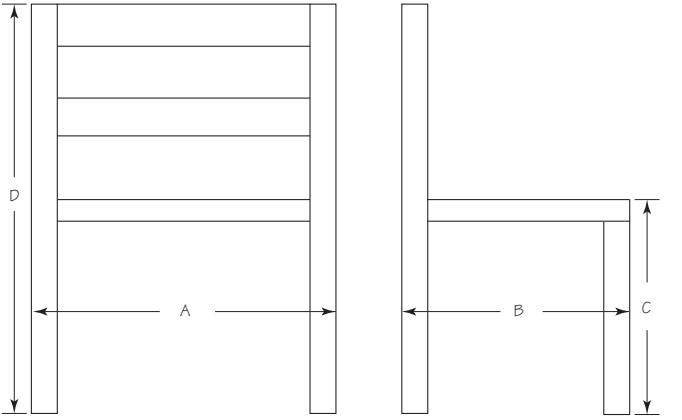
Standard Furniture Dimensions

Most chairs, dining tables and desktops are designed for average-size adults.

The illustrations that follow show the standard sizes for a variety of furniture pieces.

CHAIRS

Chairs can vary considerably in size, shape, style and utility. Chair seats can be square or rectangular, but just as often they are wider in the front than in the back.

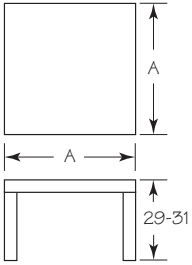


DIMENSIONS *(in inches)*	A	B	C	D
kitchen	14-16	14-16	17-18½	30-36
dining (side)	18-21	16-20	18-18½	40-48
dining (arm)	20-27	16-20	18-18½	40-48

DINING TABLES

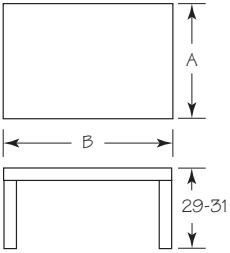
The standard dimensions shown here apply to square, rectangular and round dining tables.

Square Tables



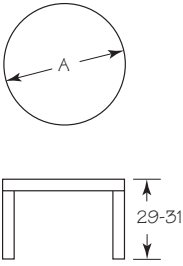
PEOPLE	MINIMUM SPACE (A)	AVERAGE SPACE (A)	AMPLE SPACE (A)
2	24	28	32
4	34	38	42
8	44	48	52

Rectangular Tables



PEOPLE	MINIMUM SPACE (A) (B)	AVERAGE SPACE (A) (B)	AMPLE SPACE (A) (B)
2	22 28	24 30	28 32
4	28 44	32 48	36 52
6	34 50	36 66	42 72
8	34 72	36 86	42 90

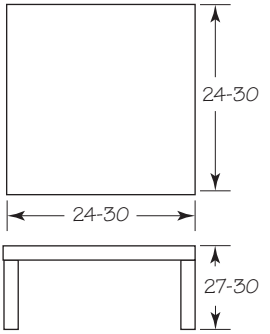
Round Tables



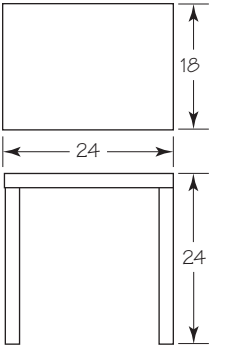
PEOPLE	MINIMUM SPACE (A)	AVERAGE SPACE (A)	AMPLE SPACE (A)
2	22	24	28
4	32	36	42
6	42	50	54
8	56	62	72

OTHER TABLES

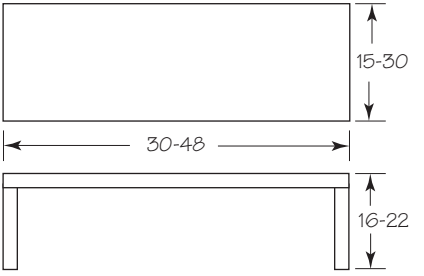
Many tables are designed for a specific use in the home. Dimensions for some of the more common ones are shown here.



Occasional Table



End Table

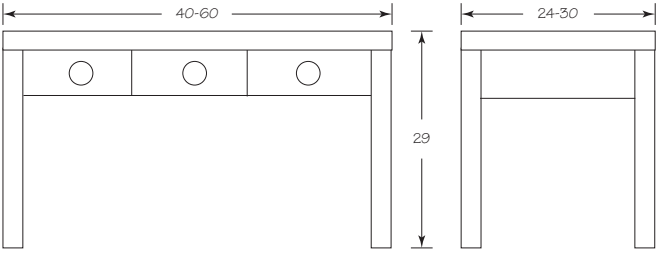


Coffee Table

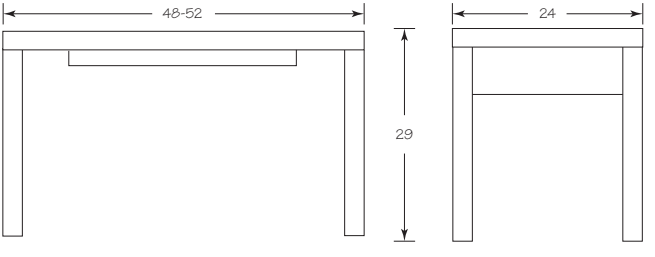
Sofa (Hunt) Table

DESKS

The dimensions of desktops can vary widely, so use the length and width figures shown only as a general guide. However, the desk height dimension is based on what is considered a comfortable working height for most people, so you should adhere to it pretty closely.



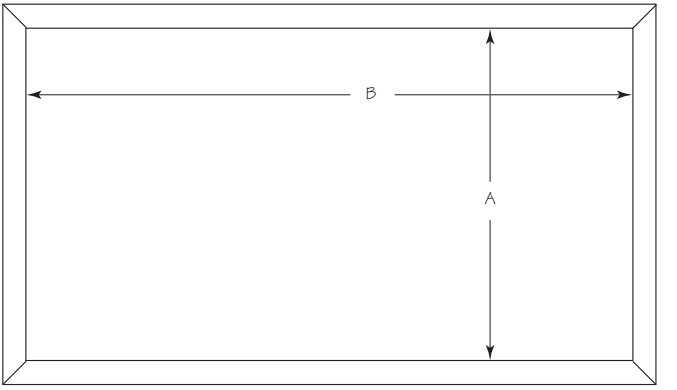
Writing Desk

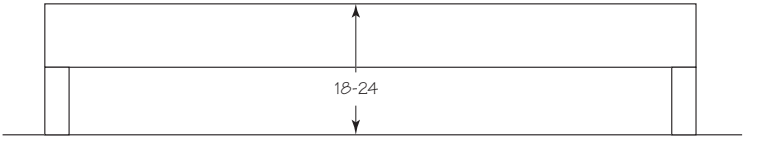


Computer Desk

BEDS

The length and width dimensions represent the distances measured to the inside of the frame. The figures are based on the standard dimensions for twin, double, queen- and king-size beds.

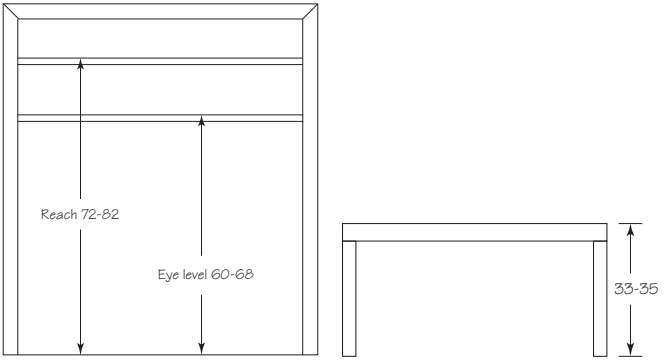




SIZE	DIMENSIONS *A (inches)*	*B (inches)*
Twin (Single)	39	75
Double (Full)	54	75
Queen	60	80
King	76	80

SHELVES

When determining shelf heights, keep in mind that you should be able to reach items on a shelf without having to use a stepstool or standing on your toes. The range of heights shown here takes into account the fact that all people are not the same height. If the shelves are to be regularly used by someone under 5'6" tall, use the lower figures.



WORKBENCHES

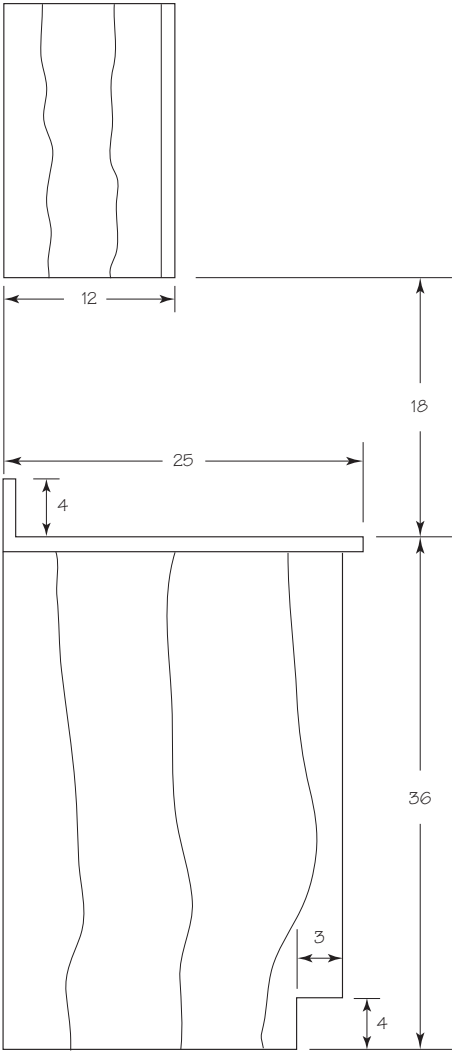
Workbench widths and lengths are not standardized. That's because individual needs and the available space in the workshop are likely to determine the best benchtop size. Commercial bench manufacturers understand this. Indeed, you'll find that commercial benches range from a compact 16" × 36" to a substantial 24" × 90", with a range of sizes in between. My bench, which I find to be a useful size for my shop, measures 30" × 60".

While benchtop sizes are widely variable, workbench heights are another matter. A workbench should be at a height that you'll find comfortable for planing, sawing, sanding and other woodworking operations. Commercial benches range in height from 33" to 35". However, if you plan to make a bench for your own use, you'll have the luxury of building it to a height that's best suited for your size.

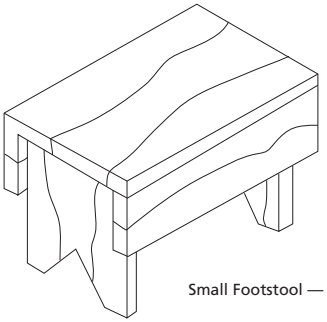
You can pretty closely determine the workbench height that's best suited for your size by standing straight with your arms hanging down at your sides. Turn the palms of your hands so they are parallel to the floor, then measure the distance from the floor to your palms. For most woodworkers, this method results in a comfortable bench height for most operations.

KITCHEN CABINETS

Kitchen cabinet dimensions have been standardized to ensure maximum convenience. Most kitchen appliances are designed for use with these standard sizes.

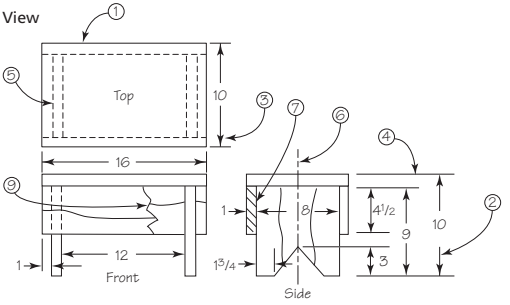


Understanding a Shop Drawing



Small Footstool — Illustration

Orthographic View



1. Outline. A heavy line representing the important visible surfaces of a part.

2. Dimension Line. A thin line, broken at the center and terminating with arrows at each end. Used to indicate length.

3. Arrowhead. Symbol used to indicate the ends of a dimension line.

4. Extension Line. Thin lines extending from (but not touching) a part. Used to establish the ends of a dimension line.

5. Dotted Line. A heavy broken line representing the important surfaces of a part that is hidden from view. Also called a hidden line.

6. Center Line. Light line used to indicate the center of surfaces, circles and arcs.

7. Sectional Lines. Light parallel lines drawn to indicate surfaces that have been sectioned.

8. Long Break Line (not shown). A zigzag line used to indicate that a part has been , allowing the part to fit better on a shop drawing.

9. Short Break Line. A zigzag line used to shorten a part, usually to expose a hidden component.

A typical shop drawing shows the footstool as viewed from the front, side and top. Such multiview drawings are generally called orthographic views. A relatively simple project might require only a front and side view in order to provide the necessary information. However, a more complicated project often requires views from the front, back, top and both sides.

A sectional view, sometimes called a section, is often used to show the profile of a hidden part. To understand a sectional view, you need to imagine that the part has been cut in two along an imaginary cutting plane. Then, too, imagine that you remove the front of the part that was cut. The part that remains represents what is shown in a sectional view. Shop drawings sometimes include an exploded view (not shown). Exploded views can be helpful, especially when used with complicated projects, because they provide a three-dimensional perspective.

Common Woodworking Abbreviations

ABBREVIATION	MEANING
AD	air dried
amp.	amperes
aux.	auxiliary
avdp.	avoirdupois
bd. ft.	board foot
bev.	bevel
B/M	bill of materials
brs.	brass
C	centigrade
cg	centigram
cl	centiliter
cbore	counterbore
c'bore	counterbore
cham.	chamfer
cir.	circle
CL	centerline
cm	centimeter
csk	countersink
c'sink	countersink
cu.	Cubic
cyl.	cylinder
D	diameter
db.	decibel
deg.	degree
dia.	diameter
diam.	diameter

ABBREVIATION	MEANING
dr.	dram
dwl.	dowel
F	Fahrenheit
FAS	firsts and seconds
F.H.	flathead
F.H.W.S.	flathead wood screw
fl.	fluid
ft.	foot
fpm	feet per minute
fps	feet per second
g	gram
gal.	gallon
galv.	galvanized
gpm	gallons per minute
hex	hexagon
hp	horsepower
hr.	hour
I.D.	inside diameter
in.	inch
KD	kiln-dried
kg	kilogram
kl	kiloliter
km	kilometer
l	liter
lb.	pound
m	meter
MC (or M.C.)	moisture content
MDF	medium-density fiberboard
mg	milligram
mldg.	moulding
mm	millimeter
min.	minute
misc.	miscellaneous
OAL	overall length
O.H.	oval head
O.H.W.S.	oval head wood screw
O.D.	outside diameter
oz.	ounce
ply.	plywood
ppm	parts per million
pt.	pint
psf	pounds per square foot

ABBREVIATION	MEANING
psi	pounds per square inch
qt.	quart
rad.	radius
R	radius
R.H.	roundhead
R.H.W.S.	roundhead wood screw
rd.	round
rpm	revolutions per minute
rps	revolutions per second
S1E	surfaced one edge
S2E	surfaced two edges
S1S	surfaced one side
S2S	surfaced two sides
S4S	surfaced four sides
S1S1E	surfaced one side, one edge
S1S2E	surfaced one side, two edges
S2S1E	surfaced two sides, one edge
sec.	second
SEL	select grade
scr.	screw
sq.	square
stl.	steel
std.	standard
temp.	temperature
T&G	tongue and groove
thd.	thread
tpi	teeth per inch
V	volt
yd.	yard

Common Woodworking Symbols

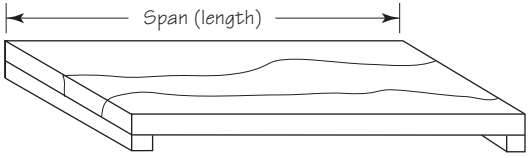
SYMBOL	MEANING	SYMBOL	MEANING
+	add (plus)	%	percent
-	subtract (minus)	°	degrees
×	multiply	'	foot
÷	divide	"	inch
=	equals	℄	centerline
#	pounds (also number)	⌞	right angle

Particleboard Shelf Spans

Particleboard is commonly used as a shelving material. Typically, shelves are exposed to two types of loads: uniform and concentrated. A uniform load is one that is applied across the entire length of a shelf. A shelf filled with books is an example of uniform loading. On the other hand, a concentrated load is one that is applied to a relatively small area. Placing a belt sander in the middle of an empty shelf is an example of a concentrated load.

Use the formulas and chart on page 74-75 to determine the maximum uniform and concentrated loads for various lengths and thicknesses of Grade M-2 particleboard. The chart offers five thickness options: 1/2", 5/8", 3/4", 1" and 1 1/8". The chart also shows the maximum deflection (sag) when the given shelf length is at maximum uniform load.

The chart is based on having end supports that are securely anchored. Supports are most effective when they extend across the full width of the shelf.



UNIFORM LOADS

For uniform loads, use the following formula:

Uniform load = expected load on the shelf (in pounds)/area of shelf (in square feet)

Example: What is the uniform load on a 6"-wide by 36"-long grade M-2 particleboard shelf that is expected to support 60 pounds of books?

1. Calculate the area of the shelf.

Area of shelf = shelf width x shelf length
= 6" × 36"
= 216 square inches

Convert square inches to square feet (see conversion table, page 35).

Area of shelf = 216 square inches × .00694 = 1.5 square feet

2. Calculate the uniform load.

Uniform load = 60 pounds/1.5 square feet
= 40 pounds per square foot (psf)

Once the uniform load is known, use the chart on page 75 to determine the thickness and maximum shelf length that can be used. As shown, for a uniform load of 40 psf, you have several shelf options: 1/2" thick by no more than 16" long, 5/8" thick by no more than 20" long, 3/4" thick by no more than 24" long, 1" thick by no more than 32" long and 1 1/8" thick by no more than 36" long.

CONCENTRATED LOADS

For a concentrated load, add a safety factor by dividing the shelf's expected load by .625, then use the uniform load formula.

Example: You want to place a 60-pound workshop dehumidifier (by itself) in the center of a ¾"-thick by 10"-wide by 36"-long Grade M-2 particleboard shelf. Can the shelf support the concentrated load?

1. Calculate the concentrated load safety factor.

Concentrated load safety factor = expected load on shelf (in pounds)/.625
= 60 pounds/.625
= 96 pounds

2. Calculate the shelf area.

Area of shelf = shelf width × shelf length
= 10" × 36"
= 360 square inches

Convert square inches to square feet (see conversion table, page 35).

Area of shelf = 360 square inches × .00694 = 2.5 square feet

3. Calculate the uniform load.

Uniform load = expected load on the shelf (in pounds)/area of shelf (in square feet)
= 96 pounds/2.5 square feet
= 38.4 psf

As shown in the chart, a ¾"-thick by 36"-long shelf can support a uniform load of only 10 pounds per square foot. However, 1⅛" thick particleboard can support 45 pounds per square foot. Replace the ¾" particleboard with 1⅛"-thick particleboard.

MAXIMUM LOADS FOR PARTICLEBOARD SHELVING

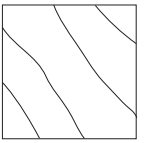
For uniformly loaded Grade M-2 particleboard.

SHELF SPAN *(INCHES)*	MAXIMUM DEFLECTION *(inches)*	UNIFORM LOAD (POUNDS PER SQUARE FOOT) *FOR SHELF THICKNESS*				
		½"	⅝"	¾"	1"	1⅛"
16	.089	45	95	124	166	186
20	.111	20	45	80	130	146
24	.133	13	25	45	107	120
28	.156	8	15	25	70	100
32	.178	-	10	18	45	65
36	.200	-	5	10	30	45
40	.222	-	-	8	20	30
44	.244	-	-	5	15	25
48	.267	-	-	-	10	15
52	.289	-	-	-	8	10
56	.311	-	-	-	5	8
60	.333	-	-	-	-	5

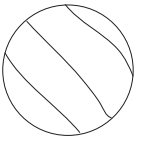
Chart courtesy of the National Particleboard Association.

Factory-Made Pine Mouldings

The mouldings shown here don't represent all the standard pine mouldings available, but they are the ones most likely used for furniture applications. If they are not in stock, most retailers can special-order them for you. The most common sizes are shown. Other sizes might be available; check your retailer.

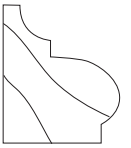


Square Block/Baluster



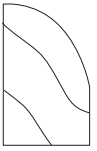
Full Round

Band

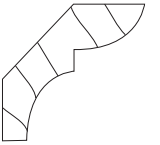


Base

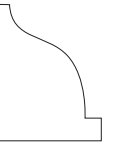
Base Cap



Floor/Shoe



Bed



Neck

COMMONLY AVAILABLE SIZES

Square Block/Baluster
$\frac{3}{4}" \times \frac{3}{4}"$
$1\frac{1}{8}" \times 1\frac{1}{8}"$
$1\frac{3}{8}" \times 1\frac{3}{8}"$
$1\frac{5}{8}" \times 1\frac{5}{8}"$

Full Round
$1\frac{1}{8}"$
$1\frac{3}{8}"$ (closet pole)
$1\frac{5}{8}"$

Band
$\frac{11}{16}" \times 1\frac{5}{8}"$

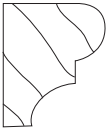
Base
$\frac{11}{16}" \times \frac{11}{16}"$

Base Cap
$\frac{11}{16}" \times 1\frac{1}{8}"$
$\frac{11}{16}" \times 1\frac{3}{8}"$

Floor/Shoe
$\frac{1}{2}" \times \frac{3}{4}"$

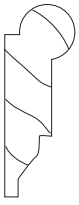
Bed
$\frac{9}{16}" \times 1\frac{5}{8}"$
$\frac{9}{16}" \times 2\frac{1}{4}"$
$\frac{9}{16}" \times 2\frac{5}{8}"$

Neck
$\frac{5}{8}" \times \frac{3}{4}"$

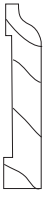


Nose and Cove

Chair Rail

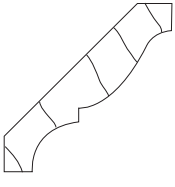


Picture

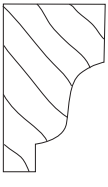


Colonial Base

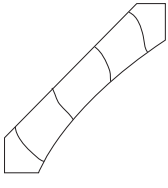
Clamshell Base



Crown



Solid Crown



Cove

COMMONLY AVAILABLE SIZES

Nose and Cove
$\frac{3}{8}" \times \frac{1}{2}"$
$\frac{1}{2}" \times \frac{5}{8}"$
$\frac{5}{8}" \times \frac{3}{4}"$

Chair Rail
$\frac{11}{16}" \times 2\frac{1}{2}"$

Picture
$\frac{11}{16}" \times 1\frac{3}{8}"$

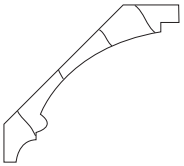
Colonial Base
$\frac{9}{16}" \times 3\frac{1}{4}"$

Clamshell Base
$\frac{9}{16}" \times 3\frac{1}{4}"$

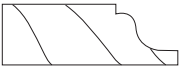
Crown
$\frac{9}{16}" \times 2\frac{5}{8}"$
$\frac{9}{16}" \times 3\frac{5}{8}"$
$\frac{11}{16}" \times 4\frac{1}{2}"$

Solid Crown
$\frac{11}{16}" \times 1\frac{5}{8}"$
$1\frac{1}{8}" \times 2\frac{1}{4}"$

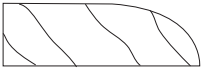
Cove
$\frac{9}{16}" \times 1\frac{5}{8}"$
$\frac{11}{16}" \times 2\frac{5}{8}"$



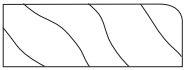
Beaded Cove



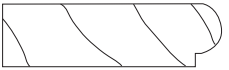
Colonial Stop



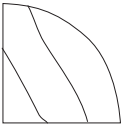
Clamshell Stop



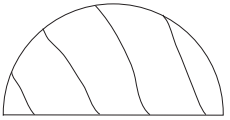
Sanitary Stop



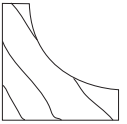
Bullnose Stop



Quarter Round



Half Round



Cove Mould

COMMONLY AVAILABLE SIZES

Beaded Cove
$11/16 \times 1\,5/8$"
$11/16 \times 2\,5/8$"

Colonial Stop
$3/8$" $\times$ $3/4$"
$3/8$" $\times$ $7/8$"
$3/8$" $\times$ $1\,1/8$"
$3/8$" $\times$ $1\,3/8$"
$3/8$" $\times$ $1\,5/8$"
$3/8$" $\times$ $2\,1/4$"

Clamshell Stop
$3/8$" $\times$ $3/4$"
$3/8$" $\times$ $7/8$"
$3/8$" $\times$ $1\,3/8$"
$3/8$" $\times$ $1\,5/8$"

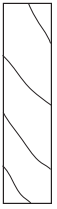
Sanitary Stop
$3/8$" $\times$ $1\,3/8$"

Bullnose Stop
$3/8$" $\times$ $1\,5/8$"

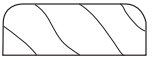
Quarter Round
$1/4$"
$3/8$"
$1/2$"
$5/8$"
$3/4$"
$7/8$"
$1\,1/8$"

Half Round
$1/2$"
$5/8$"
$3/4$"
$1\,1/8$"
$1\,3/8$"

Cove Mold
$1/2$" $\times$ $1/2$"
$5/8$" $\times$ $3/4$"
$11/16$" $\times$ $11/16$"
$11/16$" $\times$ $7/8$"
$11/16$" $\times$ $1\,1/8$"



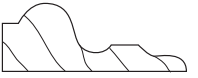
Lattice



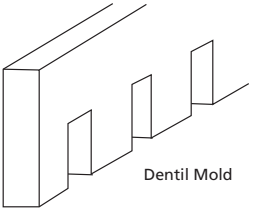
Screen (Flat)

Screen (3-bead)

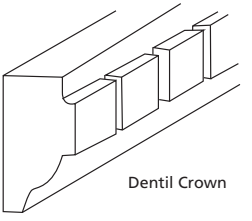
Screen (2-bead)



Panel



Dentil Mold



Dentil Crown

COMMONLY AVAILABLE SIZES

Lattice
$1/4" \times 1\,1/8"$
$1/4" \times 1\,3/8"$
$1/4" \times 1\,5/8"$
$1/4" \times 2"$
$1/4" \times 2\,5/8"$

Screen (Flat)
$1/4" \times 3/4"$

Screen (3-Bead)
$1/4" \times 3/4"$

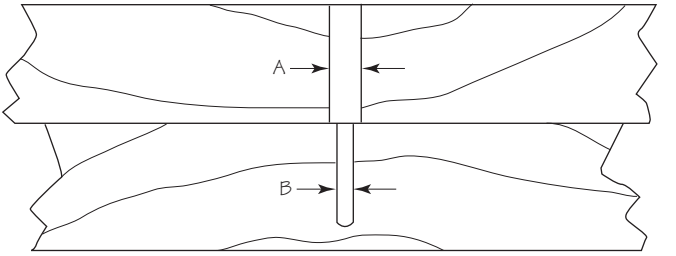
Screen (2-Bead)
$1/4" \times 5/8"$

Panel
$3/8" \times 1"$

Dentil Mold
$1/2" \times 2"$

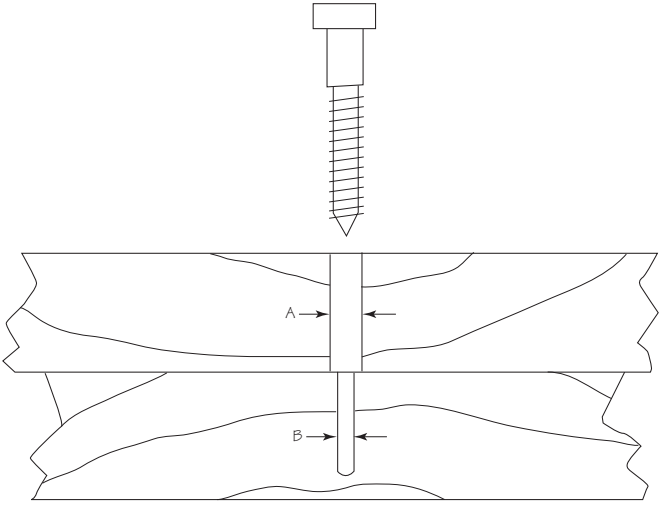
Dentil Crown
$3/4" \times 1\,5/8"$

Wood Screw Shank and Pilot Hole Drill Sizes



SCREW NUMBER	SHANK HOLE DRILL SIZE (A) *(inches)*	SOFTWOOD PILOT HOLE DRILL SIZE (B) *(inches)*	HARDWOOD PILOT HOLE DRILL SIZE (B) *(inches)*
0	1/16	-	1/32
1	5/64	1/32	1/32
2	3/32	1/32	3/64
3	7/64	3/64	1/16
4	7/64	3/64	1/16
5	1/8	1/16	5/64
6	9/64	1/16	5/64
7	5/32	5/64	3/32
8	11/64	5/64	3/32
9	3/16	3/32	7/64
10	3/16	3/32	7/64
12	7/32	7/64	1/8
14	1/4	7/64	9/64
16	17/64	1/8	5/32
18	19/64	9/64	3/16
20	21/64	5/32	13/64
24	3/8	3/16	7/32

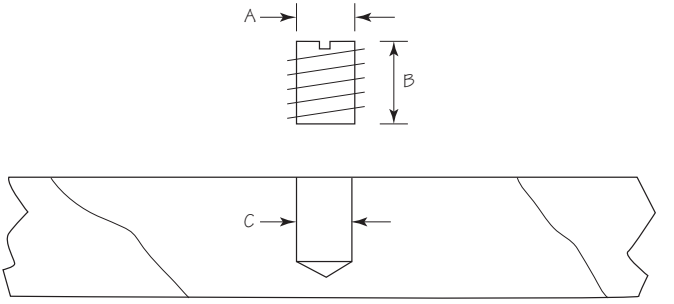
Lag Screw Shank and Pilot Hole Drill Sizes



SCREW NUMBER	SHANK HOLE DRILL SIZE (A) *(inches)*	SOFTWOOD PILOT HOLE DRILL SIZE (B) *(inches)*	HARDWOOD PILOT HOLE DRILL SIZE (B) *(inches)*
3/16	3/16	7/64	1/8
1/4	1/4	5/32	11/64
5/16	5/16	3/16	7/32
3/8	3/8	7/32	17/64
7/16	7/16	17/64	5/16
1/2	1/2	19/64	11/32

Threaded Insert (Rosan Hut) Pilot Hole Drill Sizes

(FOR HARDWOOD AND SOFTWOOD)



INTERNAL THREAD	MAJOR DIAMETER OF EXTERNAL THREAD (A) *(inches)*	LENGTH (B) *(inches)*	PILOT HOLE DRILL SIZE (C) *(inches)*
4-40	.350	3/8	1/4
6-32	.350	3/8	1/4
8-32	.350	3/8	1/4
10-24	.453	1/2	3/8
10-32	.453	1/2	3/8
1/4-20	.453	1/2	3/8
5/16-18	.594	9/16	1/2
3/8-16	.600	5/8	1/2

Clear Glass

Commonly Available Thicknesses

INCHES	MILLIMETERS
3/32	2.5
1/8	3.0
5/32	4.0
3/16	5.0
1/4	6.0
5/16	8.0
3/8	10.0
1/2	12.0

Acrylic Sheet

This product is sold under several trade names, including Plexiglas.

COMMONLY AVAILABLE THICKNESSES *inches*	*millimeters*
.080	2.0
.100	2.5
1/8	3.0
3/16	5.0
1/4	6.0

Plastic Laminate

Plastic laminate is sold under several trade names, including Formica. Some of the commonly used grades are shown below. A variety of finishes are available. See your local dealer for information on other grades.

GRADE	THICKNESS *(inches)*	TYPICAL USE
10	.050	Horizontal and vertical interior applications. Most widely used grade.
12	.042	Horizontal interior applications that require forming. Minimum outside radius: 1/2". Minimum inside radius: 3/8".
20	.030	Vertical or light-duty horizontal interior applications that require forming. Minimum outside and inside radii: 3/8".
30	.039	Vertical or light-duty horizontal interior applications. Can be formed. Minimum outside and inside radii: 1/2".
32	.032	Vertical and horizontal interior applications that require low flame-spread ratings.

CHAPTER THREE

wood

3

Commercial, Common and Botanical Names for Domestic Commercial Hardwoods

COMMERCIAL NAME	COMMON TREE NAME	BOTANICAL NAME
Alder, Red	Red Alder	Alnus rubra
Ash, Black	Black Ash	Fraxinus nigra
Ash, Oregon	Oregon Ash	Fraxinus latifolia
Ash, White	Blue Ash	Fraxinus quadrangulata
Ash, White	Green Ash	Fraxinus pennsylvanica
Ash, White	White Ash	Fraxinus americana
Aspen (Popple)	Bigtooth Aspen	Populus grandidentata
Aspen (Popple)	Quaking Aspen	Populus tremuloides
Basswood	American Basswood	Tilia americana
Basswood	White Basswood	Tilia heterophylla
Beech	American Beech	Fagus grandifolia
Birch	Gray Birch	Betula populifolia
Birch	Paper Birch	Betula papyrifera
Birch	River Birch	Betula nigra
Birch	Sweet Birch	Betula lenta
Birch	Yellow Birch	Betula alleghaniensis
Box Elder	Box Elder	Acer negundo
Buckeye	Ohio Buckeye	Aesculus glabra
Buckeye	Yellow Buckeye	Aesculus octandra
Butternut	Butternut	Juglans cinerea
Cherry	Black Cherry	Prunus serotina
Chestnut	American Chestnut	Castanea dentata
Cottonwood	Balsam Poplar	Populus balsamifera
Cottonwood	Eastern Cottonwood	Populus deltoides
Cottonwood	Black Cottonwood	Populus trichocarpa
Cucumber	Cucumber Tree	Magnolia acuminata
Dogwood	Flowering Dogwood	Cornus florida
Dogwood	Pacific Dogwood	Cornus nuttallii
Elm, Rock	Cedar Elm	Ulmus crassifolia
Elm, Rock	Rock Elm	Ulmus thomasii
Elm, Rock	September Elm	Ulmus serotina
Elm, Rock	Winged Elm	Ulmus alata
Elm, Soft	American Elm	Ulmus americana
Elm, Soft	Slippery Elm	Ulmus rubra
Gum	Sweet Gum	Liquidambar styraciflua
Hackberry	Hackberry	Celtis occidentalis
Hackberry	Sugarberry	Celtis laevigata
Hickory	Mockernut Hickory	Carya tomentosa
Hickory	Pignut Hickory	Carya glabra

COMMERCIAL NAME	COMMON TREE NAME	BOTANICAL NAME
Hickory	Pignut Hickory	Carya glabra
Hickory	Shagbark Hickory	Carya ovata
Hickory	Shellbark Hickory	Carya laciniosa
Holly	American Holly	Ilex opaca
Ironwood	Eastern Hop Hornbeam	Ostrya virginiana
Locust	Black Locust	Robinia pseudoacacia
Locust	Honey Locust	Gleditsia triacanthos
Madrone	Pacific Madrone	Arbutus menziesii
Magnolia	Southern Magnolia	Magnolia grandiflora
Magnolia	Sweet Bay	Magnolia virginiana
Maple, Hard	Black Maple	Acer nigrum
Maple, Hard	Sugar Maple	Acer saccharum
Maple, Oregon	Big Leaf Maple	Acer macrophyllum
Maple, Soft	Red Maple	Acer rubrum
Maple, Soft	Silver Maple	Acer saccharinum
Oak, Red	Black Oak	Quercus velutina
Oak, Red	Blackjack Oak	Quercus marilandica
Oak, Red	California Black Oak	Quercus kelloggi
Oak, Red	Laurel Oak	Quercus laurifolia
Oak, Red	Northern Pin Oak	Quercus ellipsoidalis
Oak, Red	Northern Red Oak	Quercus rubra
Oak, Red	Nuttail Oak	Quercus nuttallii
Oak, Red	Pin Oak	Quercus palustris
Oak, Red	Scarlet Oak	Quercus coccinea
Oak, Red	Shumard Oak	Quercus shumardii
Oak, Red	Southern Red Oak	Quercus falcata
Oak, Red	Turkey Oak	Quercus laevis
Oak, Red	Willow Oak	Quercus phellos
Oak, White	Arizona White Oak	Quercus arizonica
Oak, White	Blue Oak	Quercus douglasii
Oak, White	Burr Oak	Quercus macrocarpa
Oak, White	Valley Oak	Quercus lobata
Oak, White	Chestnut Oak	Quercus prinus
Oak, White	Chinkapin Oak	Quercus muehlenbergii
Oak, White	Emory Oak	Quercus emoryi
Oak, White	Gambel Oak	Quercus gambelii
Oak, White	Mexican Blue Oak	Quercus oblongifolia
Oak, White	Live Oak	Quercus virginiana
Oak, White	Oregon White Oak	Quercus garryana
Oak, White	Overcup Oak	Quercus lyrata
Oak, White	Post Oak	Quercus stellata
Oak, White	Swamp Chestnut Oak	Quercus michauxii

COMMERCIAL NAME	COMMON TREE NAME	BOTANICAL NAME
Oak, White	Swamp White Oak	Quercus bicolor
Oak, White	White Oak	Quercus alba
Oregon Myrtle	California Laurel	Umbellularia californica
Osage Orange	Osage Orange	Maclura pomifera
Pecan	Bitternut Hickory	Carya cordiformis
Pecan	Nutmeg Hickory	Carya myristicaeformis
Pecan	Water Hickory	Carya aquatica
Pecan	Pecan	Carya illinoensis
Persimmon	Common Persimmon	Diospyros virginiana
Poplar	Yellow Poplar	Liriodendron tulipifera
Sassafras	Sassafras	Sassafras albidum
Sycamore	American Sycamore	Platanus occidentalis
Tan Oak	Tan Oak	Lithocarpus densiflorus
Tupelo	Black Tupelo, Blackgum	Nyssa sylvatica
Tupelo	Ogeechee Tupelo	Nyssa ogeche
Tupelo	Water Tupelo	Nyssa aquatica
Walnut	Black Walnut	Juglans nigra
Willow	Black Willow	Salix nigra
Willow	Peach Leaf Willow	Salix amygdaloides

Standard, Forest Service and Botanical Names for Domestic Commercial Softwoods

STANDARD LUMBER NAME	USDA FOREST SERVICE NAME	BOTANICAL NAME
Cedar, Alaska	Alaska Cedar	Chamaecyparis nootkatensis
Cedar, Eastern Red	Eastern Red Cedar	Juniperus virginiana
Cedar, Incense	Incense Cedar	Libocedrus decurrens
Cedar, Northern White	Northern White Cedar	Thuja occidentalis
Cedar, Port Orford	Port Orford Cedar	Chamaecyparis lawsoniana
Cedar, Southern White	Atlantic White Cedar	Chamaecyparis thyoides
Cedar, Western Red	Western Red Cedar	Thuja plicata
Cypress, Red (coast), Yellow (inland) and White (inland)	Bald Cypress	Taxodium distichum
Douglas Fir	Douglas Fir	Pseudotsuga menziesii
Fir, Balsam	Balsam Fir	Abies balsamea
Fir, Balsam	Fraser Fir	Abies fraseri
Fir, Noble	Noble Fir	Abies procera
Fir, White	California Red Fir	Abies magnifica
Fir, White	Grand Fir	Abies grandis
Fir, White	Pacific Silver Fir	Abies amabilis
Fir, White	Subalpine Fir	Abies lasiocarpa
Fir, White	White Fir	Abies concolor
Hemlock, Eastern	Eastern Hemlock	Tsuga canadensis
Hemlock, Mountain	Mountain Hemlock	Tsuga mertensiana
Hemlock, West Coast	Western Hemlock	Tsuga heterophylla
Juniper, Western	Alligator Juniper	Juniperus deppeana
Juniper, Western	Rocky Mountain Juniper	Juniperus scopulorum
Juniper, Western	Utah Juniper	Juniperus osteosperma
Juniper, Western	Western Juniper	Juniperus occidentalis
Larch, Western	Western Larch	Larix occidentalis
Pine, Idaho White	Western White Pine	Pinus monticola
Pine, Jack	Jack Pine	Pinus banksiana
Pine, Lodgepole	Lodgepole Pine	Pinus contorta
Pine, Longleaf Yellow	Longleaf Pine	Pinus palustris
Pine, Longleaf Yellow	Slash Pine	Pinus elliottii
Pine, Northern White	Eastern White Pine	Pinus strobus
Pine, Norway	Red Pine	Pinus resinosa

STANDARD LUMBER NAME	USDA FOREST SERVICE NAME	BOTANICAL NAME
Pine, Ponderosa	Ponderosa Pine	Pinus ponderosa
Pine, Southern	Longleaf Pine	Pinus palustris
Pine, Southern	Shortleaf Pine	Pinus echinata
Pine, Southern	Loblolly Pine	Pinus taeda
Pine, Southern	Slash Pine	Pinus elliottii
Pine, Southern	Pitch Pine	Pinus rigida
Pine, Southern	Pond Pine	Pinus serotina
Pine, Southern	Virginia Pine	Pinus virginiana
Pine, Sugar	Sugar Pine	Pinus lambertiana
Redwood	Redwood	Sequoia sempervirens
Spruce, Eastern	Black Spruce	Picea mariana
Spruce, Eastern	Red Spruce	Picea rubens
Spruce, Eastern	White Spruce	Picea glauca
Spruce, Engelmann	Blue Spruce	Picea pungens
Spruce, Engelmann	Engelmann Spruce	Picea engelmannii
Spruce, Sitka	Sitka Spruce	Picea sitchensis
Tamarack	Tamarack	Larix laricina
Yew, Pacific	Pacific Yew	Taxus brevifolia

Common and Botanical Names for Some Imported Hardwoods

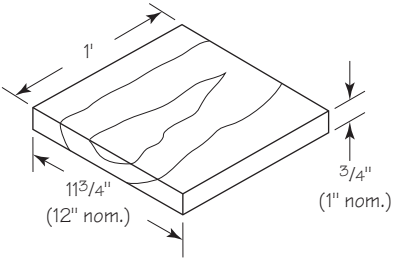
COMMON NAME	OTHER NAME	BOTANICAL NAME
Afara	Limba	Terminalia superba
African Mahogany	-	Khaya ivorensis, Khaya anthotheca
African Rosewood	Bubinga	Guibourtia spp.
African Whitewood	Obeche	Triplochiton scleroxylon
Afrormosia	Kokrodua	Pericopsis elata
Albarco	Jequitiba	Cariniana spp.
Amaranth	Purpleheart	Peltogyne spp.
Anani	Manni	Symphonia globulifera
Anaura	Kauta, Marishballi	Licania spp.
Andiroba	Crabwood	Carapa guianensis
Angelique	-	Dicorynia guianensis
Balsa	-	Ochroma pyramidale
Benge	-	Guibourtia arnoldiana
Bolivian Rosewood	-	Machaerium acutifolium
Brazilian Cherry	Jatoba	Hymenaea courbaril
Brazilian Rosewood	Jacaranda	Dalbergia nigra
Bubinga	African Rosewood	Guibourtia spp.

COMMON NAME	OTHER NAME	BOTANICAL NAME
Central American Mahogany	Honduras Mahogany, South American Mahogany	Swietenia macrophylla
Cocobolo	-	Dalbergia retusa
Crabwood	Andiroba	Carapa guianensis
Ebony	African Ebony, Ceylon Ebony, East Indian Ebony	Diospyros spp.
Goncalo Alves	-	Astronium spp.
Honduras Mahogany	Central American Mahogany, South American Mahogany	Swietenia macrophylla
Honduras Rosewood	-	Dalbergia stevensonii
Indian Rosewood	-	Dalbergia latifolia
Ipe	-	Tabebuia serratifolia
Iroko	Kambala	Chlorophora excelsa, Chlorophora regia
Jacaranda	Brazilian Rosewood	Dalbergia nigra
Jarra	Red Ironwood	Eucalyptus marginata
Jatoba	Brazilian Cherry	Hymenaea courbaril
Jequitiba	Albarco	Cariniana spp.
Kambala	Iroko	Chlorophora excelsa, Chlorophora regia
Kauta	Anaura, Marishballi	Licania spp.
Kokrodua	Afrormosia	Pericopsis elata
Lacewood	Silky Oak	Cardwellia sublimis, Grevillea robusta
Lauan	Philippine Mahogany	Shorea spp., Parashorea spp., Pentacme spp.
Lignum Vitae	-	Guaiacum officinale, Guaiacum sanctum
Limba	Afara	Terminalia superba
Mahogany, African	-	Khaya ivorensis, Khaya anthotheca
Mahogany, Philippine	Lauan	Shorea spp., Parashorea spp., Pentacme spp.
Mahogany, South American	Central American Mahogany, Honduras Mahogany	Swietenia macrophylla
Manni	Anani	Symphonia globulifera
Marishballi	Anaura, Kauta	Licania spp.

COMMON NAME	OTHER NAME	BOTANICAL NAME
Obeche	African Whitewood	Triplochiton scleroxylon
Philippine Mahogany	Lauan	Shorea spp. Parashorea spp., Pentacme spp.
Padauk	Vermillion	Pterocarpus soyauxii
Primavera	-	Cybistax donnellsmithii
Purpleheart	Amaranth	Peltogyne spp.
Ramin	-	Gonystylus bancanus
Red Ironwood	Jarra	Eucalyptus marginata
Rosewood, Bolivian	-	Machaerium acutifolium
Rosewood, Brazilian	Jacaranda	Dalbergia nigra
Rosewood, Honduras	-	Dalbergia stevensonii
Rosewood, Indian	-	Dalbergia latifolia
South American Mahogany	Central American Mahogany, Honduras Mahogany	Swietenia macrophylla
Teak	-	Tectona grandis
Vermillion	Padauk	Pterocarpus soyauxii
Wenge	-	Milletia spp.
Zebrawood	-	Microberlinia spp.

How to Calculate Board Feet

The board foot is a measure of volume. One board foot is equal to 144 square inches or a board that measures 1" thick (nominal dimension) by 12" wide (nominal dimension) by 1' long (actual dimension).



Several formulas are used to calculate board feet, but the one most often used is as follows:

Board feet = thickness (inches) × width (inches) × length (feet)/12

To use the formula for any piece of lumber, multiply the thickness (in inches) by the width (in inches) by the length (in feet) and divide the resulting number by 12. Nominal dimensions must be used for the thickness and width.

Example: How many board feet are in a 10' length of 1" × 6" lumber?

1. Plug the numbers into the formula.

Board feet = 1 × 6 × 10/12

2. Multiply the thickness, width and length.

Board feet = 60/12

3. Divide by 12.

Board feet = 5

If you prefer to avoid math, the Board Footage Chart on page 93 lists board footages for a variety of board sizes and lengths.

Board Footage Chart

Use this chart to determine board footages for the most common nominal sizes and lumber lengths. The chart also includes a column that shows the number of board feet per linear foot for each nominal size. For sizes not shown, see How to Calculate Board Feet on page 92.

NOMINAL SIZE OF BOARD *(inches)*	BOARD FEET PER LINEAR FOOT	BOARD FEET *(to the nearest hundreth)* LENGTH OF BOARD *(feet)*					
		6	8	10	12	14	16
1/2×2	.0833	.50	.67	.83	1.00	1.17	1.33
1/2×3	.1250	.75	1.00	1.25	1.50	1.75	2.00
1/2×4	.1666	1.00	1.33	1.67	2.00	2.33	2.67
1/2×6	.2500	1.50	2.00	2.50	3.00	3.50	4.00
1/2×8	.3333	2.00	2.67	3.33	4.00	4.67	5.33
1/2×10	.4166	2.50	3.33	4.17	5.00	5.83	6.67
1/2×12	.5000	3.00	4.00	5.00	6.00	7.00	8.00
1×2	.1667	1.00	1.33	1.67	2.00	2.33	2.67
1×3	.2500	1.50	2.00	2.50	3.00	3.50	4.00
1×4	.3333	2.00	2.67	3.33	4.00	4.67	5.33
1×6	.5000	3.00	4.00	5.00	6.00	7.00	8.00
1×8	.6667	4.00	5.33	6.67	8.00	9.33	10.67
1×10	.8333	5.00	6.67	8.33	10.00	11.67	13.33
1×12	1.0000	6.00	8.00	10.00	12.00	14.00	16.00
2×2	.3333	2.00	2.67	3.33	4.00	4.67	5.33
2×3	.5000	3.00	4.00	5.00	6.00	7.00	8.00
2×4	.6667	4.00	5.33	6.67	8.00	9.33	10.67
2×6	1.0000	6.00	8.00	10.00	12.00	14.00	16.00
2×8	1.3333	8.00	10.67	13.33	16.00	18.67	21.33
2×10	1.6667	10.00	13.33	16.67	20.00	23.33	26.67
2×12	2.0000	12.00	16.00	20.00	24.00	28.00	32.00
2×14	2.3333	14.00	18.67	23.33	28.00	32.67	37.33
3×3	.7500	4.50	6.00	7.50	9.00	10.50	12.00
3×4	1.0000	6.00	8.00	10.00	12.00	14.00	16.00
3×6	1.5000	9.00	12.00	15.00	18.00	21.00	24.00
3×8	2.0000	12.00	16.00	20.00	24.00	28.00	32.00
3×10	2.5000	15.00	20.00	25.00	30.00	35.00	40.00
3×12	3.0000	18.00	24.00	30.00	36.00	42.00	48.00
3×14	3.5000	21.00	28.00	35.00	42.00	49.00	56.00
3×16	4.0000	24.00	32.00	40.00	48.00	56.00	64.00
4×4	1.3333	8.00	10.67	13.33	16.00	18.67	21.33
4×6	2.0000	12.00	16.00	20.00	24.00	28.00	32.00
4×8	2.6667	16.00	21.33	26.67	32.00	37.33	42.67

NOMINAL SIZE OF BOARD *(inches)*	BOARD FEET PER LINEAR FOOT	BOARD FEET *(to the nearest hundreth)*					
		LENGTH OF BOARD *(feet)*					
		6	8	10	12	14	16
4×10	3.3333	20.00	26.67	33.33	40.00	46.67	53.33
4×12	4.0000	24.00	32.00	40.00	48.00	56.00	64.00
6×6	3.0000	18.00	24.00	30.00	36.00	42.00	48.00
6×8	4.0000	24.00	32.00	40.00	48.00	56.00	64.00
6×10	5.0000	30.00	40.00	50.00	60.00	70.00	80.00
6×12	6.0000	36.00	48.00	60.00	72.00	84.00	96.00

Softwood Lumber Grades

Softwood lumber that's used as structural members (studs, joists, rafters and the like) is classified as framing lumber. Lumber to be used for appearance applications (paneling, moulding, shelving, furniture) is classified as appearance lumber.

Framing lumber is graded primarily on the strength characteristics of the wood, with appearance a secondary consideration. Appearance lumber is graded to meet appearance standards first, and in most cases strength standards are not considered.

FRAMING LUMBER

Framing lumber has two broad classifications: dimension lumber and timbers. Most structural softwood lumber used for general building construction falls into either the dimension lumber or timber classifications.

Dimension Lumber

Dimension lumber measures between 2" and 4" in nominal thickness and has nominal widths of 2" or greater. It is used for framing members such as joists, planks, rafters, studs, posts and beams.

Light Framing Category

This is the most widely used category of lumber for framing houses. It is used when high-strength values are not required, such as wall framing, plates, blocking, sills and cripples. All lumber in this category has nominal widths of 2" to 4".

- Construction (Const): Highest grade in this category. Widely used for general framing applications.
- Standard (Stand): Used for the same applications as Construction grade but is less desirable because it may have more knots and somewhat less strength. Most building codes require that lumber used for house construction be Standard grade or better.

• Utility (Util): Can be used for temporary bracing or blocking between studs and joists. Generally quite knotty. Check building codes for acceptance.

Structural Light Framing Category
These grades fit engineering applications where the highest strength is needed for uses such as trusses and concrete forms. All lumber in this category has nominal widths of 2" to 4".

• Select Structural (Sel Str): The highest grade in this category. This grade is used when both strength and appearance are important considerations.

• No. 1 (1): Used when good strength and appearance are required.

• No. 2 (2): This grade has a less pleasing appearance but retains high strength. It is recommended for most general construction uses.

• No. 3 (3): Used for general construction when high strength isn't necessary.

Structural Joists and Planks Category
These grades fit engineering applications where higher strength is needed for such uses as trusses, joists, rafters and general framing. This category is graded according to the same guidelines that are used for the structural light framing category. All lumber in this category measures 5" nominal and wider.

• Select Structural (Sel Str): The highest grade in this category. Used where both strength and appearance are the most important considerations.

• No. 1 (1): Used when both good strength and appearance are required.

• No. 2 (2): This grade has a less pleasing appearance but retains high strength.

• No. 3 (3): Used for general construction when high strength isn't necessary.

Stud Category
A popular grade for load-bearing and non-load-bearing walls. All lumber in this grade measures 2" nominal and wider.

• Stud: Specially selected for use as studs in house framing.

Note: All four categories also have an "Economy" grade (abbreviation: Econ). However, economy grade is not intended for structural applications.

Timbers
This is a general classification for the larger sizes of structural framing lumber, but it is also the name of a specific grade and size.

Beams and Stringers Category
Lumber in this category has nominal thicknesses of 5" or more and widths more than 2" greater than the thickness (6" × 10" or 8" × 12", for example).

- Select Structural (Sel Str): Selected primarily for strength properties, but most pieces also offer good appearance for exposed applications.
- No. 1 (1): This grade has good strength qualities and many pieces have a fine appearance.
- No. 2 (2): Used when serviceability is important but higher strength properties are not required.
- No. 3 (3): Used when higher grade attributes are not required.

Posts and Timbers Category
This lumber has nominal dimensions of 5" × 5" and larger, and widths not more than 2" greater than the thickness (6" × 6" or 8" × 10", for example).

- Select Structural (Sel Str): Selected primarily for strength properties, but most pieces also offer good appearance for exposed applications.
- No. 1 (1): This grade has good strength qualities and many pieces have a fine appearance.
- No. 2 (2): Used when serviceability is important but where higher strength properties are not required.
- No. 3 (3): Used when higher grade attributes are not required.

APPEARANCE LUMBER

Appearance lumber is often called board lumber or boards. It is graded primarily for appearance rather than strength. Boards can measure from 3/8" to 4" in thickness and have widths that are 2" nominal and greater. However, the appearance boards you find in most building supply centers are likely to have 1" or 1 1/4" nominal thicknesses.

Select Grade Category
Select grades are used when the best appearance is required. The boards are graded from the best face. Select grades have a moisture content of 15 percent or less. The boards measure from 1" to 4" nominal thickness and have widths that are 2" nominal or greater. In the Select grade category, grade names for Idaho white pine differ from those used for other species.

- B and Better Select (B & Btr Sel), or Supreme (Supreme) for Idaho white pine: This is the highest grade of Select lumber. The boards might contain some small knots and slight blemishes, but many pieces are absolutely clear.
- C Select (C Sel), or Choice (Choice) for Idaho white pine: Slightly larger knots and more blemishes than B and Better Select, but is still a good quality lumber for cabinetwork.
- D Select (D Sel), or Quality (Quality) for Idaho white pine: Contains

increasingly larger knots and knotholes, but it has many of the fine appearance features of the C Select grade. It is often used as a backing or in areas that are not highly visible.

Finish Grade Category

Finish grade, like Select grade, is used when the best appearance is required. It is picked from the best side and both edges of 5" nominal and narrower pieces and from the best side and one edge of 6" nominal and wider pieces. Finish grades measure from 3/8" to 4" nominal thickness and have widths that are 2" nominal or greater. The boards are dried to a moisture content of 15 percent or less.

- Superior Finish (Superior): This is the highest grade of the finish grades. Many pieces are clear.
- Prime Finish (Prime): This grade has a fine appearance and few defects.
- E Finish (E): The E Finish grade has more defects than the Prime Finish grade. This grade is often used when it is possible to rip or crosscut the lumber to remove the defects, resulting in material that is equivalent to Prime or Superior Finish grades.

Common Grade Category

Lumber in this category has more knots than those in the select and finish grades. Common grades measure from 3/4" to 4" nominal thickness and have widths that are 2" nominal and greater. In the common grade category, grade names for Idaho white pine differ from those used for other species.

- No. 1 (1 Com), or Colonial for Idaho white pine: No. 1 Common grade has the best appearance of all the Common grades. The knots are tight and relatively small.
- No. 2 (2 Com), or Sterling for Idaho white pine: This grade is used when a knotty material with a fine appearance is required. It is often used for paneling, shelving and cabinetwork. Also, since the knots can be sealed, the boards can be painted and used for siding, soffits, fascias, cornices and other exterior applications.
- No. 3 (3 Com), or Standard for Idaho white pine: Siding, paneling, shelving, sheathing, crating, fences and boxes are some of the uses for this grade.
- No. 4 (4 Com), or Utility for Idaho white pine: Boards in this grade are generally used for subfloors, wall and roof sheathing, concrete forms, crating and low-cost fencing.
- No. 5 (5 Com), or Industrial for Idaho white pine: This grade is used when appearance and strength are not important. The boards can include unsound wood, stains, massed pitch, large knots and holes, and heavy shakes, splits and wane.

Alternate Board Grades Category
Some mills manufacture boards to the grading standards in this category. The grades are determined using the best face of the board. Alternate board grades measure from 3/4" to 1 1/2" nominal thickness and have widths that are 2" or greater.

- Select Merchantable (Sel Merch): This grade is used when knotty material can provide an acceptable appearance. Its uses include paneling and shelving.
- Construction (Const): Construction grade boards are used for roof and wall sheathing, subflooring, concrete forms and similar applications.
- Standard (Stand): This lumber is graded primarily on serviceability, although appearance is given some consideration. Lumber in this grade is usually used where it is not going to be exposed.
- Utility (Util): Utility grade lumber is selected for its utility values rather than appearance.
- Economy (Econ): The lowest grade in this category. It is often used for temporary construction. Economy grade is also used for low-grade sheathing, bracing, crating and similar applications.

Note: The grade names shown are based on the grading rules of the Western Wood Products Association. Grade names and specifications can sometimes vary among lumber grading agencies.

Softwood Lumber Standard Sizes

(NOMINAL AND DRESSED: BASED ON WESTERN WOOD PRODUCTS ASSOCIATION GRADING RULES)

ABBREVIATIONS:
S1S: Surfaced one side
S2S: Surfaced two sides
S4S: Surfaced four sides
S1S1E: Surfaced one side, one edge
S1S2E: Surfaced one side, two edges
Rough: Unsurfaced lumber cut to full specified size

FRAMING LUMBER — DIMENSION

S4S

NOMINAL SIZE		DRESSED DIMENSIONS THICKNESSES AND WIDTHS *(inches)*	
thickness (inches)	*width (inches)*	*surfaced dry*	*surfaced unseasoned*
2	2	1 1/2	1 9/16
3	3	2 1/2	2 9/16
4	4	3 1/2	3 9/16
	5	4 1/2	4 5/8
	6	5 1/2	5 5/8
	8	7 1/4	7 1/2
	10	9 1/4	9 1/2
	12	11 1/4	11 1/2
	over 12	off 3/4	off 1/2

FRAMING LUMBER — TIMBERS

Rough or S4S (shipped unseasoned)

NOMINAL SIZE *(inches)*	DIMENSIONS *(unseasoned)*
5 and larger	1/2 off nominal (S4S)

APPEARANCE LUMBER — SELECTS AND COMMONS

S1S, S2S, S4S, S1S1E, S1S2E

NOMINAL SIZE		DRY DRESSED DIMENSIONS	
THICKNESS *(inches)*	WIDTH *(inches)*	THICKNESS *(inches)*	WIDTH *(inches)*
4/4	2	3/4	1 1/2
5/4	3	1 5/32	2 1/2
6/4	4	1 3/32	3 1/2
7/4	5	1 19/32	4 1/2
8/4	6	1 13/16	5 1/2
9/4	7	2 3/32	6 1/2
10/4	8 and wider	2 3/8	3/4 off nominal
11/4		2 9/16	
12/4		2 3/4	
16/4		3 3/4	

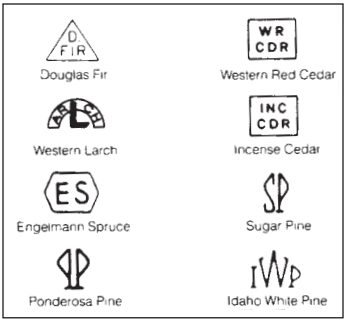
APPEARANCE LUMBER — FINISH AND ALTERNATE BOARD GRADES
*Only these sizes apply to alternate board grades.

NOMINAL SIZE		DRY DRESSED DIMENSIONS	
THICKNESS *(inches)*	WIDTH *(inches)*	THICKNESS *(inches)*	WIDTH *(inches)*
3/8	2	5/16	1 1/2
1/2	3	7/16	2 1/2
5/8	4	9/16	3 1/2
*3/4	5	5/8	4 1/2
*1	6	3/4	5 1/2
*1 1/4	7	1	6 1/2
*1 1/2	8 and wider	1 1/4	3/4 off nominal
1 3/4		1 3/8	
2		1 1/2	
2 1/2		2	
3		2 1/2	
3 1/2		3	
4		3 1/2	

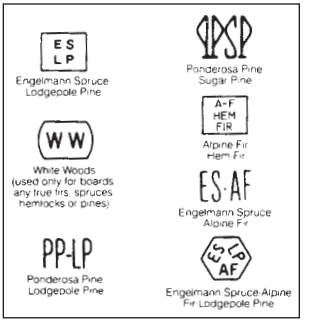
Typical Softwood Lumber Grade Stamps

Most grading stamps, except those for rough lumber or heavy timbers, contain five basic elements:

1. Grade designation. Shows grade name, number or abbreviation.
2. Species identification mark. Indicates species by individual species or species combination. Some of the marks of the Western Wood Products Association (WWPA) are shown on the next page.
3. Condition of seasoning. Indicates condition of seasoning at time of surfacing.
   MC-15: 15 percent maximum moisture content
   S-DRY: 19 percent maximum moisture content
   S-GRN: over 19 percent moisture content (unseasoned)
4. Official certification mark of the lumber association. Shown here, the mark of the Western Wood Products Association.
5. Mill identification. Shows firm name, brand name or assigned mill number.



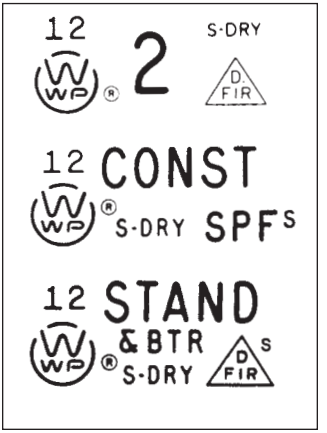
Some WWPA grade stamps identify an individual Western lumber species.



Because of timber stand composition, some mills market additional species combinations.

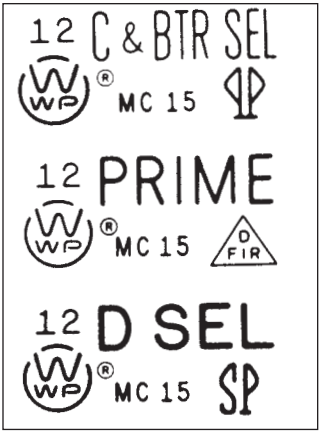
Examples of Softwood Lumber Grade Stamps

Grade stamp examples courtesy Western Wood Products Association.



Dimension Grades

Commons



Finish and Select Grades

Pressure-Treated Lumber Retention Levels

Wood exposed to moisture for long periods of time provides a perfect breeding ground for fungi to grow, and that usually results in wood decay. Also, wood is subject to attack by wood-boring insects that can weaken its structure. Wood that is pressure-treated enjoys an excellent defense against damage from decay and insects. Standards for pressure-treated wood have been developed by the American Wood Preservers Association (AWPA).

Wood preservatives fall into three broad classes: creosote, oil-borne and waterborne. Unlike creosote and oil-borne preservatives, waterborne preservatives (which use water as the solvent) leave the wood surfaces relatively clean, odor-free and paintable. Therefore, most of the pressure-treated wood sold for residential construction incorporates the waterborne preservatives. Indeed, countless backyard decks are now made from wood treated with a waterborne preservative.

For many years, chromated copper arsenate (CCA) was the most commonly used waterborne preservative. It contains arsenic, however, a known carcinogen, and that raised safety concerns among many in the general public. As a result, on January 1, 2004, the manufacturers of pressure-treated wood voluntary agreed to discontinue the use of CCA for residential applications, excepting shakes, shingles and permanent wood foundations. Two alternatives replaced CCA: alkaline copper quatermany (ACQ) and copper azole (CA).

Both ACQ and CA contain copper, and that can be corrosive to many fasteners. Fasteners should be hot-dipped galvanized to meet the American Society of Testing Materials (ASTM) Standard A153 or better.

The pressure-treating process forces the waterborne preservative deep into the wood. Resistance to fungus growth and insect attack is directly related to the amount of chemical that is added to the wood. The chemical retention level is shown as the number of pounds of chemical retained per cubic foot (pcf) of wood. A higher retention level indicates a higher resistance to fungus and insect attack.

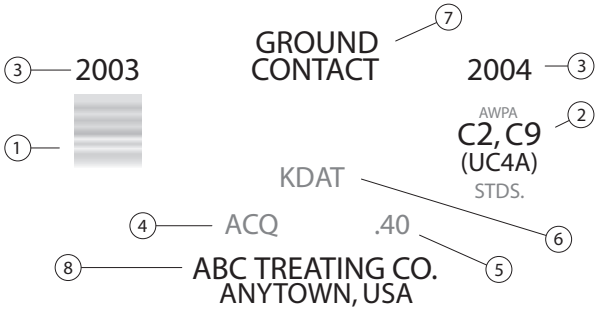
RETENTION LEVEL *(pounds pcf)*	EXPOSURE CONDITIONS	TYPICAL APPLICATIONS
.10	Above ground only	5/4-thickness deck boards
.25	Above ground only	2×-thickness framing parts, fence rails, outdoor deck not in contact with the ground
.40	Ground contact	4×-thickness and 6×-thickness deck posts, landscape landscape timbers, freshwater docks

Borate-treated wood is another option. A product of oxygen and boron, borate is found naturally throughout the world, including the deserts in California. Among its many other uses, borate is the main ingredient in certain hand-soap powders. It effectively protects wood from harmful fungi and insects. Also, it's not corrosive to fasteners. But it doesn't do as well when in direct contact with water, mostly because water can cause the borate to leach out, leaving the wood at the mercy of fungi and bugs. However, at least one company has developed a means to prevent borate from leaching out, so this is becoming less of a concern.

Typical Quality Mark for Pressure-Treated Lumber

Manufacturers associated with the AWPA apply a quality mark to pressure-treated lumber either in the form of an ink stamp or an end tag. The mark provides a variety of useful information about the pressure-treated wood. Sample below courtesy of the Southern Pine Council (www.southernpine.com).

1. Trademark of inspection agency
2. Applicable AWPA standard
3. Year wood was treated
4. Type of preservation used
5. Retention level
6. If applicable, kiln dry (KD) or kiln dry after treatment (KDAT)
7. Proper exposure conditions
8. Treating company and location



Hardwood Lumber Grades

(GENERAL REQUIREMENTS FOR EACH GRADE)

Hardwood lumber is graded differently than softwood lumber. The grading rules for hardwood lumber are established by the National Hardwood Lumber Association (NHLA).

Basically, each hardwood board is graded based on the number and size of usable pieces of wood (called cuttings) that can be obtained from a board once any defects are cut out. That means, in effect, that after cutting away the defects in a high-grade board, you'll have a low percentage of waste and end up with a relatively small number of large-size boards. And, after cutting away the defects in a low-grade board, you'll have a higher percentage of waste and a relatively large number of small-sized boards. Grades are usually determined using the poorest side of the board.

In most cases, a cutting must be "clear-faced" on at least one side in order to be considered usable. Some lower grades accept "sound cuttings," which can have several types of imperfections including stains, streaks, bird pecks, sound knots and some small holes.

The grades shown in the chart are sometimes combined. For example, grades FAS, F1F and Selects might be combined and sold as "Grade Select and Better." Grades 2A Common and 2B Common are often combined and sold as Grade No. 2 Common. In some regions, grades FAS and Selects are substituted for one another.

Not surprisingly, higher grades are more expensive than lower grades. The best grade to use depends on how you plan to use the wood. For example, if you must have long, clear-cut boards for the side of a tall cupboard, you are going to need the Select grade, or perhaps even FAS. That's because those grades, as dictated by the NHLA rules, have the longest clear-cut boards. However, if you need relatively short, narrow pieces for a chair, you might find that No. 1 Common grade is the more economical way to go.

Finally, and perhaps most importantly, there is no substitute for your own eyes. Try to examine any lumber before you buy. Usually a quick inspection will tell you if a board can provide the stock you need.

The following chart shows the general requirements for the standard grades. For detailed information, refer to the NHLA rule book. You can order it from the National Hardwood Lumber Association, 6830 Raleigh-LaGrange Road, Memphis, TN 38184-0518.

HARDWOOD LUMBER GRADE	MINIMUM BOARD SIZE	MINIMUM SIZE CUTTING	BASIC YIELD (%)	MAX. NUMBER OF CLEAR-FACED CUTTINGS
FAS (first and seconds)	6"×8'	4"×5' or 3"×7'	83 1/3	4
F1F (first and seconds, one face)	6"×8'	4"×5' or 3"×7'	83 1/3	4
Selects	4"×6'	4"×5' or 3"×7'	83 1/3	4
No. 1 Common	3"×4'	4"×2' or 3"×3'	66 2/3	5
No. 2A Common	3"×4'	3"×2'	50	7
No. 2B Common	3"×4'	3"×2'	50	7 sound cuttings
No. 3A Common	3"×4'	3"×2'	33 1/3	Unlimited
No. 3B Common	3"×4'	Not less than 1 1/2" wide containing 36 square inches	25	Unlimited sound cuttings

Note: Chart applies to most, but not all, hardwood species. See NHLA rule book for exceptions.

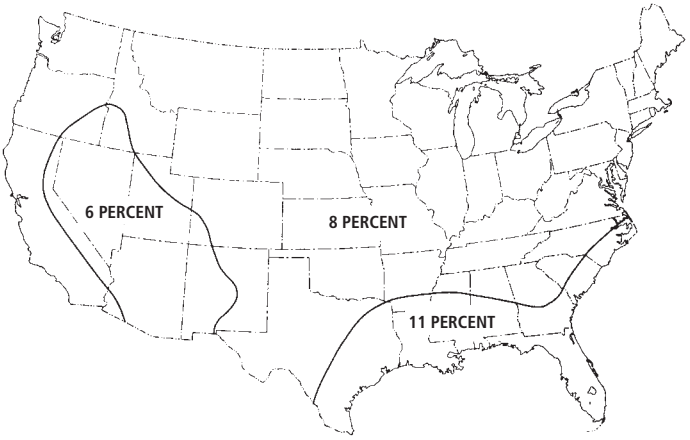
Standard Thicknesses for Hardwood Lumber (Rough and Surfaced)

ROUGH *(inches)*	S2S *(surfaced two sides)* *(inches)*	ROUGH *(inches)*	S2S *(surfaced two sides)* *(inches)*
3/8	3/16	2 1/2	2 1/4
1/2	5/16	3	2 3/4
5/8	7/16	3 1/2	3 1/4
3/4	9/16	4	3 3/4
1	13/16	4 1/2	-
1 1/4	1 1/16	5	-
1 1/2	1 5/16	5 1/2	-
1 3/4	1 1/2	6	-
2	1 3/4		

Recommended Average Moisture Content

(FOR WOOD USED TO MAKE INTERIOR FURNITURE)

The recommended average moisture content for wood varies depending upon where you live in the United States. For example, in New York, it's best to work with wood that has a moisture content of 6 percent to 8 percent. In Florida, a moisture content of 10 percent to 12 percent is ideal. Nevada woodworkers should use wood in the 4 percent to 6 percent moisture range.

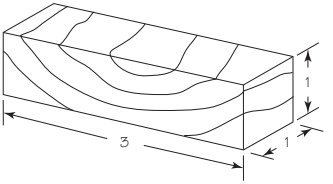


How to Determine Wood Moisture Content

A moisture meter is the fastest and easiest way to measure the moisture content in a piece of wood. Although moisture meters have become more affordable in recent years, most woodworkers feel their cost is too high to justify the expense.

Without a moisture meter in hand, your best option is to calculate the moisture content. Although the procedure is quite accurate, it isn't altogether practical for the average hobbyist woodworker. That's because you need a laboratory (gram) scale or an equivalent scale to get accurate weight measurements of the wood sample. Then, too, it can take up to twenty-four hours for the sample to fully dry in a kitchen oven — a procedure that's likely to disrupt the kitchen cooking schedule.

To do the test, you'll need a wood sample that's about 1" thick by 3" wide by 1" long. Cutting the sample in this manner exposes a considerable amount of end grain, which helps the sample dry faster. Check to make sure the sample doesn't have any knots or other defects. Also, avoid cutting the sample from an end, as that area tends to be drier than other parts of the board.



Weigh the sample using the laboratory scale and note the weight. Then place the sample in the oven and bake it at a temperature of 210° to 220° Fahrenheit. Reweigh the sample about every eight hours, taking care to avoid scorching the wood as it dries. When the sample no longer loses weight, it is at the oven-dry weight, which means it is completely free of water and has a moisture content (MC) of zero. Once you have the oven-dry weight of the sample, you can determine the MC by using the following formula:

MC = (Original weight - Oven-dry weight)/(Oven-dry weight) × 100

Example

The original weight of a sample is 14 grams. After completely drying in the oven, the sample weighs 12 grams. The moisture content of the sample was:

MC = (14 grams - 12 grams)/(12 grams) × 100
= 2 grams/12grams × 100
= .167 × 100
= 16.7 percent

Equilibrium Moisture Content

Wood either gains or loses moisture in an effort to be in balance with the relative humidity of the surrounding air. Place a dry board in a damp basement and the wood starts to slowly absorb moisture. If, after a few months, you move the same board into a bone-dry living room, the wood will start to dry out.

The amount of water in wood, expressed as a percentage of its oven-dry weight, is called its moisture content. (See previous page, How to Determine Wood Moisture Content.) The equilibrium moisture content (EMC) is defined as that moisture content at which wood is neither gaining nor losing moisture. Both temperature and relative humidity affect the EMC. The chart that follows shows the EMC for a wide range of temperature and relative humidity values.

TEMP. (F°)	EQUILIBRIUM MOISTURE CONTENT (%) AT A RELATIVE HUMIDITY OF:									
	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
30	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5
40	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.9	8.7	9.5
50	1.4	2.6	3.6	4.6	5.5	6.3	7.1	7.9	8.7	9.5
60	1.3	2.5	3.6	4.6	5.4	6.2	7.0	7.8	8.6	9.4
70	1.3	2.5	3.5	4.5	5.4	6.2	6.9	7.7	8.5	9.2
80	1.3	2.4	3.5	4.4	5.3	6.1	6.8	7.6	8.3	9.1
90	1.2	2.3	3.4	4.3	5.1	5.9	6.7	7.4	8.1	8.9
100	1.2	2.3	3.3	4.2	5.0	5.8	6.5	7.2	7.9	8.7
110	1.1	2.2	3.2	4.0	4.9	5.6	6.3	7.0	7.7	8.4
120	1.1	2.1	3.0	3.9	4.7	5.4	6.1	6.8	7.5	8.2
130	1.0	2.0	2.9	3.7	4.5	5.2	5.9	6.6	7.2	7.9
140	.9	1.9	2.8	3.6	4.3	5.0	5.7	6.3	7.0	7.7
150	.9	1.8	2.6	3.4	4.1	4.8	5.5	6.1	6.7	7.4
160	.8	1.6	2.4	3.2	3.9	4.6	5.2	5.8	6.4	7.1
170	.7	1.5	2.3	3.0	3.7	4.3	4.9	5.6	6.2	6.8
180	.7	1.4	2.1	2.8	3.5	4.1	4.7	5.3	5.9	6.5
190	.6	1.3	1.9	2.6	3.2	3.8	4.4	5.0	5.5	6.1
200	.5	1.1	1.7	2.4	3.0	3.5	4.1	4.6	5.2	5.8
210	.5	1.0	1.6	2.1	2.7	3.2	3.8	4.3	4.9	5.4
220	.4	.9	1.4	1.9	2.4	2.9	3.4	3.9	4.5	5.0
230	.3	.8	1.2	1.6	2.1	2.6	3.1	3.6	4.2	4.7
240	.3	.6	.9	1.3	1.7	2.1	2.6	3.1	3.5	4.1
250	.2	.4	.7	1.0	1.3	1.7	2.1	2.5	2.9	*

TEMP. (F°)	EQUILIBRIUM MOISTURE CONTENT (%) AT A RELATIVE HUMIDITY OF:									
	55%	60%	65%	70%	75%	80%	85%	90%	95%	98%
30	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3	26.9
40	10.4	11.3	12.3	13.5	14.9	16.5	18.5	21.0	24.3	26.9
50	10.3	11.2	12.3	13.4	14.8	16.4	18.4	20.9	24.3	26.9
60	10.2	11.1	12.1	13.3	14.6	16.2	18.2	20.7	24.1	26.8
70	10.1	11.0	12.0	13.1	14.4	16.0	17.9	20.5	23.9	26.6
80	9.9	10.8	11.7	12.9	14.2	15.7	17.7	20.2	23.6	26.3
90	9.7	10.5	11.5	12.6	13.9	15.4	17.3	19.8	23.3	26.0
100	9.5	10.3	11.2	12.3	13.6	15.1	17.0	19.5	22.9	25.6
110	9.2	10.0	11.0	12.0	13.2	14.7	16.6	19.1	22.4	25.2
120	8.9	9.7	10.6	11.7	12.9	14.4	16.2	18.6	22.0	24.7
130	8.7	9.4	10.3	11.3	12.5	14.0	15.8	18.2	21.5	24.2
140	8.4	9.1	10.0	11.0	12.1	13.6	15.3	17.7	21.0	23.7
150	8.1	8.8	9.7	10.6	11.8	13.1	14.9	17.2	20.4	23.1
160	7.8	8.5	9.3	10.3	11.4	12.7	14.4	16.7	19.9	22.5
170	7.4	8.2	9.0	9.9	11.0	12.3	14.0	16.2	19.3	21.9
180	7.1	7.8	8.6	9.5	10.5	11.8	13.5	15.7	18.7	21.3
190	6.8	7.5	8.2	9.1	10.1	11.4	13.0	15.1	18.1	20.7
200	6.4	7.1	7.8	8.7	9.7	10.9	12.5	14.6	17.5	20.0
210	6.0	6.7	7.4	8.3	9.2	10.4	12.0	14.0	16.9	19.3
220	5.6	6.3	7.0	7.8	8.8	9.9	*	*	*	*
230	5.3	6.0	6.7	*	*	*	*	*	*	*
240	4.6	*	*	*	*	*	*	*	*	*
250	*	*	*	*	*	*	*	*	*	*

* Conditions not possible at atmospheric pressure.

woodshop application

Using the Equilibrium Moisture Content Table

A basement woodshop in the northeastern United States has a year-round temperature of 60° and a constant relative humidity (with the help of a dehumidifier) of 50 percent.

1. What is the moisture content of the lumber stored for long periods of time in the basement? According to the table, the wood has an EMC of 9.4 percent at 60° Fahrenheit and 50 percent relative humidity. In short, that means lumber stored in the basement for a long enough period of time is going to end up with a moisture content of 9.4 percent.

2. Is the lumber dry enough to be used for furniture making? Referring to the guidelines for Recommended Average Moisture Content (page 107), you can see that in the northeastern United States, the average moisture content should be 8 percent. At 9.4 percent, the lumber isn't dry enough to use for furniture.

Using the EMC table you can see that the lumber can eventually be dried to 7.8 percent moisture content, an acceptable level, by maintaining the same temperature while lowering the relative humidity to 40 percent.

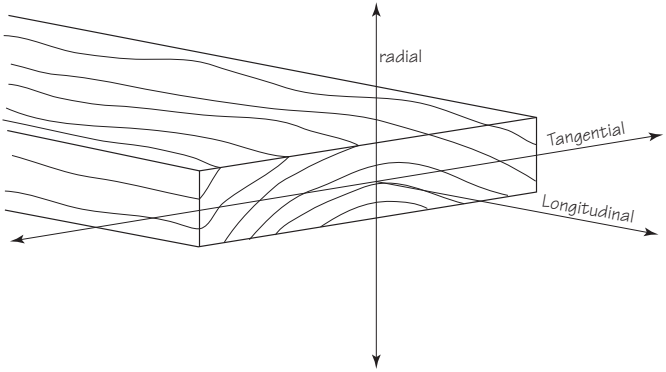
Wood Shrinkage

When a tree is harvested, the water in the cells starts to evaporate and the wood slowly dries. Little dimensional change occurs until the wood reaches its fiber saturation point. For most woods, the fiber saturation point is about 30 percent moisture content, although that number can vary up to several percentage points. Wood with a moisture content higher than the fiber saturation point is called *green wood*.

As the moisture content falls below the fiber saturation point, the wood begins to shrink primarily in two directions. Tangential shrinkage occurs in the same direction as the annular rings, while radial shrinkage occurs in a direction perpendicular to the annular rings. Little shrinkage occurs in the longitudinal direction, which is parallel to the grain of the wood. Indeed, the amount of longitudinal shrinkage is considered negligible for most woodworking projects.

The chart on the next four pages shows the amount of radial and tangential shrinkage (from green to oven-dry) for a number of domestic hardwoods, domestic softwoods and imported woods. The chart is useful in a general way because it shows that, for all wood species, tangential shrinkage is considerably more than radial shrinkage (about twice as much on average).

The chart also allows you to quickly compare the shrinkage value of one wood species to another. For example, if you must keep wood movement to a minimum and you have the option of using black cherry or sugar maple, the chart quickly shows that black cherry is the better choice.



SHRINKAGE VALUES OF VARIOUS WOOD SPECIES

SPECIES	SHRINKAGE (%) FROM GREEN TO OVEN-DRY MOISTURE CONTENT	
	RADIAL	*TANGENTIAL*
Domestic Hardwoods		
Alder, Red	4.4	7.3
Ash, Black	5.0	7.8
Ash, Blue	3.9	6.5
Ash, Green	4.6	7.1
Ash, Oregon	4.1	8.1
Ash, Pumpkin	3.7	6.3
Ash, White	4.9	7.8
Aspen, Bigtooth	3.3	7.9
Aspen, Quaking	3.5	6.7
Basswood, American	6.6	9.3
Beech, American	5.5	11.9
Birch, Alaska Paper	6.5	9.9
Birch, Gray	5.2	-
Birch, Paper	6.3	8.6
Birch, River	4.7	9.2
Birch, Sweet	6.5	9.0
Birch, Yellow	7.3	9.5
Buckeye, Yellow	3.6	8.1
Butternut	3.4	6.4
Cherry, Black	3.7	7.1
Chestnut, American	3.4	6.7
Cottonwood, Balsam Poplar	3.0	7.1
Cottonwood, Black	3.6	8.6
Cottonwood, Eastern	3.9	9.2
Elm, American	4.2	9.5
Elm, Cedar	4.7	10.2
Elm, Rock	4.8	8.1
Elm, Slippery	4.9	8.9
Elm, Winged	5.3	11.6
Hackberry	4.8	8.9
Hickory, Pecan	4.9	8.9
Hickory (True), Mockernut	7.7	11.0
Hickory (True), Pignut	7.2	11.5
Hickory (True), Shagbark	7.0	10.5
Hickory (True), Shellbark	7.6	12.6
Holly, American	4.8	9.9
Honey Locust	4.2	6.6
Locust, Black	4.6	7.2
Madrone, Pacific	5.6	12.4

SHRINKAGE VALUES OF VARIOUS WOOD SPECIES

SPECIES	SHRINKAGE (%) FROM GREEN TO OVEN-DRY MOISTURE CONTENT	
	RADIAL	*TANGENTIAL*
Magnolia, Cucumber Tree	5.2	8.8
Magnolia, Southern	5.4	6.6
Magnolia, Sweet Bay	4.7	8.3
Maple, Bigleaf	3.7	7.1
Maple, Black	4.8	9.3
Maple, Red	4.0	8.2
Maple, Silver	3.0	7.2
Maple, Striped	3.2	8.6
Maple, Sugar	4.8	9.9
Oak (Red), Black	4.4	11.1
Oak (Red), Laurel	4.0	9.9
Oak (Red), Northern Red	4.0	8.6
Oak (Red), Pin	4.3	9.5
Oak (Red), Scarlet	4.4	10.8
Oak (Red), Southern Red	4.7	11.3
Oak (Red), Water	4.4	9.8
Oak (Red), Willow	5.0	9.6
Oak (White), Burr	4.4	8.8
Oak (White), Chestnut	5.3	10.8
Oak (White), Live	6.6	9.5
Oak (White), Overcup	5.3	12.7
Oak (White), Post	5.4	9.8
Oak (White), Swamp Chestnut	5.2	10.8
Oak, White	5.6	10.5
Persimmon, Common	7.9	11.2
Sassafras	4.0	6.2
Sweet Gum	5.3	10.2
Sycamore, American	5.0	8.4
Tan Oak	4.9	11.7
Tupelo, Black	5.1	8.7
Tupelo, Water	4.2	7.6
Walnut, Black	5.5	7.8
Willow, Black	3.3	8.7
Yellow Poplar	4.6	8.2
Domestic Softwoods		
Bald Cypress	3.8	6.2
Cedar, Alaska	2.8	6.0
Cedar, Atlantic White	2.9	5.4
Cedar, Eastern Red	3.1	4.7
Cedar, Incense	3.3	5.2

SHRINKAGE VALUES OF VARIOUS WOOD SPECIES

SPECIES	SHRINKAGE (%) FROM GREEN TO OVEN-DRY MOISTURE CONTENT	
	RADIAL	*TANGENTIAL*
Cedar, Northern White	2.2	4.9
Cedar, Port Orford	4.6	6.9
Cedar, Western Red	2.4	5.0
Douglas Fir, Coast	4.8	7.6
Douglas Fir, Interior North	3.8	6.9
Douglas Fir, Interior West	4.8	7.5
Fir, Balsam	2.9	6.9
Fir, California Red	4.5	7.9
Fir, Grand	3.4	7.5
Fir, Noble	4.3	8.3
Fir, Pacific Silver	4.4	9.2
Fir, Subalpine	2.6	7.4
Fir, White	3.3	7.0
Hemlock, Eastern	3.0	6.8
Hemlock, Mountain	4.4	7.1
Hemlock, Western	4.2	7.8
Larch, Western	4.5	9.1
Pine, Eastern White	2.1	6.1
Pine, Jack	3.7	6.6
Pine, Loblolly	4.8	7.4
Pine, Lodgepole	4.3	6.7
Pine, Longleaf	5.1	7.5
Pine, Pitch	4.0	7.1
Pine, Pond	5.1	7.1
Pine, Ponderosa	3.9	6.2
Pine, Red	3.8	7.2
Pine, Shortleaf	4.6	7.7
Pine, Slash	5.4	7.6
Pine, Sugar	2.9	5.6
Pine, Virginia	4.2	7.2
Pine, Western White	4.1	7.4
Redwood, old-growth	2.6	4.4
Redwood, young-growth	2.2	4.9
Spruce, Black	4.1	6.8
Spruce, Engelmann	3.8	7.1
Spruce, Red	3.8	7.8
Spruce, Sitka	4.3	7.5
Tamarack	3.7	7.4

SHRINKAGE VALUES OF VARIOUS WOOD SPECIES

SPECIES	SHRINKAGE (%) FROM GREEN TO OVEN-DRY MOISTURE CONTENT	
	RADIAL	*TANGENTIAL*
Some Imported Woods		
Afrormosia	3.0	6.4
Balsa	3.0	7.6
Benge	5.2	8.6
Bubinga	5.8	8.4
Ebony	5.5	6.5
Lauan (Shorea spp.)	3.8	8.0
Mahogany, African	2.5	4.5
Mahogany, Honduras	3.0	4.1
Purpleheart	3.2	6.1
Rosewood, Brazilian	2.9	4.6
Rosewood, Indian	2.7	5.8
Teak	2.5	5.8

Time Required to Air-Dry Lumber to 20% Moisture Content

The following chart shows the approximate number of days required to air-dry 1"-thick green lumber to a moisture content of 20 percent. To provide the best opportunity for drying, the lumber should be stickered to allow air circulation between the boards.

You'll note that the drying time for each species varies considerably. That's because, to a large extent, the drying time depends upon the season of the year that the lumber is set out to dry. For example, the drying time for lumber set out in the spring and summer, which are the best months for drying, is likely to be near the minimum number of days. But lumber set out to dry in the fall or winter isn't likely to reach 20 percent moisture content until the following spring.

The drying times should be considered as approximations because average drying conditions can vary considerably from one year to the next. For example, an unusually cool, damp spring is going to lengthen the drying time for that season. Also, keep in mind that lumber at 20 percent moisture content must be further dried before it can be used for furniture (see page 107, Recommended Average Moisture Content).

DRYING TIME — HARDWOODS SPECIES	DAYS REQUIRED TO AIR-DRY 1"-THICK GREEN LUMBER TO 20% MOISTURE CONTENT
Alder, Red	20-180
Ash, Black	60-200
Ash, Green	60-200
Ash, White	60-200
Aspen, Bigtooth	50-150
Aspen, Quaking	50-150
Basswood, American	40-150
Beech, American	70-200
Birch, Paper	40-200
Birch, Sweet	70-200
Birch, Yellow	70-200
Butternut	60-200
Cherry, Black	70-200
Cottonwood, Black	60-150
Cottonwood, Eastern	50-150
Elm, American	50-150
Elm, Rock	80-180
Hackberry	30-150
Hickory	60-200
Magnolia, Southern	40-150
Maple, Bigleaf	60-180
Maple, Red	30-120
Maple, Silver	30-120
Maple, Sugar	50-200
Oak, Northern Red	70-200
Oak, Northern White	80-250
Oak, Southern Red	100-300
Oak, Southern White (Chestnut)	120-320
Pecan	60-200
Sweet Gum, heartwood	70-300
Sweet Gum, sapwood	60-200
Sycamore, American	30-150
Tan Oak	180-365
Tupelo, Black	70-200
Tupelo, Water	70-200
Walnut, Black	70-200
Willow, Black	30-150
Yellow Poplar	40-150

DRYING TIME — SOFTWOODS

SPECIES	DAYS REQUIRED TO AIR-DRY 1"-THICK GREEN LUMBER TO 20% MOISTURE CONTENT
Bald Cypress	100-300
Douglas Fir, Coast	20-200
Douglas Fir, Interior North	20-180
Douglas Fir, Interior South	10-100
Douglas Fir, Interior West	20-120
Hemlock, Eastern	90-200
Hemlock, Western	60-200
Larch, Western	60-120
Pine, Eastern White	60-200
Pine, Jack	40-200
Pine, Loblolly	30-150
Pine, Lodgepole	15-150
Pine, Longleaf	30-150
Pine, Ponderosa	15-150
Pine, Red	40-200
Pine, Shortleaf	30-150
Pine, Slash	30-150
Pine, Sugar (Light)	15-90
Pine, Sugar (Sinker)	45-200
Pine, Western White	15-150
Redwood, Light	60-185
Redwood, Sinker	200-365
Spruce, Engelmann	20-120
Spruce, Red	30-120
Spruce, Sitka	40-150
Spruce, White	30-120

Hardness

It can be useful to know the hardness of various woods. A wood species that's harder than another won't dent or wear as easily. A standardized procedure, called the Janka Hardness Test, is used to measure wood hardness. The test measures the force to push a 0.444" diameter steel ball until one-half its diameter (0.222") is embedded in a wood sample.

In practice, several penetrations are made, and the result is an average of all the tests on the sample. To account for grain, penetrations are made in both radial and tangential directions. The tested wood has a moisture content of 12 percent.

In the United States, the pushing force is measured in units called pound-force. As I discovered, it's possible to get dizzy reading the definition of pound-force. Thankfully, though, you don't need to understand the units; you need look only at the relative number. The higher the number, the harder the wood. For example, yellow birch, with a hardness number of 1,260, is harder than red maple, with its hardness number of 950.

DOMESTIC SPECIES	JANKA POUND-FORCE
Alder, Red	590
Ash, Black	850
Ash, White	1,320
Aspen, Quaking	350
Beech, American	1,300
Birch, Yellow	1,260
Butternut	490
Cedar, Northern White	320
Cedar, Western Red	350
Cherry, Black	950
Chestnut, American	540
Cocobolo	1,136
Douglas Fir, Western Interior	660
Elm, American	830
Elm, Slippery	860
Fir, Balsam	400
Hemlock, Eastern	500
Larch, Western	830
Locust, Black	1,700
Maple, Black	840
Maple, Red	950
Maple, Sugar	1,450
Oak, Northern Red	1,290
Oak, Pin	1,510

Oak, Southern Red	1,060
Oak, White	1,360
Pine, Eastern White	380
Pine, Longleaf	870
Pine, Ponderosa	460
Pine, Shortleaf	690
Pine, Sugar	380
Pine, Loblolly	690
Poplar, Yellow	540
Spruce, Sitka	510
Sweetgum	850
Sycamore, American	770
Walnut, Black	1,010

IMPORTED SPECIES	JANKA POUND-FORCE
Bloodwood	2,900
Brazilian Cherry (Jatoba)	2,350
Bubinga (African Rosewood)	1,980
Ebony	3,220
Goncalo Alves	2,160
Ipe	3,680
Iroko	1,260
Jatoba (Brazilian cherry)	2,350
Jarrah	1,910
Lignum Vitae	4,500
Mahogany, African	830
Padauk, African	1,725
Purpleheart	1,860
Rosewood, African (Bubinga)	1,980
Rosewood, Brazilian	2,720
Rosewood, Indian	3,170
Teak	1,000
Wenge	1,630
Zebrawood	1,575

Working Properties of Some Hardwoods

All the information in this chart is based on actual tests. Use it to determine the likelihood of success when planing, shaping, turning, boring or sanding any of the hardwoods listed. For example, the chart shows that beech turns well (90 percent fair to excellent pieces), but it doesn't do so well when shaped (24 percent good to excellent pieces).

HARDWOOD	PLANING (1)	SHAPING (2)	TURNING (3)	BORING (4)	SANDING (5)
Alder, Red	61	20	88	64	*
Ash	75	55	79	94	75
Aspen	26	7	65	78	*
Basswood	64	10	68	76	17
Beech	83	24	90	99	49
Birch	63	57	80	97	34
Birch, Paper	47	22	*	*	*
Cherry, Black	80	80	88	100	*
Chestnut	74	28	87	91	64
Cottonwood	21	3	70	70	19
Elm, Soft	33	13	65	94	66
Hackberry	74	10	77	99	*
Hickory	76	20	84	100	80
Magnolia	65	27	79	71	37
Maple, Bigleaf	52	56	80	100	*
Maple, Hard	54	72	82	99	38
Maple, Soft	41	25	76	80	37
Oak, Red	91	28	84	99	81
Oak, White	87	35	85	95	83
Pecan	88	40	89	100	*
Sweet Gum	51	28	86	92	23
Sycamore	22	12	85	98	21
Tan Oak	80	39	81	100	*
Tupelo, Water	55	52	79	62	34
Tupelo, Black	48	32	75	82	21
Walnut, Black	62	34	91	100	*
Willow	52	5	58	71	24
Yellow Poplar	70	13	81	87	19

(1) percentage of perfect pieces
(2) percentage of good to excellent pieces
(3) percentage of fair to excellent pieces
(4) percentage of good to excellent pieces
(5) percentage of good to excellent pieces

*Test data not available.

Approximate Relative Heartwood Decay Resistance

The heartwood of a tree is the older portion of wood that extends from the tree center (also called the pith) to the sapwood. Unlike sapwood, the heartwood doesn't conduct sap and it no longer has living cells. Heartwood is usually darker and has better decay resistance than sapwood.

Decay resistance is important when choosing a wood that's to be used outdoors or in a damp environment. This list enables you to quickly compare the relative heartwood decay resistances of some common domestic woods.

RESISTANT OR VERY RESISTANT
Bald Cypress (old growth)
Catalpa
Cedars
Cherry, Black
Chestnut
Cypress, Arizona
Junipers
Locust, Black*
Mesquite
Mulberry, Red*
Oak, Bur
Oak, Chestnut
Oak, Gambel
Oak, Oregon White
Oak, Post
Oak, White
Osage Orange*
Redwood
Sassafras
Walnut, Black
Yew, Pacific*

*Wood has exceptionally high decay resistance.

MODERATELY RESISTANT

Bald Cypress (young growth)
Douglas Fir
Honey Locust
Larch, Western
Oak, Swamp Chestnut
Pine, Eastern White
Pine, Longleaf
Pine, Slash
Tamarack

SLIGHTLY OR NONRESISTANT

Alder
Ashes
Aspens
Basswood
Beech
Birches
Buckeye
Butternut
Cottonwood
Elms
Hackberry
Hemlocks
Hickories
Magnolia
Maples
Oak, Red
Oak, Black
Pines (except Eastern White, Longleaf and Slash)
Poplars
Spruces
Sweet Gums
True Firs
Balsam Fir
California Red Fir
Fraser Fir
Grand Fir
Noble Fir
Pacific Fir
Subalpine Fir
Willows
Yellow Poplar

Steam Bending Table

Air-dried wood becomes quite pliable when heated to approximately 212° Fahrenheit. Bent wood has many woodworking applications, including chair parts, curved railings and walking sticks.

This table shows the limiting steam-bending radius for several domestic and imported woods. The table is based on using good quality (straight-grained and free from defects) 1"-thick air-dried wood with a moisture content of 25 to 30 percent. The bending radius shown anticipates that up to 5 percent of the pieces could break during the bending process. Note that the use of a strap, which supports the stretched wood fibers during the bend, allows for a tighter radius.

The table is adapted from *The Wood Bending Handbook* by W.C. Stevens and N. Turner, an excellent book on the subject of bending wood. It's available from Woodcraft, 1177 Rosemar Road, P.O. Box 1686, Parkersburg, WV 26102-1686; (800) 535-4482; www.woodcraft.com.

COMMON NAME	BOTANICAL NAME	RADIUS	
		UNSUPPORTED	SUPPORTED W/ STRAP
Afrormosia	Pericopsis elata	29.0	14.0
Ash, American	Fraxinus spp.	13.0	4.5
Birch, Yellow*	Betula alleghaniensis	17.0	3.0
Crabwood	Carapa guianensis	48.0	30.0
Douglas Fir	Pseudotsuga menziesii	33.0	18.0
Ebony, African	Diospyros crassiflora	15.0	10.0
Elm, Rock	Ulmus thomasii	14.0	1.5
Elm, American	Ulmus americana	13.5	1.7
Hickory	Carya spp.	15.0	1.8
Iroko	Chlorophora excelsa	18.0	15.0
Jarrah*	Eucalyptus marginata	39.0	17.5
Mahogany, African	Khaya anthotheca	24.0	20.0
Mahogany, Honduras	Swietenia macrophylla	28.0	12.0
Oak, American White	Quercus spp.	13.0	.5
Oak, Red	Quercus rubra	11.5	1.0
Purpleheart	Peltogyne spp.	30.0	18.0
Ramin	Gonystylus bancanus	37.0	36.0
Teak	Tectona grandis	35.0	18.0

*Data from results of small-scale tests only.

CHAPTER FOUR

manufactured woods

4

Softwood Plywood

Softwood plywood is used primarily for general construction applications such as wall and roof sheathing, siding and subflooring. In the woodworking shop, softwood plywood is used for jigs, fixtures, shelves, shop cabinets and much more. When building furniture, however, softwood plywood is rarely used as a substrate for plastic laminate or high-quality veneer because the uneven plywood surfaces tend to show even after a veneer or laminate is applied.

Plywood is made by gluing thin sheets of wood, called veneers or plies, at right angles to each other. This cross-grained construction results in a wood product that is exceptionally strong. Also, it creates outstanding dimensional stability, which means the plywood changes little in length and width, even as the relative humidity changes.

Softwood plywood is almost always made using an odd number of veneers, usually three, five or seven. Using an odd number of veneers allows the grain of the two outside veneers (one in front and one in back) to run in the same direction.

During manufacture, small defects in the veneers (such as knots and splits) are removed with special cutters. A wood or synthetic plug (sometimes called a patch) is used to repair the cutout.

The Engineered Wood Association (APA) is the major trade association for the softwood plywood industry. Its member mills produce approximately 80 percent of the softwood plywood made in the United States. Most softwood plywood is made into 4' × 8' panels, although 4' × 9' and 4' × 10' panels are also available.

STANDARD THICKNESSES

FRACTION *(inches)*	METRIC EQUIVALENT *(millimeters)*
1/4	6.4
5/16	7.9
11/32	8.7
3/8	9.5
7/16	11.1
15/32	11.9
1/2	12.7
19/32	15.1
5/8	15.9
23/32	18.3

STANDARD THICKNESSES

FRACTION *(inches)*	METRIC EQUIVALENT *(millimeters)*
3/4	19.1
7/8	22.2
1	25.4
1 3/32	27.8
1 1/8	28.6

SPECIES GROUP NUMBER

Softwood plywood is made from over seventy species of wood. The species are divided into five groups numbered in descending order of strength and stiffness, with Group 1 the highest and Group 5 the lowest.

GROUP 1

Apitong
Beech, American
Birch, Sweet
Birch, Yellow
Douglas Fir 1*
Kapur
Keruing
Larch, Western
Maple, Sugar
Pine, Caribbean
Pine, Loblolly
Pine, Longleaf
Pine, Ocote
Pine, Shortleaf
Pine, Slash
Tan Oak

GROUP 2

Cedar, Port Orford
Cypress
Douglas Fir 2*
Fir, Balsam
Fir, California Red
Fir, Grand
Fir, Noble
Fir, Pacific Silver
Fir, White
Hemlock, Western
Lauan, Almon
Lauan, Bagtikan
Lauan, Mayapis
Lauan, Red
Lauan, Tangile
Lauan, White
Maple, Black
Mengkulang
Meranti, Red
Mersawa
Pine, Pond
Pine, Red
Pine, Virginia
Pine, Western White
Spruce, Black
Spruce, Red
Spruce, Sitka
Sweet Gum
Tamarack
Yellow Poplar

GROUP 3

Alder, Red
Birch, Paper
Cedar, Alaska
Fir, Subalpine
Hemlock, Eastern
Maple, Bigleaf
Pine, Jack
Pine, Lodgepole
Pine, Ponderosa
Pine, Spruce
Redwood
Spruce, Engelmann
Spruce, White

GROUP 4

Aspen, Bigtooth
Aspen, Quaking
Cativo
Cedar, Incense
Cedar, Western Red
Cottonwood, Eastern
Cottonwood, Black (Western Poplar)
Pine, Eastern White
Pine, Sugar

GROUP 5

Basswood
Poplar, Balsam

*Douglas Fir grown in Washington, Oregon, California, Idaho, Montana, Wyoming, Alberta or British Columbia is classified as Douglas Fir 1. That grown in Nevada, Utah, Colorado, Arizona or New Mexico is classified as Douglas Fir 2.

EXPOSURE DURABILITY

Exposure durability classification is a measure of the strength of the softwood plywood glue bond as it relates to weather and the resulting moisture.

EXPOSURE DURABILITY CLASSIFICATION	DESCRIPTION
Exterior	Has a fully waterproof bond. Designed for permanent exposure to weather or moisture
Exposure 1	Has a fully waterproof bond. Designed for applications where high moisture conditions might be encountered, or where long construction delays are expected prior to providing protection
Exposure 2	Intended for protected applications subjected to the occasional exposure to high humidity and water leakage
Interior	Made with interior glue; intended for interior applications only

Softwood Plywood

Softwood plywood outer veneers (face and back) are graded on the basis of natural growth characteristics of the wood and also the allowable size and number of repairs that may be made during manufacture. In addition to the grades below, some manufacturers also produce an N grade, which has the highest quality veneer and is available via special order only.

OUTER VENEER GRADE	DESCRIPTION
A	Has a smooth, paintable surface. Not more than eighteen neatly made repairs permitted. Repairs can be wood or synthetic
B	Has a solid surface. Shims, sled or router-type repairs and tight knots to 1" across grain permitted. Wood or synthetic repairs permitted. Some minor splits permitted
C Plugged	Improved C veneer. Splits limited to 1/8" width; knotholes or other open defects limited to 1/4" × 1/2". Wood or synthetic repairs permitted. Admits some broken grain
C	Tight knots to 1 1/2". Knotholes to 1" across grain and some to 1/2" if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength are permitted. Limited splits allowed. Stitching permitted
D	Knots and knotholes to 2 1/2" width across grain and 1/2" larger within specified limits. Limited splits are permitted. Stitching permitted. Exposure durability classification limited to Exposure 1 or Interior

GRADE DESIGNATIONS

Softwood plywood grades are usually identified in one of two ways: either (1) in terms of the veneer grade used on the face and back of the plywood or (2) by a name suggesting the plywood's intended use (including APA Performance Rated Panels).

GRADE DESIGNATION BY FACE AND BACK VENEER GRADES

A softwood plywood that's identified by the veneer grade on the face and back might be stamped A-B. Such a designation indicates that the face has an A-grade veneer, while the back has a B-grade veneer (see page 127, Softwood Plywood Outer Veneer Grade). Other grade combinations include A-A, B-C, B-D and C-D.

GRADE DESIGNATION BY INTENDED USE

Plywood that is identified by a name suggesting the intended use might be stamped Underlayment or Marine. This grade designation also includes the APA Performance Rated Panels which are identified by such names as APA Rated Sheathing, APA Rated Sturd-I-Floor or APA Rated Siding.

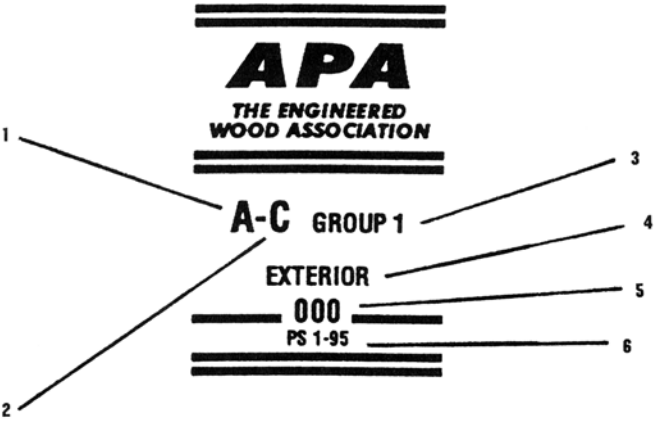
SPAN RATINGS

APA Performance Rated Panels (APA Rated Sheathing, APA Rated Sturd-I-Floor and APA Rated Sidings) are further identified with a span rating. On APA Rated Sheathing, the span numbers are shown as two numbers separated by a slash (for example, 32/16 or 48/24). The first number indicates the maximum recommended spacing of supports when the plywood is used for roof sheathing. The second number indicates the maximum recommended spacing of supports when the plywood is used for subflooring. The span rating is shown as a single number on APA Rated Sturd-I-Floor and APA Rated Siding. All span ratings are based on installing the plywood panels with the long dimension across three or more supports.

GRADE MARK

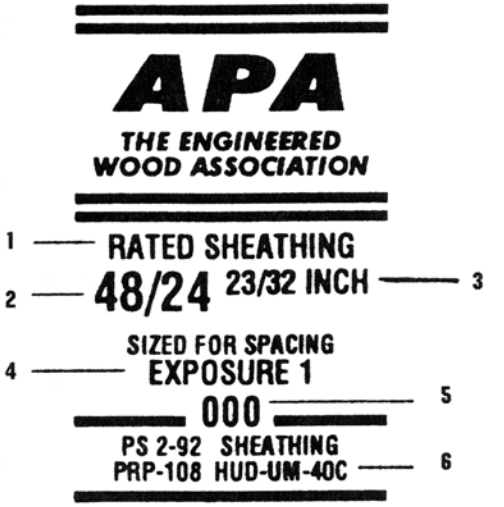
Manufacturers label plywood with a grade mark. The grade mark provides useful information about the plywood product. Depending on the grade designation, the grade mark can be applied to the back or edge of the plywood.

GRADE MARK FOR PLYWOOD IDENTIFIED BY FACE AND BACK VENEER GRADES



The grade mark for plywood, identified by the face and back veneer grades, includes (1) the grade of the face veneer, (2) the grade of the back veneer, (3) the species group number, (4) the exposure durability classification, (5) the lumber mill that produced the panel (shown as a number) and (6) the applicable product standard.

GRADE MARK FOR PLYWOOD IDENTIFIED BY INTENDED USE*



This grade mark can vary a bit, but in general includes (1) the panel grade designation, (2) the span rating, (3) the thickness, (4) the exposure durability classification, (5) the lumber mill that produced the panel (shown as a number) and (6) the applicable product standard.

*Grade mark shown is for an APA Performance Rated Panel.

Hardwood Plywood

Hardwood plywood is used primarily for appearance applications. It provides an attractive wood surface that, as a general rule, costs less than solid-stock hardwood lumber of the same species. Also, because of its construction, hardwood plywood is dimensionally stable, which means little expansion and contraction occurs as the relative humidity changes.

The plywood panel side that has the higher-grade outer veneer is called the face or the face side. The side with the lower-grade veneer is called the back. When the two outer veneers are the same grade, the panel doesn't have a back but rather has two face sides.

The material sandwiched between the two outer veneers is called the core. Hardwood plywood cores are made from either softwood or hardwood veneer (not necessarily the same grade as the outer veneers), softwood or hardwood lumber, particleboard, medium-density fiberboard (MDF) or hardboard.

When hardwood plywood has five or more plies, the first layer of veneer under the outer veneer is called the crossband. The crossband is assembled at right angles (90°) to the grain of the outer veneer. In addition, the term crossbanding is used to describe all the inner layers of veneer that have a grain direction running at right angles to the outer veneers.

The type and quality of hardwood plywood is affected by a variety of factors including (1) the wood species of the face veneer, (2) the grade of the face veneer, (3) the wood species of the back veneer, (4) the grade of the back veneer, (5) the construction of the core and (6) the type of glue bond.

When purchasing hardwood plywood, you will find a variety of thickness, width and length combinations to choose from. However, the most commonly found hardwood plywood panel sizes are 4' × 6', 4' × 8' and 4' × 10'. Commonly found thicknesses are shown in the following chart. Other thicknesses might be available; check your dealer.

HARDWOOD PLYWOOD THICKNESSES

FRACTION *(inches)*	METRIC EQUIVALENT *(millimeters)*
1/8	3.2
1/4	6.4
3/8	9.5
1/2	12.7
5/8	15.9
3/4	19.1
7/8	22.2
1	25.4
1 1/8	28.6

CATEGORIES OF WOOD SPECIES COMMONLY USED FOR FACE SIDES OF HARDWOOD PLYWOOD

CATEGORY A
Apitong
Ash, White
Beech, American
Birch, Sweet
Birch, Yellow
Bubinga
Hickory
Kapur
Dryobalanops spp.
Keruing
Dipterocarpus spp.
Maple, Sugar
Oak, Red
Oak, White
Pecan
Rosewood
Sapele
Tan Oak

CATEGORY B
Ash, Black
Avodire
Birch, Paper
Cherry
Cucumber Tree
Cypress
Douglas Fir
Elm, Rock
Fir, White
Gum
Hemlock, Western
Magnolia, Southern
Mahogany, African
Mahogany, Honduras
Maple, Black
Maple, Red
Spruce, Red
Spruce, Sitka
Sycamore
Teak
Walnut, Black
Yellow Poplar

CATEGORY C
Alder, Red
Basswood
Butternut
Cativo
Chestnut
Cottonwood, Black
Cottonwood, Eastern
Elm, American
Elm, Slippery
Hackberry
Hemlock, Eastern
Lauan
Maple, Silver
Merandi
Parashorea spp.
Pentacme spp.
Shorea spp.
Pine, Ponderosa
Pine, Sugar
Pine, Eastern White
Pine, Western White
Primavera
Redwood
Sassafras
Shorea spp.
Spruce, Black
Spruce, Engelmann
Spruce, White
Tupelo

CATEGORY D
Aspen, Bigtooth
Aspen, Quaking
Cedar, Eastern Red
Cedar, Western Red
Willow, Black

HARDWOOD PLYWOOD — STANDARD GRADES FOR FACE VENEERS

The grades, based primarily on appearance features, are shown in descending order of quality. The best appearance veneers are Grade AA, and the lowest are Grade E.

GRADE	GENERAL DESCRIPTION
AA	Highest quality veneer with an excellent appearance. For use in high-end applications such as quality furniture, case goods, doors and cabinets, and architectural paneling
A	Allows more imperfections than Grade AA but remains a high-quality panel
B	Exhibits more imperfections than Grade A, but still an attractive panel for many applications
C, D and E	Veneer has sound surfaces but allows unlimited color variation. Permits repairs that increase in size and number from Grade C to Grade E. Generally used where a more natural appearance is desired or where the surface is hidden
SP (Specialty Grade)	Grade is limited to veneers that have characteristics unlike any found in Grades AA through E. Species such as wormy chestnut and bird's-eye maple fall into Grade SP. Acceptable characteristics are as agreed upon by buyer and seller

HARDWOOD PLYWOOD — BACK GRADES

The grades are shown in descending order of quality, with Grade 1 the highest and Grade 4 the lowest.

IMPERFECTION	GRADE 1	GRADE 2	GRADE 3	GRADE 4
Sapwood	Yes	Yes	Yes	Yes
Discoloration and stain	Yes	Yes	Yes	Yes
Mineral streaks	Yes	Yes	Yes	Yes
Sound tight burls	Yes	Yes	Yes	Yes
Sound tight knots	Max. dia. 3/8"	Max. dia. 3/4"	Max. dia. 1 1/2"	Yes
Max. number of tight knots	16	16	Unlimited to 1/2", max. 16 from 1/2" to 1 1/2"	Unlimited
Knotholes	No	1/2" repaired	1*	4
Max. combined number of knotholes and repaired knots	None**	All repaired; unlimited to 3/8", no more than 8 from 3/8" to 1/2"	Unlimited to 3/8", no more than 10 from 3/8" to 1"	Unlimited
Wormholes	Filled***	Filled***	Yes	Yes
Splits or open joints	Six 1/8" × 12" repaired	Six 3/16" × 12" repaired	Yes, 3/8" for 1/4" panel length*	1" for 1/4 panel length, 1/2" for 1/2" panel length, 1/4" for full length of panel
Doze (dote) and decay	Firm areas of doze	Firm areas of doze	Firm areas of doze	Areas of doze and decay OK provided serviceability not impaired
Rough cut/ ruptured grain	Two 8"-diameter areas	5 percent of panel	Yes	Yes
Bark pockets	1/8" wide repaired	1/4" wide repaired	Yes*	Yes
Laps	No	Repaired	Yes*	Yes

*Available repaired if necessary.
**Pin knots and repaired pin knots allowed.
***Unfilled wormholes shall be a maximum of 1/16" dia.

INNER VENEER GRADES FOR VENEER-CORE HARDWOOD PLYWOOD

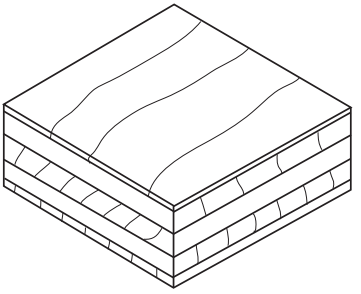
Grade designations are based on the allowable openings in the veneers.

DESCRIPTION	GRADE J	GRADE K	GRADE K	GRADE L	GRADE M
Thickness of crossbands adjacent to faces	Any thickness	Thicker than 1/10"	1/10" and thinner	Any thickness	Any thickness
Knotholes and other similarly shaped openings (max. dia.)	None	3/8"	3/4"	1"	2 1/2"
Splits, gaps and other elongated end or edge openings. Each opening is visible on only one end or edge of panel (max. width)	1/8"	1/4"	1/4"	1/2"	1"

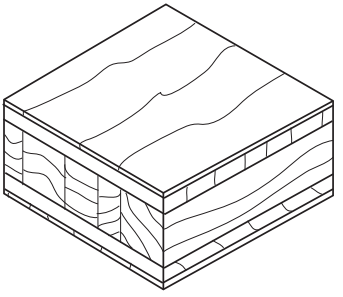
HARDWOOD PLYWOOD TYPES

Three hardwood plywood types are available. With each one, the glue bond offers different moisture-resistance qualities.

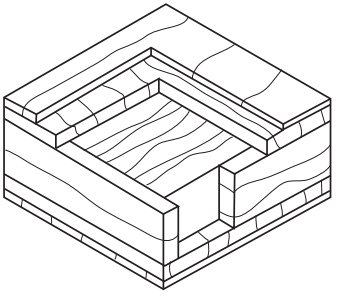
TYPE	DESCRIPTION
Technical (Exterior)	Fully waterproof. Meets panel construction criteria for special applications such as marine and aircraft
Type I (Exterior)	Fully waterproof. Allows lower grade inner veneers than technical. Not to be used for parts continuously exposed to moisture in critical applications such as marine and aircraft
Type II (Interior)	Moisture resistant but not waterproof. For interior use only



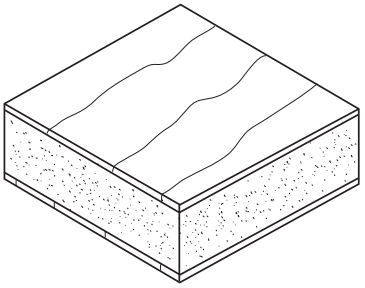
Veneer Core: Made of veneers (usually three, five or seven) which may be either hardwood or softwood; species mixing not allowed



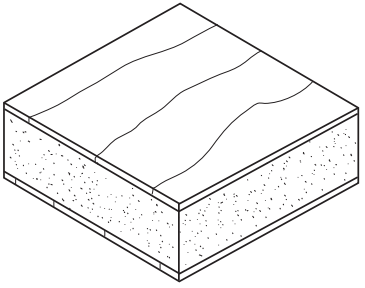
Lumber Core: Made from three, five or seven plies of edge-glued solid lumber; may be either hardwood or softwood; species mixing not allowed. Grades available are Clear, Sound and Regular. A Regular grade clear-edge version is available with edge strips at least 1½" wide to facilitate edge molding and shaping



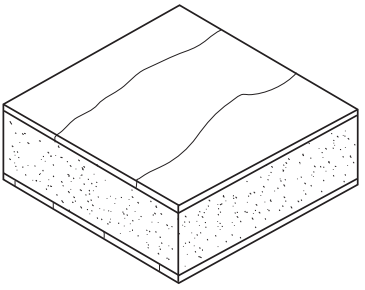
Banded Lumber Core: Bands must be made from clear stock; other specifications are as agreed upon by buyer and seller. Bands can be applied to one or two ends (B1E, B2E); one or two sides (B1S, B2S); two ends, one side (B2E1S); two sides, one end (B2S1E); or two sides, two ends (B4)



Particleboard Core: A particleboard core with hardwood veneer on each face



MDF Core: A medium-density fiberboard core with hardwood veneer on each face



Hardboard Core: A hardboard core with hardwood veneer on each face

CHARACTERISTICS OF HARDWOOD PLYWOOD PANELS

CORE TYPE	FLATNESS	VISUAL EDGE QUALITY	SURFACE UNIFORMITY
Veneer Core (all hardwood)	Fair	Good	Good
Veneer Core (all softwood)	Fair	Good	Fair
Lumber Core (hardwood or softwood)	Good	Good	Good
Particleboard Core (medium density)	Excellent	Good	Excellent
MDF Core	Excellent	Excellent	Excellent
Hardboard Core (standard)	Excellent	Excellent	Excellent
Hardboard Core (tempered)	Excellent	Good	Good

MATCHING

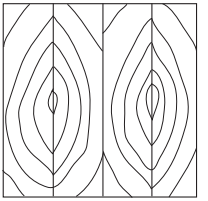
You can match hardwood plywood face veneers in different ways to create panels that have considerable visual appeal. Face veneers are matched in one of three general ways:

1. Matching between adjacent veneers. Examples of matching between veneers include: book matching, slip matching, pleasing match and random

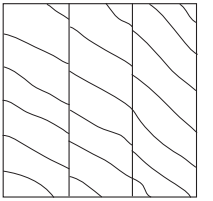
2. Matching of panel faces. Veneer is matched from one panel to another, usually to create symmetry in a room. Examples: running match, balance match and center match

3. Matching for special effects. Examples: checkerboard match, diamond match and sunburst match

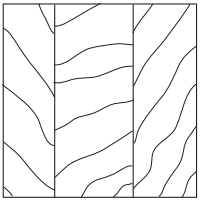
DIMENSIONAL STABILITY	SCREW HOLDING	BENDING STRENGTH	AVAILABILITY
Excellent	Excellent	Excellent	Readily
Excellent	Excellent	Excellent	Readily
Good	Excellent	Excellent	Limited
Fair	Fair	Good	Readily
Fair	Good	Good	Readily
Fair	Good	Good	Readily
Good	Good	Good	Limited



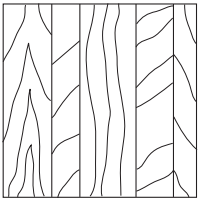
Book matching



Slip matching



Pleasing match

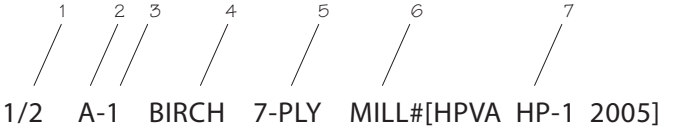


Random

TYPICAL HARDWOOD PLYWOOD EDGE STAMP

Hardwood plywood is labeled with a mill stamp that provides useful information about the panel. To avoid marring the face and back veneers, manufacturers generally stamp the panel edges with a mark called an edge stamp.

A typical edge stamp includes (1) the thickness of the plywood, (2) the grade of the face veneer, (3) the grade of the back veneer, (4) the wood species of the face, (5) the number of plies and type of core, (6) the identifying mill number and (7) the applicable standard.



Particleboard

Particleboard is made by mixing small particles of wood with synthetic resin and bonding them under heat and pressure. By modifying the manufacturing process, manufacturers can make several different grades of particleboard for various applications.

Particleboard grades are identified by a letter (or letters) followed by a hyphen and a number or letter. The letter designates the particleboard density as follows:

H = high density, generally above 50 pounds per cubic foot (pcf)

M = medium density, generally between 40 and 50 pcf

LD = low density, generally less than 40 pcf

The number following the hyphen indicates the grade identification within a particular density. For example, M-1 indicates medium-density particleboard, Grade 1. The higher the grade identification number, the higher the strength qualities of the particleboard. For example, Grade M-2 has better strength characteristics than Grade M-1.

Any special characteristics are listed after the grade identification number. For example, M-2-Exterior Glue indicates medium-density particleboard, Grade 2 made with exterior glue.

The chart on the next page lists some of the important physical properties for each grade.

PARTICLEBOARD GRADES (SELECTED REQUIREMENTS)

GRADE	MODULUS OF RUPTURE *(psi)*	MODULUS OF ELASTICITY *(psi)*	HARDNESS *(pounds)*	SCREW HOLDING FACE *(pounds)*	EDGE *(pounds)*
H-1	2393	348,100	500	405	298
H-2	2973	348,100	1000	427	348
H-3	3408	398,900	1500	450	348
M-1	1595	250,200	500	NS3	NS3
M-S2	1813	275,600	500	202	180
M-2	2103	326,300	500	225	202
M-3	2393	398,900	500	247	225
LD-1	435	79,800	NS3	90	NS3
LD-2	725	148,700	NS3	124	NS3

Notes:
Grades PBU, D-2 and D-3, used as flooring products, are not shown. Grade M-S refers to Medium-Density Special Grade. This grade was added after Grades M-1, M-2 and M-3 were established. Grade M-S falls between Grades M-1 and M-2 in terms of physical properties. NS3=not specified

Medium-Density Fiberboard (MDF)

Medium-density fiberboard is made by mixing processed wood fibers with synthetic resin (or other suitable bonding system) and bonding them under heat and pressure. By modifying the manufacturing process, manufacturers can make several different grades of MDF for various applications. Thicknesses from 3/16" to 1 1/2" are available, but the 3/4" thickness is most commonly found.

MDF is organized into product classifications rather than grades. The classifications are based on the density of the product. A two-letter designation identifies each classification. The classifications are as follows:

HD = high density, generally above 50 pounds per cubic foot (pcf)
MD = medium density, generally between 40 and 50 pcf
LD = low density, generally less than 40 pcf

MDF products with special characteristics are identified with either a letter, a number or a term that identifies the characteristic. For example, MD-Exterior Glue indicates that the MDF has a medium-density classification that meets exterior glue requirements.

The chart on the next page lists some of the important physical properties for each grade.

MEDIUM-DENSITY FIBERBOARD CLASSIFICATIONS (SOME SELECTED REQUIREMENTS

PRODUCT CLASSIFICATION	MODULUS OF RUPTURE *(psi)*	MODULUS OF ELASTICITY *(psi)*	SCREW HOLDING FACE *(pounds)*	SCREW HOLDING EDGE *(pounds)*
Interior MDF				
HD	5000	500,000	350	300
MD (.825" thick or less)	3500	350,000	325	250
MD (more than .825" thick)	3500	350,000	300	225
LD	2000	200,000	175	150
Exterior MDF				
MD-Exterior Glue (.825" thick or less)	5000	500,000	325	250
MD-Exterior Glue (more than .825" thick)	4500	450,000	300	225

Hardboard

Hardboard is made from wood chips that are converted into fibers and then bonded under heat and pressure. Other materials can be added to improve such characteristics as moisture and abrasion resistance, strength, stiffness and hardness. Hardboard is available either smooth-one-side (S1S) or smooth-both-sides (S2S).

HARDBOARD PANEL THICKNESSES

NOMINAL THICKNESS		THICKNESS RANGE (MINIMUM-MAXIMUM)	
INCHES	MILLIMETERS	INCHES	MILLIMETERS
1/12 (.083)	2.1	.070-.090	1.8-2.3
1/10 (.100)	2.5	.091-.110	2.3-2.8
1/8 (.125)	3.2	.115-.155	2.9-3.9
3/16 (.188)	4.8	.165-.205	4.2-5.2
1/4 (.250)	6.4	.210-.265	5.3-6.7
5/16 (.312)	7.9	.290-.335	7.4-8.5
3/8 (.375)	9.5	.350-.400	8.9-10.2
7/16 (.438)	11.1	.410-.460	10.4-11.7
1/2 (.500)	12.7	.475-.525	12.1-13.3
5/8 (.625)	15.9	.600-.650	15.2-16.5
11/16 (.688)	17.5	.660-.710	16.8-18.0
3/4 (.750)	19.1	.725-.775	18.4-19.7
13/16 (.812)	20.6	.785-.835	19.9-21.2
7/8 (.875)	22.2	.850-.900	21.6-22.9
1 (1.000)	25.4	.975-1.025	24.8-26.0
1 1/8 (1.125)	28.6	1.115-1.155	28.3-29.4

HARDBOARD CLASSIFICATIONS

CLASS	GENERAL DESCRIPTION
Tempered	Highest strength, stiffness, hardness and resistance to water and abrasion. Available in thicknesses from 1/12" to 3/8"
Standard	High strength and water resistance. Hardness and resistance to water and abrasion less than that of tempered class. Available in thicknesses from 1/12" to 3/8"
Service-tempered	Has better strength, stiffness, hardness and resistance to water and abrasion than service class. Available in 1/8", 3/16", 1/4" and 3/8" thicknesses
Service	Good strength, but not as strong as standard class. Available in 1/8", 3/16", 1/4", 3/8", 7/16", 1/2", 5/8", 11/16", 3/4", 1 3/16", 7/8", 1" and 1 1/8" thicknesses
Industrialite	Moderate strength. Available in 1/4", 3/8", 7/16", 1/2", 5/8", 1 1/16", 3/4", 1 3/16", 7/8", 1" and 1 1/8" thicknesses

CHAPTER FIVE

adhesives

5

Wood Bonding

When it comes to gluing ease, all woods are not created equal. As shown below, some woods are easier to glue than others. Highly dense or oily woods can be especially troublesome.

WOODS THAT BOND EASILY

Domestic Hardwoods:

- Alder
- Aspen
- Basswood
- Cottonwood
- Chestnut, American
- Magnolia
- Willow, Black

Domestic Softwoods:

- Cedar, Western Red
- Fir, Grand
- Fir, Noble
- Fir, Pacific
- Fir, White
- Pine, Eastern White
- Pine, Western White
- Redwood
- Spruce, Sitka

Imported Woods:

- Balsa
- Cativo
- Courbaril
- Hura
- Purpleheart
- Redwood
- Roble
- Spruce, Sitka

WOODS THAT BOND WELL

Domestic Hardwoods:

- Butternut
- Elm, American
- Elm, Rock
- Hackberry
- Maple, Soft
- Sweet Gum
- Sycamore
- Tupelo
- Walnut, Black
- Yellow Poplar

Domestic Softwoods:

- Cedar, Eastern Red
- Douglas Fir
- Larch, Western
- Pine, Sugar
- Pine, Ponderosa

Imported Woods:

- Afrormosia
- Andiroba
- Angelique
- Avodire
- Banak
- Cedar, Spanish
- Iroko
- Jarrah
- Limba
- Mahogany, African
- Mahogany, South American
- Obeche
- Okoume
- Opepe
- Peroba Rosa
- Sapele
- Sucupira
- Wallaba

WOODS THAT BOND SATISFACTORILY

Domestic Hardwoods:

- Ash, White
- Beech, American
- Birch, Sweet
- Birch, Yellow
- Cherry
- Hickory, Pecan
- Hickory, True
- Madrone
- Maple, Hard
- Oak, Red
- Oak, White

Domestic Softwoods:

- Cedar, Alaska
- Cedar, Port Orford
- Pine, Loblolly
- Pine, Longleaf
- Pine, Shortleaf
- Pine, Slash

Imported Woods:

- Angelin
- Azobe
- Benge
- Bubinga
- Karri
- Pau Marfim
- Parana Pine
- Pine, Caribbean
- Pine, Radiata
- Ramin

WOODS THAT BOND WITH DIFFICULTY

Domestic Hardwoods:

- Osage Orange
- Persimmon

Imported Woods:

- Balata
- Balau
- Greenheart
- Kaneelhart
- Kapur
- Keruing
- Lapacho
- Lignum Vitae
- Rosewood
- Teak

Surface Preparation Guidelines

To obtain the maximum bonding strength from any glue, the mating surfaces almost always need some attention at the start. Before adding the glue, it's a good idea to keep in mind the following:

- The surfaces must be clean; that means no dirt, oil, grease, wax, finish, old glue, or anything else.
- If possible, a last-minute shaving of the surfaces using a jointer or hand plane is a sure way to produce pristine wood-to-wood contact. This technique is especially helpful when gluing naturally oily woods like teak, rosewood, and cocobolo. The oil in the wood reduces the strength of the glue bond. By jointing or hand-planing the surface, the oils are temporarily removed from the surface. They will return before too long, but at least for a while, you have a better gluing surface.
- Avoid using a planer with badly dulled blades. When planer blades are dull, you run the risk of producing burnished or glazed surfaces that don't yield good glue bonds.
- Ideally, the parts should be machined to fit together snugly with just hand pressure. It's best not to depend on clamp pressure to correct poor fits.

Glue Guidelines

- If too cold or too hot, most types of glue won't work as well as they can. The acceptable working temperatures vary from one type of glue to another. Check the manufacturer's label for the working temperature of the glue. Then check your shop temperature to make sure both the glue and the wood fall into an acceptable range.
- Shop humidity that's especially high or low can reduce the effectiveness of some glue types. Check the manufacturer's label if the humidity is extreme either one way or the other.
- Some glues become ineffective once frozen and thawed, something that can easily happen in an unheated shop in cold weather. If you suspect your glue might have been frozen, check the manufacturer's label to make sure it can still be used.
- Glue that sits on a shelf too long can loose effectiveness. If your glue bottle has been around for a while, check the label for shelf-life info.

Commonly Used Wood Adhesives

Adhesive properties can vary from one manufacturer to another. Always read the manufacturer's directions before starting.

ADHESIVE	COMMON NAME	EXAMPLES OF BRAND NAMES
Aliphatic resin	Yellow glue	Elmer's Carpenter's Glue Titebond Wood Glue
Contact cement	Contact cement	Weldwood Contact Cement
Cyanoacrylate	Super glue	Elmer's Wonder Bond Krazy Glue
Epoxy	Epoxy glue	Devcon 2-Ton Epoxy Industrial Formulators G-1
Hide glue (dry)	Animal glue	Behlen Ground Hide Glue Moser's Pearl Hide Glue
Hide glue (liquid)	Animal glue	Franklin's Hide Glue
Polyurethane	Polyurethane	Titebond Polyurethane Glue
Polyvinyl acetate	White glue	Elmer's Glue-All
Resorcinol	Waterproof glue	Elmer's Waterproof Glue Weldwood Waterproof Glue
Urea formaldehyde	Plastic resin	Weldwood Plastic Resin

ADVANTAGES	DISADVANTAGES	COMMON USES
Easy to use; water resistant (but not waterproof); water cleanup; economical	Not waterproof (don't use on outdoor furniture)	All-purpose wood glue for interior use; stronger bond than polyvinyl acetate glue
Bonds parts immediately	Can't readjust parts after contact	Bonding wood veneer or plastic laminate to substrate
Bonds parts quickly	Limited to small parts	Bonding small parts made from a variety of materials
Good gap filler; waterproof; fast-setting formulas available; can be used to bond glass or metal to wood	Requires mixing	Bonding small parts made from a variety of materials
Extended working time; water cleanup; economical	Must be mixed with water and heated; poor moisture resistance (don't use on outdoor furniture)	Time-consuming assembly work; stronger bond than liquid hide glue; interior use only
Easy to use; extended working time; water cleanup; economical	Poor moisture resistance (don't use on outdoor furniture)	Time-consuming assembly work: interior use only
Fully waterproof; gap filling	Eye and skin irritant	Multipurpose; interior and exterior applications including wood to wood, ceramic, plastic, Corian, stone, metal
Easy to use; economical	Not waterproof (don't use on outdoor furniture)	All-purpose wood glue for interior use; aliphatic resin flue has stronger bond
Fully waterproof; extended working time	Requires mixing; dark color shows glue line on most woods; long clamping time	Outdoor furniture, marine applications
Good water resistance; economical	Requires mixing; long clamping time	Outdoor furniture, cutting boards

Properties of Common Names for Domestic Woodworking Adhesives

Adhesive properties may vary from one manufacturer to another. Always read the manufacturer's directions before starting.

ADHESIVE	FORM	PREPARATION	MINIMUM WORKING TEMPERATURE *(degrees F)*
Aliphatic resin	Liquid	None	45
Contact cement	Liquid	None	70
Cyanoacrylate	Liquid	None	40
Epoxy	Two-part liquid	Mix resin and hardener	Varies
Hide glue (dry)	Powder/flakes	Mix with water, heat (in glue pot) to to 140°- 150°F)	--
Hide glue (liquid)	Liquid	None	72
Polyurethane	Liquid	None	50
Polyvinyl acetate	Liquid	None	60
Resorcinol	Powder and liquid resin	Mix powder and liquid resin	70
Urea formaldehyde	Powder	Mix with water	70

WORKING TIME	CLAMPING TIME *(at 70° F)*	CURE TIME	SOLVENT
5 to 7 minutes	1 to 2 hours	24 hours	Warm water
Up to 1 hour bond on contact	No clamps; parts	--	Acetone
30 seconds	10 to 60 seconds; clamps usually not required	30 minutes to several hours, depending on brand	Acetone
5 to 60 minutes, depending upon epoxy formula	5 minutes to several hours, depending upon epoxy formula	3 hours and longer, depending upon epoxy formula	Lacquer thinner
30 minutes	2 to 3 hours	24 hours	Warm water
5 minutes	2 to 3 hours	24 hours	Warm water
30 minutes	2 hours while wet; abrade or scrape off when dry	8 hours	Mineral spirits
3 to 5 minutes	1 to 2 hours	24 to 48 hours	Warm water and soap
20 minutes	16 hours	12 hours	Cool water before hardening
15 to 30 minutes	16 hours	24 hours	Warm water and soap before hardening

CHAPTER SIX

tools

6

Drill Speeds

For boring wood, the optimum drill speed depends on the type of bit you are using and the wood density (hardwood or softwood). The charts that follow provide suggested speeds for boring both softwoods and hardwoods when using twist drills, brad-point bits or Forstner bits. The speeds are based on using bits made from high-speed steel.

Wood densities can vary, even within the same species, so the charts should serve only as a general guide. Use slower speeds for boring deep holes or if the wood starts to burn. For intermediate sizes, use the speed for the next larger bit size.

SUGGESTED TWIST DRILL SPEEDS

BIT DIAMETER *(inches)*	REVOLUTIONS PER MINUTE (RPM) *hardwood*	*softwood*
1/16	3500	3500
1/8	3250	3250
3/16	3000	3000
1/4	1800	2750
5/16	1500	2500
3/8	1200	2250
7/16	900	1750
1/2	750	1500
5/8	600	1250
3/4	500	800

SUGGESTED BRAD-POINT BIT SPEEDS

BIT DIAMETER *(inches)*	REVOLUTIONS PER MINUTE (RPM) *hardwood*	*softwood*
1/8	1000	1700
3/16	950	1650
1/4	900	1600
5/16	800	1550
3/8	750	1500
7/16	700	1450
1/2	600	1400
5/8	400	1300
3/4	350	1200
7/8	300	1100
1	250	1000

SUGGESTED FORSTNER BIT SPEEDS

BIT DIAMETER *(inches)*	REVOLUTIONS PER MINUTE (RPM) *hardwood*	*softwood*
1/4	1000	2000
5/16	975	1950
3/8	950	1900
7/16	925	1850
1/2	900	1800
5/8	850	1700
3/4	800	1600
7/8	750	1500
1	700	1400
1 1/8	600	1200
1 1/4	500	1000
1 1/2	350	700
1 3/4	300	600
2	250	500

SUGGESTED SPADE BIT SPEEDS

BIT DIAMETER *(inches)*	REVOLUTIONS PER MINUTE (RPM) *hardwood*	*softwood*
1/4	1500	2000
3/8	1500	2000
1/2	1500	2000
3/4	1500	1800
1	1500	1800
1 1/2	1000	1500

Suggested Wood Lathe Speeds

The best lathe speed for a given woodturning task is dictated by the size of the stock and the type of cut to be made. As the stock size increases, the lathe speed is reduced. Also, roughing cuts require slower speeds than shaping cuts or sanding.

STOCK DIAMETER *(inches)*	ROUGHING CUT *(rpm)*	SHAPING CUT *(rpm)*	SANDING *(rpm)*
under 2	800 to 1200	2400 to 2800	3000 to 4000
2 to 4	600 to 1000	1800 to 2400	2400 to 3000
over 4 to 6	600 to 800	1200 to 1800	1800 to 2400
over 6 to 8	400 to 600	800 to 1200	1200 to 1800
over 8 to 10	300 to 400	600 to 800	900 to 1200
over 10 to 12	250 to 300	300 to 600	600 to 800

SUGGESTED ROUTER SPEEDS

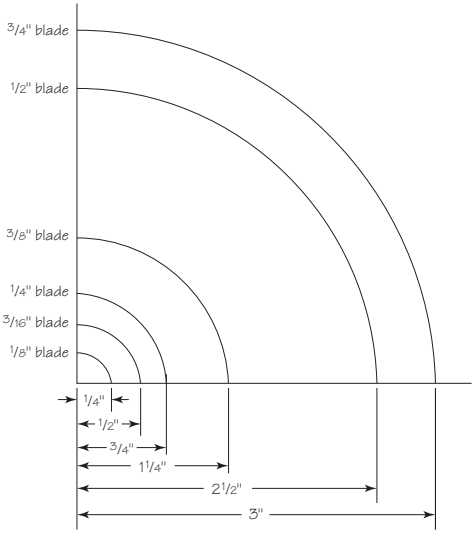
Normal operating speed for a typical router is 24,000 to 26,000 rpm. That kind of speed is ideal for bits with diameters less than 1¼". But, for safety's sake, a bit with a larger diameter needs to run at a slower speed. Most routers these days come with variable speed, allowing you to adjust the rpm simply by turning a dial on the router motor. The chart below suggests speeds for several bit diameters.

MAXIMUM DIAMETER OF ROUTER BIT (INCHES)	MAXIMUM RPM
1	24,000
1¼ - 2	18,000
2¼ - 2½	16,000
3 - 3½	12,000

Band Saw Blade Minimum Cutting Radius

The minimum cutting radius of a band saw blade is directly related to the width of the blade. As the blade width increases, so does the minimum cutting radius. For maximum control and the smoothest cut, use the widest blade that meets your minimum radius requirement.

BLADE WIDTH *(inches)*	MINIMUM CUTTING RADIUS *(inches)*
⅛	¼
3/16	½
¼	¾
⅜	¼
½	2½
¾	3



Band Saw Blade Tooth Styles

Band saw blades are available in three tooth styles: standard tooth (also called regular), hook tooth (also called saber tooth) and skip tooth. Each tooth style offers somewhat different cutting characteristics.

As shown in the illustrations, band saw blade teeth are cut at an angle called the rake angle. Teeth cut at a 90° angle to the back of the blade have a rake angle of 0°. Standard tooth and skip tooth blades have 0° rake angles. Blades with a 0° rake angle tend to cut more slowly, but the cuts are relatively smooth. Hook tooth blades have a rake angle of 10°. Blades with a 10° rake angle can cut faster, but the cuts are going to be relatively rough.

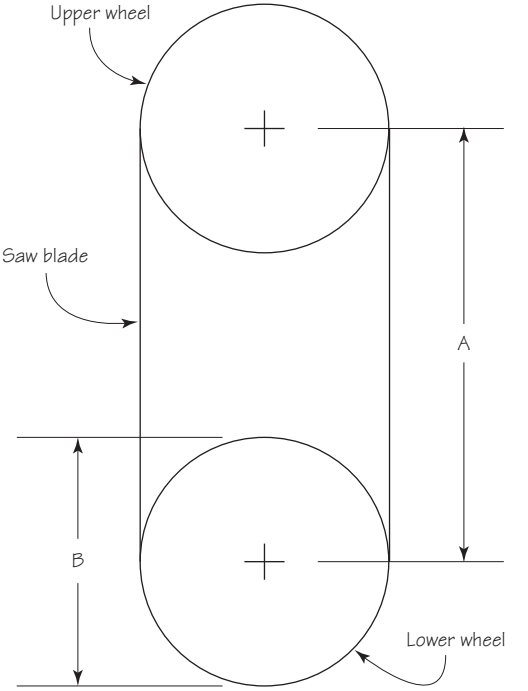
The number of blade teeth per inch (tpi) is called the *pitch*. The pitch can vary from two to twenty-four, depending on the blade style and width. A blade with many tpi has a *fine pitch*, while one with few tpi has a *coarse pitch*. Keep in mind that, when making any cut, the blade must have at least three teeth into the material.

TOOTH TYPE	AVAILABLE WIDTHS *(inches)*	PITCH RANGE *(tpi)*	DESCRIPTION
 Standard or Regular	1/16 to 1	6 to 24	0° rake. Smooth cut but with increased heat. Teeth closely spaced. Good for thin dense wood and for cutting across grain
 Hook or Saber	1/4 to 1	2 to 6	10° rake makes it an aggressive blade. Especially good good for cutting thick stock parallel to the grain
 Skip	3/16 to 1	3 to 6	0° rake. A widely used blade. Cuts faster, especially parallel to grain, but cut is coarse. Good for resawing. Not as good as standard tooth or hook tooth for cutting across grain

Determining Band Saw Blade Length

If you've lost the owner's manual for your band saw and can't remember the blade length, here's an easy formula for calculating it.

$L = (2 \times A) + (3.14 \times B)$
where:
L = band saw blade length (in inches)
A = distance between the band saw wheel center lines (in inches)
B = diameter of either the upper or lower wheel (in inches)



Note: Before measuring dimension A, locate the adjustable upper (tension) wheel so that it is midway between the fully up and fully down positions.

Scroll Saw Blades

Scroll saw blades are available in several popular tooth styles, including standard tooth (also called skip tooth, fret saw or coping saw), scroll saw tooth and spiral tooth. Other tooth styles may be available. The blade width, blade thickness and tpi may vary slightly from one manufacturer to another.

Standard

Scroll

Spiral

STANDARD TOOTH BLADES

UNIVERSAL NUMBER	BLADE WIDTH *(inches)*	BLADE THICKNESS *(inches)*	TEETH PER INCH	APPLICATION
2/0 0 1	.022 .024	.010 .011	28 25	For intricate cutting of wood, plastic and hard rubber. Cuts material from 1/16" to 1/4" thick
2 3 4	.029 .032 .035	.012 .013 .015	20 18 15	For tight radius cutting of wood and plastics. Cuts material from 3/32" to 1/2" thick
5 6	.038 .041	.046 .016	12 1/2 12 1/2	For close radius cutting of wood and plastics. Cuts material from 1/8" thick and heavier
7 8 9 10 11 12	.045 .048 .053 .059 .059 .062	.017 .018 .018 .019 .019 .024	11 1/2 11 1/2 11 1/2 11 9 1/2 9 1/2	For cutting wood and plastics. Cuts material from 3/16" to 2" thick

SCROLL SAW TOOTH BLADES

UNIVERSAL NUMBER	BLADE WIDTH *(inches)*	BLADE THICKNESS *(inches)*	TEETH PER INCH	APPLICATION
—	.049	.022	25	For tight radius cutting of
—	.070	.023	20	hardwoods and softwoods. Makes smooth finish cuts in materials from 3/32" to 1/4" thick
—	.110	.022	20	For hardwoods and softwoods.
—				Makes medium smooth finish cuts in materials from 3/32" to 1/4" thick
—	.110	.022	10	For close radius cutting of wood
—	.187	.025	10	and plastics. Cuts material
—	.250	.028	7	1/8" thick and heavier

SPIRAL TOOTH BLADES

Spiral tooth blades have 360° cutting capacity so you don't have to turn the workpiece.

UNIVERSAL NUMBER	KERF THICKNESS *(inches)*	TEETH PER INCH
0	.032	46
2	.035	41
4	.041	36
5	.047	36

Saber Saw Blades

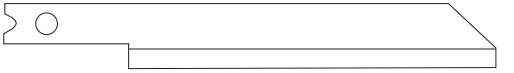
Blades for the saber saw (also called the jigsaw) are available in a variety of styles for cutting a wide range of materials. Indeed, one manufacturer offers more than a dozen different blade styles. Some of the commonly used wood-cutting blades are shown here.

ALL-PURPOSE WOOD AND COMPOSITION BLADES

Application: Fine-tooth (10 tpi), medium-tooth (7 tpi) and coarse-tooth (5 tpi) cut wood up to 3/4" thick. Blade length is 3".

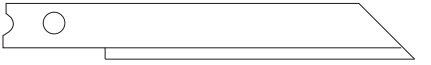
CARBIDE-COATED BLADES

Application: Medium grit cuts softwood plywood and hardwood veneer plywood. Blade length is 2 7/8".



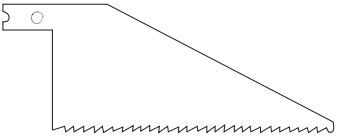
KNIFE-EDGE BLADES

Application: Veneer cutting. Blade length is 2 1/2".



FLUSH BLADES

Application: Permits flush cuts in corners, other tight locations. Blade length is 3".



Pulley Formulas

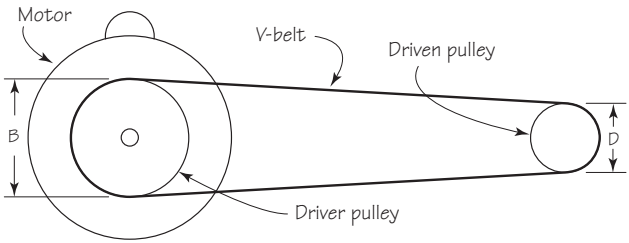
Table saws, band saws, jointers, drill presses and lathes often incorporate a pair of pulleys and a V-belt to transfer power from the motor to the business end of the machine. When two pulleys operate from a common V-belt, they relate to each other according to the following formula:

$A \times B = C \times D$

where:

A = speed (in rpm) of the motor
B = diameter (in inches) of the driver (motor) pulley
C = speed (in rpm) of the driven pulley
D = diameter (in inches) of the driven pulley

Note: The motor speed (in rpm) is usually stamped on the motor nameplate.



The above formula can be rewritten, producing four additional formulas as follows:

$A = C \times D/B$ $\quad C = A \times B/D$
$B = C \times D/A$ $\quad D = A \times B/C$

workshop application

A lathe motor operates at 1,725 rpm and has a 4"-diameter pulley. The motor pulley is connected by V-belt to a 2" pulley that turns the headstock. What is the lathe speed?

The following are known:

A = 1,725 rpm
B = 4"
C = driven pulley speed = lathe speed
D = 2"

Since C is unknown, use the formula:

$C = A \times B/D$
$= 1725 \times 4/2$
$= 6900/2$
$= 3450$ rpm

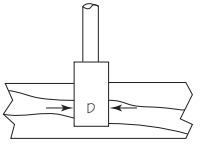
Common Router Bit Profiles

Router bits are manufactured in dozens of different profiles for a wide variety of woodworking applications. The fourteen bits shown here represent profiles most commonly used by both the hobbyist and professional woodworkers.

Bit sizes are also listed, although you won't find all of the sizes at your local hardware store. The angles are shown in degrees; all other dimensions are in inches.

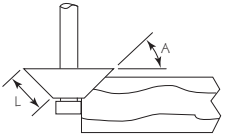
Router bits are generally made from high-speed steel, solid carbide or carbide-tipped steel. Pilots are fixed or ball-bearing guided. Shanks can be 1/4" or 1/2" diameter.

All dimensions are in inches unless otherwise noted.



Straight

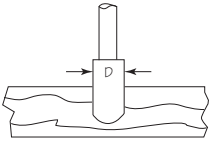
Diameter (D): 1/16, 3/32, 1/8, 5/32, 3/16, 1/4, 9/32, 5/16, 3/8, 7/16, 1/2, 9/16, 5/8, 11/16, 3/4, 13/16, 7/8, 1, 1 1/8, 1 1/4, 1 3/8, 1 1/2, 1 3/4



Chamfer

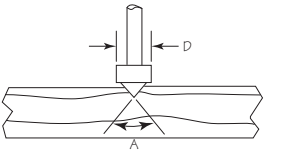
Cutting Angle (A): 15°, 22 1/2°, 25°, 30°, 45°

Cutting Length (L): 1/2, 5/8, 3/4, 1



Round Nose (Core Box)

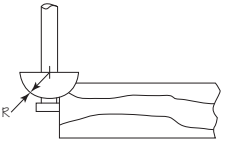
Diameter (D): 1/8, 3/16, 1/4, 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, 1 1/2, 2



V-Groove

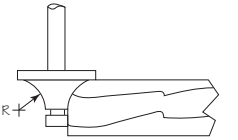
Diameter (D): 1/4, 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/2, 2

Cutting Angle (A): 90° (60° angles available in a few sizes)



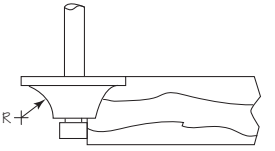
Cove

Radius (R): 1/16, 1/8, 3/16, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4



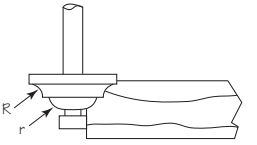
Roundover

Radius (R): 1/16, 1/8, 5/32, 3/16, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/8, 1 1/4, 1 3/8, 1 1/2



Beading

Radius (R): 1/16, 1/8, 5/32, 3/16, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/8, 1 1/4, 1 3/8, 1 1/2

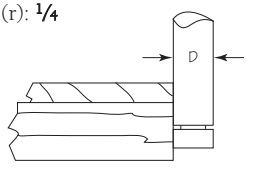


Classical Cove and Bead

Large radius (R): 1/4; small radius (r): 5/32

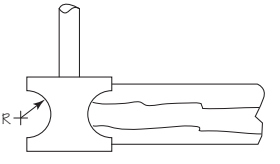
Large radius (R): 5/32; small radius (r): 5/32

Large radius (R): 1/4; small radius (r): 1/4



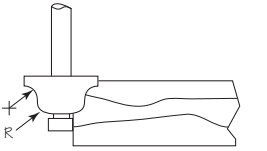
Flush Trim

Diameter (D): 1/4, 3/8, 1/2, 3/4, 7/8



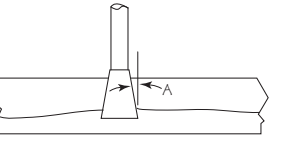
Half-Round

Radius (R): 3/32, 1/8, 3/16, 1/4, 3/8, 1/2, 5/8



Roman Ogee

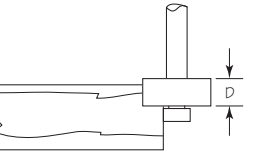
Radius (R): 5/32 1/4



Dovetail

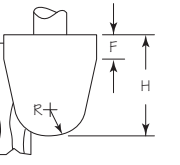
Diameter (D): 1/4, 5/16, 3/8, 1/2, 5/8, 11/16, 3/4, 1 3/16

Cutting angles (A): 7°, 7 1/2°, 8°, 9°, 10°, 14°, 18° (cutting angles are not available for all diameters shown)



Rabbeting

Depth (D): 1/4, 3/8, 1/2



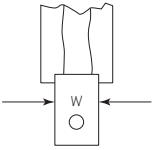
Vertical Raised Panel

Radius (R): 3/8; flat (F): 3/8; height (H): 1 5/8

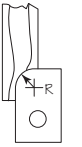
Common Moulding Head Cutter Profiles

A table or radial-arm saw equipped with a moulding head can cut a wide variety of profiles and mouldings. Shown here are some of the popular cutter profiles.

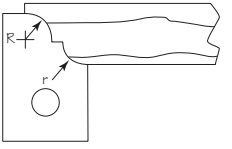
All dimensions are in inches.



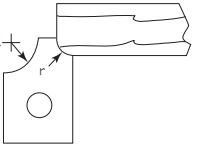
Straight
Width (W): 1



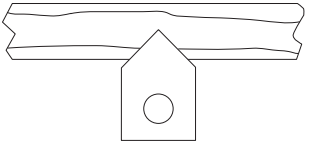
Cove
Radius (R): 5/8



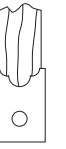
Cove and Bead
Large radius (R): 5/16
Small radius (r): 5/16



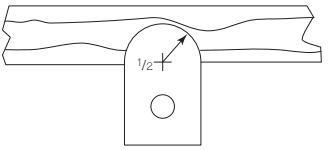
Quarter Round
Large radius (R): 1/2
Small radius (r): 1/4



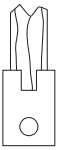
V-Groove



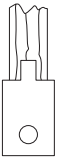
Cloverleaf



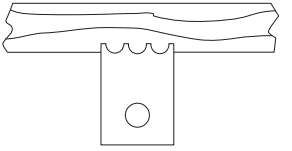
Flute
Radius: 1/2



Tongue

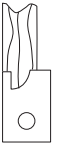


Groove



Three Bead

Glue Joint



Door Lip

Bead and Batten

Base Moulding

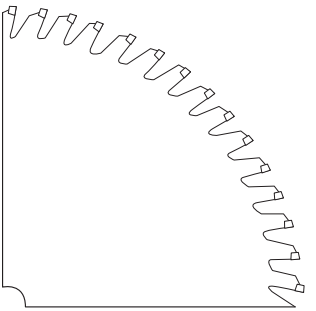
Table and Radial-Arm Saw Blades

Blades for table and radial-arm saws fall into two broad categories: (1) those made entirely from steel and (2) those made from steel with teeth that are tipped with tungsten carbide.

An all-steel blade is typically made from either carbon steel or high-speed steel. Although it won't last as long as a carbide-tipped blade, an all-steel blade costs less, so it is the more economical choice if the blade will be used only occasionally.

Carbide-tipped blades cost more than all-steel blades, but the carbide tips stay sharper for considerably longer. Indeed, a carbide-tipped blade can cut up to fifty times longer than an all-steel blade before sharpening is required. And carbide-tipped blades are even more effective when cutting particleboard, MDF and hardboard.

A number of blade designs are available, but those most commonly used are the crosscut blade, rip blade and combination blade. Other designs include specialty blades such as plywood-cutting blades, laminate-cutting blades, thin kerf blades and others.

BLADE	APPLICATION
Crosscut 	For cutting across the grain or at a diagonal. Has more teeth than rip or combination blades, resulting in a smoother cut with a minimum of splintering. Blade shown is carbide-tipped.

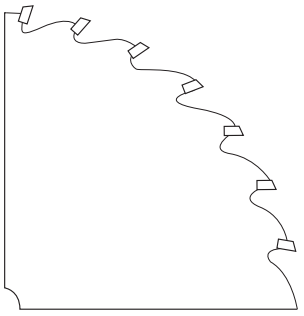
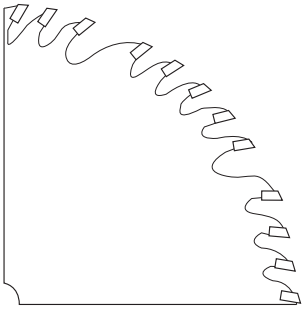
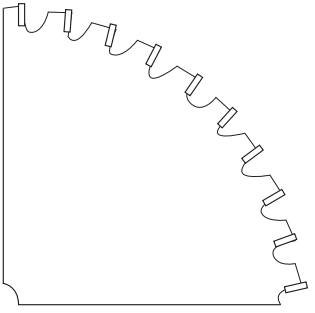
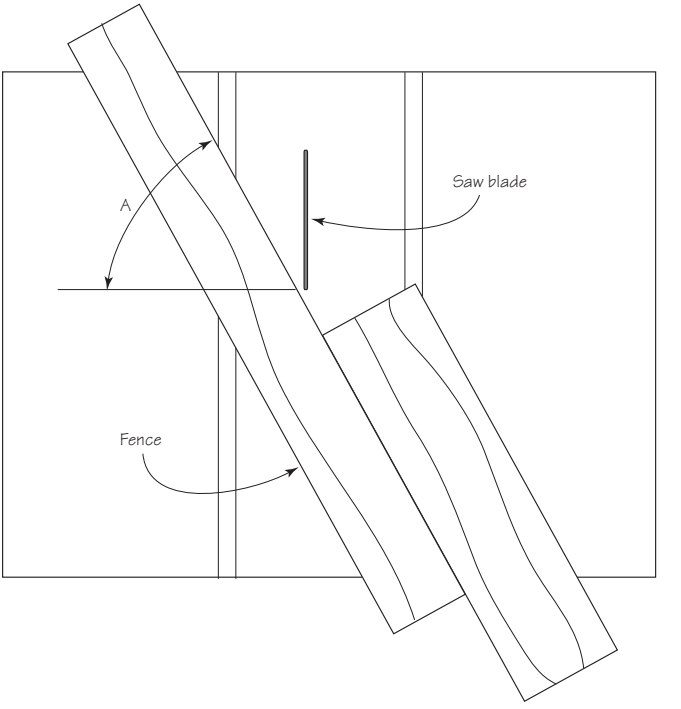
BLADE	APPLICATION
Rip 	For cutting with (parallel to) the grain. Requires fewer and larger teeth than crosscut blades. Cut is relatively rough. Blade shown is carbide-tipped.
Combination 	For both crosscutting and ripping. The number and size of the teeth are a compromise between the crosscut and rip blade designs. Eliminates having to constantly change from rip blade to crosscut blade. A good general-purpose blade for all cuts, but it doesn't rip as well as a rip blade or crosscut as well as a crosscut blade. Blade shown is carbide-tipped.
Specialty Blades 	Plywood blade shown, but specialty blades also include laminate-cutting blades, thin kerf blades and others. Blade shown is carbide-tipped.

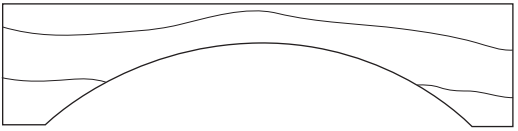
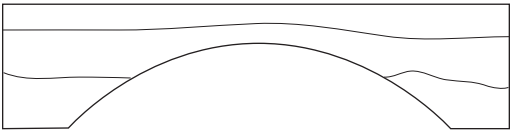
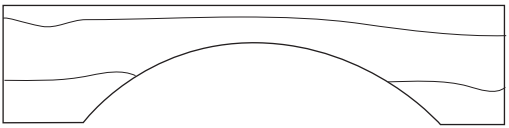
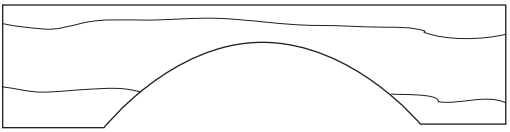
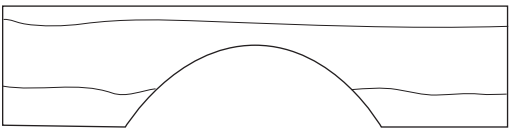
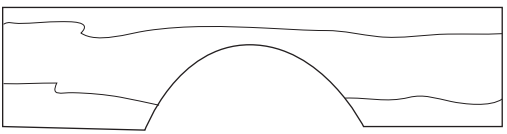
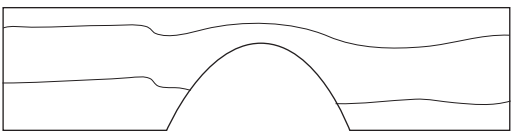
Table-Saw Coving Cuts

Woodworkers can use the table saw to make coving cuts that produce some interesting profiles. The workpiece, supported by an auxiliary fence clamped to the saw table, is slowly passed through the saw blade at an angle to create the cove. The first pass is made with the blade elevated no more than 1/16" above the saw table. After each subsequent pass, the blade is raised in 1/16" increments until the full cutting depth is reached.

The profile of the cove depends upon three factors: (1) the angle at which the stock is passed through the blade, (2) the diameter of the saw blade and (3) the height of the saw blade when the last cutting pass is made. The next page shows examples of 3/4" deep coves cut at angles of 45°, 50°, 55°, 60°, 65°, 70° and 75° using a 10"-diameter saw blade.

For safety's sake, make sure the auxiliary fence is securely attached to the saw table. Also, be sure to use a push stick, keep hands well away from the blade and always advance the workpiece slowly through the blade.



Angle A (see previous page)	Profile
45°	
50°	
55°	
60°	
65°	
70°	
75°	

CHAPTER SEVEN

sharpening

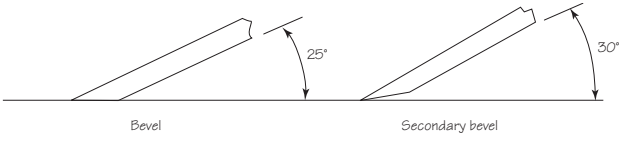
7

Sharpening Angles

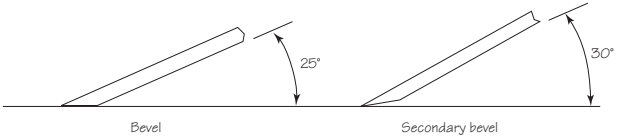
In order to cut effectively, each of the various cutting tools used for woodworking must be sharpened to a specific angle. The sharpening angles for the most commonly used wood tools are shown here.

CHISELS

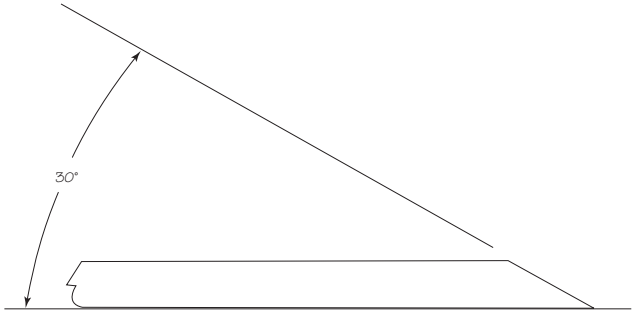
Note: Sharpen to 30° if you do a lot of mortising or deep cutting.



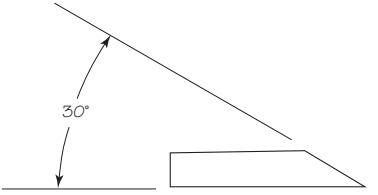
PLANE IRONS



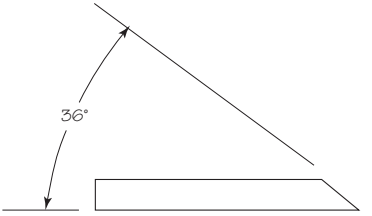
SPOKESHAVES



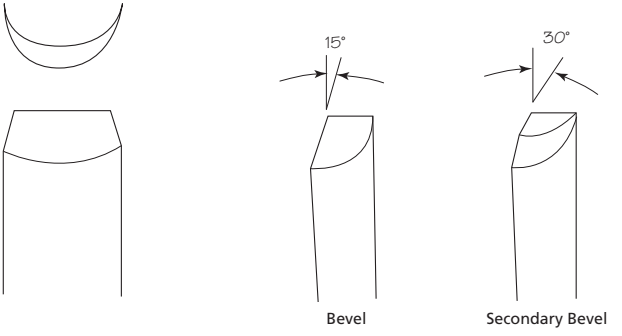
DRAWKNIVES



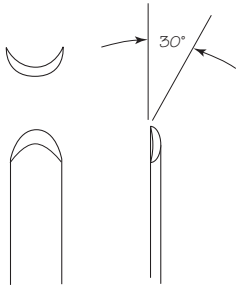
JOINTER BLADES



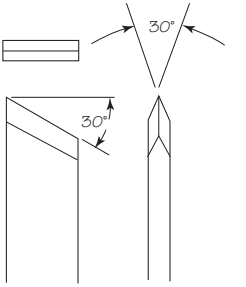
CARVING GOUGES



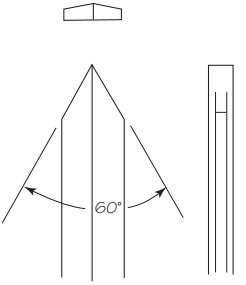
TURNING CHISELS



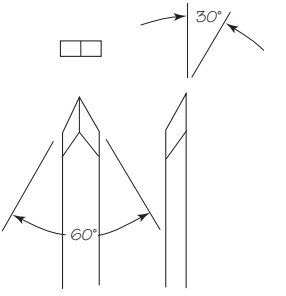
Gouge



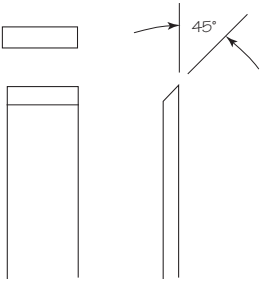
Skew



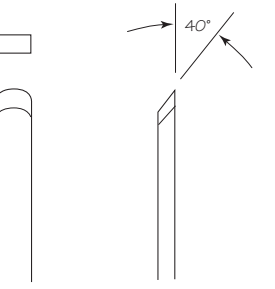
Parting Tool



Spear Point



Flat Nose



Round Nose

Types of Bench Sharpening Stones

STONE TYPE	DESCRIPTION
Aluminum oxide (trade name: India)	Synthetic oilstone. Available in coarse, medium and fine grits
Silicon carbide (trade name: Crystolon)	Synthetic oilstone. Available in coarse, medium and fine grits
Soft Arkansas	Natural oilstone, medium grit
Hard Arkansas	Natural oilstone, fine grit
Hard black Arkansas	Natural oilstone, extra-fine grit
Japanese water stones	Synthetic water stone (natural stones are marketed but extremely expensive). Available in grits from 80 to 8000
Diamond	Synthetic stone. Available in extra-coarse, coarse, fine and extra-fine
Ceramic	Synthetic stone. Available in medium, fine and ultra-fine grits

Comparison of U.S. and Japanese Grits

The United States and Japan use different grit systems for sharpening stones. This chart lists U.S. grits and the approximate Japanese equivalents.

U.S. GRIT	JAPANESE GRIT
100	150
180	240
240	280
280	360
320	500
350	600
500	1000
700	2000
900	4000

Chart courtesy Woodcraft Supply Corporation.

Selecting a Bench Sharpening Stone

SHARPENING APPLICATION	SUGGESTED STONE
Substantial metal removal for: • Cleaning up a nicked edge • Changing a bevel angle • Reshaping a cutting edge	Coarse aluminum oxide Coarse silicon carbide Japanese water stones under 300 grit
Moderate metal removal for: • Smoothing the rough surface created by the previous step • Smoothing an edge that's dull but not damaged	Medium aluminum oxide Medium silicon carbide 1000-grit Japanese water stone Coarse diamond
Light metal removal for: • Smoothing the moderately rough surface created by the previous step	Fine aluminum oxide Fine silicon carbide 1200-grit Japanese water stone Soft Arkansas Fine diamond
Very light metal removal (honing) for: • Smoothing the light scratches from the previous step • Removing the wire burr on the back of the blade	Japanese water stones above 2000 grit Hard Arkansas Fine ceramic Fine diamond
Polishing	Japanese water stones above 6000 grit Hard black Arkansas Ultra-fine ceramic Extra-fine diamond

CHAPTER EIGHT

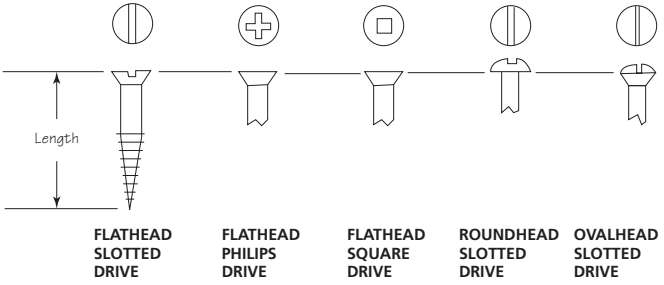
fasteners

8

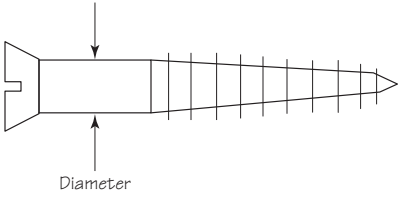
Wood Screw Head Options

Wood screws are available in three head options: flathead, roundhead and ovalhead. In addition, flathead screws have three commonly available drive options: slotted, Phillips and square.

Note that the length of a wood screw is measured from the end of the screw to the widest part of the screw head.



Wood Screw Shank Diameters

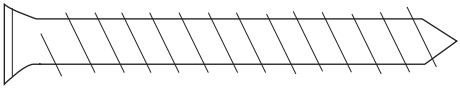


SCREW NUMBER	SHANK DIAMETER (D)	SCREW NUMBER	SHANK DIAMETER (D)
0	.060	9	.177
1	.073	10	.190
2	.086	12	.216
3	.099	14	.242
4	.112	16	.268
5	.125	18	.294
6	.138	20	.320
7	.151	24	.372
8	.164		

Wood Screw Lengths and Commonly Available Screw Numbers

LENGTH *(inches)*	COMMONLY AVAILABLE SCREW NUMBERS
1/4	0, 1, 2, 3
3/8	2, 3, 4, 5, 6, 7
1/2	2, 3, 4, 5, 6, 7, 8
5/8	3, 4, 5, 6, 7, 8, 9, 10
3/4	4, 5, 6, 7, 8, 9, 10
7/8	6, 7, 8, 9, 10, 12
1	6, 7, 8, 9, 10, 12, 14
1 1/4	6, 7, 8, 9, 10, 12, 14, 16
1 1/2	6, 7, 8, 9, 10, 12, 14, 16, 18
1 3/4	7, 8, 9, 10, 12, 14, 16, 18
2	8, 9, 10, 12, 14, 16, 18, 20
2 1/4	10, 12, 14, 16, 18, 20
2 1/2	12, 14, 16, 18, 20
2 3/4	14, 16, 18, 20
3	16, 18, 20
3 1/2	16, 18, 20
4	18, 20

Drywall (Sheetrock) Screws



Designed for securing drywall to wooden studs, this screw has found favor with many woodworkers. Unlike a wood screw, which has a tapered body, a drywall screw has the same body diameter throughout its length. The result is a thread that is sharper and deeper. Drywall screws are generally available in sizes 4, 6, 7, 8, 9, 10 and 12 and in a variety of lengths.

The screws are hardened, making them tough, but they tend to be brittle. However, when used with some softwoods, the screws can often be driven without drilling shank or pilot holes.

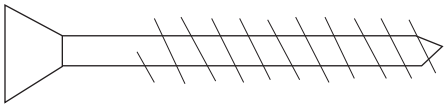
Also available, a version that has a double-lead thread. It is designed for use with steel studs and is not as effective with wood.

Particleboard and Medium-Density Fiberboard (MDF) Screws

Like drywall screws, particleboard and MDF screws do not have tapered bodies.

They have deep, sharp threads that are able to hold effectively in both particleboard and MDF.

Particleboard and MDF screws have a flat head and a Phillips or square drive. The screws are available in a limited number of sizes and lengths.



Converting Penny Size to Nail Length

The word *penny*, represented by a lowercase *d*, is used to specify the length of common, casing, finishing and several other types of nails.

PENNY SIZE	NAIL LENGTH *(inches)*
2d	1
3d	1¼
4d	1½
5d	1¾
6d	2
7d	2¼
8d	2½
9d	2¾
10d	3
12d	3¼
16d	3½
20d	4
30d	4½
40d	5
50d	5½
60d	6

Nail Gauges and Equivalent Diameters

PENNY SIZE	COMMON NAIL		CASING NAIL		FINISHING NAIL	
	GAUGE	DIAMETER *(inches)*	GAUGE	DIAMETER *(inches)*	GAUGE	DIAMETER *(inches)*
2d	15	.072	15½	.067	16½	.058
3d	14	.080	14½	.073	15½	.067
4d	12½	.095	14	.080	15	.072
5d	12½	.095	14	.080	14	.080
6d	11½	.113	12½	.095	13½	.086
7d	11½	.113	12½	.095	13	.092
8d	10¼	.131	11½	.113	12½	.095
9d	10¼	.131	11½	.113	12½	.095
10d	9	.148	10½	.128	11½	.113
12d	9	.148	10½	.128	11½	.113
16d	8	.162	10	.135	11	.121
20d	6	.192	9	.148	10	.135
30d	5	.207	9	.148	-	-
40d	4	.225	8	.162	-	-
50d	3	.244	-	-	-	-
60d	2	.262	-	-	-	-

Nails Per Pound

PENNY SIZE	NUMBER OF NAILS PER POUND (APPROXIMATE)		
	COMMON *(uncoated)*	CASING *(uncoated)*	FINISHING *(uncoated)*
2d	875	1010	1350
3d	570	635	810
4d	315	475	585
5d	270	405	500
6d	180	235	310
7d	160	210	240
8d	105	145	190
9d	95	130	170
10d	70	95	120
12d	65	90	112
16d	50	70	90
20d	30	50	60
30d	24	46	-
40d	18	35	-
50d	16	-	-
60d	11	-	-

Standard Machine Threads

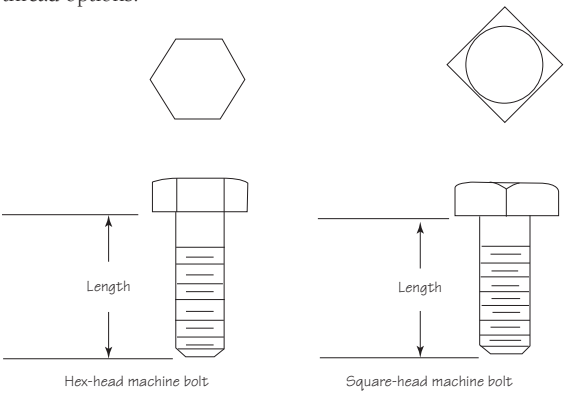
The threads shown here, which are based on the Unified National Standard, are used on machine bolts, machine screws, threaded rod and other fasteners. Coarse threads (UNC) are suitable for most general applications. Fine threads (UNF) are sometimes used for the assembly of jigs, fixtures and machine components. Extra-fine threads (UNEF) are primarily used in the automotive and aircraft industries.

NOMINAL SIZE *(inches)*	MAJOR DIAMETER *(inches)**	THREADS PER INCH		
		COARSE *(unc)*	FINE *(unf)*	EXTRA-FINE *(unef)*
1	.0730	64	72	-
2	.0860	56	64	-
3	.0990	48	56	-
4	.1120	40	48	-
5	.1250	40	44	-
6	.1380	32	40	-
8	.1640	32	36	-
10	.1900	24	32	-
12	.2160	24	28	32
1/4	.2500	20	28	32
5/16	.3125	18	24	32
3/8	.3750	16	24	32
7/16	.4375	14	20	28
1/2	.5000	13	20	28
9/16	.5625	12	18	24
5/8	.6250	11	18	24
11/16	.6875	-	-	24
3/4	.7500	10	16	20
13/16	.8125	-	-	20
7/8	.8750	9	14	20
15/16	.9275	-	-	20
1	1.0000	8	12	20
1 1/8	1.1250	7	12	18
1 1/4	1.2500	7	12	18

*The major diameter is the outside diameter of the screw thread.

Machine Bolts

Machine bolts are specified by size, number of threads per inch, material, type of head and length. Example: $\frac{3}{8}$-16 steel hex-head machine bolt, 2" long. Note that the length is measured from the end of the bolt to the underside of the head. See Standard Machine Threads on page 183 for thread options.



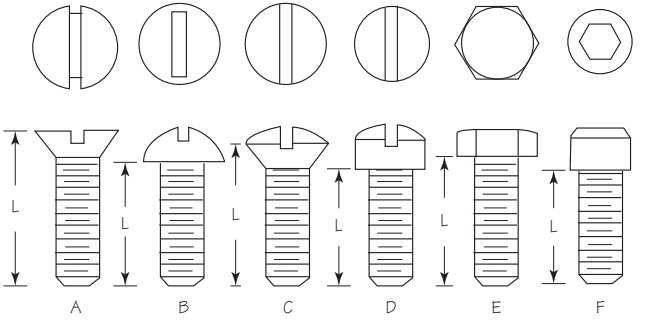
Hex-head machine bolt

Square-head machine bolt

Machine Screws

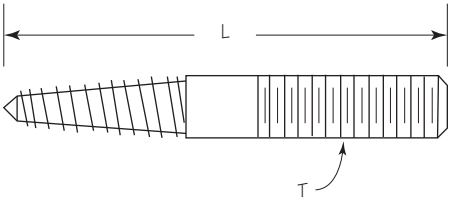
Machine screws are specified by size, number of threads per inch, material, type of head and length. Example: 10-32 brass ovalhead machine screw, $1\frac{1}{2}$" long. See Standard Machine Threads on page 183 for thread options.

Screw head options are shown below: (A) flathead, (B) roundhead, (C) ovalhead, (D) fillister head, (E) hex-head and (F) socket head.



Hanger Bolts

Usually available only in steel. The thread on one end (T) is a standard machine thread; the thread on the opposite end is a wood screw thread.



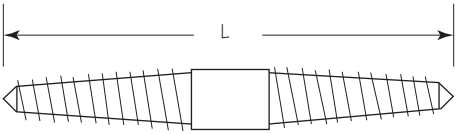
COMMONLY AVAILABLE SIZES

THREAD (T)	LENGTH (L) *(inches)*
10-24	1
10-24	1 1/2
10-24	1 3/4
10-24	2
10-24	3
10-24	3 1/2
1/4-20	1 1/2
1/4-20	1 3/4
1/4-20	2
1/4-20	2 1/4
1/4-20	2 1/2
1/4-20	2 3/4
1/4-20	3
1/4-20	3 1/2
1/4-20	4
1/4-20	5
5/16-18	2

THREAD (T)	LENGTH (L) *(inches)*
5/16-18	2 1/2
5/16-18	3
5/16-18	3 1/2
5/16-18	4
5/16-18	4 1/2
5/16-18	5
5/16-18	5 1/2
5/16-18	6
3/8-16	2
3/8-16	2 1/2
3/8-16	3
3/8-16	3 1/2
3/8-16	4
3/8-16	4 1/2
3/8-16	5
3/8-16	5 1/2
3/8-16	6

Dowel Screws

Usually available only in steel. Each end has a wood screw thread.

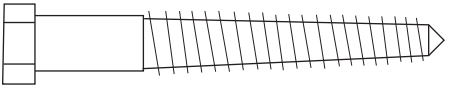


COMMONLY AVAILABLE SIZES

SIZE	LENGTH (L) *(inches)*	SIZE	LENGTH (L) *(inches)*
No. 10	1 1/2	1/4	3 1/2
3/16	1 1/2	5/16	1 1/2
3/16	1 3/4	5/16	2
3/16	2	5/16	2 1/2
3/16	2 1/2	5/16	3
3/16	3	5/16	3 1/2
1/4	1 1/2	5/16	4
1/4	1 3/4	5/16	4 1/2
1/4	2	5/16	5
1/4	2 1/2	3/8	5 1/2
1/4	3	3/8	6

Lag Screws

Available in steel with either square head or hex head. Also, available in stainless steel in some sizes and lengths. The thread is a wood screw thread.



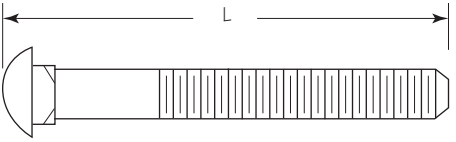
LAG SCREWS — COMMONLY AVAILABLE SIZES

SIZE	LENGTH (L) *(inches)*
1/4	1
1/4	1 1/4
1/4	1 1/2
1/4	1 3/4
1/4	2
1/4	2 1/2
1/4	3
1/4	3 1/2
1/4	4
1/4	4 1/2
1/4	5
1/4	5 1/2
1/4	6
5/16	1
5/16	1 1/4
5/16	1 1/2
5/16	1 3/4
5/16	2
5/16	2 1/2
5/16	3
5/16	3 1/2
5/16	4
5/16	4 1/2
5/16	5
5/16	6
3/8	1
3/8	1 1/4
3/8	1 1/2
3/8	1 3/4
3/8	2
3/8	2 1/2
3/8	3
3/8	3 1/2
3/8	4
3/8	4 1/2
3/8	5
3/8	5 1/2
3/8	6
3/8	6 1/2
3/8	7
3/8	8
3/8	10

SIZE	LENGTH (L) *(inches)*
1/2	1 1/2
1/2	1 3/4
1/2	2
1/2	2 1/2
1/2	3
1/2	3 1/2
1/2	4
1/2	4 1/2
1/2	5
1/2	6
1/2	6 1/2
1/2	7
1/2	8
1/2	9
1/2	10
1/2	12
5/8	2
5/8	2 1/2
5/8	3
5/8	3 1/2
5/8	4
5/8	4 1/2
5/8	5
5/8	5 1/2
5/8	6
5/8	7
5/8	8
5/8	10
5/8	12
3/4	2 1/2
3/4	3
3/4	3 1/2
3/4	4
3/4	4 1/2
3/4	5
3/4	5 1/2
3/4	6
3/4	7
3/4	8
3/4	10
3/4	12

Carriage Bolts (Square Necked)

Available in steel. Also available in stainless steel in some sizes and lengths.

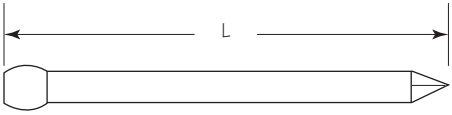


COMMONLY AVAILABLE SIZES

SIZE	LENGTH (L) *(inches)*	SIZE	LENGTH (L) *(inches)*
1/4-20	1	3/8-16	1 1/2
1/4-20	1 1/4	3/8-16	1 3/4
1/4-20	1 1/2	3/8-16	2
1/4-20	1 3/4	3/8-16	2 1/2
1/4-20	2	3/8-16	3
1/4-20	2 1/2	3/8-16	3 1/2
1/4-20	3	3/8-16	4
1/4-20	3 1/2	3/8-16	4 1/2
1/4-20	4	3/8-16	5
1/4-20	4 1/2	3/8-16	5 1/2
1/4-20	5	3/8-16	6
1/4-20	6	1/2-13	6 1/2
5/16-18	1	1/2-13	2
5/16-18	1 1/4	1/2-13	2 1/2
5/16-18	1 1/2	1/2-13	3
5/16-18	2	1/2-13	3 1/2
5/16-18	2 1/2	1/2-13	4
5/16-18	3	1/2-13	4 1/2
5/16-18	3 1/2	1/2-13	5
5/16-18	4	1/2-13	5 1/2
5/16-18	4 1/2	1/2-13	6
5/16-18	5	1/2-13	6 1/2
5/16-18	6	1/2-13	7
3/8-16	1	1/2-13	8

Brads

Brad sizes are designated by length and wire gauge number.

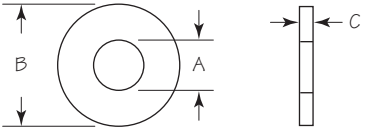


COMMONLY AVAILABLE SIZES

LENGTH (L) *(inches)*	STEEL WIRE GAUGE NUMBER	WIRE DIAMETER *(inches)*
1/2	19	.0410
1/2	20	.0348
5/8	18	.0475
5/8	19	.0410
3/4	16	.0625
3/4	17	.0540
3/4	18	.0475
7/8	17	.0540
7/8	18	.0475
1	16	.0625
1	17	.0540
1	18	.0475
1 1/4	15	.0720
1 1/4	16	.0625
1 1/4	17	.0540
1 1/4	18	.0475
1 1/2	16	.0625
1 1/2	17	.0540

Plain Washer Dimensions (For Lag Screws and Bolts)

Washers are made from steel.

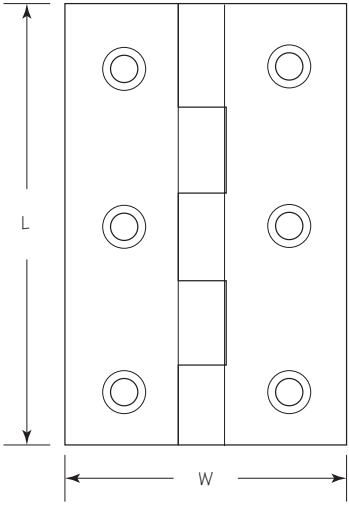


LAG SCREW OR BOLT SIZE *(inches)*	HOLE DIAMETER (A) *(inches)*	OUTSIDE DIAMETER (B) *(inches)*	THICKNESS (C) *(inches)*
3/16	1/4	9/16	3/64
1/4	5/16	3/4	1/16
5/16	3/8	7/8	1/16
3/8	7/16	1	5/64
7/16	1/2	1 1/4	5/64
1/2	9/16	1 3/8	3/32
9/16	5/8	1 1/2	3/32
5/8	11/16	1 3/4	1/8
3/4	13/16	2	1/8

Common Butt Hinge Sizes

Butt hinges come in a wide range of sizes. Some of the commonly available ones are shown here.

Butt hinge sizes are specified by their length (L) and open width (W). For example, a 2 × 3 butt hinge has a length of 2" and a width (with the leaves open) of 3".



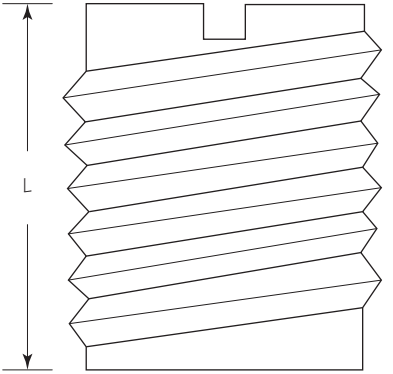
LENGTH	WIDTH
1/2	1/2
1/2	9/16
3/4	1/2
3/4	1
3/4	5/8
1	5/8
1	3/4
1	1
1 1/4	5/8
1 1/4	3/4
1 1/4	1 7/8
1 1/2	3/4
1 1/2	7/8
1 1/2	1
1 1/2	1 1/2

LENGTH	WIDTH
1 1/2	1 1/4
1 1/2	2
1 1/2	2 3/8
2	7/8
2	1
2	1 1/8
2	1 1/4
2	1 3/8
2	3
2 1/4	1 1/4
2 1/2	1 1/2
2 1/2	1 1/2
2 1/2	1 5/8
3	1 5/8
3	2

Knock-Down Hardware

THREADED INSERTS (ROSAN NUTS)

Usually available in brass or steel.

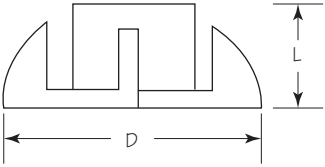


COMMONLY AVAILABLE SIZES

INTERNAL THREAD	LENGTH (L) *(inches)*
4-40	3/8
6-32	3/8
8-32	3/8
10-24	1/2
10-32	1/2
1/4-20	1/2
1/4-28	1/2
5/16-18	5/8
5/16-24	5/8
3/8-16	5/8
3/8-24	5/8

T-NUTS

Usually available in steel or plated steel.



COMMONLY AVAILABLE SIZES

INTERNAL THREAD	FLANGE DIAMETER (D) *(inches)*	BARREL LENGTH (L) *(inches)*
4-40	3/8	7/64
6-32	9/16	1/4
8-32	23/32	1/4
10-24	3/4	5/16
1/4-20	3/4	5/16
1/4-20	3/4	9/16
5/16-18	7/8	3/8
3/8-16	1	7/16

CHAPTER NINE

finishing

9

Coated Abrasives

Coated abrasives include such products as sheet sandpaper, belt sander belts, bench sander belts, sanding disks and more. Coated abrasive products vary, depending upon the size and type of abrasive particle, the type of backing and also the kind of adhesive used to bond the particles to the backing. Much of the information included here is courtesy of the Norton Abrasive Company.

COATED ABRASIVE PARTICLE SIZES

Coated abrasives are graded according to the size of the particles (also called grits or grains). In the United States, sandpaper manufacturers adhere to the grading specifications of the Coated Abrasive Manufacturers Institute (CAMI). Most European sandpaper manufacturers, and some U.S. manufacturers, use the grading specifications of the Federation of European Producers of Abrasives (FEPA). FEPA sandpaper particle sizes are prefixed by the letter P. Sandpaper made from emery has a unique grading system.

Use this chart to convert or compare the CAMI, FEPA and emery grading systems. The chart also provides the particle size both in inches and microns. A micron, by the way, is equal to one millionth of a meter.

PARTICLE SIZE *(inches)*	PARTICLE SIZE *(microns)*	ALL PRODUCTS OTHER THAN EMERY—GRADING SYSTEM		EMERY	
		CAMI	FEPA	POLISHING PAPER	CLOTH
.00026	6.5	1200	-	4/0	-
.00036	9.2	1000	-	2/0	-
.00048	12.2	800	-	-	-
.00060	15.3	-	P1200	-	-
.00062	16.0	600	-	1/0	-
.00071	18.3	-	P1000	-	-
.00077	19.7	500	-	0	-
.00085	21.8	-	P800	-	-
.00092	23.6	400	-	-	-
.00100	25.75	-	P600	-	-
.00112	28.8	360	-	-	-
.00118	30.0	-	P500	-	-
.00137	35.0	-	P400	-	-
.00140	36.0	320	-	-	-
.00158	40.5	-	P360	-	-
.00172	44.0	280	-	1	-
.00180	46.2	-	P320	-	-

PARTICLE SIZE *(inches)*	PARTICLE SIZE *(microns)*	ALL PRODUCTS OTHER THAN EMERY—GRADING SYSTEM		EMERY	
		CAMI	FEPA	POLISHING PAPER	CLOTH
.00204	52.5	-	P280	-	-
.00209	53.5	240	-	-	-
.00228	58.5	-	P240	-	-
.00254	65.0	-	P220	-	-
.00257	66.0	220	-	2	-
.00304	78.0	180	P180	3	-
.00363	93.0	150	-	-	Fine
.00378	97.0	-	P150	-	-
.00452	116.0	120	-	-	-
.00495	127.0	-	P120	-	-
.00550	141.0	100	-	-	Medium
.00608	156.0	-	P100	-	-
.00749	192.0	80	-	-	Coarse
.00768	197.0	-	P80	-	-
.01014	260.0	-	P60	-	-
.01045	268.0	60	-	-	-
.01271	326.0	-	P50	-	-
.01369	351.0	50	-	-	Ex-Coarse
.01601	412.0	-	P40	-	-
.01669	428.0	40	-	-	-
.02044	524.0	-	P36	-	-
.02087	535.0	36	-	-	-
.02426	622.0	-	P30	-	-
.02448	638.0	30	-	-	-
.02789	715.0	24	-	-	-
.02886	740.0	-	P24	-	-
.03530	905.0	20	-	-	-
.03838	984.0	-	P20	-	-
.05148	1320.0	16	-	-	-
.05164	1324.0	-	P16	-	-
.06880	1764.0	-	P12	-	-
.07184	1842.0	12	-	-	-

ABRASIVE MATERIALS

Several synthetic and natural materials are used to make abrasive particles. The most commonly used abrasive materials are described here.

MATERIAL	DESCRIPTION
Aluminum oxide	Synthetic abrasive. Extremely tough. Well-suited for hardwoods, carbon steel, alloy steels and bronze
Silicon carbide	Synthetic abrasive. Hardest and sharpest of the commonly used abrasive materials, although it tends to be brittle. Generally used for finishing nonferrous metals (aluminum, brass, bronze, etc.), plastics, rubber, softwoods and hardwoods
Zirconia alumina	Synthetic abrasive. Has long life because abrasive particles self-sharpen with use. Often used for heavy wood sanding and metal grinding applications
Garnet	Natural abrasive. Not as hard or durable as the synthetic abrasives. Particles have sharp edges but tend to dull rapidly when used to sand metal. Often used for finish-sanding of furniture and wood products
Emery	Natural abrasive. Block-shaped particles cut slowly. Used primarily for polishing metals
Flint	Natural abrasive. Tends to dull quickly. Low cost often makes it the best choice for applications that cause sandpaper to clog quickly, such as removing paint or old finish

BACKINGS FOR COATED ABRASIVES

Several types of backing material are used to make coated abrasives, but paper or cloth backings are used most often for woodworking applications.

Paper Backing

Paper backing is classified by weight. (Paper weights are based on the number of pounds in a ream of 480 sheets.) Lighter-weight backing offers greater flexibility; heavier-weight backing provides better resistance to tearing. Some paper backings are waterproofed for use in wet applications.

Cloth Backing

Compared to paper backings, cloth backings offer better durability and resistance to tearing, plus they stand up better to constant flexing.

PAPER BACKING

WEIGHT	DESCRIPTION
A-weight	Made from 40-pound paper. Light and flexible. Used mostly for hand finishing work
C-weight	Made from 70-pound paper. Less flexible but stronger than A-weight backing. Used for hand sanding work and with small portable power sanders
D-weight	Made from 90-pound paper. Less flexible but stronger than C-weight backing. Used for hand sanding work and with small portable power sanders
E-weight	Made from 130-pound paper. Less flexible but stronger than D-weight backing. Used when high resistance to tearing is important, such as roll, belt and disc sander applications
F-weight	Made from 165-pound paper. Least flexible but strongest weight. Mostly used for rolls and belts in industrial applications

CLOTH BACKING

WEIGHT	DESCRIPTION
J-weight (Jeans)	Lightest and most flexible cloth backing. Typically used to sand curved surfaces
X-weight (Drills)	Less flexible but stronger than J-weight backing. Used for applications ranging from coarse-grit heavy sanding through fine-grit polishing
Y-weight (Heavy Drills or Sateen)	Stronger, with better resistance to longitudinal splitting than regular drills cloth. Used in severe applications such as narrow belt grinding of hand tools and wide belt sanding of wood and particleboard
H-weight (Heavy Duty)	Strongest cloth backing. Use for applications requiring coarse grits and heavy stock removal

Note: In addition to the above, other cloth backings are sometimes used. They include combination backing (a lamination of paper and cloth), fiber backing and polyester film backing.

COAT COVERAGE

The amount of abrasive material applied to the backing is called the coverage. There are two coverage options: open coat and closed coat.

COVERAGE	DESCRIPTION
Closed coat	Abrasive particles completely cover the surface. Removes a lot of material before dulling
Open coat	Abrasive particles cover about 50 to 60 percent of the surface. Tends to cut fast with a minimum of clogging. Better flexibility than closed coat

ADHESIVE BONDS

Abrasive particles are bonded to the backing with an adhesive. Two types of adhesive are used to bond abrasives: animal glue and resin-based glue. Two coats of the adhesive are applied. A *maker coat* is added first, followed by a *sizer coat*.

ADHESIVE BOND	DESCRIPTION
Glue	Uses animal-hide glue for both the maker and sizer coat. Produces more uniform, less harsh finish
Resin	Liquid phenolic or urea adhesive product. Used for both maker and sizer coats. Offers greater durability and resistance to heat when removing heavy amounts of material. Best all-around adhesive for coated abrasives
Resin over glue	Resin sizer coat added over glue maker coat to combine the advantages of each bond. Cuts faster than glue bond, yet results in a better finish than resin bond

SANDPAPER USE CHART

GRIT SIZE	TYPICAL USES
24 to 36	Removing heavy paint and finishes
40 to 50	Smoothing very rough wood surfaces. Removing paint and heavy finishes
60 to 80	Preliminary sanding of rough wood. Removing planer marks
100 to 120	Smoothing wood surfaces. Removing scratches from the 60- to 80-grit sanding step
150 to 180	Removing scratches from the 100- to 120-grit step
220 to 240	Final sanding of wood surfaces
280 to 320	Sanding between finish coats
360 to 400	Final sanding of finish coat

Steel Wool Grades

GRADE NUMBER	DESCRIPTION	TYPICAL USE
4	Extra coarse	Removing chipped paint and heavy rust
3	Coarse	Removing paint and heavy rust
2	Medium coarse	Removing paint and rust
1	Medium	Smoothing wood scratches; removing raised wood fibers
0 (1/0)	Fine	Smoothing shallow wood scratches; removing raised wood fibers; stripping finishes
00 (2/0)	Very fine	Light smoothing between finish coats
000 (3/0)	Extra fine	Smoothing between finish coats
0000 (4/0)	Super fine	Final rub down of finish

Thinning Shellac

The term *pound cut* describes the number of pounds of shellac flakes in a gallon of alcohol solvent. For example, a 3-pound cut has 3 pounds of shellac flakes in 1 gallon of alcohol. When shellac needs to be thinned to a lower pound cut, use this chart as a guide for adding the correct amount of alcohol.

STARTING POUND CUT	DESIRED POUND CUT	MIXING PROPORTIONS	
		alcohol	*shellac*
5	4	1 part	4 parts
5	3	1 part	2 parts
5	2	1 part	1 part
5	1	2 parts	1 part
5	½	7 parts	1 part
4	3	1 part	4 parts
4	2	3 parts	4 parts
4	1	3 parts	1 part
4	½	5 parts	1 part
3	2	2 parts	5 parts
3	1	4 parts	3 parts
3	½	4 parts	1 part

Choosing a Stain

Pigment stains consist of finely ground particles suspended in a water- or oil-based solvent. When applied to wood the solvent evaporates, leaving the colored pigment on the wood surface. Pigment stains are relatively easy to use and are available in a wide choice of colors, but they tend to obscure the grain of the wood somewhat.

Aniline dye powders dissolve completely when mixed with water-, alcohol- or oil-based solvents. The dissolved dyes thoroughly saturate the wood fibers with color, allowing the grain to show through.

STAIN TYPE	FORM	PREPARATION	CHARACTERISTICS
PIGMENT STAINS			
Oil-based	Liquid	Mix thoroughly	Apply with rag, brush or spray; resists fading
Water-based	Liquid	Mix thoroughly	Apply with rag, brush or spray; resists fading; water cleanup
Gel	Gel	None	Apply with rag; won't raise grain; easy to use; no drips or runs
Water-based gel	Gel	None	Apply with rag; easy to use; no drips or runs; water cleanup
Japan color	Concentrated liquid	Mix thoroughly	Used for tinting stains, paints, varnish, lacquer
DYE STAINS			
Water-based	Powder	Mix with water	Apply with rag, brush or spray; deep penetrating; best fade resistance of dye stains; good clarity; raises grain
Oil-based	Powder	Mix with toluol, lacquer thinner, turpentine or naphtha	Apply with rag, brush or spray; penetrating; does not raise grain; dries slowly
Alcohol-based	Powder	Mix with alcohol	Apply with rag, brush or spray; penetrating, does not raise grain; dries quickly; lap marks sometimes a problem
NGR	Liquid	Mix thoroughly	Apply with rag, brush or spray (use retarder if wiping or brushing); good clarity; does not raise grain

Choosing a Top Coat

FINISH TYPE	FORM	PREPARATION	CHARACTERISTICS
Shellac	Liquid	Mix thoroughly	Dries quickly; economical; available either clear or amber-colored; high gloss luster; affected by water, alcohol and heat
Shellac flakes	Dry flakes	Mix with alcohol	Dries quickly; economical (mix only what is needed); color choices from amber to clear; high gloss luster; affected by water, alcohol and heat
Lacquer	Liquid	Mix with thinner for spraying	Dries quickly; clear (shaded lacquers available), high gloss luster; flattening agents available; durable; moisture resistant
Varnish	Liquid	Mix thoroughly	Dries slowly; amber color; gloss, semigloss or satin lusters; very good durability and moisture resistance; flexible
Polyurethane	Liquid	Mix thoroughly	Dries slowly; clear to amber colors; gloss, semigloss and satin lusters; excellent durability and moisture resistance; flexible
Water-based polyurethane	Liquid	Mix thoroughly	Dries quickly; clear; won't yellow; gloss and satin lusters; moisture and alcohol resistant; low odor
Tung oil	Liquid	None	Dries slowly; amber color; satin luster; poor moisture resistance; easy to use
Danish oil	Liquid	Mix thoroughly	Dries slowly; amber color; satin luster; poor moisture resistance; easy to use

Top Coat Dry Times

FINISH TYPE	DRY TIME
Shellac	2 hours
Lacquer	30 minutes
Varnish	3 to 6 hours
Polyurethane	3 to 6 hours
Water-based polyurethane	2 hours
Tung oil	20 to 24 hours
Danish oil	8 to 10 hours

Note: Dry times are based on a temperature of 70° Fahrenheit and 40 percent relative humidity. Lower temperature and/or higher relative humidity can increase drying time.

Making a Tack Cloth

1. Use mineral spirits to dampen a piece of cheesecloth or cotton cloth.
2. Place the cloth in a resealable plastic bag and add a small amount of varnish to the cloth. Close the bag.
3. Knead the cloth in the bag until the entire cloth surface becomes moderately sticky.
4. Store the tack cloth in the plastic bag (or in a glass jar). Over a period of time, the cloth is going to dry and lose some stickiness, but you can simply add a bit more varnish to rejuvenate it.

CHAPTER TEN

safety

10

General Safety Rules

The workshop is a great place to relax and enjoy working with wood, but it is not without hazards. Cutters and blades revolving at high speed can inflict serious injury — even death. A misused hand chisel can cause a nasty cut. A flying chip from the table saw can permanently injure an unprotected eye.

Clearly, it's important to use a good measure of caution and common sense when in the workshop. To that end, I suggest that you photocopy these rules and post them in a conspicuous place in your workshop. If you keep these do's and don'ts in mind, your workshop will be a safer place.

Do install a smoke detector in the workshop.

Do keep a class ABC fire extinguisher in the workshop.

Do wear safety glasses in the workshop. Wear goggles when using chemicals or finishes that are dangerous to eyes.

Do wear hearing protection when using noisy power equipment.

Don't attempt any procedure that makes you concerned about safety.

Don't attempt any procedure unless properly equipped.

Don't work when tired or under the influence of medication, alcohol or drugs.

Do be sure to know your power tool; read the owner's manual and understand the limitations and potential hazards of the tool before using it.

Do keep cutting tool edges properly sharpened.

Do use blade guards on tools that are equipped with them.

Do use power tools that are double-insulated and grounded.

Don't use power tools in wet locations.

Do unplug power tools before making adjustments or changing saw blades, bits, cutters and the like.

(Continued on next page)

GENERAL SAFETY RULES (CONT'D)

Do make sure that the power tool switch is in the *off* position before connecting the power plug.

Don't force a tool to do an operation it's not designed to do.

Do use clamps or other means to make sure the workpiece is held securely in place when using a power tool.

Do keep hands well away from moving saw blades, bits, cutters and the like.

Don't wear jewelry or loose clothing that can get caught in moving parts.

Do wear a dust mask if the work is producing dust.

Do keep the workshop clean and uncluttered.

Do keep the workshop well lighted.

Don't allow children near the work area.

Do use a National Institute for Occupational Safety and Health (NIOSH) approved dual-cartridge respirator when using chemicals, finishes or solvents that produce hazardous vapors. Install filters that are appropriate for the chemicals or finishes used.

Do provide adequate ventilation when using chemicals, finishes or solvents that produce hazardous vapors.

Do place all oily waste materials in a sealed water-filled metal container to avoid the dangers of spontaneous combustion.

Do store flammables in a metal container away from sources of ignition or heat.

Don't use solvents like acetone, mineral spirits or lacquer thinner to clean your hands; the solvents can be absorbed into the body through the skin.

Do not smoke, drink or eat when using chemicals, finishes or solvents.

Do dispose of chemicals, finishes or solvents in an environmentally friendly manner. Don't dump them onto the ground or down drains.

Safe Extension Cord Wire Gauges and Lengths

An extension cord with a wire gauge size that's too small causes a drop in voltage, loss of power, motor overheating and possible motor damage. Use this chart as a guide to selecting the correct wire gauge size based on the motor ampere rating and the extension cord length. (The smaller the wire gauge size, the larger the wire diameter.) The chart is based on limiting the line voltage drop to 5 volts at 150 percent of the rated amps. The wire gauge sizes shown are American Wire Gauge (AWG) standards. If you'll use the connected tool outdoors, you must use an extension cord rated for outdoor service.

Example 1: An electric drill has a 3.5 amp motor. The drill needs a 75' extension cord in order to reach a backyard shed. What's the minimum wire gauge size you can use with the 3.5 amp motor?

Answer: According to the chart, a minimum wire gauge of 16 must be used.

Example 2: A belt sander with a 7.5 amp motor requires a 50' extension cord. What's the minimum wire gauge size that you can use?

Answer: According to the chart, a minimum wire gauge of 14 must be used.

TOOL AMPERE RATING (*shown on nameplate*)	**MINIMUM WIRE GAUGE SIZE (AWG)**			
	25'	**50'**	**75'**	**100'**
0-2.0	18	18	18	18
2.1-3.4	18	18	18	16
3.5-5.0	18	18	16	14
5.1-7.0	18	16	14	12
7.1-12.0	16	14	12	10

Noise in the Workshop

Noise is defined as any unwanted sound. Some sounds, unfortunately, have such high intensity that they can cause permanent hearing loss. The Occupational Safety and Health Administration (OSHA) has set standards for limiting worker exposure to dangerous noise levels.

Sound, including noise, is measured using a unit called the decibel (dB). The dB level for an assortment of sounds, including several woodworking power tools, is shown on page 211.

Noise danger is related not only to the intensity of the sound, but also to the length of time that you are exposed to a sound (see Permissible Noise Exposure Time, right).

Based on an 8-hour day, OSHA has determined that a decibel level greater than 90 can cause hearing loss. (Some experts feel that number should be lowered to 85 decibels.) As the chart shows, most woodworking power tools exceed the 90 decibel limit, so be sure to wear ear protection when running woodworking equipment. A good set of ear plugs or earmuff-type hearing protectors, properly fitted and used, can reduce noise levels by 15 to 30 decibels, depending upon the manufacturer and model. Make sure the 15 to 30 decibel drop lowers the noise to a safe level.

For more information about noise and its effects on hearing loss, contact the National Institute for Occupational Safety and Health (part of the U.S. Department of Health and Human Services); (800) 35-NIOSH (354-4674).

PERMISSIBLE NOISE EXPOSURE TIME

Use this chart to determine the maximum length of time you can safely withstand various noise levels.

Example: A radial-arm saw creates 105dB of noise as it crosscuts wide stock. How long can you continue cutting before it becomes a risk to your hearing?

Answer: According to the chart, at a noise level of 105 decibels, the exposure time must be limited to a maximum of 1 hour.

Note: If you wear ear protectors that reduce the noise level by 15 decibels (from 105dB to 90dB), you can increase the maximum exposure time, according to OSHA, to 8 hours per day. That said, NIOSH would prefer you use ear protectors that reduce noise by at least 20dB, putting noise levels below their recommended limit of 85dB.

NOISE LEVEL *(dB)*	TIME LIMIT PER DAY *(hours)*
115	1/4 or less
110	1/2
107	3/4
105	1
102	1 1/2
100	2
97	3
95	4
92	6
90	8

NOISE LEVELS OF VARIOUS SOUNDS

Keep in mind that this scale is logarithmic, not linear. A 95dB noise has one hundred times more sound energy than a 75dB noise. All the woodworking power tool measurements are taken from the normal position of the machine operator. The decibel levels represent the noise generated when the tool is cutting (or sanding) wood. The decibel levels shown are approximate and may vary somewhat depending on room size, specific machine type and other factors.

WOODWORKING POWER TOOLS	DECIBEL LEVEL *(dB)*	OTHER SOUNDS
	150	Jet taking off (150)
	145	
	140	Gunshot (140)
	135	
	130	Jackhammer (130)
	125	
	120	Rock concert (120)
	115	
Chain saw (108)	110	Textile loom (110)
Radial-arm saw (105)	105	
Portable circular saw (100)	100	
Router (95), Belt sander (93)	95	
Planer (93), Table saw (92)	90	Lawn mower (90)
Shop vacuum (86), Drill press (85)	85	
	80	Subway (80)
	75	
	70	Busy street (70)
	65	
	60	Restaurant (60)
	55	
	50	Conversation (50)
	45	
	40	Urban home (40)
	35	
	30	Suburban home (30)
	25	
	20	Whisper (20)
	15	
	10	Rustling leaves (10)
	5	
	0	Silence

Working with Pressure-Treated Wood

Since the advent of pressure-treated lumber, billions of board feet have been safely used. However, be aware that to make the lumber resistant to moisture and insects, the pressure-treating process forces chemicals deep into the wood cells (see page 103). The pressure-treated lumber commonly used for backyard decks contains the chemicals chromated copper arsenate (CCA) or ammoniacal copper zinc arsenate (ACZA). Both of these chemicals contain inorganic arsenic, so it certainly is prudent to follow some special safety rules when working with pressure-treated lumber.

SAFETY RULES FOR WORKING WITH PRESSURE-TREATED LUMBER

- Always wear a dust mask.
- Always wear gloves when handling pressure-treated lumber (unless the gloves pose a risk when using power equipment).
- After construction, clean up and properly dispose of sawdust from pressure-treated wood.
- Wash clothes covered with pressure-treated sawdust separately from other household clothing.
- Don't use pressure-treated wood where the chemical could become a component of food or animal feed.
- Don't use pressure-treated wood where it could come into direct or indirect contact with drinking water (except incidental contact such as when used on docks or bridges).
- Don't use pressure-treated wood to make toys, countertops or kitchen cutting boards.
- Don't burn pressure-treated wood because toxic chemicals may be released in the smoke and ashes.

Hazardous Woodworking Chemicals

Many commonly used workshop products contain hazardous chemicals. Adhesives, degreasers, thinners, solvents, dyes, fillers, strippers, stains, waxes and finishes often include chemicals that could pose a threat to your health if not used with caution. Also, many workshop chemicals are a dangerous fire hazard when exposed to heat or flames.

Exposure to chemicals can produce both acute and chronic effects. Acute effects generally result from single short-term exposures, usually less than 24 hours in duration. Chronic effects generally result from long and repeated exposures, often in small amounts, usually over a period of time greater than a few months.

Hazardous chemicals can enter the body through inhalation, ingestion and skin contact. Many woodworking-related chemicals quickly become vapors, so inhalation is a common route of entry into the body. Always use a well-fitting respirator approved by the National Institute for Occupational Safety and Health (NIOSH), and be sure that the filter is acceptable for the chemical in use. For some chemicals, such as methylene chloride and methanol, there is no approved filter. Also, remember that filters have a limited life span, so they must be changed periodically.

Ingestion can occur when a chemical is accidentally swallowed, an unfortunate event that happens to children more than adults. Adults are more likely to ingest chemicals by bringing food, drink or cigarettes into the shop. Indeed, vapors can settle on food and drink, which soon end up in the stomach and absorbed by the bloodstream. Also, vapors that settle on hands can easily make it into the mouth. To avoid ingesting chemicals, don't eat, drink or smoke in the shop. Of course, smoking also increases the risk of fire when using chemicals that are flammable.

Some chemicals can be absorbed through the skin or through skin cuts and abrasions. The chemicals are then absorbed by the blood. To minimize this risk, always wear approved gloves when handling chemical products. And be sure to wash hands thoroughly with soap and water after working.

The list that follows includes many of the chemicals commonly found in woodshop products. It describes the dangers presented by the chemical and notes the Threshold Limit Value (TLV). The TLV represents the maximum airborne contaminant level, in parts per million (ppm), that most healthy adults can sustain in a 40-hour workweek without a health risk. The lower the TLV, the more dangerous the chemical.

ACETONE
Synonyms: Dimethyl ketone, ketone propane, propanone, pyroacetic ether
Common uses: Epoxy, lacquer, paint stripper, wood filler
Toxicity (TLV in ppm): 750
Dangers: Can irritate eyes, nose, throat, skin and central nervous system; high vapor levels can cause narcosis
Fire risk: Extremely flammable

BENZENE
Synonyms: Benzol, coal naphtha, carbon oil, cyclohezatriene
Common uses: Lacquer thinner, petroleum distillate, paint stripper
Toxicity (TLV in ppm): 10
Dangers: Do not use; dangerous carcinogen; can poison through inhalation of the vapors or absorption through skin; chronic exposure may cause leukemia
Fire risk: Extremely flammable

BIS(2,3-EPOXYPROPYL) ETHER
(see Digylcidyl ether)

BUTYL METHYL KETONE
(see Methyl n-butyl ketone)

CARBON OIL
(see Benzene)

COAL NAPHTHA
(see Benzene)

CYCLOHEZATRIENE
(see Benzene)

DGE
(see Digylcidyl ether)

DIALLYL ETHER DIOXIDE
(see Digylcidyl ether)

DICHLOROMETHANE
(see Methylene chloride)

DI(EPOXYPROPYL) ETHER
(see Digylcidyl ether)

DIGYLCIDYL ETHER
Synonyms: Bis(2,3-epoxypropyl) ether; DGE, diallyl ether dioxide; di(epoxypropyl) ether; 2,3-epoxypropyl ether
Common uses: Epoxy
Toxicity (TLV in ppm): 0.1
Dangers: Can cause severe irritation of skin, eyes and respiratory system; skin burns

DIMETHYL BENZENE
(see Xylene)

2,3-EPOXYPROPYL ETHER
(see Digylcidyl ether)

ESANI
(see n-Hexane)

ETHANOL
Synonyms: Ethyl alcohol, methyl carbinol, wood alcohol
Common uses: Shellac, stain
Toxicity (TLV in ppm): 1,000
Dangers: Can affect eyes, nose, skin, central nervous system and upper respiratory tract; large doses can cause alcohol poisoning
Fire risk: Dangerous when exposed to heat or flame

ETHYL ALCOHOL
(see Ethanol)

GUM SPIRITS
(see Turpentine)

GUM TURPENTINE
(see Turpentine)

HEKSAN
(see n-Hexane)

N-HEXANE
Synonyms: Esani, heksan, hexanen
Common uses: Contact cement, quick-drying cement, rubber cement, rubbing oils, spray adhesive, varnish
Toxicity (TLV in ppm): 50
Dangers: Can affect skin, respiratory system, central and peripheral nervous systems, general health
Fire risk: Dangerous when exposed to heat, flame and powerful oxidizers

HEXANEN
(see n-Hexane)

2-HEXANONE
(see Methyl n-butyl ketone)

HEXONE
(see Methyl-isobutyl ketone)

ISOBUTYL METHYL KETONE
(see Methyl-isobutyl ketone)

ISOPROPYL ALCOHOL
Synonyms: Isopropanol, rubbing alcohol
Common uses: Lacquer
Toxicity (TLV in ppm): 400
Dangers: Can cause irritation of eyes and skin; high airborne concentrations may cause narcosis

KETONE PROPANE
(see Acetone)

KSYLEN
(see Xylene)

MBK
(see Methyl n-butyl ketone)

METHANOL
Synonyms: Carbinol, methyl alcohol, wood alcohol, wood spirit
Common uses: Dye, lacquer, paint, paint stripper, varnish
Toxicity (TLV in ppm): 200
Dangers: Can affect skin, eyes, central nervous system; ingestion may cause blindness or death
Fire risk: Dangerous when exposed to heat or flame

METHYL BENZENE
(see Toluol)

METHYL CARBINOL
(see Ethanol)

METHYL-ETHYL KETONE
Synonyms: 2-Butanone, MEK
Common uses: Lacquer, wood filler, plastic cement
Toxicity (TLV in ppm): 200
Dangers: Can affect skin, central nervous system, upper respiratory tract
Fire risk: A dangerous fire and explosive hazard

METHYL-ISOBUTYL KETONE
Synonyms: Hexone, Isobutyl methyl ketone, MIBK
Common uses: Lacquer, paint, plastic cement, spray can products, varnish, wood filler
Toxicity (TLV in ppm): 50
Dangers: Can affect respiratory system, eyes, skin, central nervous system
Fire risk: Dangerous when exposed to heat, flame or oxidizers

METHYL N-BUTYL KETONE
Synonyms: Butyl methyl ketone, 2-hexanone, MBK
Common uses: Aerosols, lacquer, oils, quick-drying finishes, wax, varnish, wood filler
Toxicity (TLV in ppm): 5
Dangers: Can affect respiratory system, eyes, skin, nose, central nervous system
Fire risk: Dangerous when exposed to heat or flame

METHYLENE CHLORIDE
Synonyms: Dichloromethane, methylene dichloride
Common uses: Adhesives, contact cement, paint strippers
Toxicity (TLV in ppm): 50
Dangers: Can affect skin, kidneys, liver, central nervous system

METHYLENE DICHLORIDE
(see Methylene chloride)

MIBK
(see Methyl-isobutyl ketone)

MINERAL SPIRITS
Synonyms: Odorless paint thinner, Stoddard solvent, turpentine substitute, white spirits
Common uses: Varnish, polyurethane, tung oil, brush cleaner, thinner, degreaser
Toxicity (TLV in ppm): 200
Dangers: Can affect skin, lungs, central nervous system

ODORLESS PAINT THINNER
(see Mineral spirits)

PETROLEUM ETHER
(see Petroleum naphtha)

PETROLEUM NAPHTHA
Synonyms: Petroleum ether, petroleum spirits
Common uses: Lacquer, wax, paint, varnish, wood filler
Toxicity (TLV in ppm): 100
Can affect: Eyes, skin, respiratory system, central nervous system
Fire risk: Very dangerous when exposed to heat or flame

PETROLEUM SPIRITS
(see Petroleum naphtha)

PROPANONE
(see Acetone)

PYROACETIC ETHER
(see Acetone)

SPIRITS OF TURPENTINE
(see Turpentine)

STODDARD SOLVENT
(see Mineral spirits)

TOLUEN
(see Toluol)

TOLUENE
(see Toluol)

TOLUOL
Synonyms: Methyl benzene, toluen, toluene, toluolo
Common uses: Adhesives, lacquer thinner, finishing oils, polyurethane, paint stripper, wood putty
Toxicity (TLV in ppm): 100
Can affect: Eyes, skin, upper respiratory tract, central nervous system, liver, kidneys
Fire risk: Dangerous when exposed to heat or flame

TOLUOLO
(see Toluol)

TURPENTINE
Synonyms: Gum spirits, gum turpentine, spirits of turpentine, wood turpentine
Common uses: Tung oil, wax, brush cleaner, degreaser, thinner
Toxicity (TLV in ppm): 100
Dangers: Can affect skin, eyes, lungs, central nervous system, bladder, kidneys
Fire risk: Dangerous when exposed to heat, flame and oxidizers

TURPENTINE SUBSTITUTE
(see Mineral spirits)

VARNISH MAKER'S AND PAINTER'S NAPHTHA
(see VM&P naphtha)

VM&P NAPHTHA
Synonym: Varnish maker's and painter's naphtha
Common uses: Degreaser, lacquer, solvent, varnish
Toxicity (TLV in ppm): 300
Dangers: Can affect eyes, skin, lungs, central nervous system
Fire risk: Dangerous when exposed to heat, flame and oxidizers

WHITE SPIRITS
(see Mineral spirits)

WOOD ALCOHOL
(see Ethanol)

WOOD TURPENTINE
(see Turpentine)

XILOLI
(see Xylene)

XYLENE
Synonyms: Dimethyl benzene, ksylen, xilole, xyloli
Common uses: Adhesives, lacquer, paint, paint stripper
Toxicity (TLV in ppm): 100
Dangers: Can affect skin, upper respiratory tract, central nervous system
Fire risk: Dangerous fire hazard from heat, flame and powerful oxidizers

XYLOLE
(see Xylene)

CHAPTER ELEVEN

suppliers

11

Hard-to-Find Woodworking Supplies

Adams Wood Products
974 Forest Dr.
Morristown, TN 37814
423-587-2942
www.adamswoodproducts.com
(table legs, bed posts, furniture components)

Art Essentials of New York, Ltd. (The Gold Leaf People)
P.O. Box 38
Tallman, NY 10982-0038
800-283-5323
www.artessentialsofnewyork.com
(gold leaf)

The Bartley Collection
65 Engerman Ave.
Denton, MD 21629
800-787-2800
www.bartleycollection.com
(antique reproduction furniture kits)

Certainly Wood
13000 Route 78
East Aurora, NY 14052
716-655-0206
www.certainlywood.com
(raw wood veneer)

Cherry Tree Toys, Inc.
2104 Beloit Ave.
Janesville, WI 53546
800-848-4363
www.cherrytreetoys.com
(toy plans, parts and suppliers)

Christian J. Hummul Co.
422 Third St.
P.O. Box 522
Nescopeck, PA 18635
800-762-0235
www.hummul.com
(solid brass and solid copper sheet stock)

Country Accents
1723 Scaife Rd.
Williamsport, PA 17701
570-478-4127
www.piercedtin.com
(pierced tin, pierced copper and pierced brass)

Delta Machinery
4825 Hwy. 45 North
P.O. Box 2468
Jackson, TN 38302-2468
800-223-7278
www.deltamachinery.com
(parts for Walker-Turner machinery)

Eagle America
510 Center St.
P.O. Box 1099
Chardon, OH 44024
800-872-2511
www.eagleamerica.com
(large selection of router bits)

Floral Glass and Mirror, Inc.
895 Motor Parkway
Hauppauge, NY 11788
800-647-7672
(beveled glass, mirror glass)

Happy House Miniatures
135 N. Main St.
Mocksville, NC 27028-2422
336-751-1424
(dollhouse supplies)

Klingspor Abrasives, Inc.
P.O. Box 3737
Hickory, NC 28603-3737
800-645-5555
www.klingspor.com
(sanding supplies)

Luthiers Mercantile International
7975 Cameron Dr.
Bldg. 1600
Windsor, CA 95492
800-477-4437
www.lmii.com
(guitar wood, rosettes, inlays, and guitar-making tools)

Maine Coast Lumber
17 White Birch Ln.
York, ME 03909
800-899-1664
www.mainecoastlumber.com
(hardwood plywood)

McFeely's Square Drive Screws
3720 Cohen Pl.
P.O. Box 11169
Lynchburg, VA 24506-1169
800-443-7937
www.mcfeelys.com
(square drive screws)

Micro-Mark
340 Snyder Ave.
Berkeley Heights, NJ 07922-1595
800-225-1066
www.micromark.com
(thin lumber, small tools for model makers)

MLCS Router Bits and Woodworking Products
P.O. Box 4053
Rydal, PA 19046
800-533-9298
www.mlcswoodworking.com
(large selection of router bits)

Oakwood Veneer Company
3642 W. 11 Mile Rd.
Berkley, MI 48072
800-426-6018
www.oakwoodveneer.com
(veneer)

Ohio Tool Systems, Inc.
3863 Congress Parkway
Richfield, OH 44286
www.ohiotool.com
(parts for Millers Falls Co., machinery)

The Old Fashioned Milk Paint Co., Inc.
436 Main St.
Groton, MA 01450
978-448-6336
www.milkpaint.com
(milk paint)

Osborne Wood Products, Inc.
4620 GA Highway 123
Toccoa, GA 30577
800-849-8876
www.osbornewood.com
(turned table legs, bed posts)

Pearl Works, Ltd.
Rt. 3, Box 122
Mechanicsville, MD 20659
717-646-9122
www.pearlworks.com
(mother-of-pearl inlay)

Reid Supply Company
2265 Black Creek Rd.
Muskegon, MI 49444
800-253-0421
www.reidtool.com
(plastic knobs and handles for jig making)

Ridge Carbide Tool Company
595 New York Ave.
P.O. Box 497
Lyndhurst, NJ 07071
800-RCT-TOOL
www.ridgecarbidetool.com
(custom router bits)

River Bend Turnings
3730 Vandermark Rd.
Scio, NY 14880
585-593-3495
www.rctc.com
(custom turning)

Shaker Workshops
P.O. Box 8001
Ashburnham, MA 01430-8001
800-840-9121
www.shakerworkshops.com
(chair tape for Shaker chairs)

Tremont Nail Company
8 Elm St.
Wareham, MA 02571
800-842-0560
www.tremontnail.com
(old-fashioned cut nails, colonial hardware)

Woodworks, Ltd.
4521 Anderson Blvd.
Fort Worth, TX 76117
800-722-0311
www.woodwrks.com
(miscellaneous small wood parts)

General Woodworking Suppliers

Constantine's Wood Center of Florida, Inc.
1040 E. Oakland Park Blvd.
Ft. Lauderdale, FL 33334
800-443-9667
www.constantines.com

Garrett Wade Co., Inc.
161 Avenue of the Americas
New York, NY 10013
800-221-2942
www.garrettwade.com

Highland Hardware
1045 N. Highland Ave. N.E.
Atlanta, GA 30306
800-241-6748
www.highlandhardware.com

Lee Valley
U.S.:
P.O. Box 1780
Ogdensburg, NY 13669-6780
800-267-8735
Canada:
P.O. Box 6295, Station J
Ottawa, ON K2A 1T4
800-267-8761
www.leevalley.com

Rockler Woodworking and Hardware
4365 Willow Drive
Medina, MN 55340
800-279-4441
www.rockler.com

Seven Corners Hardware, Inc.
216 West 7th St.
St. Paul, MN 55102
800-328-0457
www.7corners.com

Shopsmith, Inc.
6530 Poe Ave.
Dayton, OH 45414-2591
800-762-7555
www.shopsmith.com

Tools for Working Wood
800-426-4613
www.toolsforworkingwood.com

Woodcraft Supply Corp.
1177 Rosemar Rd.
P.O. Box 1686
Parkersburg, WV 26102
800-535-4482
www.woodcraft.com

Woodworker's Supply, Inc.
5604 Alameda Pl., N.E.
Albuquerque, NM 87113
800-645-9292
www.woodworker.com

Hardware Suppliers

Anglo-American Brass Company
P.O. Box 9487
San Jose, CA 95157
408-246-0203

Ball and Ball
463 W. Lincoln Hwy.
Exton, PA 19341
610-363-7330
www.ballandball-us.com

Garrett Wade Co., Inc.
161 Avenue of the Americas
New York, NY 10013
800-221-2942
www.garrettwade.com

Horton Brasses, Inc.
49 Nooks Hill Rd.
Cromwell, CT 06416
800-754-9127
www.horton-brasses.com

Imported European Hardware
Woodworker's Emporium
4320 W. Bell Dr.
Las Vegas, NV 89118
702-871-0722

Meisel Hardware Specialties
P.O. Box 70
Mound, MN 55364-0070
800-441-9870
www.meiselwoodhobby.com

Paxton Hardware, Ltd.
P.O. Box 256
Upper Falls, MD 21156
800-241-9741
www.paxtonhardware.com

Period Furniture Hardware Company
123 Charles St.
P.O. Box 314
Boston, MA 02114
617-227-0758

Rufkahr's
P.O. Box 241384
Memphis, TN 38187-1384
800-545-7947
www.rufkahrs.com

The Stanley Works
1000 Stanley Dr.
New Britain, CT 06053
860-225-5111
www.stanleyworks.com

Whitechapel, Ltd.
P.O. Box 11719
Jackson, WY 83002
800-468-5534
www.whitechapel-ltd.com

Hardwood Suppliers

Arroyo Hardwoods
2707 East Foothill Blvd.
Pasadena, CA 91107-3411
626-304-0021
www.arroyohardwoods.com

Austin Hardwoods Inc.
2119 Goodrich Ave.
Austin, TX 78704-4005
512-442-4001

Berea HardWoods Co., Inc.
18745 Sheldon Rd.
Middleburg Heights, OH 44130
877-736-5487
www.bereahardwoods.com

Berkshire Products Inc.
Route 7A
P.O. Box 591
Sheffield, MA 01257
413-229-7919
www.berkproducts.com

Bristol Valley Hardwoods
4054 Bristol Valley Rd.
Bristol, NY 14424
800-724-0132
www.bristolvalley.com

Maurice L. Condon Co., Inc.
248 Ferris Ave.
White Plains, NY 10603
914-946-4111

Croffwood Mills
8106 Bridge St.
Driftwood, PA 15832
814-546-2532

Dunham Hardwoods
3385 130th St.
Dunlap, IA 51529
712-643-5320
www.dunham-hardwoods.com

Exotic Hardwoods and Veneers
4800 Coliseum Way
Oakland, CA 94601-5010
510-436-5702
www.exotichardwoods.com

Garreson Lumber
7201 Craig Rd.
Bath, NY 14810
607-566-8558
www.garresonlumber.com

General Woodcraft, Inc.
531 Broad St.
New London, CT 06320
860-444-9663
www.generalwoodcraftinc.com

Gilmer Wood Company
2211 N.W. St. Helens Rd.
Portland, OR 97210
888-667-3979
www.gilmerwood.com

Goby Walnut Products
5016 Palestine Rd. N.W.
Albany, OR 97321
541-926-1079
www.gobywalnut.com

Groff & Groff Lumber, Inc.
858 Scotland Rd.
Quarryville, PA 17566-9747
800-342-0001
www.groffslumber.com

Memphis Hardwood Lumber
6535 Church St.
Memphis, TN 13112
800-286-3949
www.memphishardwoodlumber.com

Leonard Lumber Company
P.O. Box 646
Durham, CT 06422
800-848-8338
www.leonardlumber.com

MacBeath Hardwood Company
930 Ashby Ave.
Berkeley, CA 94710
800-479-9907
www.macbeath.com

Niagra Lumber and Wood Products, Inc.
47 Elm St.
East Aurora, NY 14052-2503
800-274-0397
www.niagralumber.com

Northend Hardwoods
Red Village Rd.
Lyndonville, VT 05851
800-626-3275
www.northernhardwoods.com

Northland Forest Products
16 Church St.
P.O. Box 369
Kingston, NH 03848
603-642-3665
www.northlandforest.com

Sterling Hardwoods, Inc.
412 Pine St.
Burlington, VT 05401
800-820-0186

Steve Wall Lumber Company
P.O. Box 287
Mayodan, NC 27027
802-633-4062
www.walllumber.com

Talarico Hardwoods
22 Hardwood Ln.
Mohnton, PA 19540
610-775-0400
www.talaricohardwoods.com

Wood World
2460 W. George St.
Chicago, IL 60618
773-267-3800
www.woodworld.com

Woodcrafter's Supply, Inc.
7703 Perry Highway (Rt. 19)
Pittsburgh, PA 15237
412-367-4330
www.woodcrafterssupply.com

Wood-Ply Lumber Corporation
100 Benington Ave.
Freeport, NY 11520
800-354-9002
www.woodply.com

Woodworker's Source
5402 S. 40th St.
Phoenix, AZ 85040
800-423-2450
www.woodworkerssource.net

Wood Finishing Suppliers

Hood Finishing Products, Inc.
P.O. Box 97
Somerset, NJ 08875-0097
800-229-0934
www.hoodfinishing.com

Industrial Finishing Products, Inc.
465 Logan St.
Brooklyn, NY 11208
718-277-3333
www.industrialfinishings.com

Wood Finishing Enterprises
1729 N. 68th St.
Wauwatosa, WI 53213
414-774-1724
www.woodfinishingenterprises.com

Clock Parts Suppliers

Armor Crafts
728 Larkfield Rd.
East Northport, NY 11731
800-292-8296
www.armorplans.com

Klockit, Inc.
P.O. Box 636
N3211 County Road H
Lake Geneva, WI 53147
800-556-2548
www.klockit.com

S. LaRose, Inc.
3223 Yanceyville St.
Greensboro, NC 27405
888-752-7673
www.slarose.com

Turncraft Clocks, Inc.
P.O. Box 100
Mound, MN 55364-0100
800-544-1711
www.meiselwoodhobby.com

Manufacturers' Customer Service Telephone Numbers and Web Sites

Accuride
562-903-0200
www.accuride.com

Agazzani/Eagle Tools
323-999-2909
www.eagle-tools.com

Black and Decker
800-544-6986
www.blackanddecker.com

Bosch Power Tools
877-267-2499
www.boschtools.com

Bridgewood
800-235-2100
www.wilkemach.com

CMT
888-268-2487
www.cmtusa.com

Delta
800-223-7278
www.deltawoodworking.com

Delmhorst
877-335-6677
www.delmhorst.com

DeWalt
800-433-9258
www.dewalt.com

Dremel
800-437-3635
www.dremel.com

Eagle America
800-872-2511
www.eagleamerica.com

Fein
800-441-9878
www.feinus.com

Felder
800-572-0061
www.feldergroupusa.com

Festool
888-337-8600
www.festool-usa.com

Forrest
800-733-7111
www.forestblades.com

Freud
800-334-4107
www.freudtools.com

General
819-472-1161
www.general.ca

General International
514-326-1161
www.general.ca

Grizzly
800-523-4777
www.grizzly.com

Hammer
800-700-0071
www.hammerusa.com

Harbor Freight
843-676-2603
www.harborfreight.com

Hitachi
800-706-7337
www.hitachipowertools.com

Infinity
877-872-2487
www.infinitytools.com

Irwin
800-464-7946
www.irwin.com

JDS
800-480-7269
www.jdstools.com

Jet
800-274-6848
www.wmhtoolgroup.com

Keller
800-995-2456
www.kellerdovetail.com

Laguna
800-332-4094
www.lagunatools.com

Leigh
800-663-8932
www.leighjigs.com

Lenox Saw
800-628-8810
www.lenoxsaw.com

Lie-Nielsen
800-327-2520
www.lie-nielsen.com

Makita
800-462-5482
www.makita.com

Metabo
800-638-2264
www.metabousa.com

Milwaukee
800-729-3878
www.milwaukeetool.com

Mini-Max
866-975-9663
www.minimax-usa.com

Oliver
800-559-5065
www.olivermachinery.net

Oneida
800-732-4065
www.oneida-air.com

Paslode
800-222-6990
www.paslode.com

Penn State Industries
800-377-7297
www.pennstateind.com

Porter-Cable
888-848-5175
www.porter-cable.com

Powermatic
800-274-6848
www.wmhtoolgroup.com

Primark
800-742-3869
www.primarktoolgroup.com

Ridgid
800-474-3443
www.ridgid.com

Rikon
877-884-5167
www.rikontools.com

Rojek
800-787-6747
www.rojekusa.com

Ryobi
800-525-2579
www.ryobitools.com

SawStop
866-729-7867
www.sawstop.com

Sears/Craftsman
800-697-3277
www.craftsman.com

Senco
800-543-4596
www.senco.com

Shop Fox
800-840-8420
www.shopfoxtools.com

Skil
877-754-5999
www.skil.com

Stanley
800-262-2161
www.stanleyworks.com

Starrett
978-249-3551
www.starrett.com

Timber Wolf
800-234-7297
www.suffolkmachinery.com

Titebond
800-347-4583
www.titebond.com

Veritas
800-267-8735
www.leevalley.com

Whiteside Machine
800-225-3982
www.whitesiderouterbits.com

Wilke
800-235-2100
www.wilkemach.com

Woodjoy
508-669-5245
www.woodjoytools.com

Yorkcraft
800-235-2100
www.wilkemach.com

index

A

Abbreviations, 70–72
Acrylic sheet, 83
Adhesives
  common names, 148–151
  wood bonding, 145–146
Angles, 15, 45–50, 171–173

B

Board feet, 92–94
Bolts
  carriage, 188
  hanger, 185
  machine, 184
  standard machine threads, 183
  washers, 190
Brads, 189

C

Chemicals, 2, 213–219
Circles, 19, 22, 25, 53
Clock parts suppliers, 232–233
Coated abrasives, 195–199
Conversion table, 2, 38–44

D

Drills, 80–82, 153–154

F

Fasteners
  bolts. *See* Bolts
  brads, 189
  butt hinges, 191
  knock-down hardware, 192–193
  nails, 180–182
  screws. *See* Screws
  standard machine threads, 183
  suppliers, 226–228
  washers, 190
Finishing
  coated abrasives, 195–199
  shellac, 200, 202–203
  stain, 201–203
  steel wool, 200
  suppliers, 232
  tack cloth, 203
  topcoat, 202–203
Formulas
  area, 20–22
  circumference, 25
  perimeter, 23–24
  pulleys, 161
Fractions to decimal equivalents, 32
Fractions to metric equivalents, 33
Furniture design
  abbreviations, 70–72
  acrylic sheet, 83
  drill sizes, 80–82
  glass, 2, 82
  joints, 55–61
  mouldings, 76–79
  particleboard shelving, 73–75
  plastic laminate, 83
  shop drawings, 69–70
  standard dimensions, 62–68
  symbols, 72
  wood moisture content, 107–111

G

Geometry, 15–31
Glass, 2, 82
Glue guidelines, 147
Grid patterns, 51–53

H

Hardboard, 142–143
Hardware. *See* Fasteners
Hardwoods
  domestic, 85–87
  drying time, 116
  imported, 89–91
  lumber grades, 105–106
  plywood, 131–140
  standard thicknesses, 106
  suppliers, 228–232
  working properties, 120
Heartwood decay resistance, 121–122

J

Joints, 55–61

M

Manufactured woods
  hardboard, 142–143
  hardwood plywood, 131–140
  medium-density fiberboard (MDF), 141–142, 179
  particleboard, 73–75, 140–141

softwood plywood, 125–130
Math. *See* Woodworking math
Medium-density fiberboard (MDF), 141–142
Metric conversion chart, 2
Metric to decimal equivalents, 34
Metric weights and measures, 36
Moisture content of wood, 107–111, 115–117
Mouldings, 76–79, 164–165

N

Nails, 180–182

P

Particleboard, 73–75, 140–141, 179
Plastic laminate, 83
Plywood, 125–140
Polygons
area formulas, 20–21
geometry, 16–18
miter angles, 45–47
perimeter formulas, 23–24
side lengths, 47
Pressure-treated lumber, 103–104, 212

S

Safety rules
chemicals, 2, 213–219
extension cords, 207
general rules, 205–206
glass shelving, 2
noise, 208–211
power tools, 2, 211
pressure-treated wood, 212
Screws
dowell, 186
drywall, 179
lag screws, 186–187
machine, 184
particleboard and MDF, 179
pilot holes, 80–83
standard machine threads, 183
washers, 190
wood screws, 177–178
Sharpening
angles, 171–173
grit systems, 174
stones, 174–175
Shellac, 200, 202–203
Shelves
furniture dimensions, 67
glass, 2, 82
particleboard shelving, 73–75
Shop drawings, 69–70
Softwoods
domestic, 88–89
drying time, 117
lumber grades, 94–98, 100–101
plywood, 125–130
standard sizes, 98–100
Stain, 201–203
Steel wool, 200
Suppliers
clock parts, 232–233
general supplies, 225–226
hard-to-find supplies, 221–225
hardware, 226–228
hardwood, 228–232
phone numbers and web sites, 233–238
wood finishing, 232
Surface preparation guidelines, 147
Symbols, 72

T

Tack cloth, 203
Tools
band saw, 155–157
drills, 80–82, 153–154
moulding head cutter, 164–165
pulleys, 161
radial-arm saw, 166–167
router, 162–163
saber saw, 160
safety rules, 208–211
scroll saw, 158–159
sharpening, 171–175
table saw, 166–169
wood lathe, 154–155

U

U.S. equivalents and metrics, 37–38
U.S. weights and measures, 35–36

W

Washers, 190
Wood

air-drying, 115–117
board feet, 92–94
bonding, 145–151
hardness, 118–119
hardwoods. *See* Hardwoods
heartwood decay resistance, 121–122
manufactured. *See* Manufactured woods
moisture content, 107–111, 115–117
pressure-treated, 103–104, 212
screws, 177–178
shrinkage, 111–115
softwoods. *See* Softwoods
steam bending table, 123
Woodworking math
angles, 15, 45–47, 48–50
area formulas, 20–22
circles, 19, 22, 25, 53
conversion table, 2, 38–44
ellipse, 30–31
formulas. *See* Formulas
fractions to decimal equivalents, 32
fractions to metric equivalents, 33
grid patterns, 51–53
metric to decimal equivalents, 34
metric weights and measures, 36
polygons. *See* Polygons
triangles, 16, 20, 23, 26–29
U.S. equivalents and metrics, 37–38
U.S. weights and measures, 35–36