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WOODWORKING IS AWESOME!

**PROJECTS,
SKILLS,
AND IDEAS
FOR YOUNG
MAKERS**



**12 FUN
DIY PROJECTS
FOR AGES 8+**

CHRIS PETERSON

STANLEY[®] Jr.

**WOODWORKING
IS AWESOME!**



Inspiring | Educating | Creating | Entertaining

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The techniques shown in this book are general techniques for various applications. In some instances, additional techniques not shown in this book may be required. Always follow manufacturers' instructions included with products, since deviating from the directions may void warranties. The projects in this book vary widely as to skill levels required: some may not be appropriate for all do-it-yourselfers, and some may require professional help.

Consult your local building department for information on building permits, codes, and other laws as they apply to your project.

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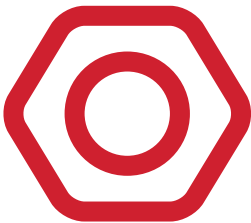
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CONTENTS



6 Introduction

1

9 The Kid's Workshop

2

33 Building Basic Skills

3

49 Fun & Hobby Projects

50 Your Backyard Birdhouse

56 Feathered Friend Feeder

61 Have-A-Blast Toss Across

66 Terrific Tic Tac Toe Board

70 Vroom! Toy Car Parking Garage

76 The Great Catapult

4

83 Handy Helpers

84 Terrific Tool Carrier

88 Building-Block Storage Box

92 Woodworker's Workbench

5

96 Great Gifts

98 Precious Jewelry Box

102 Picture Perfect Frame

106 Mutating Bookshelf Boxes

110 Conversion Chart

111 Index



INTRODUCTION



Welcome to the wonderful world of woodworking!
You're about to discover what makes woodworking so purely awesome.

First of all, it's just plain fun. Imagine taking a couple boring boards, a few simple screws, some glue, a couple of tools, and presto! A brand-new creation you made all by yourself. Learn the basics of woodworking and you can make things that will help you make other things, such as a tool carrier (you'll find a handy one on page 84). Or you can melt mom's heart by making her the jewelry box on page 98.

If you're worried that any of these projects are a little over your head, don't be. Even if you haven't worked with wood before, the projects in this book are absolutely doable for beginners, and they'll give you the chance to learn while you make. In fact, one of the fantastic things about crafting these or any other woodworking projects is that you're going to gain skills that are yours for life.

More than anything, building something with your own two hands can be mighty satisfying. You know you can do it, and everyone else does, too.

You're probably eager to get started on your first woodworking adventure. That makes sense; there's a lot of fun just waiting to happen. But you should really take the time to read the first two chapters in the book. You'll find the most important section, safety, is right up front in chapter one. There are many sharp objects and tools in a woodshop that can hurt you if used incorrectly, so please don't

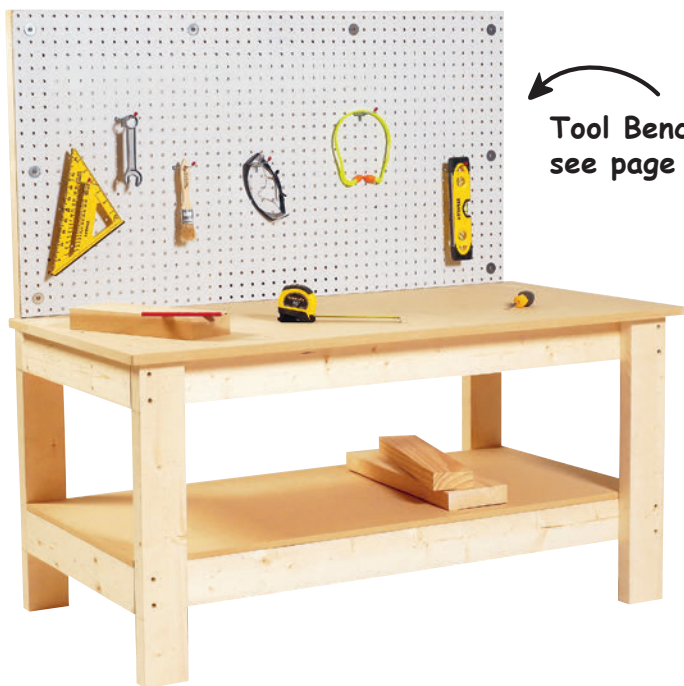
skip this section. Of course, you also need to know a little bit about those tools if you're going to use them in the right way, so you'll find a tool guide that gets right to the point as well as an explanation of different woods and their best uses. To round things out, there are directions for some basic techniques every woodworker should know to finish projects as quickly and accurately as possible.

Once you have all the basics under your belt, it's time to build something. Go ahead and flip the book around and find your very first project.

Each project is labeled with a skill level, but you can try any of them. The harder ones just require a little bit more attention to detail, which might mean getting some help from Mom, Dad, or another adult. No matter what, get in the habit of cleaning up after yourself and putting all tools back where they belong.

Good luck, and get making!





Tool Bench,
see page 92



Building-block
storage, see
page 88



Parking Garage,
see page 70



Tool Box,
see page 84

WOODSHOP STEAM

Learn While You're Doing with STEAM

The best way to learn anything is while you're doing something you really like. That's why you'll find some easy "STEAM" (Science, Technology, Engineering, Arts, and Math) lessons throughout this book. They won't seem like lessons because they're so darn interesting, useful, and fun, but don't be surprised if you get better grades because of them!



You're on your way to becoming a woodworker, so you should have a space to do your projects. Even if it's in a shed or part of a larger room, a dedicated woodworking workshop will be your way to set things just how you like. The basics for any woodworking shop are: a flat, level work surface, a place for every tool, an uncluttered floor, and a place to store the actual wood. Place your tools exactly where they'll be needed most, in obvious spots that make them simple to locate. Spend some time deciding where you'll store particular tools, such as bar clamps. That one simple step will make all your projects a lot easier to construct.

THE KID'S WORKSHOP



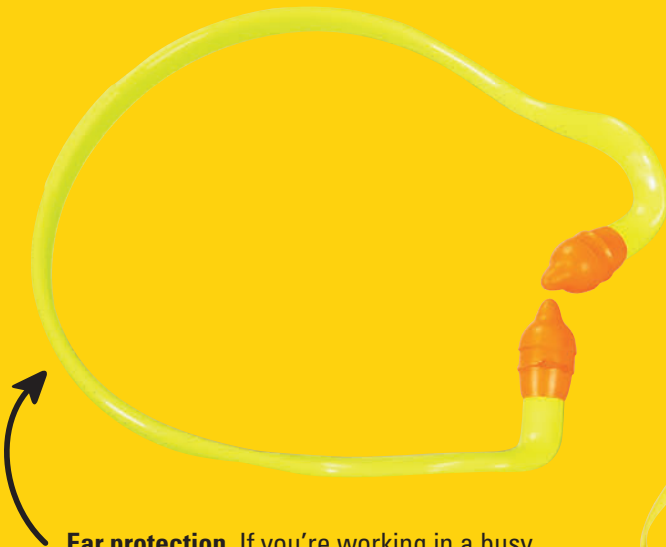
You also need a way to organize the smaller bits and pieces, such as screws and nails. Label like crazy, so that you know exactly what you're grabbing, and you can tell when you're out of an important or common piece of hardware. It's also nice to have a portable work surfaces, such as sawhorses or movable worktables. Chances are, your dad or mom already has some of these in the garage or workshop.

Use the information in this chapter to set up your ideal workspace. It will add to how much you enjoy woodworking—which should always be loads of fun.

SAFETY FIRST

Before you start any project, make sure you're working safely. Getting hurt can take all the fun out of woodworking. Make good safety practices and equipment second nature and you'll be setting yourself up for success. That starts with having the right safety gear.

Safety glasses. Shatterproof safety glasses are a must—from the moment you walk in to the shop to whenever you shut down for the day. Leave them in the shop on their own hook.



Ear protection. If you're working in a busy wood shop around power tools, a good pair of noise-blocking earphones or earplugs helps prevent hearing loss over time.

Gloves. You don't usually need gloves for working on wood with tools, but you should wear them to move lumber and carry projects you've finished. They can also help you grip tools and materials.



Dust mask. Wear a mask any time you're sawing or sanding. Small particles of wood dust aren't good for your lungs!

It is safer for young and inexperienced woodworkers to work with hand tools rather than power tools. A few additional basic safety practices will ensure that your woodworking projects are as injury-free as they are fun.

WORKSHOP SAFETY RULES

-  **Don't wear loose clothing.** Loose clothing can get caught in a power tool. Always roll up long sleeves. If you have long hair, hold it back with a hair tie or a hat.
-  **Don't leave toes exposed.** You must wear shoes in the workshop; no bare feet, sandals, or flip-flops. Boots are best, but any closed-toe shoe will protect your toes from anything you might drop on them.
-  **Don't operate power tools** without an adult present.
-  **Don't work tired.** Did you have a lot of homework last night? Did you stay up late watching a movie? If you're still a little worn out, pick another day to tackle your project.
-  **Don't work off balance.** Never stand on a less-than-stable structure to get a better angle for sawing or drilling. It's better to find a different, lower work surface, or have a taller adult help you.
-  **Don't reach into a container of loose screws.** Screws and nails have sharp tips that can poke you. When using fasteners, spill them out on a clean, flat surface, and pick them up one at a time.
-  **Do secure work pieces with** clamps, in a vice, or otherwise, whenever you're cutting, drilling, or sanding. Not only can unstable wood be ruined if it moves while you're working on it, you could hurt yourself.
-  **Do unplug power tools when** they are not in use. That way, you can never accidentally switch them on.
-  **Do check reused or recycled lumber** for staples, nails, or other hardware. Sawing through wood and hitting a nail can cause tool and human damage.
-  **Do move any power tool or sharp hand tool away from the body,** never toward the body. And make sure fingers and hands are always out of the path that a saw or other tool is taking through the wood.

KNOW YOUR WOOD

There are two different types of lumber: softwood and hardwood.

Softwood comes from trees with needles, while hardwood comes from trees with leaves. The big difference is spelled out in the words themselves: softwoods are softer than hardwoods. They are more easily dented or scratched, while hardwoods are naturally more resistant to water, insects, and the sun. Softwoods are usually less expensive than hardwoods, but most people don't think they look as nice. Softwoods are often better for projects that will be kept indoors, while hardwoods are better for outdoor projects. The other difference—and it's a big one—is that softwoods such as pine are easier to work with.

No matter what type of wood you choose, you'll need to pick a **grade**. Wood is graded on how many defects it has—imperfections like knots, cracks, or areas of sap. The fewer flaws, the “clearer” the board is. **Select** or **finish** grades are the best lumber you can buy. The worst is **common** grade. All the projects in this book call for select boards.

CHECK IT OUT

Even though the mill has done some of the work for you by grading the wood, always inspect any board before you buy it. Check that there are no big, obvious problems such as knots or checking. Look down the length of the board. If it looks a little twisted or bowed, it might be slightly warped, which will make it a lot harder to craft what you want to build. Always pick the straightest boards.

Softwood, i.e. Pine

Pine, such as the board shown here, is the most popular softwood. It is easy to cut and drill and looks good when painted and stained.

Hardwood, i.e. Cedar

Hardwoods, such as this cedar, are durable and often have abundant natural oils. That means the wood is good for outdoor projects even without being finished.

GAUGE THE GRAIN

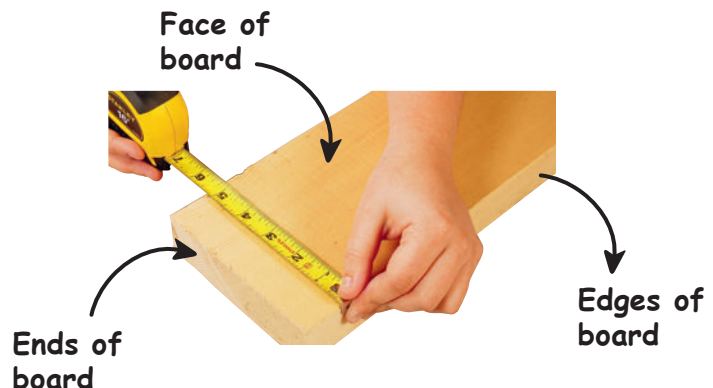
If you look at a board's surface, you'll see wavy lines that run in one direction. That is the grain of the wood. Why does grain matter? Well, it's how the fibers of the board are oriented, and it determines the best way to cut and prep the wood.

For instance, when you cut across the width of a board, you're cutting **against the grain**. For that type of sawing, you should use a **crosscut saw**. Sawing along the length—with the grain—is called **ripping**. That's when you use a **rip cut saw**. Some saws are **combination saws**, meaning they can both rip- and crosscut. Always sand with the grain or you risk scratching or marring the surface.



Wood Words

You'll need to know what the different parts of a board are called to follow many directions for crafting wood-working projects. The **face**, which is the flat surface on either side of the board, the **edges** are the longer sides, and the **ends** which are the shorter sides.



THE RIGHT SIZE

Lumber sizing can be a little confusing because it's not as obvious as it might be. The numbers used for any board—such as a 2×4 —all follow the same pattern. The first number is always the thickness, and the second is always the width. When you see a third number, that's the length.

More importantly, though, modern lumber is not actually the size it's labeled. Sounds crazy, right? Well, it's true; lumber is measured in **nominal** sizes, which are smaller than the labeled size. Just remember this: Anytime the lumber size is 1", the actual, nominal size is $\frac{3}{4}$ ". In all other instances, the nominal size is $\frac{1}{2}$ " less than the labeled size. In other words, if you buy a 2×4 , it is actually $1\frac{1}{2} \times 3\frac{1}{2}$ ".

Understanding the actual size is important if you want to change a woodworking plan. (Or for when you get good enough to draw up your own plans!)

Keep in mind that sawmills process a lot of lumber. Not every board will be cut perfectly. Before you begin any project, measure the boards you'll be using to make sure that they are exactly the size you think they are.

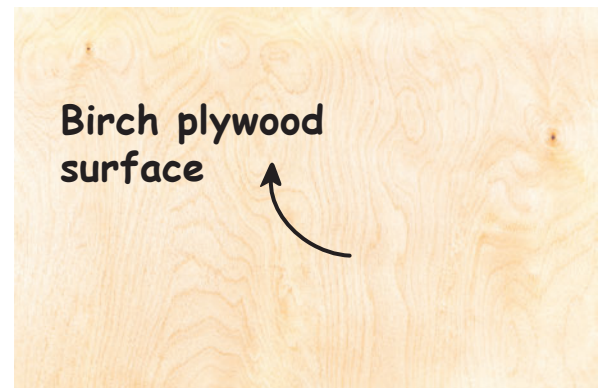


The Special Case of Plywood

Plywood is a special type of lumber that comes in sheets made of thin layers (called **plies**) of wood glued together. Plywood can be useful for many different projects. Because of the way it's put together, plywood is strong. It's made in different thicknesses, including $\frac{1}{8}$ ", $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", and $\frac{3}{4}$ ". Its one weakness is that the edges can soak up moisture, causing the wood to swell and warp.

Like other lumber, plywood is graded. Woodworkers usually use only "premium" or "good" grades of plywood. There are also different types of plywood, and they can look very different from one another. Birch plywood is one of the nicest looking, but it's not good for outside use. If you're painting the surface, the look doesn't really matter. No matter what, always buy plywood rated for "exterior use" when you're building something to go outdoors.

One advantage to using plywood is that it's wider than most lumber. That means it can take the place of using several boards side by side, which means plywood saves you the hassle of cutting a lot of boards. This can be a big help when you're building something that has a wide, flat surface, such as a tabletop. Sheets of plywood are big, usually measuring $4 \times 8'$. That makes it a little awkward and heavy to work with, but lumberyards and home centers will usually cut the plywood down to size for you if you ask.



The Wonder of Wood

You probably think you know exactly what wood is. Well, you might be surprised. This amazing material is both strong and soft, durable and easily destroyed. That's why it has been used throughout history for building everything from furniture to bird feeders to entire buildings.

STRENGTH

Wood is unique among building materials. Plastic and metal have the same strength in all directions (making them what's called *isotropic*). Wood doesn't. You can break a wood board in the middle without much effort, but if you and a friend tried to pull the board apart from either end, you'd never be able to do it (the property of having different strengths in different directions is called *anisotropic*). Various

types of wood are stronger or weaker. Some, such as pine or oak, are used more often than other types because of their strength and how easy they are to work with.

WOOD AND WATER

Water and wood have a weird relationship. When a tree is growing, it needs a lot of water. Once it's cut, however, the wood is *seasoned* (aged) by the lumber mill specifically to dry it out. Dried lumber is stronger and less flexible.

Wood floats because it's not as dense as water. At the same time, it's *hygroscopic*—it absorbs water. That can be a problem. If your project absorbs too much water, boards warp, and pieces won't fit together correctly. This is why woodworking projects

that will be exposed to water—such as a birdhouse—are usually coated in a waterproof finish, such as paint or polyurethane. The exception is certain hardwoods that are naturally water-resistant.

So, if wood absorbs water, why are some woods considered naturally resistant to it? The answer is the opposite of water—oil. Some woods, such as cedar, are extra oily. Their oils don't dry out after the wood is cut, which protects the surface from water infiltration.



TOOL TIME

The right tool makes woodworking easier. That is, if the tool has been kept in good shape. Power tools make building a project faster, and they are more precise than hand tools. The trade-off is that power tools can be dangerous and more expensive. They are also harder to control.

Until you gain experience and get a little older, it's wisest to use hand tools and only the safest and easiest to operate power tools. The projects in this book offer both manual and power tool options. However, if the project calls for any power tool other than a drill or jigsaw, an adult must operate it.

High-quality hand tools may take a little more time and effort, but they also give you more control. Many woodworkers like the feel of using hand tools. Start with a basic set of tools. As you become more skilled, move up to a range of power tools.

SUPER USEFUL POWER TOOLS

Safety is the number-one concern when using any power tool. That's why only adults should operate something like a **circular saw** or **router**. But even though you might not be operating most power tools, learning how they work is part of becoming an experienced woodworker. Here are the basics.

Power drill. Drills are easy and safe for beginning woodworkers, but you should still be careful when using one. Power drills should only be operated by an adult. They still sell power drills with a plug (and your mom or dad may even have one in the toolbox or garage), but cordless power drills are the most common these days. Cordless versions are easier and more efficient because you don't have to constantly move the cord out of your way, and you're not stuck working close to an electrical outlet. Always have an extra charged-up battery pack on hand, so you don't have to stop working if the drill's battery runs out.

You'll also need a full selection of **bits**. These are the tool tips that go into the hole (*chuck*) in the barrel of the drill (see "A Little Bit About Bits" opposite).

Alternatives: A drill press is a powerful, table-mounted power drill. It should only be operated by an adult. Drill presses are much more accurate and quicker to use than a handheld drill. If your mom or dad has a drill press in the garage or workshop, it will save time on projects that require multiple and/or large holes. Woodworkers using a drill press must be careful and constantly aware of the spinning bit. They never hold a piece of wood that they are drilling. Instead, the wood should be held in place with a clamp or a fence. Anyone using a drill press must wear eye protection and should never wear loose clothing or jewelry when operating one. Any loose item could easily and quickly be snagged and cause injury.



Cordless
power drill



Drill bits

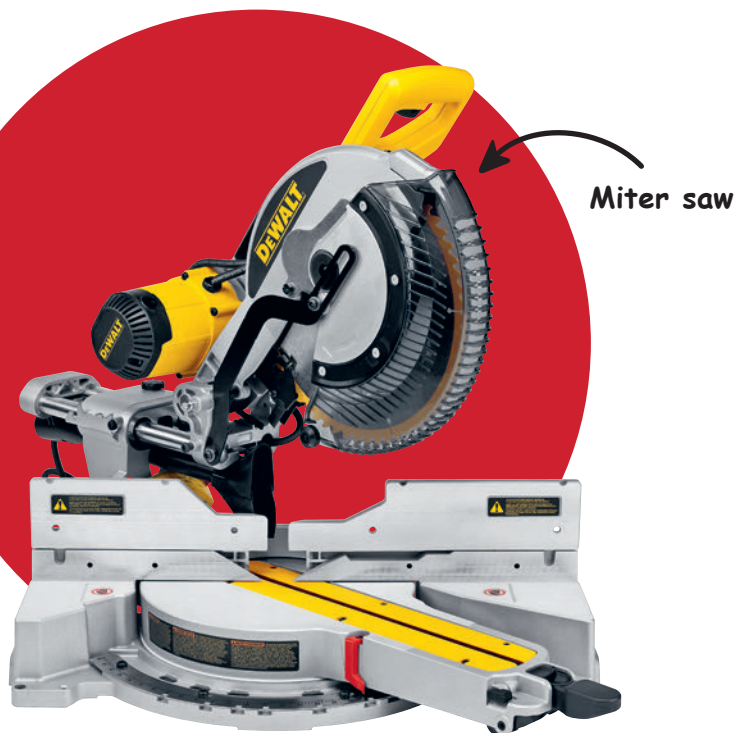


A Little Bit about Bits

Drill bits are the interchangeable cutting tips used with power drills. They come in many different types and sizes.

- **Twist bit.** These are sold with drills as sets. They are ideal all-around bits. They'll cut wood, metal, and plastic. Carbide bits are black, with a coating that prevents rust. Titanium bits are gold, more expensive, and coated with a material that helps the bit last longer. These work best with a starter hole punched by an awl or center punch.
- **Self-centering.** These have a more pronounced pointed tip so you don't need a starter hole, and these bits don't "wander" like a regular twist bit can.
- **Brad point.** These have an even more pointed tip that stops the bit from moving around on the surface of the wood. These are great for drilling straight but are not as effective for drilling angled holes or enlarging existing holes.
- **Forstner.** The end of a Forstner bits looks like a bottle cap with bladed edges. These bits are used to create clean, round, flat-bottomed holes and are especially good for **stopped** holes. But they can bind in thick wood, or hardwoods, and may have difficulty penetrating some woods.
- **Spade.** With a paddle end and sharp point, spade bits are used to create the same type of large holes as Forstner bits. Though they tend to tear the wood, they are faster and easier to work with than Forstner bits.
- **Combination countersink.** These are essentially regular twist bits with a special feature called a "countersink collar." This collar cuts a tapered hole at the surface of the wood, so that screw heads sit perfectly flush for a nicer appearance.

Miter saw. A power miter saw is a circular saw mounted on a small table with a swivel base that allows you to make precise miter and beveled cuts. A miter saw should only be operated by an adult. It can also be used to make quick and accurate straight cuts. Anyone using a miter saw should always wear eye and ear protection. For an even safer option, see the **miter box** and **handsaw** on page 20.

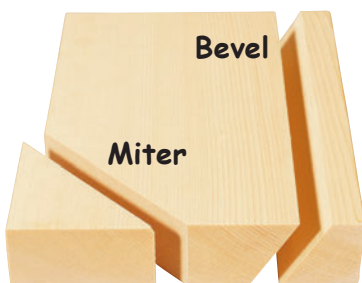


Jigsaw. These handheld power saws are easy and safe for a beginning woodworker, though you still need to be careful. A jigsaw should only be operated by an adult. It can be useful for cuts to small pieces of wood. They are especially handy for curved cuts. It's easy to swap out blades to cut just about any wood and almost any thickness. You can even use special blades to cut fiberglass or metal.

Wood Words

A **miter** is any cut of less than 90°—perpendicular to the edge of the board. Miter cuts create a professional-looking joint, like the corner of a picture frame. Beginning woodworkers are sometimes confused by the difference between a

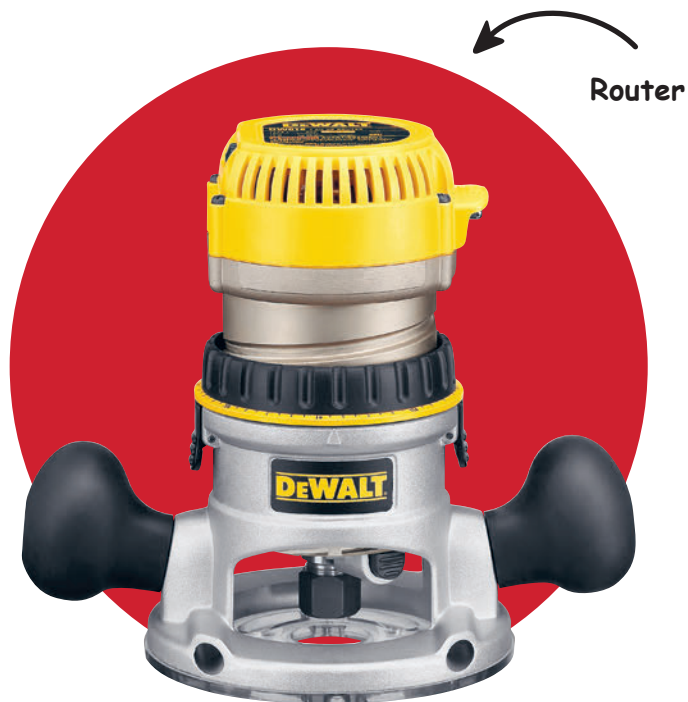
miter and a bevel cut. A **bevel** is any cut made with the blade positioned at an angle to the face of the board. You can also make a combination cut involving both.



Alternative: Most of what you can do with a jigsaw you can do with a **coping saw** as well. This hand tool is slower to use, but the fine blade gives you a lot of control over intricate, curving shapes.

Palm sander. A palm sander is easier than sanding by hand and simpler to control than a more powerful sander. Palm sanders should only be operated by an adult. They are the smallest power sanders, meant to be held in one hand comfortably (smaller woodworkers might find using two hands gives them more control). These are sometimes called “finish sanders” because they are best for light, final sanding. Many palm sanders have a square pad, but others are made with a triangular pad for sanding weird shapes or getting into corners. Always sand in the direction of the grain.

Alternatives: An **orbital sander** is a slightly bigger version of a palm sander, with a square sanding pad that sands in the same way as the palm sander—using a back-and-forth motion. A **random orbital sander** has a round pad and sands in all directions, which means it is best for surfaces such as plywood or any that are going to be painted. A **belt sander** is the most powerful handheld sander. The belt spins very fast in one direction, and it sands a lot of wood quickly. That means it’s easy to sand too much wood. You’ll have the most control over what you’re doing with a plain old **sanding block** and sanding sheets. A sanding block is a rubber or wood rectangular block with slots for precut sheets. The sheets are secured into the block and replaced when they wear out.



Router. Only adults should use a router. None of the projects in this book require one. This is a two-handed tool that allows you to put decorative edges on wood pieces. It can also carve channels in the face of a piece of wood.

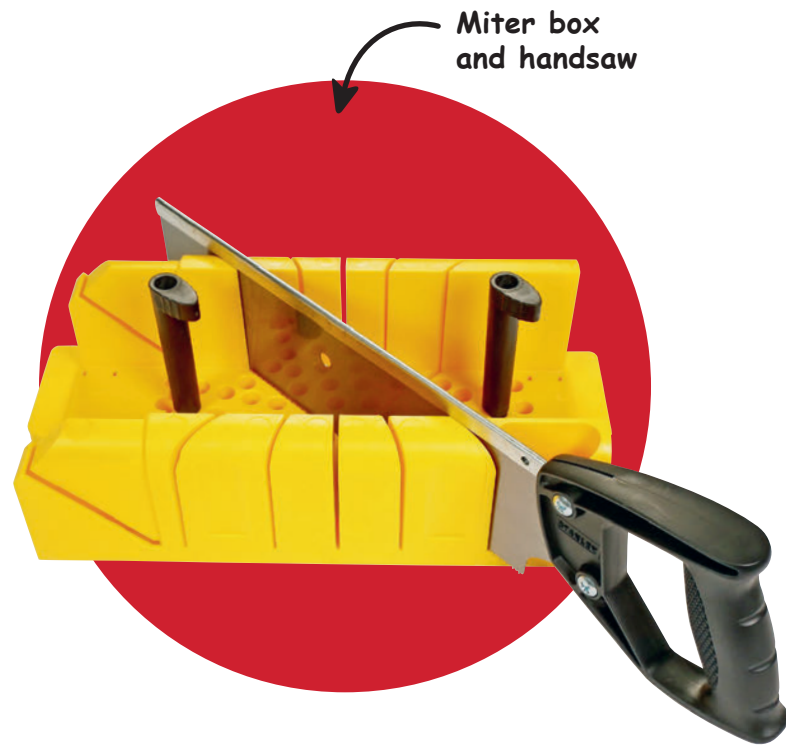
Alternative: A **rotary tool**, such as a Dremel, can do many of the things a router can. Rotary tools are easy to handle and there are lots of attachments available that allow you to add special effects to projects. Various attachments will enable you to shape, sand, and carve wood.

HANDY HAND TOOLS

Beginning woodworkers use hand tools as a safe way to learn proper techniques and craft projects. Hand tools take more effort to use than power tools but are also much less expensive.

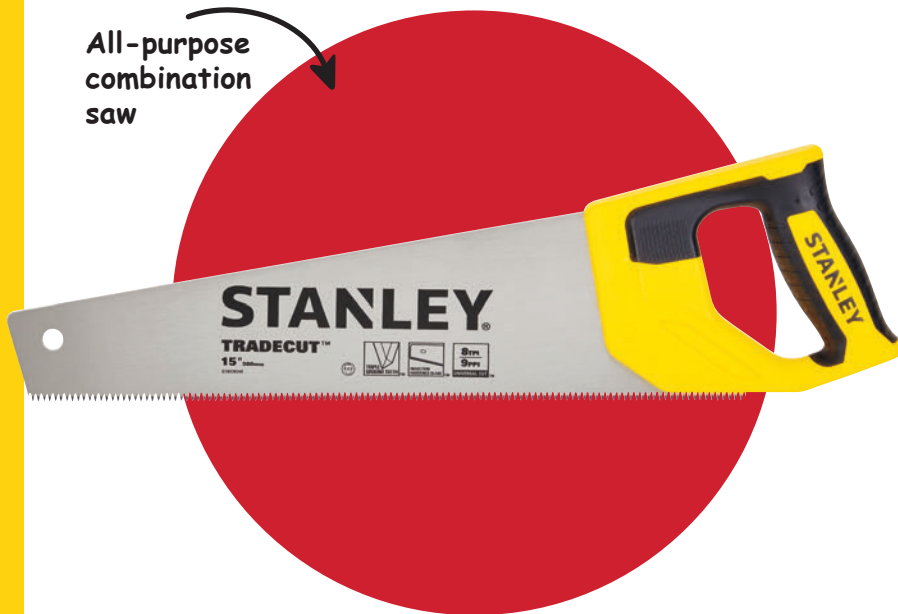
Saw. A common handsaw has a wide handle that lets you get a good grip. The saw cuts the wood on the forward, or *push* stroke. Use a *rip saw* to make cuts with the grain along the length of a board or use the more common *crosscut saw* to cut against the grain across the width of the board. You can also use a crosscut saw to rip wood although it will cut more slowly. An **All-purpose combination saw** can be used for both types of sawing and is the handiest choice for a beginner. A good all-purpose size is a 14" saw with 12 to 14 teeth per centimeter.

There are many specialty saws for different purposes. The one that makes the most sense for a beginner is a miter box and handsaw. The handsaw has many more teeth than a combination saw, with a short and straight rectangular blade. The saw is used with the slots in a miter box to make angled cuts.



Miter box and handsaw

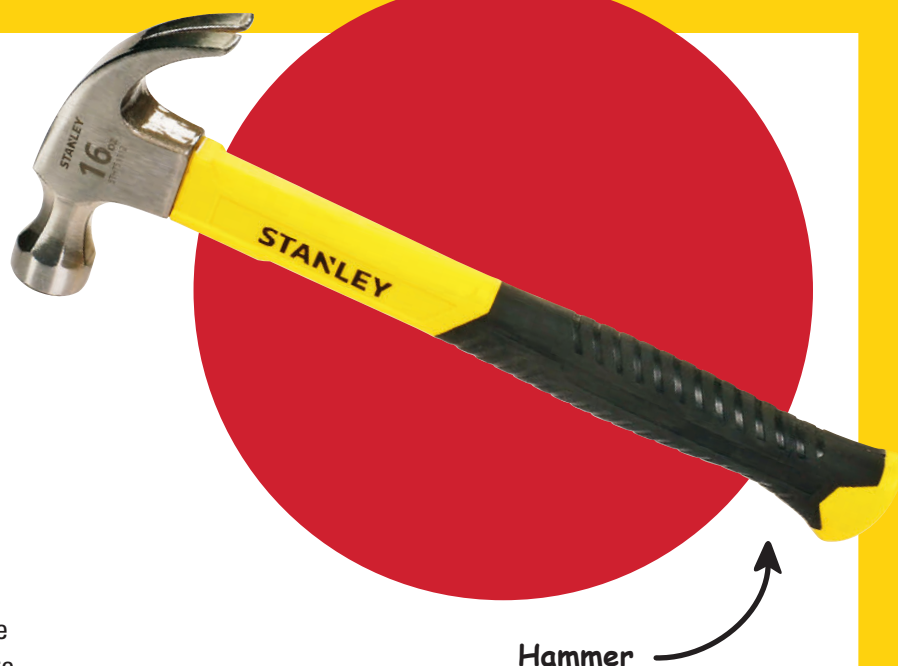
All-purpose combination saw



Tool Care

Keeping saws sharp is key to making sure they are easy, efficient, and safe to use. Don't bang a saw around in a toolbox or on a workbench. Use a *saw guard* (a plastic or rubber strip that clamps onto the teeth) to protect the saw's teeth and hang the saw from a pegboard or other support when you're not using it.

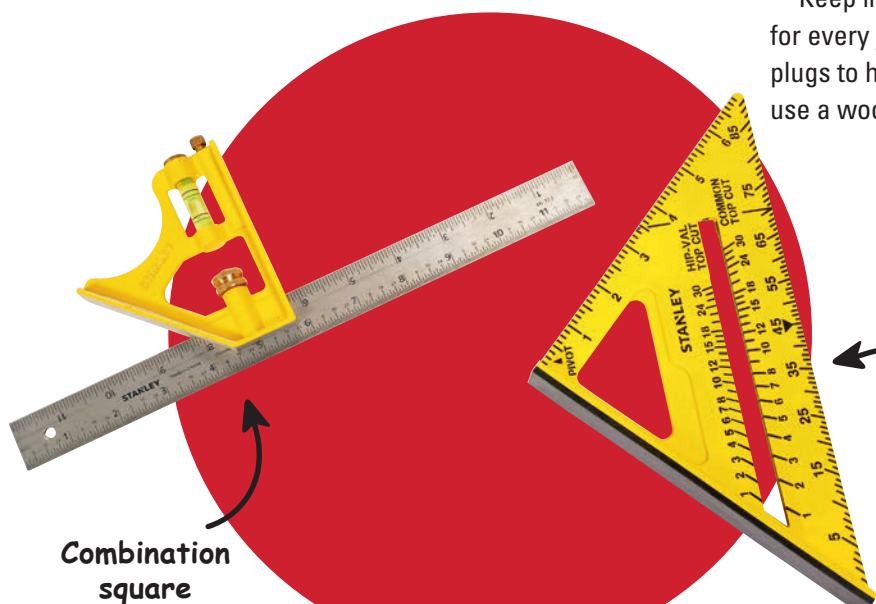
Squares. Carpentry squares help woodworkers “square up” boards. They are the most precise way to mark boards for exact cuts and precise angle cuts than a tape measure. The most basic square is a **framing square**. It’s a metal “L” with standard and metric measurements along both edges. The longer part of the L is the **blade**, which is also wider than the shorter side known as the **tongue**. The framing square is great for when you want to draw perfectly straight lines on a larger surface such as a plywood sheet. A **speed square** is a metal triangle with a flanged side and angle markings. You can use it to draw a perfectly straight line across the width of a board, or to quickly draw a precise angled line for a miter. In both cases, the flanged side squares the speed square up to the board’s edge. A **combination square** is basically a straight metal ruler with a sliding handle. The handle lets you adjust the square for different size boards and different angles. Most also have a bubble level.



Hammer

Hammer. Every woodworker’s toolbox must include a good-quality **claw hammer** it has a metal head opposite a curved “claw” that is split down the middle to remove nails. The handle is wood or plastic. The most common sizes are 8 to 16 ounces. The ideal way to find the right hammer by picking up and holding several different sizes. You should be able to grip the hammer tightly and hold it comfortably by the end of the handle. Hold the hammer straight out for several seconds. If you can do that, you can control the hammer.

Keep in mind that a claw hammer isn’t necessarily right for every job. For instance, when pounding in dowels or plugs to hide screw heads, it makes much more sense to use a wood or plastic mallet.

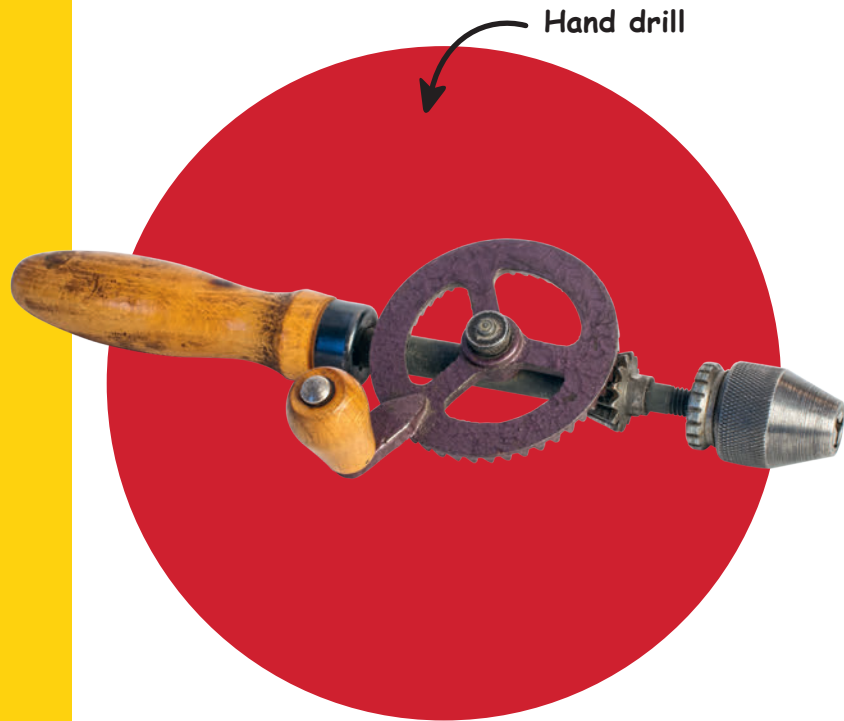


Combination square

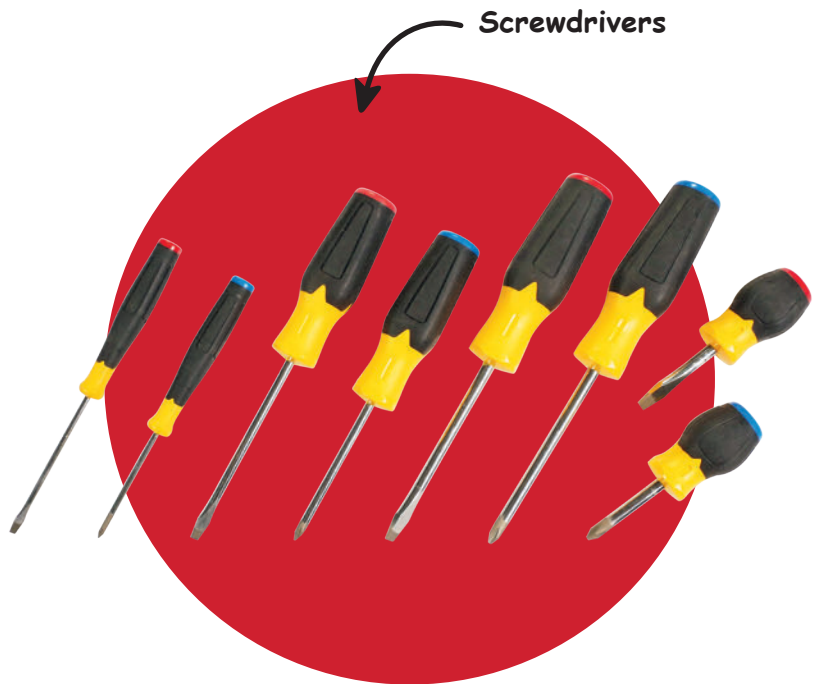
Speed square

Hand drills. A hand drill is shaped like a wand with a crank. It takes a lot more effort and time to drill a hole with a hand drill, but they are very safe and easy to use. You change drill bits in these drills the same way you would in a power drill.

Hand drill



Screwdrivers

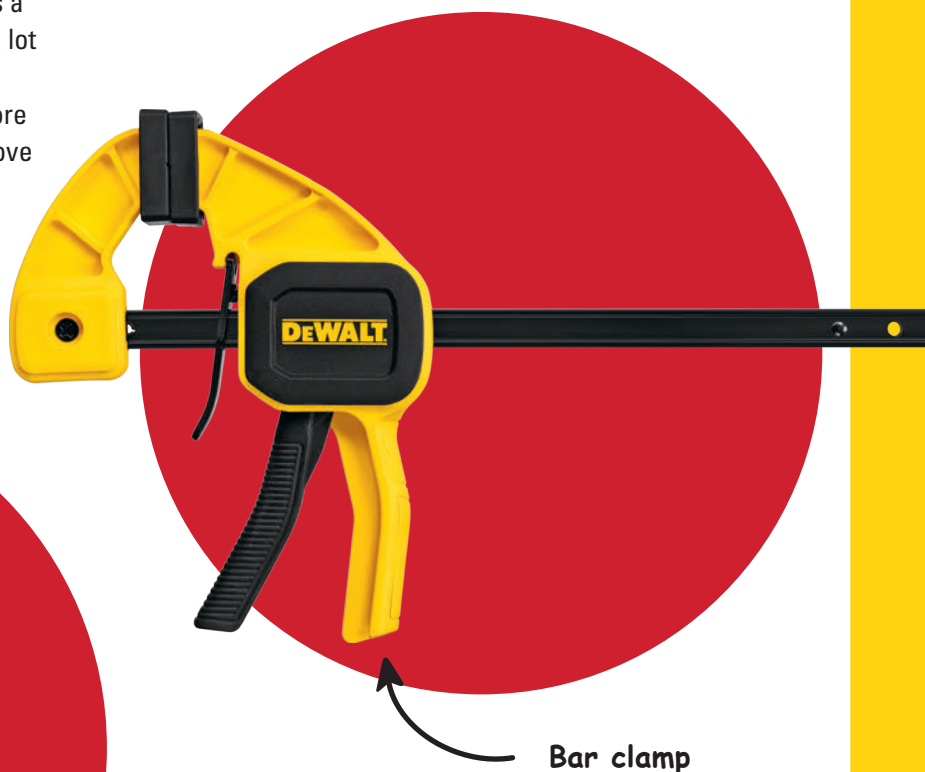


Screwdrivers. A good set of screwdrivers in different sizes—and in both standard (flat bladed) and Phillips heads—is a must-have for any woodworker. Luckily, your parent(s) probably have several in the home toolbox. There are also more specialized screws that you'll deal with once you become more accomplished and tackle harder projects. Specialized fasteners such as Torx screws require a special screwdriver. You can buy the screws and driver at the same time.

Planes. These tools have a flat bottom plate with a slot that holds a sharp blade, and a curving handle that fits nicely in your palm. Most also have a small knob on the front so that you can use your free hand to guide the plane. Slide the plane over the edge of a board to shave a small amount of wood off in a curl. A **surform plane** is shaped like other planes, but instead of a blade, it has a raspy surface that is used like sandpaper to remove a lot of wood all at once. Surform planes are handy whenever you want to round off a workpiece to give it a more finished appearance but it's easy to accidentally remove too much wood when using one.



Clamps and vises. Clamps are the more common way to hold wood for drilling, gluing, cutting, or joining. Clamps come in many types and sizes. **Bar clamps** are the handiest, but **C-clamps** are good for holding small pieces to a work surface. **Vises** hold wood securely but are limited in the size and shape of wood they can accommodate. Vises also aren't mobile. Line the jaws of a general-purpose vise when holding soft woods such as pine; the textured metal surface can mar wood. Woodworking vise jaws are lined with blocks of wood for just this reason.

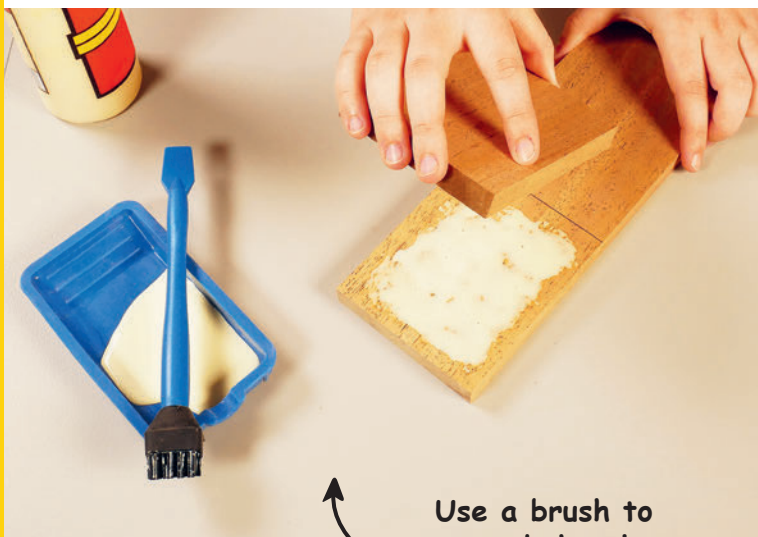


ADHESIVES & FASTENERS

There are two basic ways to attach pieces of wood together securely: with physical fasteners and with adhesives. They are often used together.

GLUES

Adhesive doesn't mar the appearance like screw or nail heads do. If you're painting the project, the unfinished appearance won't matter. Choose an adhesive, based on if the project will be placed outside and how durable you need the construction to be. Wood glue won't hold as well as screws or nails. Some types aren't water resistant, so always check the label.



Use a brush to spread the glue over a larger surface.

Polyvinyl Acetate (PVA) Adhesives

This is one of the handiest glues because it creates a durable, strong bond between pieces of wood, but dries flexible. It holds even when wood pieces swell, contract, or go through wear and tear. PVA is less messy than other options because it's water-soluble; use water to clean it up. It is usually dry to the touch in about twenty minutes, and "cures" fully—becoming completely dry and secure—in twenty-four hours.

PVA adhesives don't take stain very well. If you plan on staining or painting your project, carefully scrape away any "squeeze-out" of glue from joints clamped together.

PVA glue is meant for indoor projects. Yellow versions are better for outdoor projects, or for something that has to hold up to rough handling. They are also the right choice for any construction that will be exposed to a range of temperatures. Look for the word "waterproof" on the label.

In rare instances, PVA glue can react to resins in oak, turning the wood black. Use a different adhesive with oak.

Most PVA glues come in clear bottles with applicator tips. This gives you a lot of control when laying down a bead of glue, even along a thin edge. Use a brush to spread the glue over a larger surface. Wash the brush thoroughly after you're done—and before the glue dries—in warm water.



Cyanoacrylate (CA) Glue

You may know this as “super glue” or “crazy glue.” It’s strong and quick-drying. The glue sets almost immediately. You won’t have to wait long to continue working on the project, but you also don’t have a lot of time to fiddle with lining parts up. If you’ve messed up and need to separate wood pieces, put them in an oven set to 375°F (with your parents’ help) or use a special debonding solvent.

Cyanoacrylate adhesives can bond different materials together. That means you can stick metal or plastic onto your woodworking project, which creates a lot of possibilities.

CA glue is a great for fixing broken pieces of wood because it dries clear. Wear disposable gloves when using CA glue to avoid irritating your skin or sticking something to your fingers by accident. Use it only in a ventilated workshop because the fumes can irritate your throat and lungs, and they are flammable.

WOODSHOP STEAM

Sticky Chemistry

Basic wood glue—polyvinyl acetate, or “PVA”—is an incredibly interesting material. It can bond two pieces of wood, but won’t stick to the plastic bottle that holds it.

To understand PVA, you first need to know what a **polymer** is. A polymer is any material made of long repeating chains of molecules—like bolting a bunch of metal chains together. The polymers in PVA glue are formed by the reaction between **acetylene** and **acetic acid**. That reaction is caused by a chemical **catalyst** (chemical compounds that start an action or reaction). The resulting polymer is then mixed into an **emulsion**, or base—like chocolate syrup can be mixed into milk to make chocolate

milk. The emulsion has many ingredients, including chemicals that keep it from drying out on the shelf, and **plasticizers** that stabilize the texture. The emulsion is white in wood glue.

The big question is, how does the glue actually stick? The secret is the water in the emulsion. PVA polymer chains are flexible and strong, and readily attach to wood, plastic, and other material. But they also stick to themselves. The emulsion keeps them liquid. When the wood glue is applied, air begins to evaporate the water in the emulsion, drying out the glue. As the glue dries, the polymers are what remains—firmly attached to each other and to the wood.



Polyurethane Glue

This is fairly new to woodworking. When it was first introduced, there were a lot of great claims: super strength, waterproof, and stainable. As it turns out, those might have been exaggerations. The glue is good for filling minor gaps and it does dry clear. It can usually be stained, but it expands as it dries so you will need to scrape or sand away squeeze-out. One of the most promising aspects of polyurethane glues is that they can bond different materials. You can stick plastic or rubber to your woodworking project, for instance.

Hide Glue

Hide glue is made from animal skins. It is flexible and easy to remove but it is difficult to work with and usually only used by woodworking experts.

Epoxies

Epoxies are complicated adhesives. They are used mostly for filling big cracks or blemishes. They have good bonding strength. Epoxies are two-part formulations, and you have to mix them just right to get the result you want. They are waterproof, which is why epoxies are used for boats. But, plain old wood glue will serve you better for most of your projects.

PHYSICAL FASTENERS

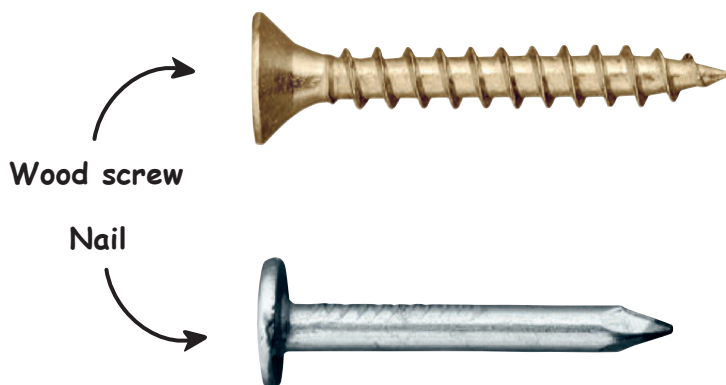
Securing one piece of wood to another with a screw or nail is a great way to make a lasting project that will put up with loads of wear and tear. There are an incredible number of nails and screws from which to choose. Luckily, only a few are ideal for small woodworking projects.

Nail or Screw?

The two most common fasteners are nails and screws. But it can be confusing to figure out which is better. Neither is really better; one or the other is only better for the given situation.

Screws are made of harder metal than nails because they have to penetrate wood without their threads breaking off. But this also means they are more brittle. Although a nail won't hold two pieces of wood together as tightly as a screw does, it will allow more flexibility and movement. That means where two pieces of wood must be joined and not loosen even under stress, screws are better. But where wood might swell and shift, nails allow for movement in the wood, preventing cracking or splitting.

Nails are quicker and easier to use, and are less apparent on the finished piece. However, screws allow you to take the project apart easily, should you need to. If you're driving a fastener into a thin surface, drill **pilot holes** before nailing or screwing the wood together. Pilot holes are drilled with a bit that is one size smaller than the shaft of the fastener. They are a way of making sure the wood doesn't split.



Penny nails



The Best Nails

Penny nails. These come in various sizes and all have a wide, flat head that makes the nail easy to drive. Penny nails are sold by size, which has a “d” after the number (for instance, 10d or the smaller 6d). They offer good holding strength, but the large head can detract from the appearance of a project.

Brad nails. Brads are very similar to what are known as “finishing nails”—much so that the two are sometimes confused for one another. Both are extremely useful. Brads are the smaller of the two, with a tiny head, skinnier shank, and slightly less holding power. Brads almost disappear after you’ve driven them into the wood, and they rarely cause splitting—a common problem with penny nails.

Brad nail



Finish nails. These are larger than brads, made of 15- or 16-gauge wire rather than a brad’s thinner 18-gauge. That means they have more holding strength and are good choices for heavier projects or any that will see a lot of use. The head is similar to a brad, but you’ll need to putty and sand over finish nail heads before staining or painting the project.

Finish nails



Strong Screws

Screws can be super effective at holding wood pieces tightly together even when they expand and contract or bear a lot of weight or use. Any screw has a tip (the pointy end), shank, threads, and a head. Any or all of those will differ from one type of screw to another. All screws are organized by size, which is listed by a hash mark followed by a number. The higher the number, the bigger the screw. For instance, a #10 screw is thicker in diameter than a #6 screw.

Head Start

Screw heads are the most obvious differences. Slotted heads take standard screwdrivers; Phillips head screws have slots that form a cross. They are less likely to strip when screwing but you can strip a Phillip's head if you're using the wrong size screwdriver for the screws. Avoid overtightening these screws.

Torx screws come with a six-point star blade slot. Torx are specifically designed to eliminate problems such as stripping, issues that are common to other types of screws. But they are also more expensive. For the projects in this book—and most of the projects you tackle as a beginner—Phillips head screws are best.

Screw heads also come in a variety of shapes, from perfectly flat to rounded (also called **panhead**). In general, a flat-head screw is best for a small woodworking project because it will sit flush with the surface, making a more attractive appearance.

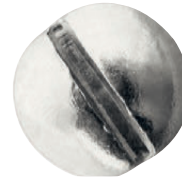
Panhead



Flat head



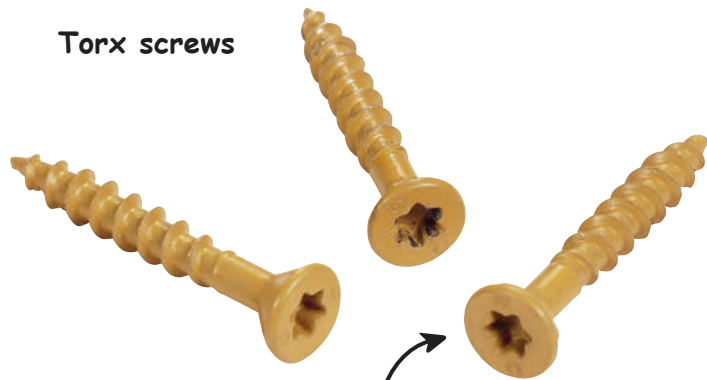
Slotted head



Phillips head



Torx screws



Six-point star blade slot

Screw Types

Woodworkers often use **deck screws** because they are easy to drive, and are inexpensive. They are especially good for exterior use, because they are weatherproof.

Wood screws were designed specifically for wood and are great for just about any woodworking situation. The same goes for **multi-purpose screws** (sometimes called **production screws**), which resemble a wood screw but have a self-drilling tip that eliminates the need for a pilot hole.

Basic
woodworking
screws



THE FINISH LINE

Screws come in many different materials and finishes. Galvanized or zinc-coated screws are low-cost options for exterior woodworking projects and won't rust. Stainless steel is a good alternative, but more expensive. Bronze and copper screws are usually only used to add a decorative touch.

Zinc-coated screws



Finishing is the last step in woodworking. Whatever you cover your woodworking masterpiece with will determine how it looks now and in the future. Regardless of which you pick, make sure that the wood is properly prepared. Sand rough spots down and carefully remove dust, dirt, and grease. Depending on the fasteners and the type of wood you've used, putty over screws or nail heads and sand them smooth.

Paint. Paint comes in every color of the rainbow and is easy to work with. Oil-based paints are durable and provide excellent coverage, but are difficult to use. Water-based, or **alkyd** paints are a better option for the beginner. They last a long time and look nice. Unlike oil paints, you can clean up water-based versions with warm water.

The *sheen* is how shiny paint is when it dries. Paint sheens range from flat (matte with no shine) to glossy, which dries shiny. Whenever you paint wood, prime it first with a **primer**. This is a formulated to prepare the wood for a topcoat. Most primers are white.

Paint covers flaws and is good for projects built with poorer quality wood, with a lot of fasteners, or that will be exposed to the outdoors. However, paint also covers up the look of the wood, and it's not good for surfaces that will come in contact with food.





Clear Finishes. A clear finish preserves the beauty of the wood while protecting it. The most common is **polyurethane**. It dries clear, and today's products don't yellow over time and exposure to sunlight. Polyurethane protects wood from water, dirt, and other damaging elements.

Oils can also protect the wood and there are two different types, **drying** and **non-drying**. The drying oils don't necessarily dry out. Instead, they change to a hard-protective coating when exposed to oxygen, so they feel dry. These include boiled linseed oil and tung oil. You can use mineral and vegetable oils, such as olive oil, to treat wood and stop water damage, but since they never really dry, they aren't "finishes." These are used on surfaces meant for food, like a cutting board. Non-drying oils wear away more quickly and have to be reapplied more frequently.

Varnishes and **lacquers** can give wood a slightly yellow tint, and are more complicated to apply.

Stains. Stains split the difference between a clear finish and paint. They range from light to almost black, and they soak into and stain wood. You can still see the grain patterns, but the tint is different from the natural appearance. Darker stains are good ways to hide minor imperfections while highlighting grain patterns. If the wood's grain isn't attractive, stick with a lighter stain.

Stains are easy to use. Some are brushed on, but most are applied with a rag. Apply stain evenly to avoid blotchy or inconsistent areas. Many woodworkers cover stain with polyurethane, which protects the surface and can add shine (polyurethane comes in flat to glossy).

No matter which finish you choose, take your time. Apply several thin coats rather than one thick one. Read and follow the label instructions. Most importantly, ventilate the room. Save yourself a lot of hassle by wearing latex gloves. Don't leave a container of finish uncovered any longer than necessary; you don't want to have to throw it out.

Combination products. These come in several different tints but are intended only for indoor applications. Just brush them on and let them dry.

The Hybrid: Danish Oil

Danish oil is really a combination of oil and polyurethane. It's easy to apply, and excellent at protecting wood surfaces. Danish oil is available in different tints as well as clear. Build up coats by applying one per day. Watco is one of the bestselling Danish oils, but there are others. All are easy to use and a good alternative to plain oils.

Safety First

Proper ventilation is crucial whenever you're applying a finish indoors. This means fresh air is actively moving through the space. That calls for a fan of some sort, not just an open window.



Skills are like the bricks in a big building; once you have the first layer in place, you've got a good base you can build on. With woodworking there is always room to improve and develop. Learn the basics and get them down pat. As you read through this chapter, focus on understanding the techniques. Do them correctly from the start and you'll get better results in the projects you tackle. Something such as correctly measuring and marking a piece of wood, or figuring out angled cuts, can come in handy out in the real world. These are skills that will serve you for a lifetime.

2 BUILDING BASIC SKILLS



You don't have to worry about being overwhelmed. All the skills discussed in this chapter are easy to learn. Just take your time, make sure you've got it, and enjoy the process. Because, after all, woodworking is supposed to be fun!

MEASURING & MARKING

The most crucial skill is the ability to correctly measure and mark wood for cutting and fabrication. Get it wrong and no matter how good you are at other techniques your projects are going to turn out badly. This isn't a hard skill to pick up, but it does take attention to detail. There is an old woodworker's saying: "Measure twice, cut once." It means be extra careful when making your measurements because improper measurements can be nearly impossible to fix down the line.

A quality tape measure is one of the most useful measuring tools a woodworker can have. Any decent tape measure has a lock-out slide button that allows you to keep the tape extended when you need to use both hands for marking and holding the board.

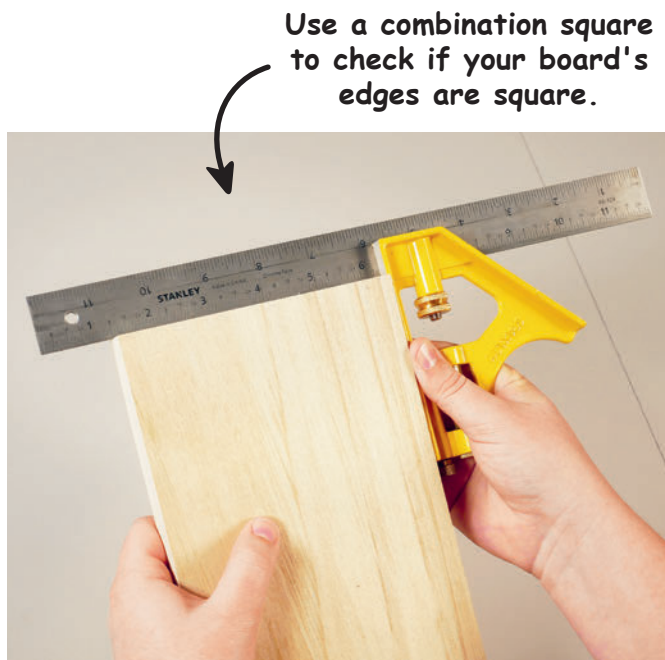
However, over time the metal hook can become deformed and loose, making the tape less accurate. That's why woodworkers often measure from the 1" mark, deducting 1" from the final measurement. Keep the blade of the tape measure flush with the edge of the board when measuring along the length of a board. If the tape becomes skewed, it can throw off your measurement by more than $\frac{1}{4}$ "—enough to create problems in the completed project.

You can test the accuracy of your tape measure by hooking the tape on the end of a long metal yardstick or ruler; the measurements should line up exactly, or you'll be able to see how far off the tape measure is.

A combination square is a more precise tool. It is precisely calibrated so that you can check the square of boards (whether they've been cut to a true 90° right angle) by holding the combination square in the corner of the board. If you see space between the blade and the end of the board, it isn't square and should be recut. But combination squares really shine when it comes time to mark a 45° angle cut across a board. Where framing squares are good for marking 90° right angles, the combination square includes a flange that allows you to adjust the blade for a 45° angle.



Make sure your measuring tape is still precise after years of use.



Use a combination square to check if your board's edges are square.

Wood Words

It's important when measuring and cutting wood that you don't cut into the **live area**, the part of the wood surface used in the final project. Power saw blades are relatively thick and if you cut exactly along a marked line, you could wind up losing as much as $\frac{1}{8}$ " from the live area. This is called **blade waste** and it's why you always saw on the side of the board you won't be using, or the **waste side**. In fact, when you mark a board for cutting and know that you will be using a power saw, mark the waste side with an "X" or other clear mark, and then cut on that side. Even if you have to recut or sand down to your original measurement line, at least you won't have to toss out a piece of wood that has been cut too short.

Mastering Angle Math

Sooner or later, every woodworker needs to calculate, measure, and mark an angle. Once you understand the basic math it's not difficult to figure out.

Angles are the measure in degrees of the space between two intersecting lines. If the lines are exactly the same, the angle is a circle, or 360° . Half a circle, or the arc describing the flat plane of a board (two lines running off in exactly opposite directions), is half that: 180° . That 180° arc is made up of two 90° right angles, or two perpendicular lines.

A 45° angle is half of a 90° angle and is one of the most useful angles in woodworking because two 45° angles joined together (in the corner of a picture frame, for example) make a perfect 90° right angle.

To figure out miter cuts—or angles—of joined pieces. Take the number of sides; for example, a picture frame with four sides. Divide 360° by the number of sides. In the case of a picture frame, that equals 90° ($360 \div 4 = 90$). That number is the angle of each corner. Of course, two pieces of the frame join at the corner, so divide the corner number (90°) by two. In this case, the number is 45° . That's the miter cut for each piece that makes up the frame. This equation works no matter how many pieces there are.

Most miter saws have marked settings to quickly set up the saw to cut the most common woodworking angles— 45° , 30° , and 22.5° .



SPEED SQUARE

When it comes to quickly and accurately marking angles, a speed square is essential. The square is shaped in a 90° angle and allows you to mark any angle less than 90° with incredible ease. Simply butt the flange of the square up to the outside or larger edge of the cut and then slide the protractor side—the side with the angle markings—to the appropriate angle mark. Now just run your pencil up the ruler edge opposite the angle markings and you'll have a precise angle cut line.





MEASURING A CIRCLE

From time to time, you'll need to mark a circle or arc on a board. There are several ways to draw an accurate circle on wood. A simple **pencil compass** has two legs—one with a needle that anchors in the center of the circle you want to draw, and the other with a clamp for a pencil. A hinge on one end allows you to adjust the compass to match the circle size that you need. Just stick the needle at the center point and use the pencil leg to trace a circle or arc around the center.

The problem is that a pencil compass can only open so wide; you'll need another method for larger circles. That's

where a **trammel** comes in. A trammel is a long stick, bar, or ruler with two adjustable trammel points. One point has a needle that is stuck in the center of the circle. The other point has a clamp to hold a pencil. That point is moved in or out to the exact **radius**, or half the diameter, of the circle.

CLAMPING & HOLDING

Clamps are essential in your workshop. They hold project pieces to allow you to concentrate on cutting, drilling, fastening, or gluing. The more types and sizes you have, the better.

Some of the most useful clamps are also the simplest, such as **spring clamps**. You just squeeze the handles until the jaws open, then slip them over the boards. The stronger the spring clamp is, the harder it will be to open. So, in some cases, you may need an adult's strength to open the spring clamps and put them in place. But don't use weak spring clamps, because they'll allow the wood to slip, which can mess up a whole project or even cause an injury.

Standard screw-type
bar clamps



Quick-release
bar clamps



Quick-release bar clamps are as simple to use as spring clamps. Squeeze the trigger of the adjustable handle to slide it toward or away from the fixed clamp pad on the end of the bar. You can slip this over a board and adjust the clamp with one hand. The great thing about bar clamps with a quick-release handle is that they accommodate large and small jobs alike.

Although they come in different sizes, **C-clamps** are better for smaller jobs and for holding small pieces together. They are also a little more awkward to use, because you have to hold the "C" in place while you screw the clamp tight. Unfortunately, the screw bar on a C-clamp can be clunky and often knocks against the workbench. When working with screw clamps, always remember that they tighten by turning the handle clockwise. The old saying applies: "Righty tighty; lefty loosey."



C-clamp ↗

There's no such thing as too many clamps. Just make sure you know where clamps will go before you apply glue. Misalignment, or not clamping with enough pressure, can lead to bad results. If you want to drill, sand, or saw the clamped piece, be sure it's secure before you begin.

Wood Words

A **jig** is a special brace for holding wood in place while you work on it. There are jigs for sawing, drilling, gluing, and even routing. Although there are many different jigs available through specialty websites, lumberyards, home centers, and hardware stores, many woodworkers prefer to make their own from scraps they have lying around in the shop.



Notice that the jaws of this steel vise are lined with wood, which prevents wood damage.

WISE SQUAD

Vises are another way to hold wood pieces together. They are not as handy as clamps, however, because you can't move them around and they are usually only good for holding pieces vertically.

There are two basic types of vise: **all-purpose** and **woodworking**. The difference is in the jaws. An all-purpose vise usually has steel jaws with a rough surface that aids gripping. A woodworking vise has jaws lined with softwood so that the jaws don't mar wood held in the vise.

Using Clamps

Clamping is simple. But it's also simple to do the job incorrectly.

Always do a dry run to figure out how exactly you're going to clamp the pieces. Do this even if you're clamping something basic such as two boards that you are edge-gluing.

MAKE IT!

How to Make a Simple Corner Clamping Jig

Clamping mitered corners is a challenge that most woodworkers face sooner or later. A simple home-made jig will keep clamped corners straight and true.

TOOLS & MATERIALS

TAPE MEASURE

CARPENTER'S PENCIL

1 × 4 × 16" PINE OR CEDAR BOARD

SPEED SQUARE OR COMBINATION SQUARE

POWER DRILL AND BITS (ADULTS ONLY)

JIGSAW

PAINTER'S TAPE

CUT LIST

(4) $\frac{3}{4}$ × $3\frac{1}{2}$ × 7" PINE CORNER BRACE



- 1** Use a long scrap 1 × 4 or several smaller scraps (a 1 × 3 will also work but you'll need to make the rectangle smaller). Draw a 7 × 3½" rectangle on the board with a speed or combination square. Working from one long edge, use the speed square to mark a triangle with a 90° point at the center of the rectangle.





- 2** Drill a $\frac{3}{4}$ " hole at the point of the triangle. Clamp the board and use a jigsaw to carefully cut exactly along the legs of the triangle. Then cut the rectangle out of the larger board.
- 3** Use the rectangle as a template to mark three more rectangles along the board in the same way. Cut them out using the same process.



- 4** To clamp a mitered corner, glue the two pieces together to form the corner. Place the triangle cutout on the inside of the corner, with the hole you drilled in the corner, and put the rectangle over the outside of the corner. Now clamp the triangle and rectangle together from the outside edges.

Optional: Avoid glue squeeze-out sticking to the clamping jig by putting a strip of blue painter's tape between the jig and the mitered wood pieces when you clamp the corner. This is a trick you can use any time you clamp pieces together, and the tape can be used under a bar clamp to ensure it doesn't mark up wood.

SANDING & FINISHING

Here's the best advice you'll get for finishing your wood-working projects: Always sand with the grain and apply several thin coats of finish rather than one thick coat. Now let's back up and start with the basics: Why sand wood anyway?

The surface of most wood is fairly rough. To apply finish properly, it needs to be smoother. So, we sand the wood. How much you sand depends on the type of wood, how you want to finish it, and the condition of the lumber. Control how much wood you remove by choosing from different **grades** of sandpaper. A grade tells you how rough or smooth the sandpaper is. Grades are listed by grit, and a higher number—such as 100 grit—is actually finer and smoother than a lower number, such as 80 grit.

Don't sand wood absolutely smooth. If you do, the wood pores will be tight and clogged, and the wood won't take the finish. Any finish needs a tiny bit of surface roughness—what is called **tooth**—for the finish to hold.

PUTTY CAREFULLY

Sometimes you'll need to cover up obvious screw or nail heads before finishing your wood project. If you don't, the final look will be less than perfect. Fortunately, the solution for small blemishes that need to be masked is wood putty. It's easy to use. Read the label, grab a small putty knife, a sheet of sanding paper, and a rag or two. Use the putty knife to drag a little wood putty over the screw head—just enough to cover it—and then take another swipe to smooth it. Clean up any drips with the rag. Wait for it to dry, and then sand the putty just a little to make it smooth and the same level as the surrounding wood.

USING THE PALM SANDER

The sandpaper needs to be secure in the sander. Some sanders use peel-and-stick sanding sheets. Peel off the backing, carefully align the sheet with the pad, and press down firmly. The other style holds precut or custom-cut sheets that wrap around the end of the sander's pad, held in place by clips or jaws. Buy or cut sheets to fit, then slide a sheet into the clips on each end and make sure the sandpaper is held tight.

Turn on the sander only when it is off the surface of the wood. Just like working by hand, sand only in the direction of the grain and check your work often. You only want to have a fairly smooth surface. If you sand too long, you can round edges and create dips in the wood.

Using a
Palm Sander





FINALLY FINISHING

How you finish your project is a matter of preference and what's best for the wood. Certain woods, such as cedar and redwood, are best left natural even when they're used in projects meant to go outside. They have oils and resins that protect them, and they age to a handsome grey color.

Other woods need to be protected. You might also like the look of a certain stain or paint. Whatever finish you choose, read the can closely. Always follow the manufacturer's instructions—especially the safety information. Only apply a finish in a well-ventilated area. Outdoors is best, weather permitting. Otherwise, there needs to be some form of active ventilation, such as a fan, moving air through and out of the workshop. Have rags on hand for any spills, and wear latex gloves for easy and quick cleanup.

Applying stain



WOODSHOP STEAM

How Sandpaper is Made

Sandpaper is simple stuff—a stiff paper backing with an *abrasive* glued to it. Abrasives, though, are not so simple. Despite the name, sandpaper abrasives aren't sand. Actual "sand" sandpaper has been used in history, but—even though it's cheap to make—it deteriorates too fast to be useful.

Many different materials have been tried out as sandpaper abrasives, but the most common these days are *garnet* and *corundum*.

Garnet is a hard mineral with a crystalline structure. If you've ever looked at a crystal under a microscope, you'll know

that it's made of straight lines and sharp angles. When garnet is crushed, it fractures into smaller and smaller particles that are all pointy, angular, and sharp. That makes it perfect for scraping wood off lumber surfaces.

The form of corundum used in sandpaper—aluminum oxide—is a metal. It also has a crystalline structure. When crushed it makes small, sharp particles, but aluminum oxide has an advantage. Where garnet can be worn down and flattened, aluminum oxide particles break down into smaller, sharper particles. As the sandpaper is used, it sharpens itself!

COLLECTING SKILLS

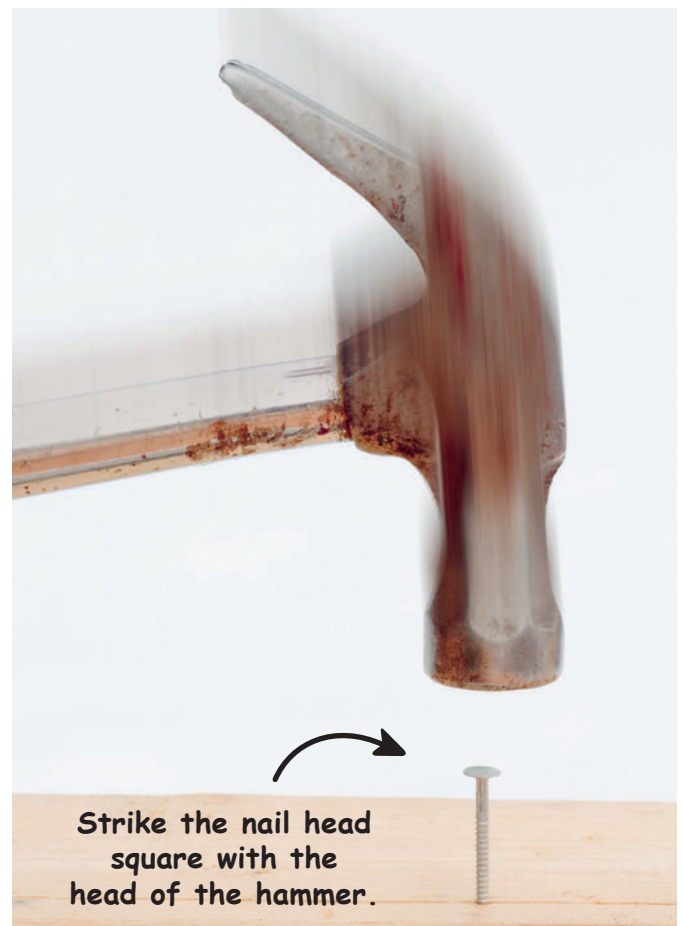
The skills you learn in a woodworking are useful in other places. Hammering a nail correctly to make a storage box is the same as hammering a nail correctly to hang a picture or build a house. Driving a screw without stripping it applies to your wood projects as much as replacing a part on an engine or hanging a flat screen TV on a wall. Learn to do these skills the right way and you'll pick up abilities you can use for the rest of your life. Plus, the proper techniques make any woodworking much less frustrating, because you'll limit.

WIELDING A HAMMER

Driving nails is something every woodworker will do about a million times. It's an easy skill to master. But you have to do it right or you'll wind up damaging wood surfaces or bending nails rather than driving them all the way into the wood.

Hold the hammer firmly so that you're in control. You should be able to stop it in mid-motion during a slow swing. If you can't, change your grip or get a smaller hammer. To start a nail, hit it with just enough force to set the nail tip into the wood. It's important to be careful at the start because if you swing too strongly you could miss and whack your hand. Use more force once the nail is firmly in place and can stand upright on its own.

Strike the nail head square with the head of the hammer to prevent bending nails or driving them in at odd angles. Your motion should be parallel to the direction of the nail. Don't hit the nail at an angle. Use shorter, more controlled blows rather than long, arcing blows, which have a greater chance of missing the nail altogether and damaging the wood.





Practice hammering nails on a thick slice of log or even a stump (you can also use a scrap 2 × 4). Use cheap ten-penny nails—or any extra nails your dad or mom has lying around—and practice driving them straight down into the wood until the head is flush with the wood’s surface. Once you get good, you may be able to drive the nail all the way in with just two or three blows.

DRILLING FOR SUCCESS

Most woodworking projects require some drilling. Sometimes you have to drill a hole to guide a fastener in place, and less often you might need to add a structural feature such as the entry for a birdhouse.



Keyed chuck

Always think about where the drill bit is going to go. The most common mistake beginners make is drilling right through a piece of wood down into the workbench. Instead, make sure there is a “sacrificial” board under what you’re drilling. The diameter of the bit should match the shaft of the nail or screw, not the head. If you need to make a specific opening for something like air vent holes, pick the bit that corresponds to the hole size in the plans.

Secure and remove the drill bit from the **chuck**. The chuck is the ring around the barrel of the drill gun. It holds the bit securely during drilling. On most drills, you can open the chuck by turning it counterclockwise as you look straight at the barrel. Tighten the bit in place by turning the chuck in the opposite direction until you hear it click or until you can’t pull the bit out.

Some older drills have what’s known as a **keyed chuck**—the bit is locked into the barrel with a type of key. The key is a bar with a gear on one end, and a handle on the opposite end. Put the tip into the hole in the chuck, so that the gear teeth match the chuck collar teeth. Turn clockwise to lock, counterclockwise to unlock.

Flawlessly Driving Screws

Driving screws is—next to hammering nails—the simplest job in woodworking. Ensure your screw goes exactly where you want without splitting wood by drilling a pilot hole slightly smaller than the shaft of the screw. The screw’s threads will then follow the sides of the hole rather than the grain of the wood.

Pick the exact match between screwdriver head and screw slots to avoid stripping the screw head. Start the screw slowly, holding it with one hand and applying pressure as you turn with the other (you need to be above the

Magnetic Attraction

A magnetic head will hold a screw securely in place as you start it. Some screwdrivers come with magnetic heads, but you can magnetize yours even if you own a standard screwdriver. Just scrape the tip across a large magnet several times and it will be magnetized.

This happens because metals (with a few exceptions) have distinct sections called *domains*. The electrons in the atoms of different domains naturally point in different directions. Stroke a magnet across metal and the electrons in all the domains are attracted to point in the direction of the

magnet's positive charge. Consequently, they all line up the same. This magnetizes the screwdriver tip.

Here are some neat facts about magnetism: If a screwdriver is magnetized all the way down its shaft, the shaft will have a north and a south pole. The north pole attracts another magnet's south pole and repels another magnet's north pole. Weirdly, if you cut the screwdriver's shaft in half, both halves are magnetized and have individual north and south poles! The north pole of any magnet will always point to Earth's north pole—which is also how a compass works.

Magnetize your own standard screwdriver



Drive a screw straight into a butt joint.



screw to do this—stand on something if necessary). Tighten the screw slowly and firmly, stopping when it's snug.

You can also drive screws with a power drill—or what's known as a power driver—using a screwdriver bit. Be careful because the drill or driver's power can cause you to overtighten the screw, stripping the head. All modern power drills have what's known as a clutch; it's a collar around the chuck where the bit slips into the drill. Set the clutch to the lowest possible setting when driving a screw to slow down the drill's rotation. That will give you more control over the process. Power drivers also have a clutch setting.

Wood Words

A kerf is a slot cut in a piece of wood, and is usually sized to match the width of the saw blade (or multiples of that width). Kerfs can be used to create joints between two pieces of wood (a tongue is cut in the edge of the mating piece) or to allow the wood to be bent.

SURE SAWING

Sawing boards is easy but it's also easy to do it wrong. Just a little off the line one way or another can mean a bad cut and a board you can't use. That's why slow and steady is the rule whenever you're sawing wood. Make sure your cut line is clearly marked and you can see it even with the saw in place. Guarantee accuracy by clamping a guide piece on top of the board along the marked line.

Once you have the board secured, check that the blade of the saw has a clear path of travel, and that it won't make contact with anything other than the board. Stand directly behind the cut, with your body perpendicular to the board. Then set a starting groove by slowly pushing the saw forward along the cut line at the edge of the board. At the end of the stroke, raise the saw, reposition it back to where you started, and push it through again. (If you're using a pull saw, do the opposite.)

Once the groove is deep enough to guide the blade, start making the actual cut. Push the saw forward with downward pressure, then pull it back without any pressure. Saw smoothly and steadily and keep your body, arms, and shoulders relaxed. If you're using a pull saw, put the effort into the pull stroke.

If the saw binds—sticks—in the cut at all, apply a very light pressure on the waste side to open the kerf slightly.

You need to be far enough above the board to get the right leverage to properly saw through the piece.



USING POWER SAWS

Power saws are quicker and easier to use than handsaws, however, except for a jigsaw, only an adult should use power saws. When you get old enough to use a circular saw, table saw, band saw, or miter saw, safety should be your first consideration. Always assume that a power tool is plugged in and keep hands and other body parts away from the blade. Never hold the board in place with your hands; clamp it into place.

A power miter saw makes the same straight cuts that a crosscut saw does, but you can also quickly set it to make accurate angle cuts and even bevel cuts. With the saw turned off, lower the blade onto the cut line. It must be aligned before beginning the cut. Once the blade is lined up, clamp the board in place, start the saw, and lower the blade slowly and steadily.

When making angle cuts, mark the cut using a speed square and then check that the mark is correct using the gauge on the miter saw plate.

Now that you have the basics down and understand how to use all the tools for crafting the projects that follow, it's time to get building!





The best woodworking projects are not only fun to build, they're fun after you're done building them. The topics in this chapter dial the fun up to ten! You'll enjoy these creations long after you're finished building them and, chances are, so will other members of your family.

These are perfect projects for beginners, but they are also interesting and challenging enough even if you've already done some woodworking. Build these and you'll learn a couple new techniques or get better at skills you already have. Just keep in mind that many of these involve relatively small pieces, which means that any errors will be magnified. So, take your time, be careful, and be precise.

3 FUN & HOBBY PROJECTS



These are also adaptable. Use different colors or a different pattern. Make the birdhouse bigger or add a bottom support so that it can be post mounted rather than hung. You'll find, as you become more experienced, that you'll often want to change designs to match your own tastes.

Birds eat a lot of insects and fruit and spread seeds with their poop. They are super valuable to any ecosystem. The problem is, they just don't have enough homes in the wild. Bird populations are falling fast; North America has billions fewer birds than we did just ten years ago!

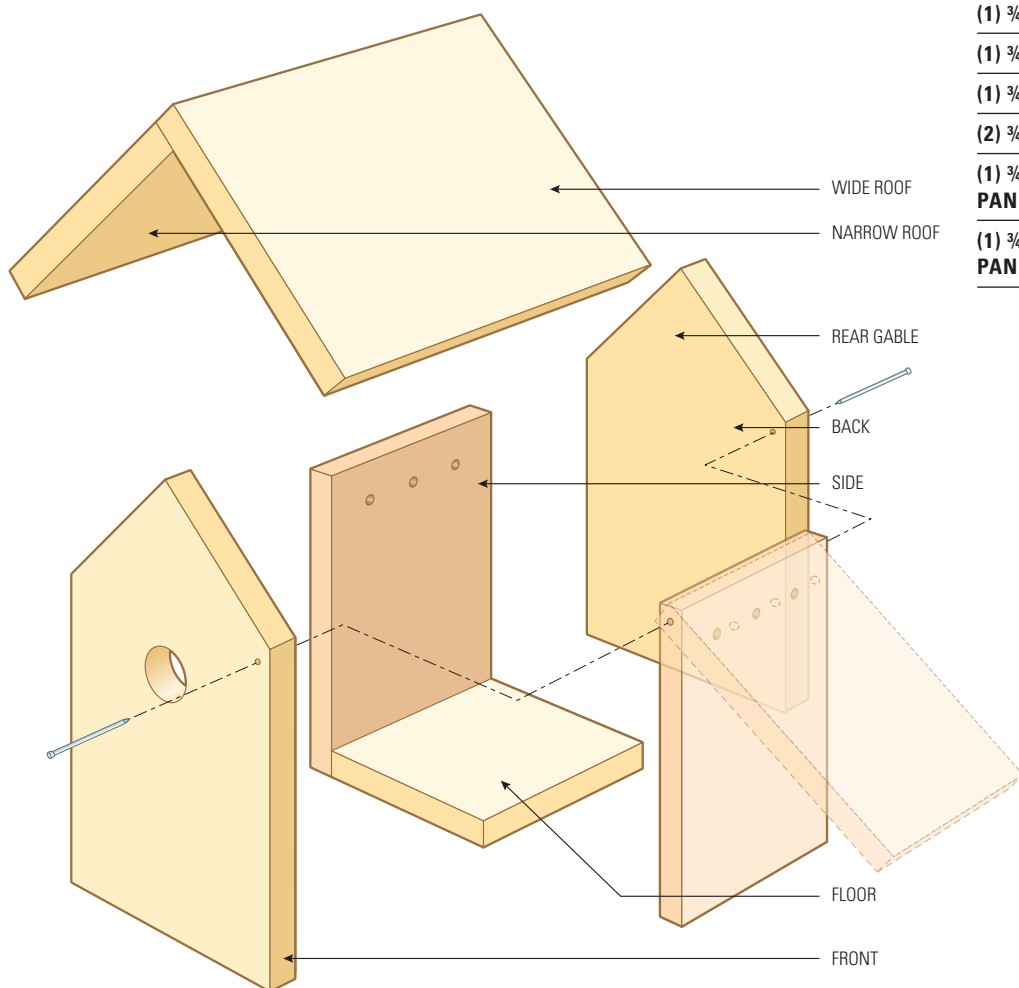
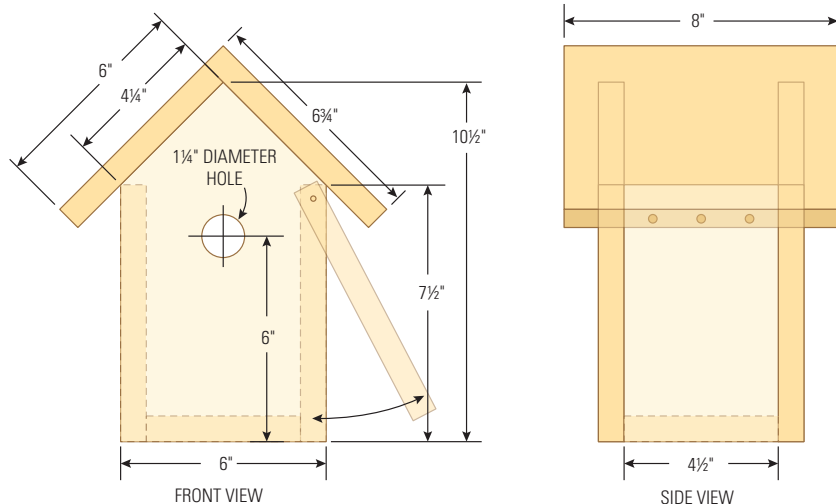
Of course, you also want the birdhouse to look nice. This birdhouse is cedar, which holds up well to bad weather and harsh sunlight. Don't get any paint or other finish inside the birdhouse. It could make the birds sick.

Each species has its own preferences when it comes to where it nests. The birdhouse here was designed for a bird called a warbler. There are lots of different types of warblers, and there is probably at least one kind around where you live. If you want to change the size and shape of your birdhouse to suit a different bird, see "Bird Preferences" on page 53.

YOUR BACKYARD BIRDHOUSE

EXPERTISE LEVEL:
Beginner to Moderate





TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

HANDSAW AND MITER BOX, OR
POWER MITER SAW (ADULTS ONLY)

POWER DRILL AND BITS (ADULTS ONLY)

BAR CLAMPS

1 1/4" FORSTNER BIT

WOOD GLUE

1 1/2" GALVANIZED FINISH NAILS

80-GRIT SANDPAPER

1" PAINTBRUSH (OPTIONAL)

EXTERIOR PAINT (OPTIONAL)

(2) SCREW EYES

3/4" HOOK CATCH

CUT LIST

(1) 3/4 x 4 1/2 x 4 1/2" CEDAR FLOOR

(1) 3/4 x 10 1/2 x 6" CEDAR FRONT

(1) 3/4 x 7 1/2 x 4 1/2" CEDAR BACK

(2) 3/4 x 7 1/2 x 5 1/4" CEDAR SIDES

(1) 3/4 x 6 3/4 x 8" CEDAR ROOF
PANEL—WIDE

(1) 3/4 x 6 x 8" CEDAR ROOF
PANEL—NARROW



MAKE IT!



- 1** Cut all the pieces for the project to the dimensions listed on the cut list. Mark and cut the gable (the pointed end) for the front. Measure 7½" from one end along each long side. Mark each point with a pencil and use a speed square to connect each side mark, forming a 90° angle at the other end. Use a handsaw and miter box to cut the gable, or have an adult use a power miter saw to make the cuts.
- 2** Use the front gable as a template to mark the back gable. Cut the back gable in the same way.

3 Measure and mark the center of the entry hole on the front, 6" up from the bottom and centered side to side. Clamp the front to the work surface on top of a sacrificial piece of wood. Drill out the entry hole with a 1½" Forstner bit.

4 Drill three ¼" holes centered side to side and about 1" down from one 4½" edge of each side. These will be ventilation holes to make sure the birds get fresh air and don't overheat inside the birdhouse.





- 5** Drill pilot holes and glue and nail one short end of a side to an edge of the floor. Make sure the ventilation holes are at the top of each wall opposite to the floor.
- 6** Drill pilot holes and glue and nail the front piece to the wall and the floor, aligning it along the edges. Position and attach the back wall in the same way. Sand all the pieces lightly with 80-grit sandpaper.
- 7** Position the narrower roof panel on top of the gables so that the long edge spans front to back. The panel should overlap the front and rear gable by exactly 1". Once it's in position, drill pilot holes along the front and back, down into the gable edges. Remove the panel and coat the gable edges with wood glue. Reposition the panel and nail it in place.

Birdhouse Preferences

Birds are picky about where they nest. You'll have better luck attracting the birds you want if you size the birdhouse for that species (see the chart below). Your feathered friends also appreciate a good lookout point where they can keep an eye peeled for enemies. Different species like to be higher or lower to the ground. Contact your local agricultural extension office (pickyourown.org/countyextensionagentoffices.htm) or the Audubon Society (audubon.org) to find out what birds are common in your area. The table below lists birdhouse measurements for different species.

* These are open nesters; they don't breed or live in birdhouses.

Species	Entry Hole	Hole to Ground	Hole to Floor	Roof to Hole	Floor Dimension
American Kestrel	3"	12–30'	9–12"	3"	10×12"
American Robin	*	8–10'	*	*	5×8"
Bluebird	1½"	4–8'	6–10"	2"	4×4"
Chickadee (all species)	1⅞"	7–12'	6–8"	2"	4×4"
Flicker	2½"	12–20'	14–16"	16–18"	7×7"
Flycatcher	1¾"	5–15'	8–10"	2–3"	6×6"
House Finch	2"	8–12'	4–6"	2–4"	6×6"
House Wren	1–1⅞"	4–10'	3–6"	2"	4×4"
Nuthatch	1¼"	5–15'	6–8"	2–4"	4×4"
Owl, Barn	4"	10–25'	4–6"	4–6"	20×10"
Owl, Barred	7–10"	15–20'	12–14"	0–4"	14×14"
Owl, Screech	3"	10–30'	9–12"	3–5"	9×9"
Purple Martin	2⅞"	10–20'	1–1½"	5"	6×6"
Sparrow	1⅜–2"	8–15'	6–7"	3–5"	5×5"
Titmouse	1¼"	6–15'	6–8"	2"	4×4"
Tree Swallow	1½"	10–15'	5"	1–4"	5×5"
Woodpecker	2"	12–20'	10–12"	3–5"	6×6"
Wood Duck	3×4"	6–20'	10–12"	4–6"	9×9"
Yellow Warbler	1¼"	5–8'	6"	2–3"	5×5"

Bird Biology

Birds are concerned primarily with SWaG: Safety, Water, and Grub. They need all three to live, and especially to breed. That's why attracting birds into your backyard is about more than just building a nice birdhouse.

SAFE SPACE

The inside of the birdhouse must be large enough to accommodate eggs and allow the birds to move around comfortably, but not so large that the birds feel exposed. It needs to be far enough from the ground so that household pets and wildlife can't get to the birds or eggs. Because all songbirds face the threat of multiple predators, the house should have a clear line of sight on all sides.

INTERIOR CONTROL

Just like humans, birds don't like being too hot or too cold in their homes. That's why it's essential to include ventilation holes. The holes provide fresh air and moderate the temperature inside the birdhouse. It's also why you should never paint a birdhouse a dark color as darker colors absorb more sunlight and heat than light colors do.

THE BIRD DIET

Some birds like to feed on insects, others fruit and seeds, and still others a combination of the two. Make sure there are plenty of each by growing a variety of flowering plants in the yard. The plants will eventually develop fruit or seeds and the flowers will attract insects. It's like putting together a buffet for your feathered friends.

Even more important, birds need clean drinking water. That's why many people add a birdbath to their yard. The birdbath serves two purposes: bathing and drinking. Birds wash off dust and small bothersome pests, such as mites, by splashing the water. Clean a birdbath often.





8 Position the wider roof panel to match the narrow roof panel and overlap them at the top of the roof (it must align perfectly). Drill pilot holes along the edges and where the panels overlap. Remove the panel and coat the gable edges with glue. Nail the panel in place.

9 Position the remaining side wall between the front and rear walls. Measure and mark for hinge-nail holes at the exact same location on each edge of the front and back, about $\frac{1}{4}$ " down from the top of the side wall. Ensure that the wall will swing up between the front and the back. Lightly sand one edge of the side wall if the fit is too snug.

10 Drill pilot holes at the marks, through the front and back and into the edges of the side wall. Drive a brad into each hole but leave it loose enough for the wall to swing out. (This wall is a clean-out door so that you can clean the birdhouse every year after the occupants leave.)



11 Drill pilot holes and screw the latch and catch to the bottom of the side wall and the birdhouse bottom. This will keep the swing-out wall secure when birds are using the house.

12 You can hang the birdhouse from a sturdy tree branch by screwing eye hooks into the roof and hanging it with chain. You can also mount the birdhouse on a post (ask your parents for help with this). In either case, the birdhouse should be 6 to 8' off the ground, with no bushes or thick growth around the house.



This simple and satisfying project is the perfect partner to the birdhouse, but you have to fill it with the right food. Birds need nutritious edibles, and they aren't the only ones that love free meals. Squirrels, raccoons, deer, and other backyard visitors will gladly snack at your bird

feeder. Place the feeder high enough to be out of reach of four-legged diners and hang it by a cable thin and slippery enough that squirrels or other sneaky critters won't be able to use it for access. Make sure that the feeder is never empty for more than a day.

FEATHERED FRIEND FEEDER

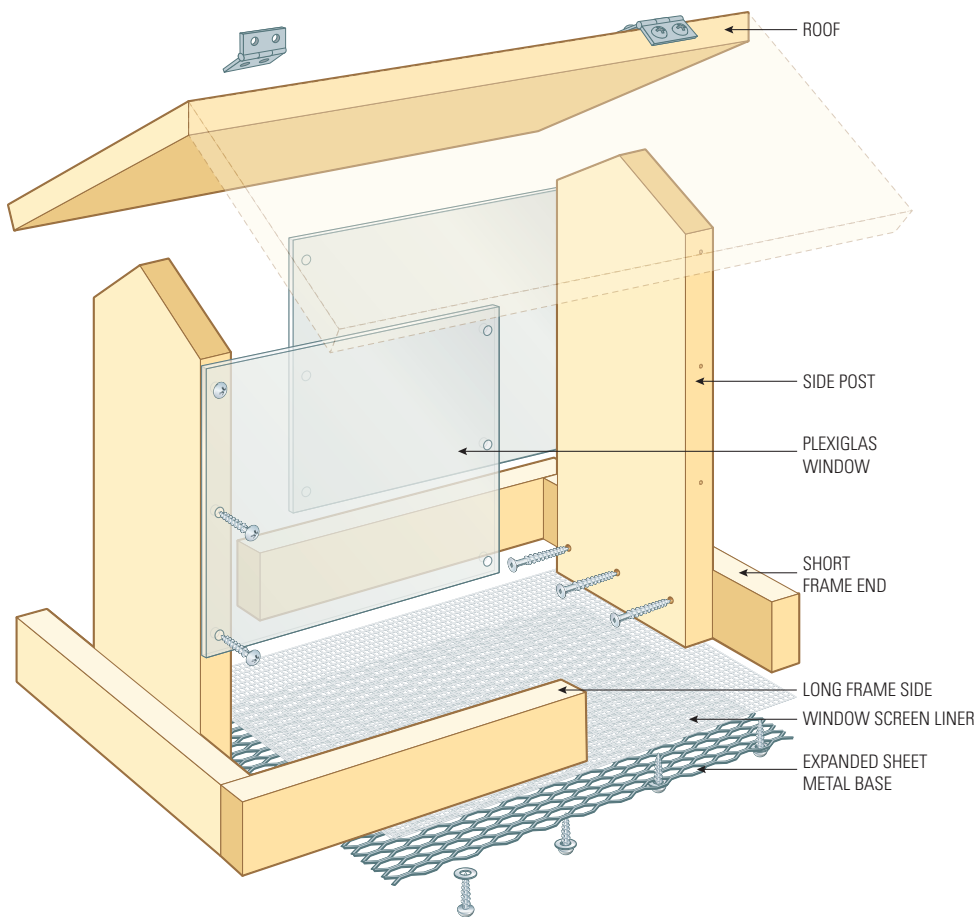
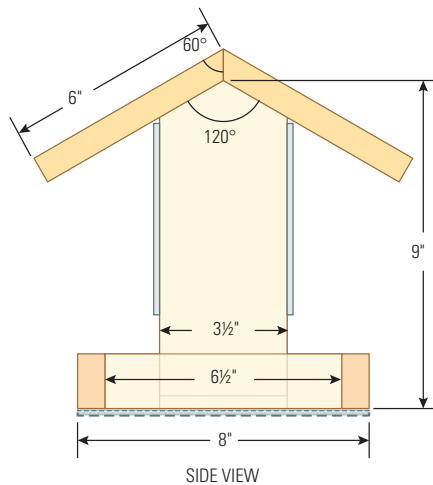
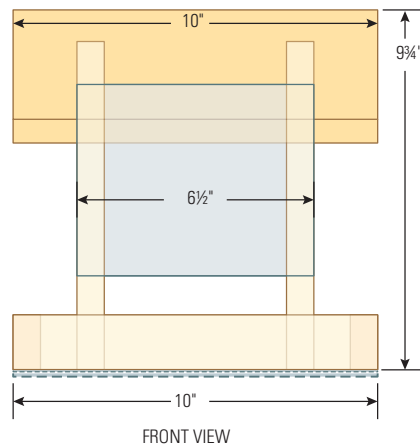
EXPERTISE LEVEL:
Beginner to Moderate



Good Food

Birds are picky eaters. Keep the birds in your backyard healthy and happy with a selection of appealing treats.

- Never put out chocolate, baked goods, or potato chips. You may love them, but they are bad for birds.
- Birds love all kinds of seeds, but some of their favorites are black sunflower seeds, pumpkin seeds (unsalted), millet, nyjer seeds, and milo.
- Peanuts (unsalted) are a favorite of many birds.
- Mealworms supply precious protein for small birds.
- Crushed eggshells help birds digest other foods.



TOOLS & MATERIALS

MEASURING TAPE

FELT-TIP MARKER

TABLE SAW OR BAND SAW
(ADULTS ONLY)

HANDSAW AND MITER BOX, OR
POWER MITER SAW (ADULTS ONLY)

ROUTER (ADULTS ONLY)

1/4" EXPANDED METAL SHEET

FIBERGLASS WINDOW SCREEN

HACKSAW OR JIGSAW

HEAVY-DUTY SHEARS

POWER DRILL AND BITS (ADULTS ONLY)

1 1/2" DECK SCREWS

3/4" ZINC WASHERS

(12) 3/4" PANHEAD SCREWS

HAMMER

STAPLE GUN AND STAPLES

UTILITY KNIFE

1/8" PLEXIGLAS SHEET

1 1/2" GALVANIZED FINISH NAILS

(2) 1" STAINLESS STEEL BUTT HINGES

CUT LIST

(2) 3/4 x 3 1/2 x 9" CEDAR SIDE POST

(2) 3/4 x 1 1/2 x 10" CEDAR LONG
FRAME SIDE

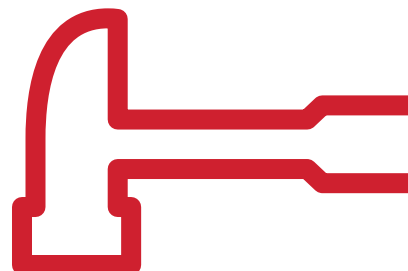
(2) 3/4 x 1 1/2 x 6 1/2" CEDAR SHORT
FRAME END

(2) 3/4 x 6 x 10" CEDAR ROOF PANEL

(1) 1/4 x 8 x 10" EXPAND SHEET
METAL BASE

(1) 8 x 10" WINDOW SCREEN LINER

(2) 1/8 x 6 x 8 1/2" PLEXIGLAS WINDOW

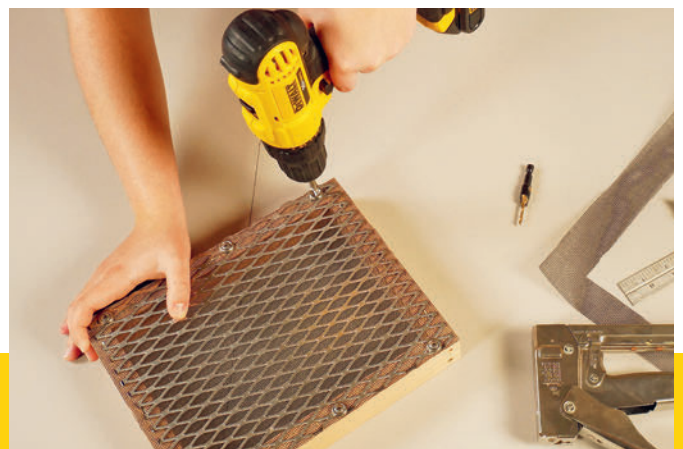


MAKE IT!



- 1** Cut all the pieces to the dimensions listed on the cut list. Measure and mark the gable (the pointed end) on each post. The angle for the gables is 120°. Use a handsaw and miter box to miter one long edge of each roof panel to 60° so that they will meet flush at the roof peak. You can also ask an adult to use a power miter saw to make the miters.
- 2** Cut the expanded metal sheet to size using a hacksaw or jigsaw. Cut the window screen to size using heavy-duty shears.

- 3** Assemble the tray frame by drilling pilot holes at each corner and screwing the corners together with two 1½" deck screws. Clamp the frame together first, checking to ensure the square is exact (measure diagonally two ways—the measurements should be the same), and then screwing each corner together.
- 4** Align the window screen on top of the frame. Use a staple gun to staple it into place. Now align the expanded metal sheet directly over the window screen. Drill pilot holes and screw the metal sheet to the frame with ½" panhead screws and ¾" zinc washers.
- 5** Flip the frame over and sit it on a level, flat surface. Measure and mark ½" in from one side of the frame along the end. Mark the same measurement on the other end piece.





6 Hold one post inside the frame, with one edge lined up with the end mark (the other side of the post should be exactly $1\frac{1}{2}$ " in from the other frame side). The bottom of the post should sit flush on the window screen and expanded metal sheet base. Once you're sure it's properly aligned, drill three pilot holes equidistant across the frame into the bottom of the post. Screw the frame to the post with three $1\frac{1}{2}$ " deck screws.

7 Repeat the process on the other side with the second post. But before you drill the pilot holes, hold one roof panel in place and make sure it sits level across the top of the posts. Then drill the pilot holes and screw the post to the frame.

8 Check the measurement for the plexiglas windows from post to post. Mark the cut line and use a straight-edge, such as a metal ruler, to guide the blade of the utility knife as you cut along the line several times. Once a deep cut has been established, you can snap the waste portion off by aligning the cut with the edge of the workbench and snapping downward.

9 Sit the first roof panel in place across the top of the posts. The beveled long edge of the panel should be flush with the point of the post tops, and the panel should overhang equally on both sides. Drill pilot holes down into the posts and nail the roof panel in place with $1\frac{1}{2}$ " galvanized finish nails.

10 Place the second roof panel flush to the first and mark the location for the hinge on both panels. Remove the second panel and drill pilot holes for the hinge screws in both panels. Replace the second panel and screw the hinges to both roof panels.

11 Measure and mark three pilot hole locations down each short side of one Plexiglas window. Clamp it on top of the second window and drill the pilot holes for both windows at once. Screw the windows to the posts with $\frac{3}{4}$ " panhead screws.

12 Set a post where you want to place the feeder. The feeder should be about 5' above the ground with a clear space all around. Attach the feeder to the post top with $1\frac{1}{2}$ " deck screws and washers. Fill the feeder half full by pouring bird feed into the opening under the hinged roof panel.



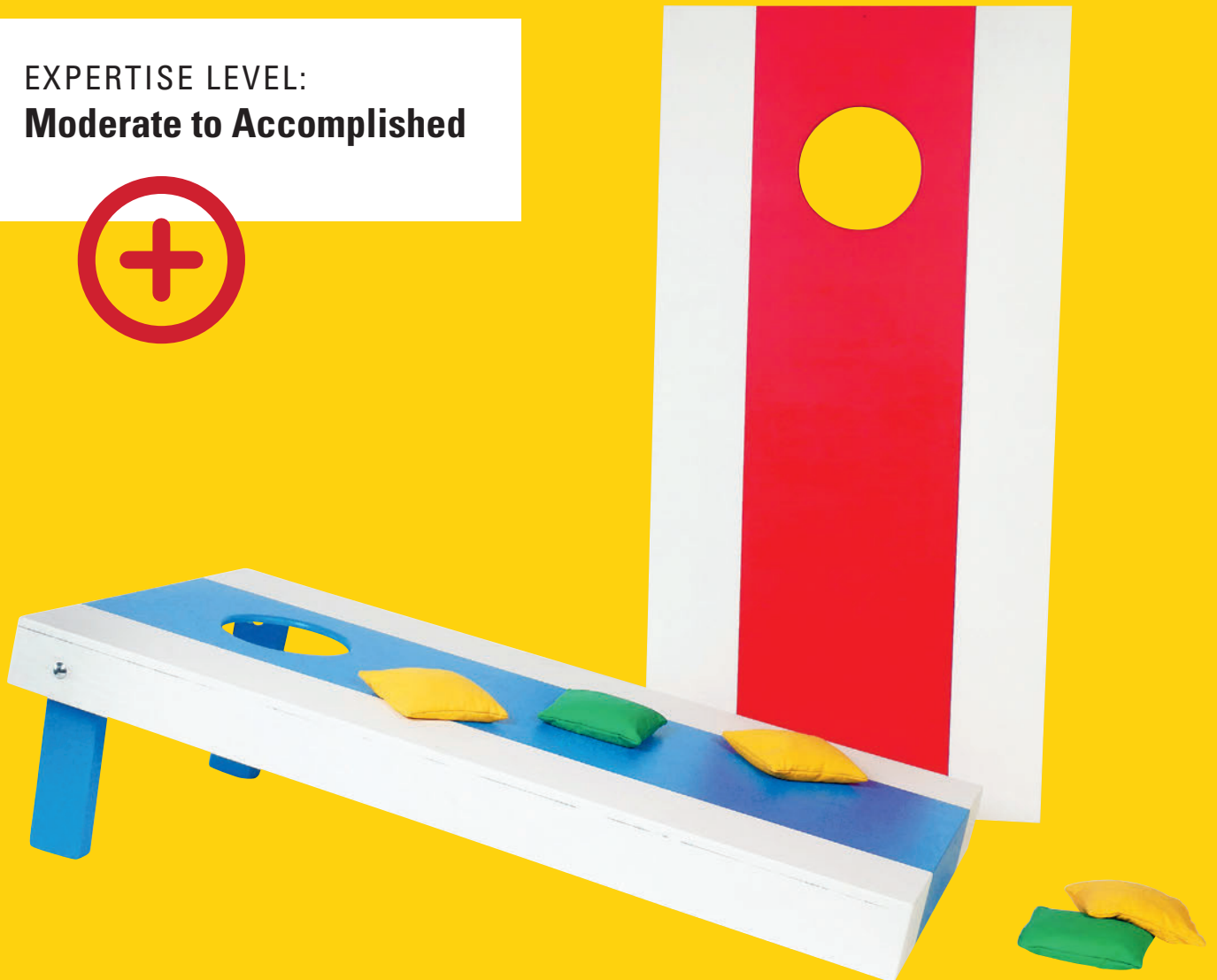
Toss Across, also known as the Cornhole Game, is endless outdoor fun. You can use this project to fabricate two boards according to the regulation measurements. All you need to supply are the standard 3½" bean bags: four in one color and four in another.

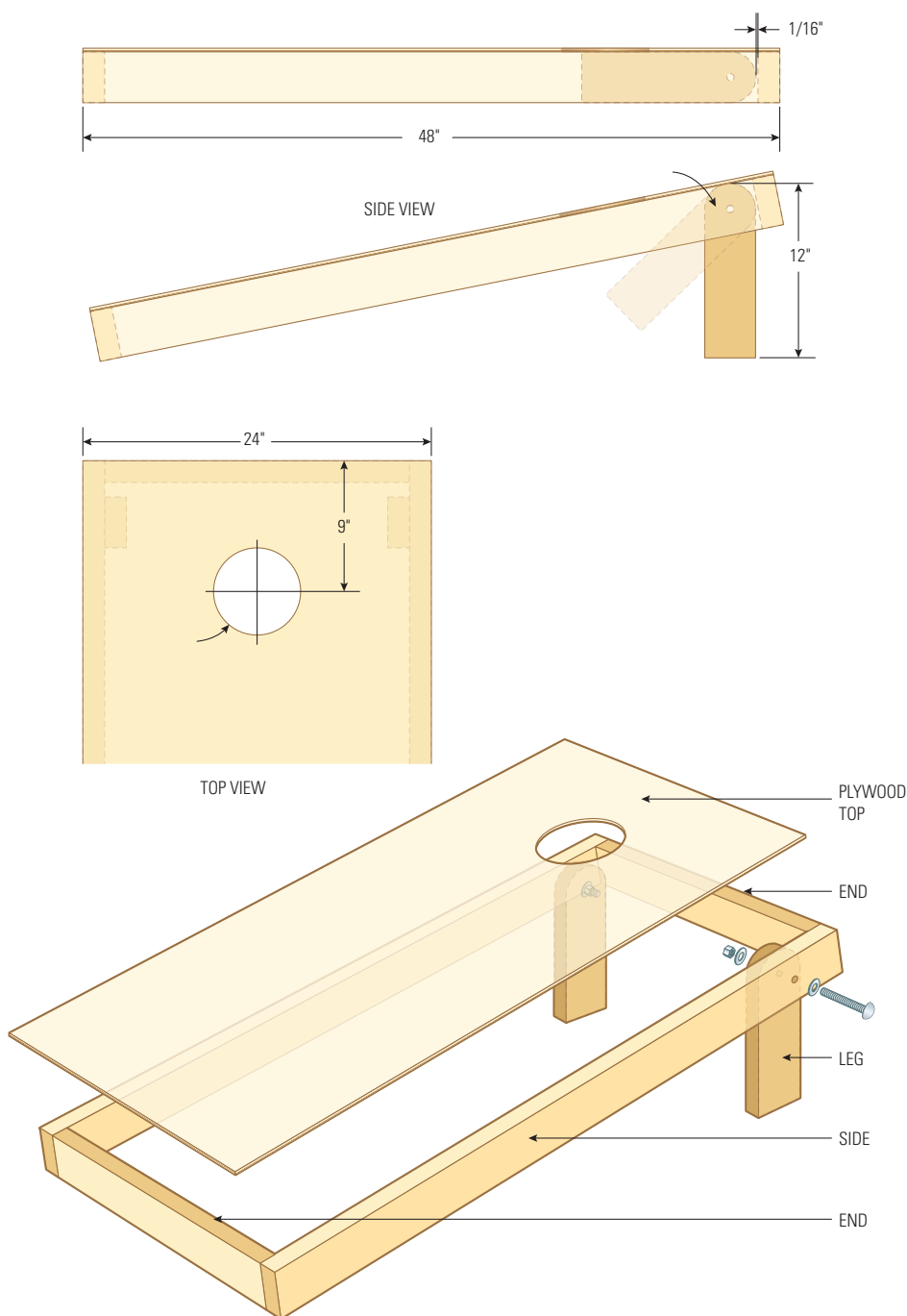
Set the boards 27 feet apart, front edges facing each other. Score points by throwing the bean bags into the hole or by landing them on the top of the board. Teams alternate throwing a bag

on the board is worth 1 point, while one in the hole equals 3. Once all the bags are thrown, add up the points. Whichever team has the highest score, subtract the other team's score and the points left over are what the winning team earned. First team to twenty-one wins. A match is the best out of three games. However, your team must win by two points, or you keep playing until one team is two points ahead.

HAVE-A-BLAST TOSS ACROSS

EXPERTISE LEVEL:
Moderate to Accomplished





TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

SHEET OF 1/4" PLYWOOD
(EXTERIOR GRADE)

2 x 4 PINE BOARDS

HANDSAW, OR TABLE SAW
(ADULTS ONLY)

MITER BOX AND HANDSAW, OR
POWER MITER SAW (ADULTS ONLY)

CLAMP

FRAMING SQUARE

POWER DRILL AND BITS (ADULTS ONLY)

3" DECK SCREWS

CARPENTER'S COMPASS OR TRAMMEL

JIGSAW

6D 2" FINISH NAILS

SANDING BLOCK

80-GRIT OR 100-GRIT SANDPAPER

2" PAINTBRUSH

PAINTER'S TAPE

WHITE EXTERIOR GLOSS PAINT

BLUE EXTERIOR GLOSS PAINT

RED EXTERIOR GLOSS PAINT

(4) 1/2 x 4" CARRIAGE BOLTS

(4) 1/2" WASHERS

(4) 1/2" NUTS

1/2" PLYWOOD

BAR CLAMPS

CUT LIST

FOR SET OF TWO BOARDS

(2) 1/2 x 24 x 48" PLYWOOD TOP

(4) 1 1/2 x 3 1/2 x 48" PINE FRAME SIDE

(4) 1 1/2 x 3 1/2 x 22 1/2" PINE FRAME END

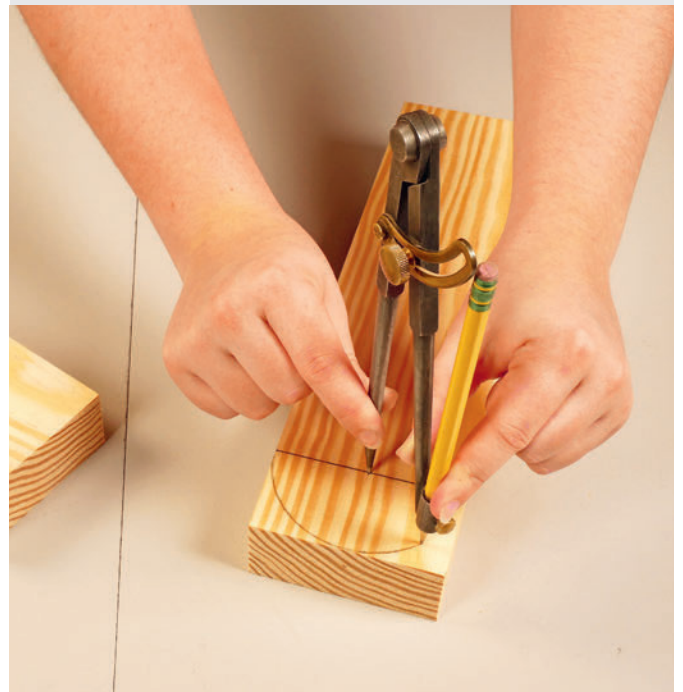
(4) 1 1/2 x 3 1/2 x 12" PINE LEG

MAKE IT!



- 1** Cut the pieces for both boards to the dimensions listed on the cut list using a handsaw or have an adult cut them with a table saw or circular saw. Have an adult cut the tops from a sheet of $\frac{1}{2}$ " plywood using a table saw or circular saw. Lumberyards and home centers will also cut the plywood for free if you ask—the tops are exactly one-quarter of a standard plywood sheet.
- 2** Lay out and clamp one frame together with the ends sandwiched between the frame sides to create a rectangle. Use a framing square to check that the corners are perfectly square, and adjust them if they are not.

- 3** Drill pilot holes in the corners and screw the frame together using two 3" deck screws at each corner. Repeat the process to assemble the second frame.
- 4** Separate the two points of the compass or trammel $1\frac{3}{4}$ " apart. Measure down $1\frac{3}{4}$ " from one end of each leg and make a mark centered side to side. Use this mark to position the compass needle. Draw an arc with a $1\frac{3}{4}$ " radius, across the end of the leg.



5 Clamp the leg securely to a work surface and use the jigsaw to cut the arc. Use the first leg as a template to mark the three remaining legs, and cut the arcs in those legs.

6 Stand a frame on a flat, level work surface, with its long side facing down. Lay a leg against the inside of the long edge, flush with the side. Position the arched end of the leg $\frac{1}{16}$ " from the inside corner of the frame. Use a $\frac{1}{2}$ " bit to drill a hole at the center mark you used to draw the arc on the leg. Drill all the way down through the frame. Repeat the process with a second leg on the opposite frame side, and then with the two remaining legs and the second frame.



7 Set one top in place on a frame with the hole at the same end of the frame as the legs. Make sure the top is aligned with the frame perfectly all the way around and clamp it to the frame. Drill pilot holes about every 6" around the edge of the top, down into the frame. Nail the top to the frame with 6d 2" finish nails.

8 Lay out the hole at one end of the first top. Use a framing square to measure and mark the center of the hole exactly 9" from the end and 12" in from the side. Use a compass or trammel to mark a 6" circle around the center point.





9 Use a ½" spade bit to drill a starter hole right inside the line of the marked circle. Use this hole as access for the jigsaw blade. Very carefully cut out the circle with the jigsaw blade. Lay the first top over the second. Align all sides perfectly and then mark the circle on the second top using the first as a template. Cut out the second hole.

10 Screw the second top to the second frame in the same way. Putty over all the screw heads on both Toss Across boards and sand them smooth. Sand the edges of the holes in both tops, using 80-grit or 100-grit sandpaper. Prime the frames, tops, and legs, and then paint them white.

11 Measure and mark 6" in from each side, at several points from one end of the frame to the other. Draw straight lines all the way down the top to connect these points. Lay a strip of blue painter's tape following each line, on the side of the line opposite the hole. Paint this stripe blue and remove the painter's tape after the paint has dried slightly.

12 Repeat the process on the second top, using red paint. Attach the legs to both frames with carriage bolts, washers, and nuts holding each leg.



The Math of a Circle

A circle is a common woodworking shape and one of the most interesting in geometry—the math of shapes.

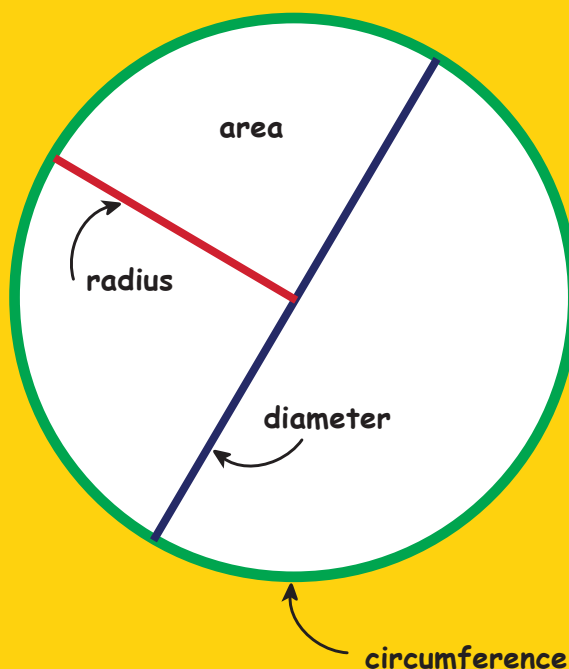
The **radius** is the distance from the center of a circle to any point on the outside edge of the circle.

The **diameter** is the distance across the center of the circle. The diameter is always twice the radius.

The **circumference** is the distance around the outside of the circle.

Sooner or later, in math class, you'll be asked to calculate the circumference of a circle. Just multiply the diameter by 3.14 (pi). For instance, if the diameter is 10", the circumference is 31.4".

You may also be asked to figure out the **area** of a circle. That's a measure of the space inside the circle. To get the area, multiply 3.14 (pi) by the radius squared. Squaring a number means multiplying it by itself. So, using the example above, half the diameter of 10 is 5 (the radius). Now square the radius by multiplying it by itself ($5 \times 5 = 25$). Now multiply that by pi ($3.14 \times 25 = 78.5$).



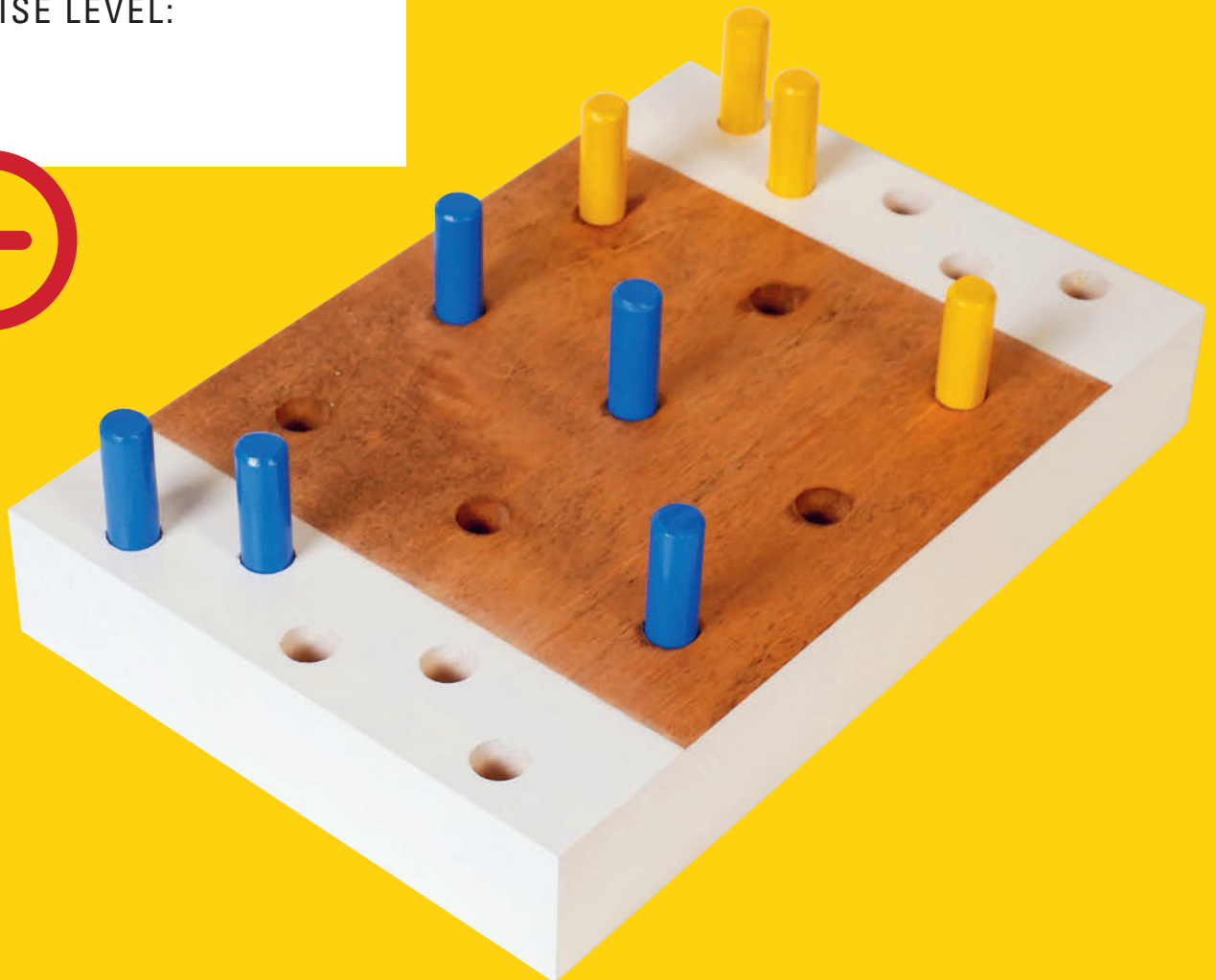
Tic Tac Toe is known and played around the world. It's a super simple game, but endlessly fascinating.

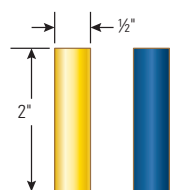
To play, each player takes a turn placing one of their pieces. The first player to place three pieces in a row—diagonally, horizontally, or vertically—wins. The better the players are, the more likely they will be to come to a draw,

or tie. Even if you don't wind up playing all the time, this board is a nice-looking piece all on its own. It makes a great gift, and you can change the design to show off your own taste. You could also glue dowel playing pieces in the board holes and then paint metal washer to create fun and fascinating player pieces.

TERRIFIC TIC TAC TOE BOARD

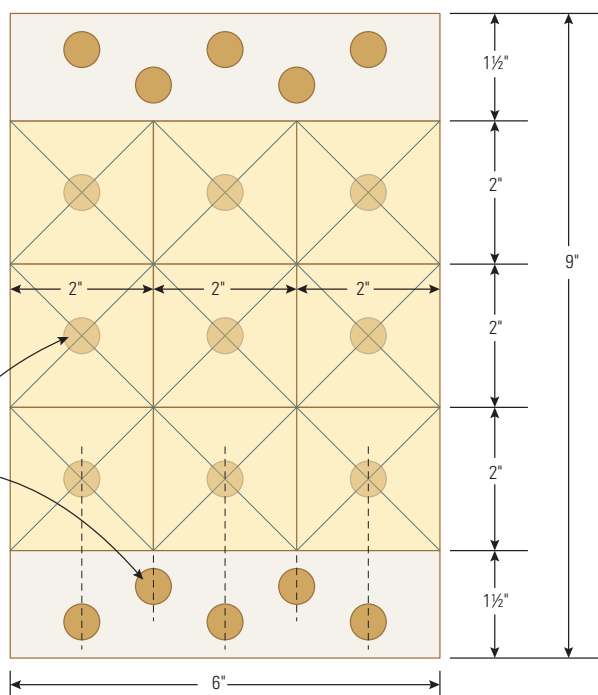
EXPERTISE LEVEL:
Basic



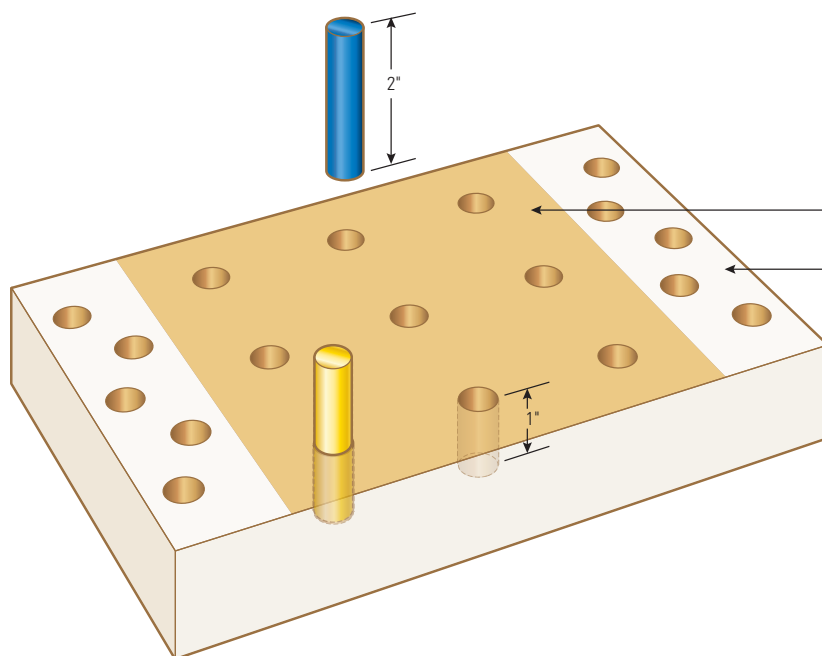


PLAYING PIECE
DOWEL DETAILS

1/2" DIAMETER HOLES



TOP VIEW



WALNUT STAINED
PLAYING FIELD SECTION

WHITE PAINTED
HOME AREA SECTION

TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

2 x 8 x 12" PINE BOARD

HANDSAW, OR TABLE SAW
(ADULTS ONLY)

1/2 x 24" DOWEL

COMBINATION SQUARE

AWL OR CENTER PUNCH

POWER DRILL AND BITS (ADULTS ONLY)

BAR CLAMPS OR LARGE C-CLAMPS
100-GRIT SANDPAPER

PAINTER'S TAPE

1" PAINTBRUSH

GLOSS WHITE PAINT

BLUE PAINT

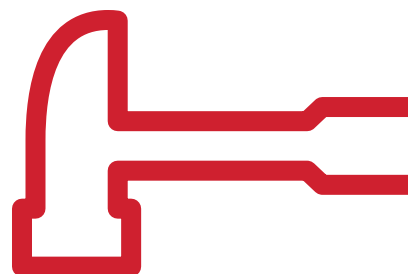
YELLOW PAINT

WALNUT STAIN

CUT LIST

(1) 1 1/2 x 6 x 9" GAME BOARD

(10) 1/2 x 2" DOWEL PLAYING PIECES



MAKE IT!



- 1** Cut the Tic Tac Toe board plank to the dimensions on the cut list using a handsaw, or have an adult cut the plank on a table saw. The board will need to be ripped down to 6" wide; you can use a rip cut saw or have an adult cut it down on a table saw. Either way, make sure the playing board is squared off at the corners.
- 2** Use a fine-toothed handsaw to cut the dowel to length for the playing pieces. The easiest way to do this is in a miter box with a handsaw, or have an adult use a power miter saw to quickly cut the playing pieces.

- 3** Mark the top of the playing board with a carpenter's pencil. Measure in from both ends 1½" and draw lines long side to long side to define the "home" sections. Measure and mark the playing field into 2" squares both ways. Outline the squares. Then draw Xs corner to corner in each square.
- 4** Mark the "home" holes by drawing a zigzag pattern on the home field on each side. Mark five holes for the playing pieces.





- 5** Mark all the hole locations and the centers of the Xs with an awl or center punch to guide the drill bit. Make a depth gauge on a ½" drill bit by wrapping the bit in painter's tape or masking tape 1" from the tip.
- 6** Carefully drill all the holes. Watch closely and stop drilling when the edge of the painter's tape is flush with the top of the wood. Move the bit around slightly in each hole to allow each piece to sit without being forced.
- 7** Sand the board all over with 100-grit sandpaper, until the pencil marks are removed. Make sure the holes are cleaned up, with no splinters or rough areas.

- 8** Cover the playing field with painter's tape, masking it off entirely. Paint the surrounding areas white, including the side of the board. Let the paint dry entirely, then use painter's tape to mask off the painted areas and wipe the stain on the bare wood of the playing field by following the instructions on the can. Use stain or paint to finish the dowel pieces in different colors. You can leave five of the pieces natural or color them however you like.



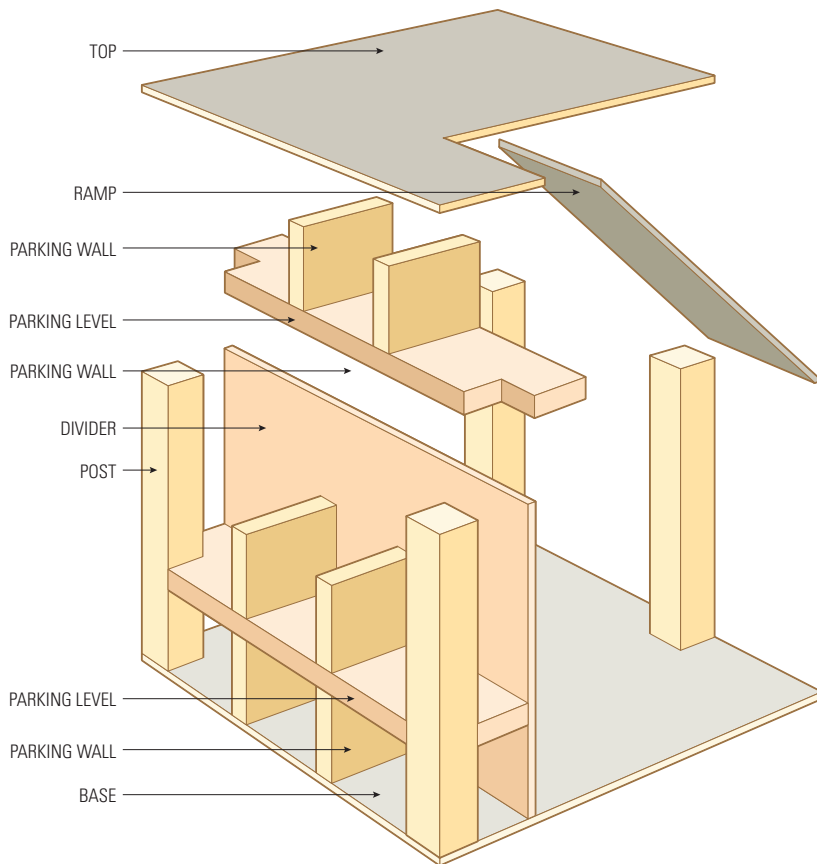
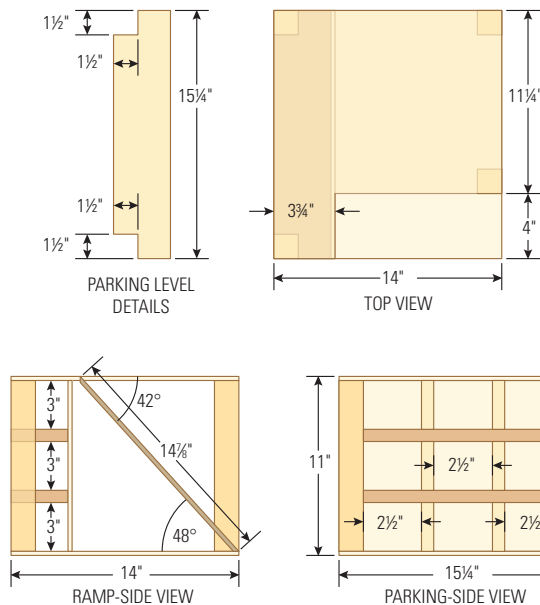
This structure includes nine parking spaces for your favorite models; its dimensions accommodate Matchbox-sized cars, but the spaces are roomy enough to park even larger toy cars. You can also change the plans to fit the cars you own.

This is a complex project. It will go much faster if you have a parent who can use a power saw and other power tools to speed things up. Be careful with the measurements because there is little room for error.

VROOM! TOY CAR PARKING GARAGE

EXPERTISE LEVEL:
Experienced





TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

1/2" PLYWOOD

2 x 2 x 48" PINE BOARD

1 x 4 x 34" PINE BOARD

HANDSAW, OR TABLE SAW
(ADULTS ONLY)

MITER BOX AND HANDSAW, OR
POWER MITER SAW (ADULTS ONLY)

WOOD GLUE

POWER DRILL AND BITS (ADULTS ONLY)

HAMMER

TORPEDO LEVEL

1" WOOD SCREWS

CLAMP

JIGSAW

1" FINISH NAILS

1 1/2" FINISH NAILS

2" FINISH NAILS

WOOD PUTTY

SANDING BLOCK

100-GRIT SANDPAPER

PAINTBRUSH

PRIMER

WHITE GLOSS PAINT

BLACK CHALKBOARD PAINT

CUT LIST

(2) 1/2 x 15 1/4 x 14" PLYWOOD TOP
& BASE

(1) 1/2 x 4 x 14 7/8" PLYWOOD RAMP

(1) 1/2 x 10 1/2 x 15 1/4" PLYWOOD DIVIDER

(2) 3/4 x 3 1/2 x 15 1/4" PINE PARKING LEVELS

(6) 3/4 x 3 x 3" PINE PARKING WALLS

(4) 1 1/2 x 1 1/2 x 10 1/2" PINE POSTS

MAKE IT!



1 Cut the pieces for the structure to the dimensions on the cut list. You can cut the plywood with a handsaw, but that will take a lot of time and effort. The smaller pieces may also be hard to cut by hand to the exact measurements. This will go faster and easier if an adult cuts the pieces with a circular saw. Watch and ask questions as the adult uses the table saw; it's a great opportunity to learn how to cut unusual shapes.

2 Use a miter box and handsaw or ask an adult to use a power miter saw to bevel either end of the parking structure's ramp. Each end is cut to a 45° bevel, so if you look at the board from the side the two cuts will form a V.

3 Measure and mark the location of the inset front post on the base. The post is positioned 4" in from the left short edge of the base. Glue each post down to the base—the first where marked, and the other three in the three other corners.

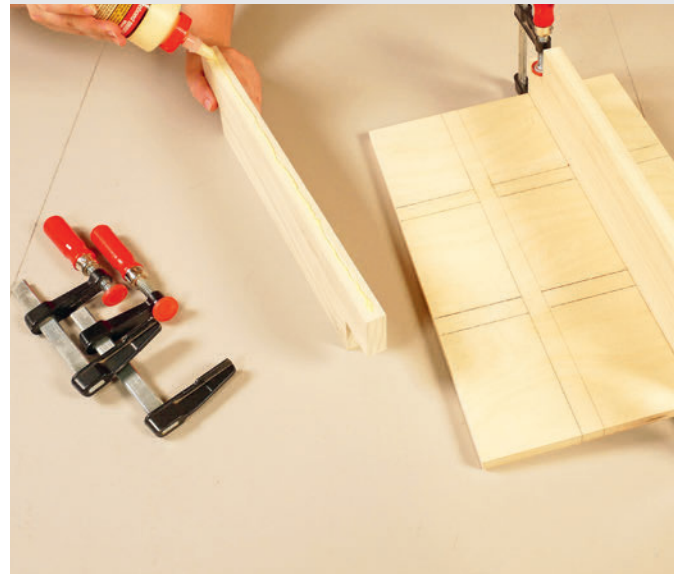
4 Once the glue has dried, flip the base upside down and drill pilot holes directly down into the center of each post. Screw the base to the posts with two 1" wood screws per post.





- 5** Measure and mark a $1\frac{1}{2}$ " $\times$ $1\frac{1}{2}$ " notch at the two corners of one long edge on each parking level board. Clamp each board to a work surface and carefully cut out the notches with a jigsaw.

- 6** Carefully measure and mark the locations for the two parking levels 3" in from each long edge of the plywood divider. Spread glue along one long edge of each parking level board, then glue them in place on the edge of the divider. Clamp them in place until the glue dries.



Street Science

The asphalt used on the driving surface of a parking garage and to pave most streets is an amazing material. It is **viscoelastic**, which means that it is both elastic like silly putty and pours like maple syrup. Those two properties are much more pronounced when the material is heated. That's why, when asphalt is very hot, it's easy to pour and spread over a street. The asphalt seems rock hard, but in reality, it's still elastic. Although we can't see the effect, when a heavy truck

drives over a paved asphalt road, the asphalt squishes a little bit under the weight and then rebounds to its original shape.

Because the asphalt we use on roads is actually an **aggregate**—it contains other ingredients such as crushed rock and chemical binders—it eventually loses its elasticity. That's why streets and roads crack and wear over time.

The asphalt is **bitumen**. By itself, it looks like tar, because they are similar substances; both come

from ancient plants and animals that have been crushed under tremendous pressure over long periods of time. It's the same process that produces the oil we drill out of the ground. That's why asphalt is called a petroleum product.

Asphalt isn't new—the French used it as a binding agent to create the first asphalt road in Paris, France, in 1824!





7 Measure and mark the placement of the six parking walls (each parking stall is defined by walls 3" high by 2½" wide). Apply wood glue to three edges of each wall, leaving one 3" edge uncoated. Slide the walls into place between, above, and below the parking level boards. Clamp them into the correct positions so that they are perfectly perpendicular to the divider.

8 Once the glue has dried completely, flip the divider over so the construction is standing on the front edges of the parking levels and walls.

9 Carefully measure and mark the back side of the divider with lines representing the center of the parking levels and walls. Drill pilot holes every 2" along these lines and use a hammer to nail the divider to the parking levels and walls with 1½" finish nails.

10 Place the parking stall construction in position between the two back posts of the base. Check that the top sits level across the posts and the stall construction, and then drill pilot holes and nail the post on each side to the top and bottom parking levels using 2" finish nails.



11 Place the top on the parking structure and use a level to check that all the posts are **plumb** (perfectly vertical). Drill pilot holes and screw the top to the posts using 1" wood screws. Carefully drill pilot holes through the top down into the parking walls and nail the top to the walls with 1" finish nails.

12 Use wood glue to glue the ramp in place between the top and the bottom. Clamp it in place and let the glue dry completely before continuing.

13 Putty over the screw and nail heads and sand the parking structure all over using a sanding block and 100-grit sandpaper. Prime the entire structure, and then paint everything but the top and the ramp white. Paint the top and the ramp with black chalkboard paint. When it dries, you can use chalk to make parking lines, arrows, or even words.

The catapult relies on some basic physics, but it is a simple device. That means that it is pretty easy to build. You can even put it together with scrap wood you find around your dad or mom's workshop.

There are a lot of neat experiments you can do with a catapult, but you can also use it to fling things across the backyard. This catapult

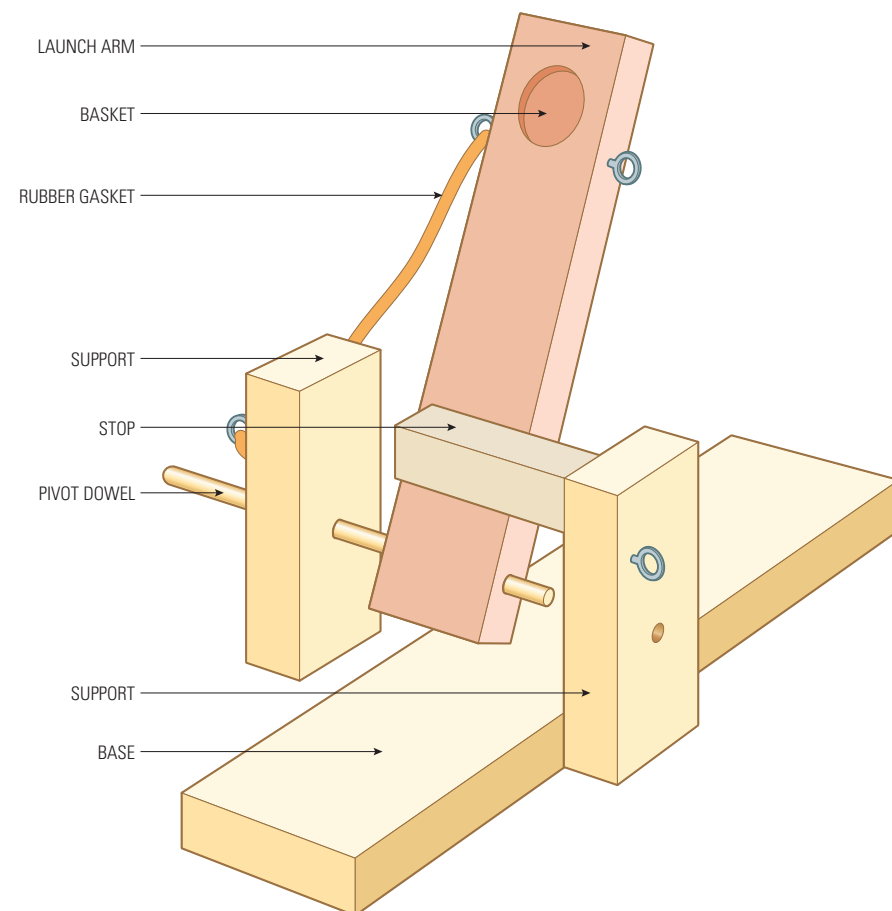
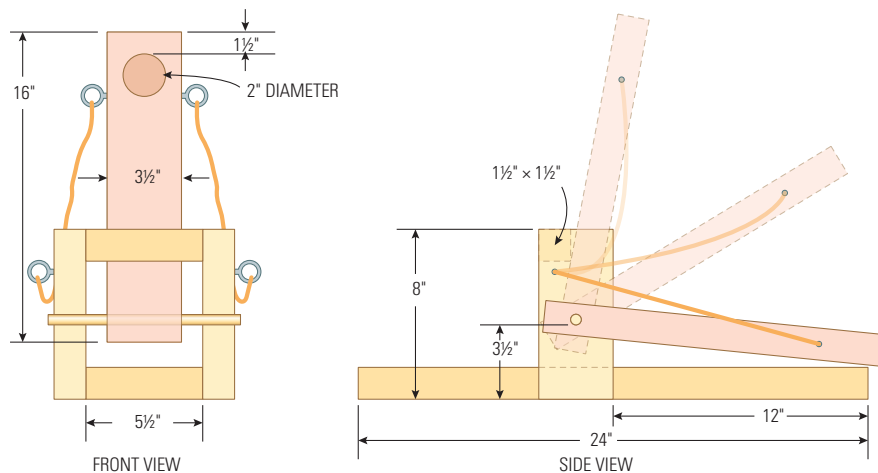
can throw rubber balls, tennis balls, or similar small projectiles.

In any case, keep in mind where the projectiles will go—especially before you know how far your catapult will hurl something. Never use this indoors and do not aim at windows, cars, people, or animals.

THE GREAT CATAPULT

EXPERTISE LEVEL:
Moderate





TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

2 x 4 PINE

2 x 6 PINE

HANDSAW, POWER MITER SAW (ADULTS ONLY) OR TABLE SAW (ADULTS ONLY)

BAR CLAMPS

AWL OR CENTER PUNCH

DOWELING JIG, OR DRILL PRESS (ADULTS ONLY)

2" FORSTNER BIT

POWER DRILL AND BITS (ADULTS ONLY)

1/2" DOWEL

COMBINATION SQUARE

WOOD OR PLASTIC Mallet

2 1/2" DECK SCREWS

1/4"-THICK FURNITURE PAD, OR RUBBER GASKET

SILICONE ADHESIVE

(4) 2" SCREW EYES

PAINTER'S TAPE

SLINGSHOT/CATAPULT TUBING, CUT TIRE INNER TUBE, OR HEAVY-DUTY BUNGIE CORD

CUT LIST

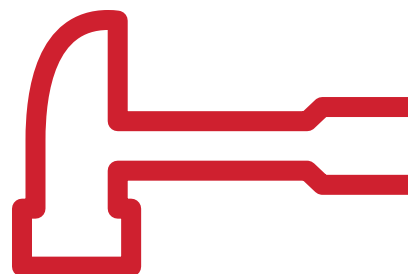
(1) 1 1/2 x 3 1/2 x 16" PINE LAUNCH ARM

(1) 1 1/2 x 5 1/2 x 24" PINE BASE

(2) 1 1/2 x 3 1/2 x 8" PINE SUPPORT

(1) 1 1/2 x 1 1/2 x 5 1/2" PINE STOP

(1) 1/2 x 8 1/2" DOWEL PIVOT



MAKE IT!



- 1** Cut all the pieces for the project to the sizes listed on the cut list. Before you cut the stop, check the width of the base board. Not all lumber is cut accurately, and the board may be slightly more or less than 5½" wide (the stop's length must exactly match the width of the base board). Use a handsaw to make all the cuts, or have your dad or mom make the cuts more quickly with a miter saw or table saw.

- 2** Clamp the launch arm board to a work surface. Measure and mark the center of the 2" basket hole. The center is 2½" from one end, centered side to side. Mark the center of the hole with an awl or center punch. Have an adult use a drill press with a 2" Forstner bit to drill a 1"-deep stopped hole (see "Wood Words", page 87).





- 3** Use a doweling jig or ask an adult to use a drill press to drill a $\frac{1}{2}$ " hole all the way through from one long edge of the launch arm to the other. The hole should be at the opposite end of the basket hole and should be $1\frac{3}{4}$ " up from the end.
- 4** Measure and mark each support for dowel holes $3\frac{3}{4}$ " up from one end and centered side to side. Use a $\frac{1}{2}$ " bit to drill the holes. Check the fit with the dowel, and slightly enlarge the holes if the dowel doesn't easily slide in. Slide the dowel through the launch arm. An equal amount of dowel should poke out on each side.
- 5** Measure and mark the support locations on either side of the base, starting 12" from one end. Use a combination square to mark the exact location on both sides.

- 6** Clamp the base down and position one support in place, aligned with the bottom of the base. The support's pivot dowel hole should be closer to the base. Drill pilot holes and screw the support to the base with $2\frac{1}{2}$ " deck screws.
- 7** Slide the dowel of the launch arm into the hole in the support. Position the second support, sliding it onto the opposite end of the launch arm dowel. Drill pilot holes and loosely screw the support into place with $2\frac{1}{2}$ " deck screws.



Catapulting Energy

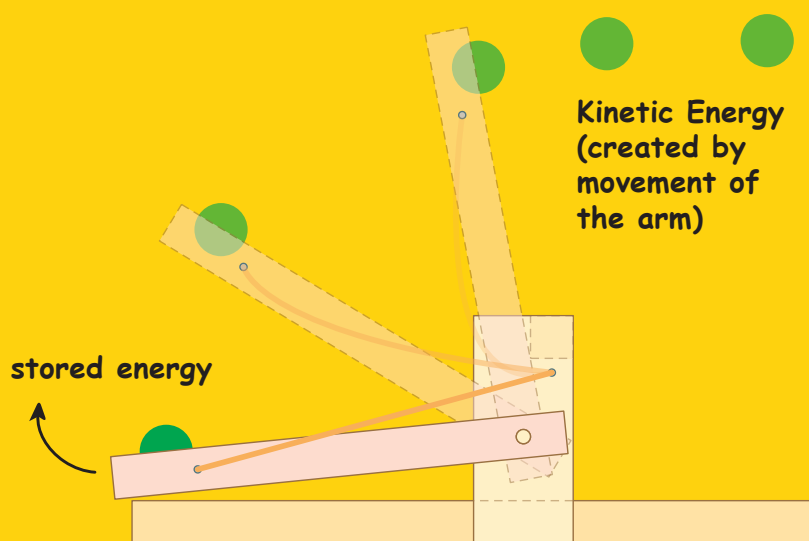
A catapult is all about converting **stored energy** into **kinetic energy**. Stored energy is also called potential energy because it represents energy that hasn't been put to use yet. Take a ball on the counter for instance. Sitting on the counter, a ball has very little potential energy. But if you hold it six feet above the ground, it now has much more potential energy because gravity wants to pull it down. You can convert that energy into a fall simply by dropping the ball. Energy in motion is kinetic energy.

The catapult is an example of both potential and kinetic energy. Energy

is stored in the launch arm. When it is pulled back against the resistance of a rubber band or other elastic material, the potential energy increases. Release the arm and that potential energy is converted into kinetic energy—which is transferred to the object being thrown.

Catapults illustrate one of the most basic formulas in physics: $\text{Force} = \text{Mass} \times \text{Acceleration}$. The heavier the object being propelled, the more energy (acceleration) it takes to propel it. But the more acceleration applied, the more force will be produced, making your object fly farther away. Think about it

this way; if you put a feather in the catapult basket, it won't go very far. That's because although you have significant acceleration (energy in the arm, fueled by the band), there isn't enough mass to amplify that energy and produce force (distance). Put a metal ball in the basket and it will go further and hit harder because you've increased the result by increasing the mass. Want to test out this formula for yourself? Hurl different objects of different sizes and weights and measure how far each goes.



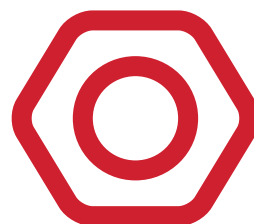
8 Screw the stop in place between the two supports with 2½" deck screws. Tighten all support screws.

9 Attach the furniture pad centered on the inside of the stop. Although the pad is self-adhesive, remove the plastic from the sticky side and coat it with silicone adhesive to ensure that the pad stays in place. Clamp it in place, center it side to side on the stop, and let it cure fully before using the catapult.

10 Measure, mark, and drill starter holes for the screw eyes ¾" in from the front and 2" down from the top of each support. Repeat the process for screw eyes on either side of the launch arm, on the edges. The launch arm screw eyes should be located 3½" down from the top and centered side to side. Screw in the screw eyes. Make sure they are deep enough to be secure.



11 With the launch arm held straight up, fasten the elastic tubing, strong bungee cord, or heavy-duty rubber bands between the supports and the launch arm screw eyes. The tubing should be tied or attached at one end to a support screw eye, woven through the launch arm screw eye on that side, run behind the launch arm through the second launch arm screw eye, and then secured to the second support screw eye.



One of the great things about woodworking is that you can create stuff that will help you with future projects. There are an amazing number of workshop helpers that you can build yourself, and this chapter features three of the best.

All three are going to be banged around the workshop, so you don't have to worry about the finishing. That said, you can always personalize something like a tool carrier, even if it's just by painting or stenciling your name on it.

4 **HANDY HELPERS**



Don't take any shortcuts when constructing these because they need to be built to last. And don't be afraid to adapt or change the plans to suit your own needs. For instance, if you're a little taller than the average kid your age, you might want to raise the workbench higher to make sure you're comfortable work.

This is an ideal first project because it is simple enough to build in a day and it's super useful.

The carrier is sized just right, exactly between the tiny toy tool carriers for little children and the large, heavy totes used by professional

craftspeople. It's meant to be carried, so it shouldn't be so large that you find it heavy or awkward to pick up. But it should be large enough to hold the tools you use most often. The project is made of pine, which is lightweight and durable.

TERRIFIC TOOL CARRIER

EXPERTISE LEVEL:
Moderate



Tool Tip

Miter boxes are used to saw angled edges on pieces of lumber, but you can use them to make accurate straight cuts as well. They'll help you make more precise cuts than if you mark the line in pencil and tried to follow the line with the handsaw. Whether you're using a miter box or you're cutting a board on a worktable or across sawhorses, clamping the board down gives you a lot more control and makes sawing the board much easier.



TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

HANDSAW AND MITER BOX, OR
POWER MITER SAW (ADULTS ONLY)

JIGSAW

PALM SANDER OR SANDING BLOCK

80-GRIT SANDING SHEETS

WOOD GLUE

BAR CLAMPS

POWER DRILL AND BITS (ADULTS ONLY)

6D 2" FINISH NAILS

AWL OR CENTER PUNCH

3/4" FORSTNER BIT

1 1/2" DRYWALL SCREWS

PINE 2 x 4S

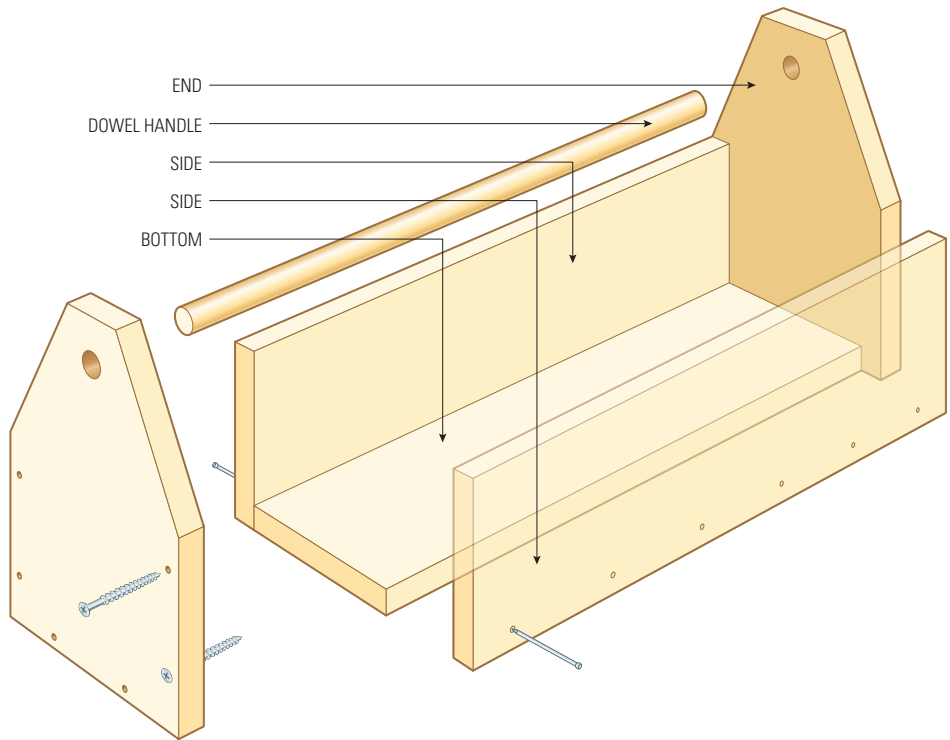
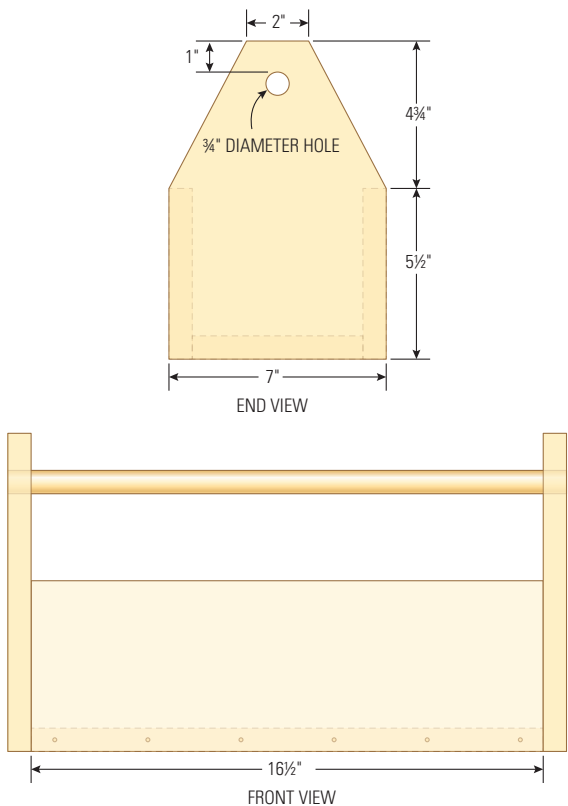
CUT LIST

(1) 3/4 x 5 1/2 x 16 1/2" PINE BOTTOM

(2) 3/4 x 5 1/2 x 16 1/2" PINE SIDES

(2) 3/4 x 7 x 10 1/4" PINE ENDS

(1) 3/4 x 18" DOWEL HANDLE



MAKE IT!



- 1** Cut the pieces for the tool carrier to the dimensions listed on the cut list. Measure and mark the end pieces for the angled cuts.
- 2** Make the angled end cuts with a jigsaw. Sand all the cut edges on the pieces smooth with 80-grit sandpaper.

Wood Words

A **sacrificial piece** is any scrap piece of wood used under another piece of wood to stop a drill or saw from going through the top piece and damaging the workbench or surface below it.



- 3** Coat the long edges of the 16½" bottom with wood glue. Put the sides in place and clamp them together using bar clamps. Align the edges perfectly. Allow the glue to dry completely.
- 4** Use a straightedge to draw a line along each side where it is glued to the bottom. The line should be ¾" in from the bottom edge of each side. Mark points along each line every 2". Drill pilot holes and nail the sides to the bottom with finish nails.
- 5** Clamp one end piece to the workbench on top of a sacrificial piece. Measure and mark for the center of the handle hole; 1⅜" from the top and centered between the sides. Use an awl or center punch to mark a starter hole at the center of the handle hole.
- 6** Use a drill with a ¾" Forstner bit to drill the handle hole. Be careful to hold the drill and bit perfectly vertical and drill straight down through the end piece until you're all the way through the board. Repeat the process with the second end piece. *Note: If your dad or mom has a drill press have them use that to drill these holes—but don't use a drill press without adult supervision!*



- 7** Lightly sand the handle holes. Use a straightedge or square to measure and mark a line along the bottom, $\frac{3}{8}$ " up from the edge. Mark three screw locations equidistant along where the end will be in contact with the bottom of the box. Measure and mark lines on either side $\frac{3}{8}$ " in from the edges. Mark three screw locations equidistant along each side where the sides will contact the end. Repeat with the second end piece.



- 8** Clamp the body of the tool carrier to a bench and align one end piece with the ends of the sides and bottom. Drill pilot holes at the screw locations.

- 9** Apply wood glue to the edges of the bottom and sides and clamp the end in place. Screw it to the bottom and sides using $1\frac{1}{2}$ " deck screws.

- 10** Apply wood glue to the end of the dowel handle and use a wood mallet to tap it into the handle hole working from the inside of the end piece). Keep tapping until the end of the dowel is flush with the outside face.



- 11** Apply wood glue to the opposite ends of the bottom and sides, and to the free end of the dowel handle. Tap the second end into place on the end of the dowel handle and align it with the bottom and sides.

- 12** Drill pilot holes and screw the end to the sides and bottom, using $1\frac{1}{2}$ " deck screws. Wait for all the glue to dry, then scrape off any squeeze-out and lightly sand any rough areas.

Wood Words

A hole that doesn't go all the way through a piece of wood is called a **stopped hole**. Stopped holes can be pretty handy in the right circumstance. For instance, you could use stopped holes in the ends of this tool carrier to hold the handle, rather than drilling holes all the way through the ends. That way, it would be easy to drive a screw through each end into the end of the handle, to ensure it holds tight.

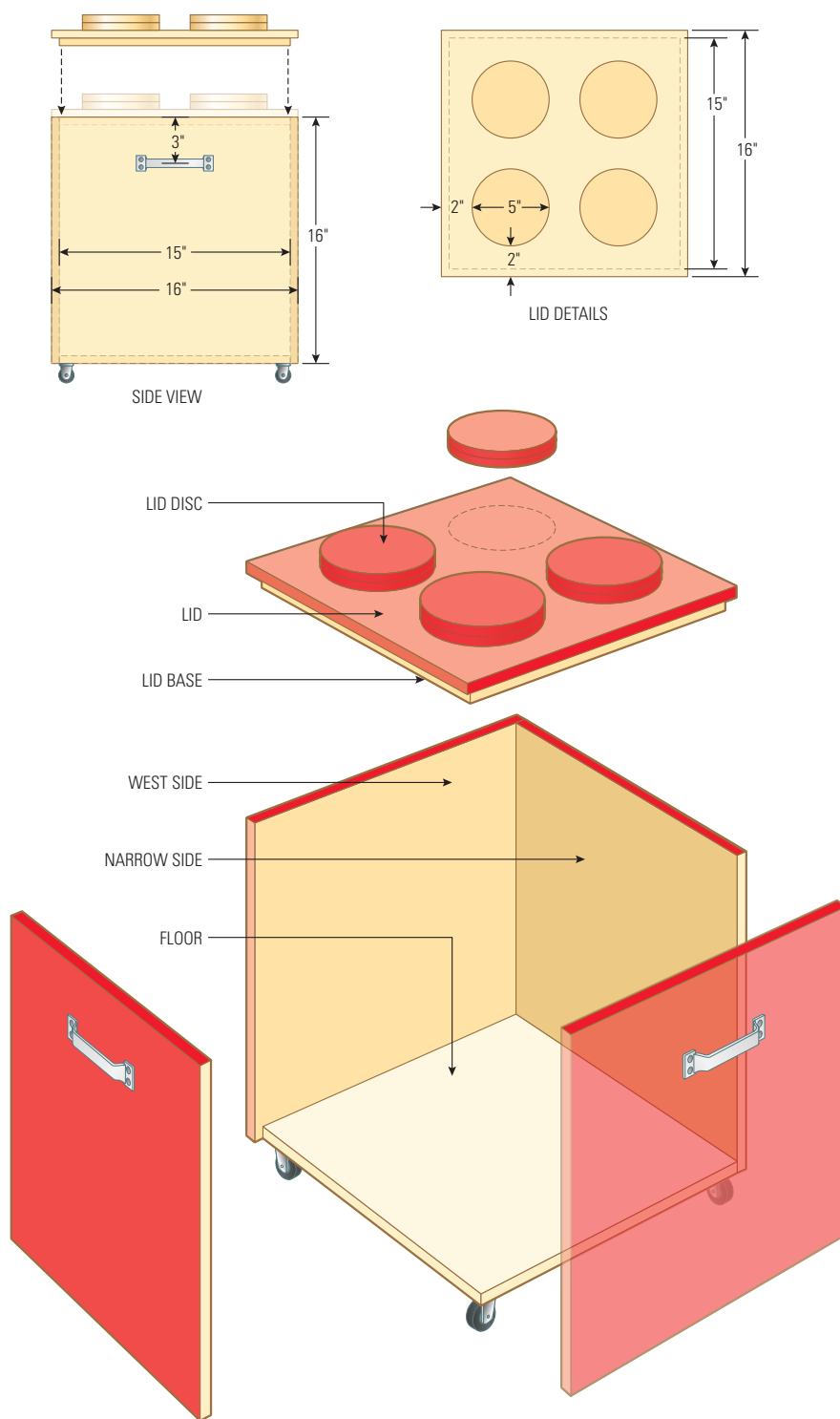
This design is witty and amusing and would make a great present. Ultimately, no matter what it looks like, this box offers a handy place to keep your stuff. The size is meant to be ideal in case you want to carry the box somewhere. It also has wheels, called **casters**, and handles that allow you to push or pull the box if it's full of tools or other items that make it too heavy to carry.

No matter what, you can personalize your box by painting it whatever color you want. Gloss is best, because it makes the box really look like a plastic block and it's easy to clean. But beyond that, go wild!

BUILDING-BLOCK STORAGE BOX

EXPERTISE LEVEL:
Basic





TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

$\frac{1}{2}$ " PLYWOOD SHEET

HAMMER

HANDSAW, OR TABLE SAW
(ADULTS ONLY)

POWER DRILL AND BITS (ADULTS ONLY)

JIGSAW

WOOD GLUE

BAR CLAMPS

1" FINISH NAILS

SANDING BLOCK

80-GRIT SANDPAPER

100-GRIT SANDPAPER

CARPENTER'S COMPASS

AWL OR CENTER PUNCH

PUTTY

2" PAINTBRUSH

PRIMER

GLOSS RED PAINT

1" WOOD SCREW

(4) 1" SWIVEL CASTERS

(2) 5" GATE HANDLES

CUT LIST

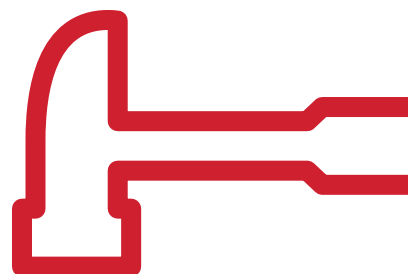
(2) $\frac{1}{2}$ $\times$ 16 $\times$ 16" PLYWOOD WIDE SIDE

(2) $\frac{1}{2}$ $\times$ 16 $\times$ 15" PLYWOOD NARROW SIDE

(1) $\frac{1}{2}$ $\times$ 16 $\times$ 16" PLYWOOD LID

(2) $\frac{1}{2}$ $\times$ 15 $\times$ 15" PLYWOOD LID BASE AND
FLOOR

(8) $\frac{1}{2}$ $\times$ 5" DIA. PLYWOOD LID DISCS

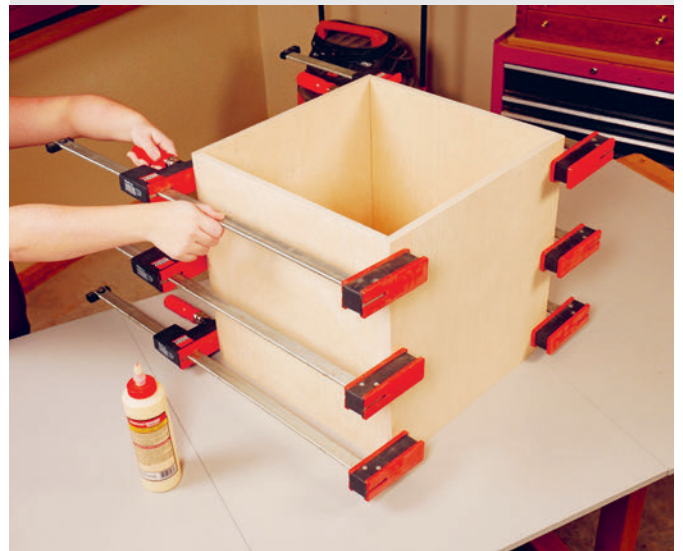


MAKE IT!



- 1** Measure, mark, and cut all the pieces for the project from a single sheet of $\frac{1}{2}$ " plywood to the dimensions listed on the cut list. You can cut the pieces with a handsaw, but it will be much quicker and easier if your parent cuts them to size with a table saw or circular saw.
- 2** Measure and mark eight 5" circles on the plywood. Drill an access hole slightly outside the cut lines and use a jigsaw to cut out the circles.

- 3** Coat the edges of the box sides and all edges of the floor with wood glue. Clamp the sides to the floor and each other. Make sure that all sides and the floor are aligned correctly. Leave until the glue has dried.
- 4** Drill pilot holes every 2" along each wall edge, and along the bottom of the walls at the floor. Nail the walls to each other and the floor using 1" finish nails.





- 5** Check that the lid base will fit inside the box. Measure and make registration marks for the 15" lid base on one face of the lid, so you can line it up again. The base must be inset exactly $\frac{1}{2}$ " all around. Glue the base in place on the lid with wood glue, then clamp it until the glue dries.
- 6** Use wood glue to join the lid discs in pairs, with one disc on top of another. Make sure each pair of discs is perfectly aligned. Clamp them until they are dry. Once they've dried, sand each disc pair well. They should be smooth, with no apparent glue squeeze-out on the sides.
- 7** Measure and mark the disc locations on the lid (opposite face from the base), with the center for each exactly $4\frac{1}{2}$ " in from each edge. Use the center marks as a base point for a compass and draw four thick, very clear circles on the lid.

- 8** Apply wood glue to one face of each disc pair and carefully set each pair in place on the lid. Clamp them down until the glue fully dries.
- 9** Turn the box upside down and place the casters in position, one in each corner 1" in from each edge. Remove them and use an awl to mark the screw locations. Mark the locations for the handles on two opposite sides of the box. Each is located 2" down from the top edge and centered, level, side to side. Mark the screw holes for the handles in the same way.
- 10** Putty over any obvious nail holes or imperfections and let it dry. Starting with 80-grit and then working down to 100-grit sandpaper, sand the box and lid all over so that it is smooth with no apparent defects. Prime the box and lid all over. When the primer is completely dry, paint the box and lid gloss red.
- 11** Use the supplied screws—unless they are longer than $\frac{1}{2}$ ", in which case replace them with $\frac{1}{2}$ " wood screws—to fasten the casters and handles in place on the box.



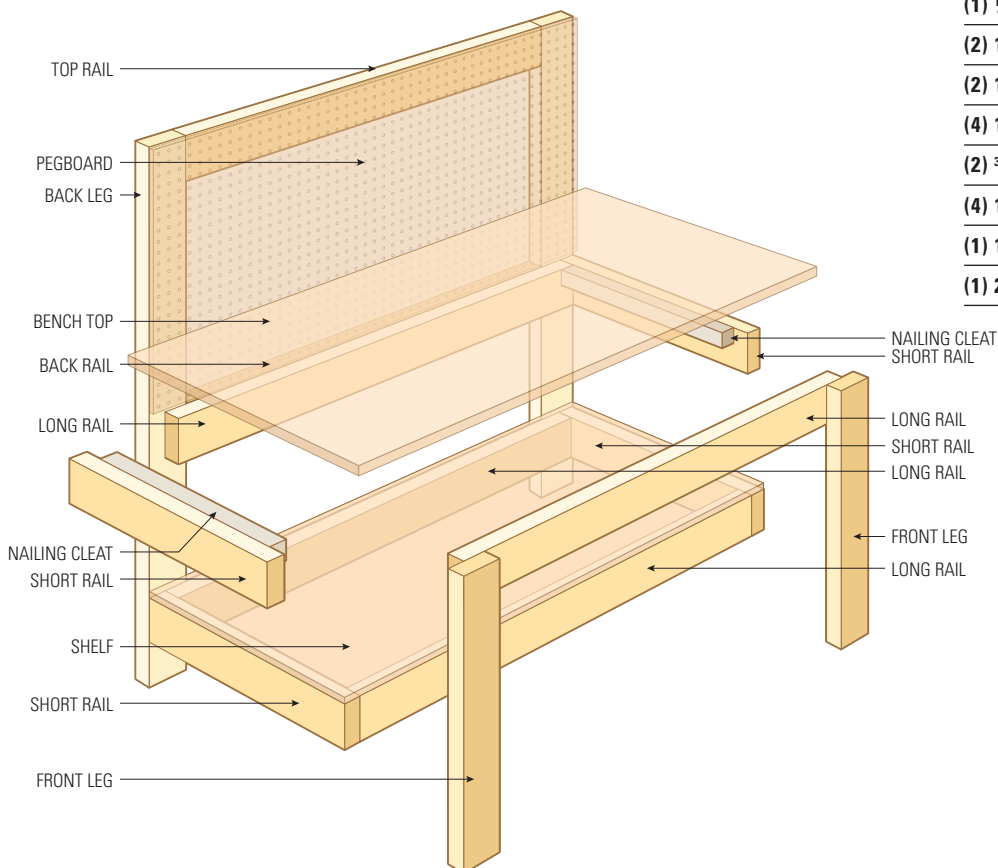
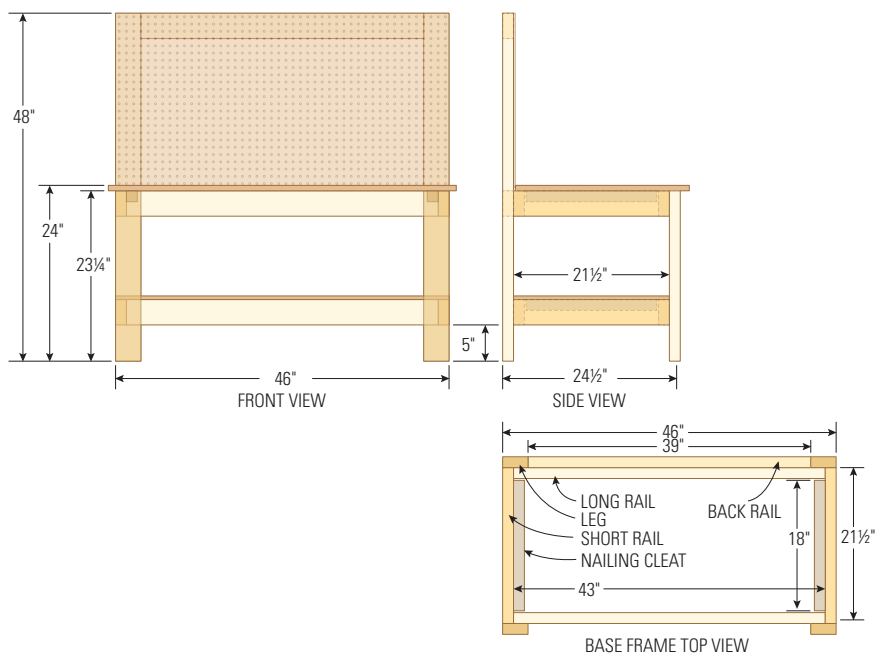
It is never too early to have your own personal work surface, where you can build all your projects. This particular design was developed to be the perfect size for younger craftspeople. It's not only an ideal size and shape for a work surface, there's a bonus pegboard rack for the tools you use most often. Hang tools right behind a workbench and they are always ready for you whenever you need them. You'll find cheap hangers for the pegboard at any hardware store or home center.

Although this may look like a big, involved project, the actual construction is fairly basic and doesn't require any advanced techniques. Be careful with your measurements. Work slowly and methodically and double-check all the dimensions. If they are off even a little, the table will not sit level and stable.

WOODWORKER'S WORKBENCH

EXPERTISE LEVEL:
Moderate





TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

(1) SHEET 3/4" MDF

(1) SHEET 1/2" MDF

2 x 4 PINE BOARDS

2 x 2 PINE BOARDS

HANDSAW, OR TABLE SAW
(ADULTS ONLY)

CLAMP

POWER DRILL AND BITS (ADULTS ONLY)

LEVEL S HOOKS

(1) SHEET PEGBOARD

2 1/2" WOOD SCREWS

(6) 2" WOOD SCREWS

(8) 1" WOOD SCREWS

(8) 1" FINISH NAILS

(8) 1" FENDER WASHERS

CUT LIST

(1) 3/4 x 24 x 48" MDF BENCH TOP

(1) 1/2 x 21 1/2 x 46" MDF SHELF

(2) 1 1/2 x 3 1/2 x 23 1/4" PINE FRONT LEGS

(2) 1 1/2 x 3 1/2 x 48" PINE BACK LEGS

(4) 1 1/2 x 3 1/2 x 21 1/2" PINE SHORT RAILS

(2) 3/4 x 3/4 x 18 1/2" PINE NAILING CLEATS

(4) 1 1/2 x 3 1/2 x 43" PINE LONG RAILS

(1) 1 1/2 x 3 1/2 x 39" UPPER BACK RAIL

(1) 24 x 46" PEGBOARD TOOL WALL

MAKE IT!

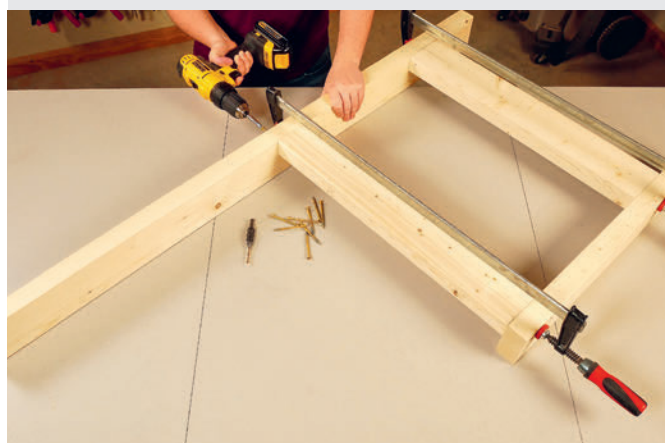


- 1** Cut all the pieces for the project to the dimensions listed on the cut list. This, and all the cuts, will be easiest to do on a table saw, so ask your parent to use one to make the cuts more quickly. Or just take your time and use a handsaw.
- 2** Measure and mark the legs for the placement of the lower rails 5" up from one end. Measure and mark 19 $\frac{3}{4}$ " up from the same end of the legs as well.



- 3** Build the leg pairs by clamping a top side rail down on its face and butting the legs up to each end. Drill pilot holes and fasten the legs to the rail with 2 $\frac{1}{2}$ " wood screws, using two per leg. Position the lower side rail with its bottom edge on the 5" mark and fasten it in the same way. Repeat the process to build the opposite leg pair.

- 4** Position a front rail across the inside faces of the front (shorter) legs. Drill pilot holes and screw the rail to the front legs from the inside. Repeat with the lower front rail, aligning it with the 5" mark, and then repeat the process for the back legs to install the back top and bottom rails.





- 5** Lay the frame on its back and position the upper rail between the top of the two back legs. Drill pilot holes and screw the legs into the ends of the rail. Use a 4' level to check that the frame sits level and doesn't wobble.
- 6** With the frame standing on a flat, level work surface, set the MDF top in place. It should be flush with the back legs and should overhang the front and sides by exactly 1". When you're sure it's correctly positioned, drill pilot holes and screw the top to the front, back, and side rails with wood screws. Use three screws on each side.

- 7** Position the lower shelf in place. It should be perfectly aligned with the rails all around. Drill pilot holes and nail the shelf to each rail, using two 1" finish nails per rail.
- 8** Position the pegboard in place on the back legs. Make sure it's aligned all around and drill two pilot holes into each leg and along the top rail. Fasten the pegboard in place with 1" wood screws and fender washers. Hang your tools with steel S hooks or specialty hangers.





Some of the most rewarding projects you'll ever craft in a woodshop are gifts for people close to you. Handmade wood projects are a special way to show how much you care. Heck, you can even give someone in your family a present out of the blue. Imagine their surprise and delight! Moms, dads, and even grandparents will flip out and appreciate something you've made with your own two hands just as much or even more than anything you might buy.

5 **GREAT GIFTS**



If one of these projects comes out really good, you can always make another for yourself. Along the way you'll learn even more cool techniques and skills and hone your woodworking expertise. Don't be afraid to put your own special touch on these gifts. Finish it in a color scheme or with a wood tone that you choose or add special details like a scroll design you make with a rotary tool.

A jewelry box is the type of gift most moms (or sisters, or grandmas) would never buy for themselves, but almost always need.

The design is simple but interesting, and the box is just big enough to hold a good collection of jewelry or other valuables. You don't have to follow the finish details in the project exactly. You might want to paint the whole thing one solid

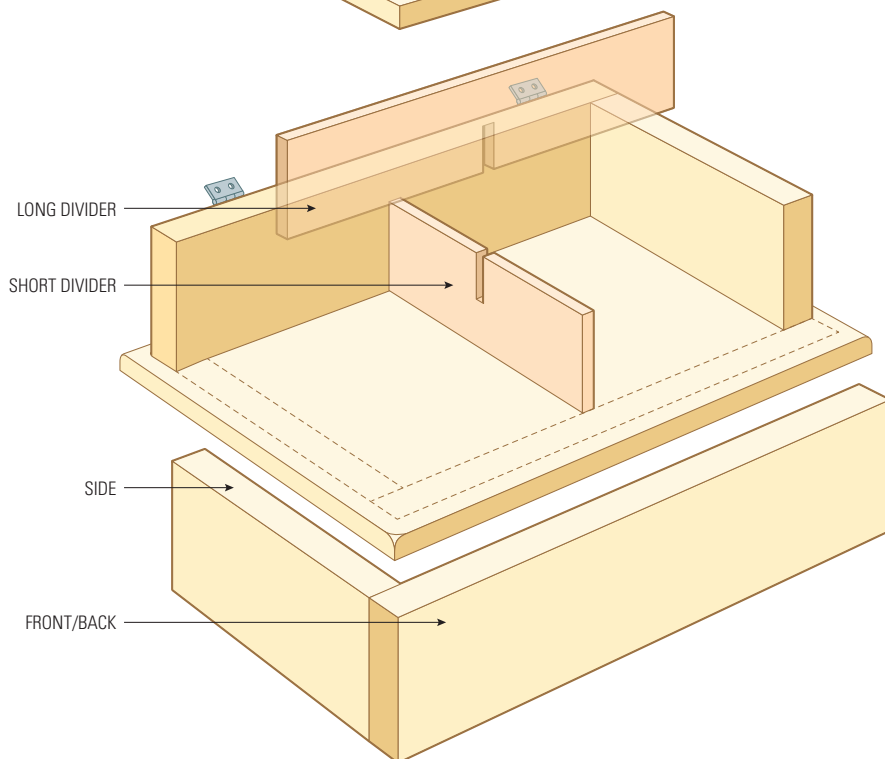
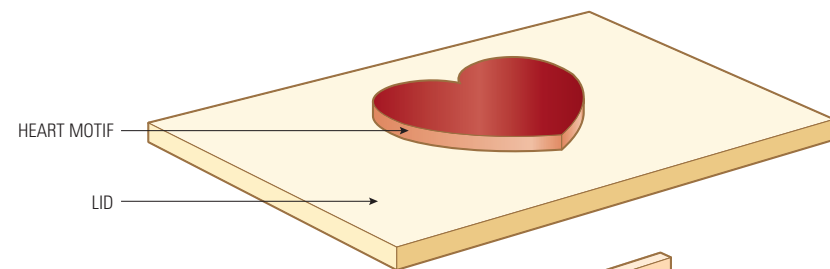
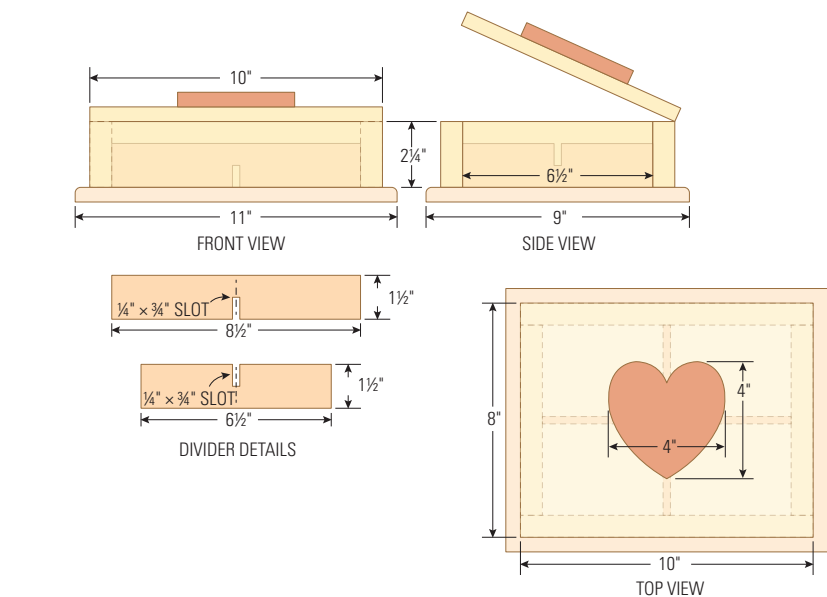
color, which is an easier way to go and can be just as pretty.

You can also vary the construction details to suit different tastes and preferences or different gift recipients. Change the shape of the balsa wood applique on the lid of the box. A heart is nice for mom, but a diamond might be better for dad.

PRECIOUS JEWELRY BOX

EXPERTISE LEVEL:
Basic





TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

1 × 4" SELECT PINE BOARD

1/2" PLYWOOD

1/2" BALSA WOOD SHEET

1/4" BALSA WOOD SHEET OR STRIPS

HANDSAW AND MITER BOX, OR MITER SAW (ADULTS ONLY) OR TABLE SAW (ADULTS ONLY)

UTILITY KNIFE OR JIGSAW

PALM SANDER OR SANDING BLOCK

120-GRIT SANDPAPER

WOOD GLUE

BAR CLAMPS

POWER DRILL AND BITS (ADULTS ONLY)

1 1/2" FINISH NAILS

NAILSET

WOOD PUTTY

100-GRIT SANDPAPER

DARK WALNUT OR EBONY STAIN-AND-POLY COMBINATION PRODUCT

1" PAINTBRUSH

WHITE GLOSS PAINT

RED MODEL PAINT

(2) 1 × 3/4" BRASS BUTT HINGES

CUT LIST

(1) 1/2 × 9 × 11" PLYWOOD BASE

(1) 1/2 × 8 × 10" PLYWOOD LID

(2) 3/4 × 2 1/2 × 10" PINE FRONT & BACK

(2) 3/4 × 2 1/2 × 6 1/2" PINE SIDES

(1) 1/4 × 4 × 4" BALSA HEART

(1) 1/4 × 1 1/2 × 8 1/2" BALSA WOOD
LONG DIVIDER

(1) 1/4 × 1 1/2 × 6 1/2" BALSA WOOD
SHORT DIVIDER

MAKE IT!



- 1** Cut the pieces for the box, base, and lid to the dimensions listed on the cut list. You can use a handsaw to cut the pieces or ask an adult to cut the pieces on a table saw or miter saw.
- 2** Download and print out the heart shape you want (or, if you're good at freehand illustration, draw one on tracing paper). The heart should be about 4" by 4" at its outside points, but the dimension doesn't have to be exact. Transfer the shape to a sheet of $\frac{1}{4}$ " plywood and cut it out with a utility knife with a new blade or a jigsaw with a fine-tooth blade. Do not use a rip cut blade. Sand the heart all around with 120-grit sandpaper, being careful not to chip or splinter the edge.
- 3** Cut out the shapes of the dividers from the $\frac{1}{4}$ " balsa wood using a utility knife fit with a new blade. Mark the exact center along one long side of each divider, then mark $\frac{3}{4}$ " up from the previous mark and draw a thick line between the two, making a **notch line**. Make a $\frac{1}{8}$ " cut along this notch line; you can use a jigsaw, making multiple cuts, or cut out the notches with the utility knife.

- 4** Have an adult put a decorative profile on the edges of the base using a router or do it yourself with a rotary tool. You can also choose to leave the base edges squared off.
- 5** Coat the ends of the frame sides with wood glue and clamp the box frame together with the two long sides overlapping the ends of the short sides. Measure diagonally both ways; the measurements should match if the frame is square. If not, adjust the frame before the glue has a chance to dry.
- 6** Once the glue has dried, drill pilot holes through the long frame sides into the ends of the short frame sides. Nail the frame together using $1\frac{1}{2}$ " finish nails, two at each joint. Use a nailset to sink the nail heads.
- 7** Carefully putty over the nail heads. Sand the frame all over, starting with 100-grit sandpaper and moving to 120-grit. Stain the frame with the ebony stain following the instructions on the can's label.



- 8** Lightly coat the edges of the base and lid with wood putty. Let it dry, and then sand the base and lid all around to eliminate any rough areas or voids. Center the heart on the lid and trace around it. Prime and paint the base and lid white, leaving the area inside the heart outline unpainted.



- 9** Set the base on top of the frame and measure carefully to ensure the overhang on all sides is $\frac{1}{2}$ ". Clamp the two together, recheck the measurements, then drill pilot holes down through the base and into each side of the frame. Nail the base to the frame with $1\frac{1}{2}$ " finish nails.



- 10** Place the lid in position on top of the box, aligned on all sides. Measure and mark for the two hinges, 2" in from each edge. Drill pilot holes and screw one leaf of each hinge to the lid's back edge and one to the frame.

- 11** Paint the heart red, leaving one face unpainted. When the paint has dried, coat the unpainted face with glue and clamp it on the lid over the outline you marked. Carefully wipe away any wet glue squeeze-out. Paint the dividers white, except for the edges. Once the paint has dried, coat all but the top edges in wood glue and slide the dividers into each other, and then into the box. Wipe away any extra glue.



There are few gift projects simpler or more satisfying than a handsome picture frame. Everyone can use a well-made picture frame, and it's ready for gifting the minute you finish it. The nice thing about this project is that you only need basic skills to complete it, but it will look like it came right out of a professional frame shop.

Make this gift even more fabulous by printing out a picture of yourself, or you and your siblings, and putting it in the frame before you wrap it. Add a frame hook on one long side to make it more versatile. That way, whomever you give the frame to can hang it vertically or horizontally, depending on the orientation of the photo they want to display.

PICTURE PERFECT FRAME

EXPERTISE LEVEL:
Basic



Wood Words

A **rabbet** is a uniform recess, like a notch, cut in the edge of any stock. Rabbits are meant to hold other elements in place (such as the glass, the picture, and the backing in this frame) or to create a shiplap joint with another wood piece with a matching rabbet.

TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

1 x 2" CEDAR BOARD

HANDSAW AND MITER BOX

TABLE SAW (ADULTS ONLY)

1/8" MASONITE

UTILITY KNIFE

WOOD GLUE

KRAFT OR WAX PAPER

BAR CLAMPS

PALM SANDER OR SANDING BLOCK

100-GRIT SANDPAPER

120-GRIT SANDPAPER

COMBINATION DARK WALNUT
STAIN-AND-POLY FINISH

FRAME HANGER

SCREWDRIVER OR HAMMER

GLAZER POINTS

GLASS CUTTER

CUT-PROOF GLOVES

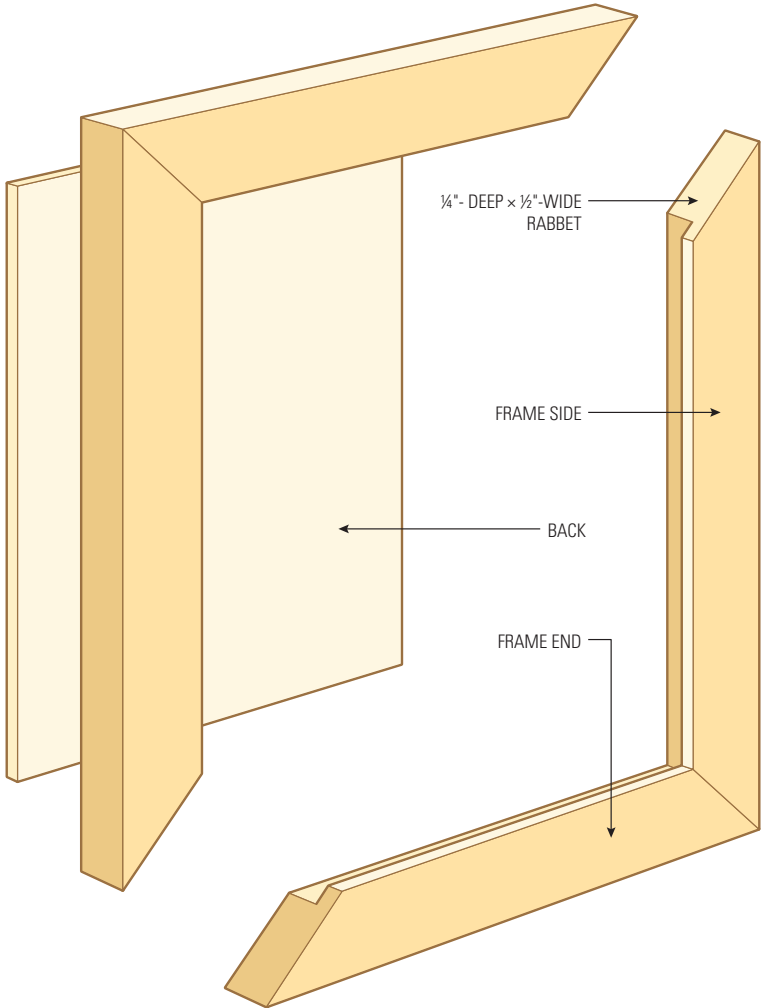
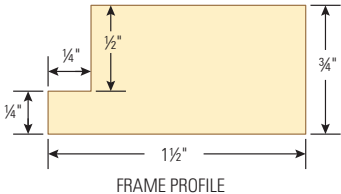
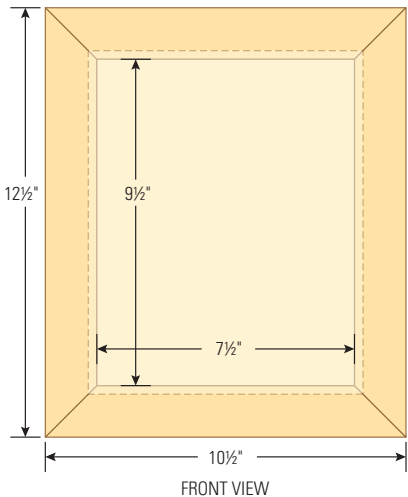
EYE PROTECTION

CUT LIST

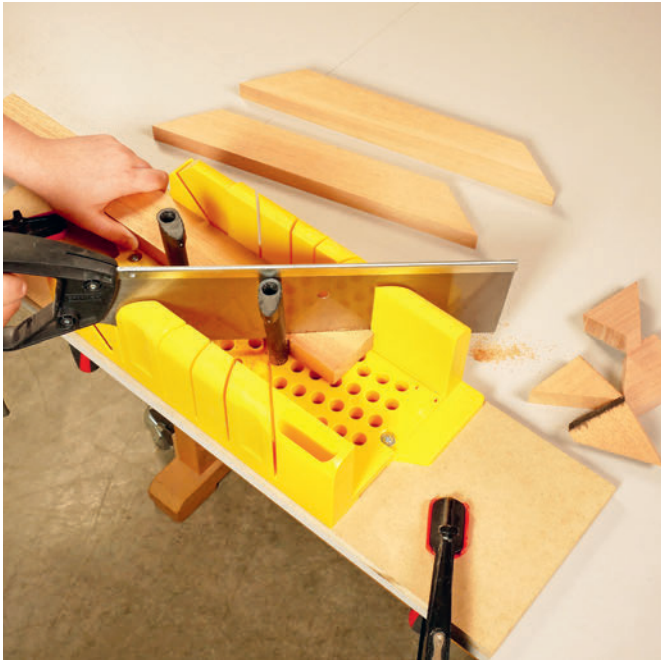
(2) 3/4 x 1 1/2 x 12 1/2" CEDAR FRAME SIDE

(2) 3/4 x 1 1/2 x 10 1/2" CEDAR FRAME END

(1) 1/8 x 8 x 10" MASONITE BACK



MAKE IT!



- 1** Cut the pieces for the frame using a handsaw. If the Masonite sheet isn't already 8 × 10", carefully measure, mark, and cut it to size with a utility knife equipped with a new blade.
- 2** Use a miter box and handsaw to cut 45° miters at each end of each frame piece. Be very careful and precise because the ends must fit together perfectly to create seamless joints.

- 3** Have an adult cut the $\frac{1}{4} \times \frac{1}{4}$ " rabbet along the edge opposite the long edge of each frame piece, using a table saw or a router with a rabbeting bit. Watch closely so that you understand how the rabbet is cut, and check the final pieces to ensure the rabbets are all smooth inside.
- 4** Dry fit the frame together and check that the glass for the frame will fit neatly in the rabbet.
- 5** Size the end grain of each miter cut by mixing five parts white wood glue with one-part water in a plastic cup. Using a plastic straw, stir the mixture to combine the two ingredients. Use a small brush or your finger to brush a thin layer of the mixture onto each miter cut. Wait for 1 to 2 minutes—just enough time for the glue mixture to soak into the end grain but not dry entirely—and proceed to the next step.





- 6** Lay a large sheet of kraft or waxed paper on a clean, flat, level work surface. Coat each miter cut with a generous layer of wood glue. Assemble the frame on the surface of the paper and use a strap clamp or bar clamps to clamp the frame together. Make sure each piece is level with the next at each joint. Wipe away any obvious glue squeeze-out.

Optional: If you find that when you assembled the frame, there was a tiny gap in a mitered joint, create a more polished look by filling the gap with a small amount of wood glue and then rubbing sawdust over the joint. Sand over the joint with fine grit sandpaper, such as 100-grit, to smooth over the gap. Let dry and finish the wood.

- 7** When the frame is completely dry, unclamp it and sand it all over. If the glass is too tight inside the rabbet, sand inside the rabbet all around until the glass fits without sticking. Stain the frame with the stain-and-poly product and let it dry. Paint one face of the Masonite back bright white.

- 8** Lay the frame upside down on a flat, clean work surface. Screw or nail a frame hanger into what will be the top of the frame; add a hanger on an adjacent edge to make the frame even more usable. Clean the glass and lay it in the frame's rabbet. If you're using a mat, lay it on the glass. Lay the picture on top, and lay the Masonite, painted side down, on top of the picture. Secure everything in place by driving glazier points into each piece of the frame, using the tip of a screwdriver.

Tech Tip

Cutting glass can be a handy skill for a woodworker. Once your skills improve and you get old enough to use a range of power tools, there's a good chance that you will want to build more elaborate projects, such as a shadow box, display cabinet, or routed picture frames. Those will require custom-size glass inserts.

You'll need a **glass cutter**, a marker, a metal straightedge, the glass, **cut-proof gloves** and eye protection, and a clean, flat work surface. Put on your gloves and eye-protection. Measure and clearly mark the cut line on the glass with the marker.

Hold the glass cutter by the handle, as you would a toothbrush, but with the tip of your index finger on the flat part of the handle right above the tines. Press firmly down on a metal straightedge held along the cut line, and, pressing firmly and evenly with the other hand, hold the cutter's **scoring wheel** tightly against the glass. (Hold the cutter at about a 35° angle to the glass.)

When scoring the glass, use one steady, continuous motion. You don't have to press down super hard, just firmly. Don't stop during the cut. **Score** in one even movement.

If you're doing it right, you'll hear a high-pitched grating sound. Afterward, there will be an obvious white score line where you scored the glass. Lay the glass along the edge of the table or work surface with the score line lined up precisely with the edge of the table. In one quick motion, snap the overhanging glass downward while pressing down on the glass on the table with the other hand. The glass should snap cleanly along the cut line.

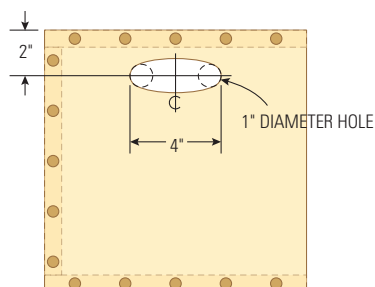
There are lots of little odds and ends that need storing in any house. That's what makes these boxes such a practical, useful gift.

These three boxes include a big cube, a small cube, and a rectangle. The pegging detail makes them even more eye-catching. Basically, you'll be cutting wood plugs to fit over all the screw holes, and those sanded down pegs end up looking like an intentional design detail. Pretty cool, right?

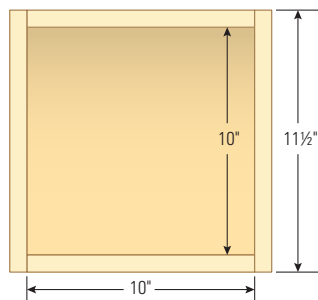
MUTATING BOOKSHELF BOXES

EXPERTISE LEVEL:
Basic

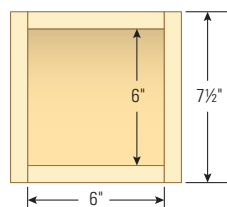




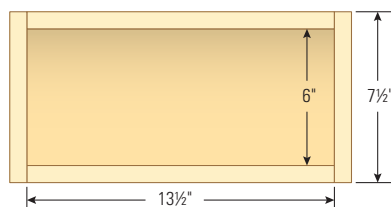
LARGE SQUARE BOX
SIDE VIEW



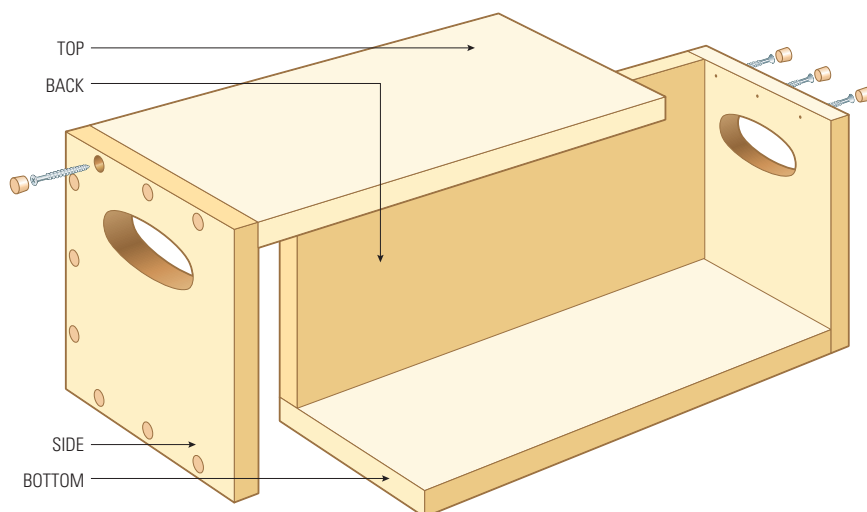
LARGE SQUARE BOX
FRONT VIEW



SMALL SQUARE BOX
FRONT VIEW



RECTANGULAR BOX
FRONT VIEW



TOOLS & MATERIALS

MEASURING TAPE

CARPENTER'S PENCIL

1 × 8" SELECT PINE BOARD

1 × 12" SELECT PINE BOARD

1/2" DOWEL

HANDSAW, OR TABLE SAW
(ADULTS ONLY)

AWL OR CENTER PUNCH

1 1/4" SPADE BIT

POWER DRILL AND BITS (ADULTS ONLY)

COPING SAW OR JIGSAW

SANDING BLOCK

60-, 80-, AND 100-GRIT SANDPAPER

WOODWORKING GLUE

BAR CLAMPS

3/8" COUNTERBORE/COUNTERSINK
WITH PILOT HOLE BIT

SPEED SQUARE OR FRAMING SQUARE

2" WOOD SCREWS

FLUSH CUT SAW

CUT LIST

LARGE SQUARE BOX

(2) 3/4 × 11 1/4 × 11 1/4" PINE SIDES

(1) 3/4 × 10 × 10" PINE BACK

(1) 3/4 × 11 1/4 × 10" PINE TOP AND BOTTOM

SMALL SQUARE BOX

(2) 3/4 × 7 1/4 × 7 1/4" PINE SIDES

(1) 3/4 × 6 × 6" PINE BACK

(1) 3/4 × 7 1/4 × 6" PINE TOP AND BOTTOM

RECTANGULAR BOX

(2) 3/4 × 7 1/4 × 7 1/4" PINE SIDES

(1) 3/4 × 6 × 13 1/2" PINE BACK

(1) 3/4 × 7 1/4 × 13 1/2" PINE TOP AND BOTTOM

MAKE IT!



1 Cut all the pieces to the dimensions listed on the cut list, using a handsaw. You should cut all the pieces at the same time but organize them carefully so that you don't cut more of one piece than you need. Label each piece that you cut with a marker, noting the side and box number (i.e., "1-Side"). Cut the dowels last, into $\frac{1}{2}$ "-long pieces.

2 Measure and mark a handle on each side by penciling a point 2" in from one end and centered side to side. Draw a line parallel to the end, with the mark at its center. Measure along the line $1\frac{1}{2}$ " on each side and make another mark. Tap each of these marks with an awl or center punch to create a starting point for the spade bit.

3 Use the $1\frac{1}{4}$ " spade bit to drill holes at the marks on each side of the center mark. Use one of these as an access hole for a jigsaw or coping saw. A coping saw will give you more control for such a tight cut-out shape. Cut out the remaining waste to create the handle opening. Repeat with the other sides (if you complete step 4 for this first handle, you can use it as a template to outline the others).

4 Sand the handle holes smooth, starting with 60-grit sandpaper and working up to 100-grit.

5 Measure and mark half the sides with lines $\frac{3}{8}$ " in from both ends and one edge above, below, and to the right of the handle. Each line should be exactly parallel to the edge. Mark the remaining sides with the same lines, but with the vertical line to the left, rather than the right, of the handle.





6 Working one box at a time, spread wood glue on the “mating” edges of the floor, top and bottom, and carefully clamp the box together. Make absolutely sure that the edges are aligned all around.

7 Create a depth gauge on the $\frac{1}{2}$ " counterbore bit by wrapping masking tape around the bit $\frac{1}{2}$ " up from the tip (or use the adjustable stop collar if the bit has one). Drill the counterbores (flat-bottomed recess holes) at each marked point. The bit should drill the $\frac{1}{8}$ " pilot hole in the middle of the counterbores. *Note: Counterboring and drilling the pilot holes will go much faster with a drill press. If your mom or dad has one, ask him or her to drill the holes for you.*

8 Once the glue has dried, screw the box together by driving 2" wood screws into the counterbored pilot holes.

9 Fill a small plastic container half full of wood glue. Working slowly and carefully, dip one end of a dowel plug into the glue. Slide the glued end into a hole. If necessary, tap it lightly with a hammer. Repeat the process with all the remaining counterbored holes, then let the glue dry completely.

11 Cut each dowel off flush to the surface of the box side using a flush trimming saw or mini hacksaw or what's known as a jab saw.

12 Sand over the dowel plugs using a sanding block with 100-grit sandpaper. Remember to always sand with the grain. Finally, sand smooth any rough areas on each box.



CONVERSIONS

Metric Conversions

To Convert:	To:	Multiply by:
Inches	Millimeters	25.4
Inches	Centimeters	2.54
Feet	Meters	0.305
Yards	Meters	0.914
Millimeters	Inches	0.039
Centimeters	Inches	0.394
Meters	Feet	3.28
Meters	Yards	1.09

Lumber Dimensions

Nominal - U.S.	Actual - U.S. (in inches)	Metric
1 × 2	¾ × 1½	19 × 38 mm
1 × 3	¾ × 2½	19 × 64 mm
1 × 4	¾ × 3½	19 × 89 mm
1 × 5	¾ × 4½	19 × 114 mm
1 × 6	¾ × 5½	19 × 140 mm
1 × 7	¾ × 6¼	19 × 159 mm
1 × 8	¾ × 7¼	19 × 184 mm
1 × 10	¾ × 9¼	19 × 235 mm
1 × 12	¾ × 11¼	19 × 286 mm
1¼ × 4	1 × 3½	25 × 89 mm
1¼ × 6	1 × 5½	25 × 140 mm
1¼ × 8	1 × 7¼	25 × 184 mm
1¼ × 10	1 × 9¼	25 × 235 mm
1¼ × 12	1 × 11¼	25 × 286 mm
1½ × 4	1¼ × 3½	32 × 89 mm
1½ × 6	1¼ × 5½	32 × 140 mm
1½ × 8	1¼ × 7¼	32 × 184 mm
1½ × 10	1¼ × 9¼	32 × 235 mm
1½ × 12	1¼ × 11¼	32 × 286 mm
2 × 4	1½ × 3½	38 × 89 mm
2 × 6	1½ × 5½	38 × 140 mm
2 × 8	1½ × 7¼	38 × 184 mm
2 × 10	1½ × 9¼	38 × 235 mm
2 × 12	1½ × 11¼	38 × 286 mm
3 × 6	2½ × 5½	64 × 140 mm
4 × 4	3½ × 3½	89 × 89 mm
4 × 6	3½ × 5½	89 × 140 mm



INDEX



A

abrasives, 43
acetic acid, 25
acetylene, 25
adhesives, 24–26
aggregates, 74
alkyd paints, 30
angles, 35
anisotropic (term), 15
asphalt, 74

B

bar clamps, 23, 38
basic skills
 about, 33
 clamping and holding, 38–41
 collecting skills, 44–47
 measuring and marking, 34–37
 sanding and finishing, 42–43
 simple jig, 40–41
belt sanders, 19
bevel cuts, 18
birdhouse project, 50–55
birds
 biology of, 54
 birdhouse project, 50–55
 feeder for, 56–59
bits, 16–17
bitumen, 74
blade waste, 35
bookshelf boxes project, 106–109
brad nails, 27
brad point bits, 17

C

catalysts, 25
catapult project, 76–81
C-clamps, 23, 38–39
chucks, 45
circles
 math of, 65
 measuring, 37
clamping and holding, 38–41
clamps, 23
clear finishes, 31
collecting skills, 44–47
combination countersink bits, 17
combination squares, 21, 34
common grade, 12
conversions, 110
crosscut saws, 13, 20

cut-proof gloves, 105
cyanoacrylate (CA) glue, 25

D

Danish oil, 31
deck screws, 29
Dremel tools, 19
drill press, 16
drills
 hand, 22
 power, 16–17
 using, 45
driving screws, 45–46
dust mask, 10

E

ear protection, 10
edges of board, 13
emulsions, 25
ends of board, 13
epoxies, 26

F

face of board, 13
fasteners, 26–29
feeder project, 56–59
finish grade, 12
finish nails, 27
finishes, 30–31, 42–43
flat head screws, 28
Forstner bits, 17
framing squares, 21

G

glass, cutting, 105
gloves, 10
glues, 24–26
grain direction, 13

H

hammers
 about, 21
 wielding, 44–45
hand drills, 22
hand tools, 20–23
hardwoods, 12
hide glue, 26
hygroscopic (term), 15

I

isotropic (term), 15

J

jewelry box project, 98–101
jigs, 39, 40–41
jigsaws, 18

K

keyed chucks, 45
kinetic energy, 80

L

lacquers, 31
live area, 35
lumber sizing, 14

M

magnetism, 46
measuring and marking, 34–37
miter cuts, 18
miter saws, 18
multi-purpose screws, 29

N

nails, 26–27, 44–45

O

orbital sanders, 19

P

paint, 30
palm sanders, 19, 42
panhead screws, 28
parking garage project, 70–75
pencil compass, 37
penny nails, 27
picture frame project, 102–105
pilot holds, 26
planes, 23
plasticizers, 25
plywood, 14
polymers, 25
polyurethane glue, 26
polyvinyl acetate (PVA) adhesives, 24
power drills, 16–17
power saws, using, 47
power tools, 16–19





primer, 30
production screws, 29
putty, wood, 42

Q

quick-release bar clamps, 38

R

random orbital sanders, 19
rip cut saw, 13, 20
ripping, 13
rotary tools, 19
routers, 19

S

sacrificial piece, 86
safety, 10–11, 31
safety glasses, 10
sanding and finishing, 42–43
sanding blocks, 19
sandpaper and sandpaper grades, 42, 43
saws
 hand, 20
 power, 47
 using, 47
scoring wheels, 105
screwdrivers, 22
screws, 26, 28–30, 45–46
select grade, 12
self-centering bits, 17
sheen, 30
simple jig, 40–41
six-point star blade slot, 28
slotted head screws, 28
softwoods, 12
spade bits, 17
speed squares, 21, 36
squares, 21
stains, 31
STEAM lessons
 on adhesives, 25
 on angle math, 35
 on bird biology, 54
 on catapults, 80
 on magnetism, 46
 on math of a circle, 65
 on sandpaper, 43
 on street science, 74
 on wood, 15
stopped hole, 87
storage box project, 88–91
stored energy, 80
street science, 74

T

tape measures, 34
Tic Tac Toe board project, 66–69
tool carrier project, 84–87
tools
 care of, 20
 hand, 20–23
 power, 16–19
 See also basic skills
Torx screws, 28
Toss Across project, 60–64
trammel, 37
twist bits, 17

V

varnishes, 31
viscoelastic (term), 74
vises, 23, 39

W

waste side, 35
wood
 grades for, 12
 grain of, 13
 plywood, 14
 size of, 14
 strength of, 15
 types of, 12
 water and, 15
 wood words, 13, 18, 35, 39, 86, 87
wood screws, 29
workbench project, 92–95
workshop
 safety in, 10–11
 setup for, 9

Z

zinc-coated screws, 30

