The PVC Pipe Book

Projects for the Home, Garden, and Homestead

CHRIS PETERSON

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INTRODUCTION

Although it may seem like a completely contemporary material, polyvinyl chloride has been around for a long, long time. In fact, the polymer actually first saw the light of day—literally—in a Frenchman's test tube, in 1838. Chemist Henri Victor Regnault was puzzled to find that a white film had formed in a test tube full of vinyl chloride gas exposed to sunlight. But it would be almost a century more before anyone made a concerted effort to find uses for the unusual material. In 1913, German inventor Friedrich Heinrich August Klatte patented the material. It would eventually make its first industrial mark as a waterproof coating for clothing.

It's fair to say that PVC pipes have revolutionized modern plumbing.

The 1960s saw expanded use of what came to be known by the acronym “PVC,” with the most rapid advancements in building trade applications. The combination of low cost, durability, light weight, ease of manipulation, and a super smooth surface made PVC pipes a wonder material for plumbing. The plastic could be molded to different thicknesses to withstand varying pressures, which only increased the number of potential applications. No rival has been found for the polymer, and PVC is now the third best-selling type of plastic in the world. It is used universally for drain-waste-vent (DWV) pipes, anywhere iron or copper is not mandated.

That widespread acceptance is due in part to the appealing combination of pure toughness and malleability that makes working with PVC pipe so easy. As the pipes and fixtures became much more common, inventive DIYers realized those same attractive qualities would make PVC pipe a wonderful choice for furniture and other non-plumbing projects. In fact, a vast grassroots movement has sprung up around finding new, innovative, and extremely practical uses for PVC pipe and fixtures.

The diversity of projects in this book represents that variety. The most common use of PVC in home craft projects is for furniture. (And, in fact, some PVC pipe is specified “furniture grade” for just that reason.) Accordingly, you’ll find sizable, substantial projects, such as the Rolling Workshop Table, something that can serve as an extra pair of hands in a workshop or other room, and could even double as a desk.

But this book goes far beyond simple furnishings. If something smaller or simpler is more to your taste or better suits your available workshop time, you can turn to the handy Firewood Rack or perhaps the Birdhouse. Or maybe you’re just in it for the fun? In that case, you’ll find a whole chapter to tickle your imagination (Chapter 5: Just for Fun!), with ingenious and enjoyable creations such as a PVC pipe flute (shown here) or an alternative to a store-bought water gun (shown here). The projects in that chapter are wonderful ways to get kids working in the workshop, learning about construction and

crafting methods, and keeping them busy with something that doesn’t involve a screen. There are lessons of all types for kids to learn in working with PVC pipe—from physics to basic math, and even self-reliance.

Regardless of what you or your children choose to build, you’ll find that all of the projects in this book will be well within your skill level (and that of many kids, with a little help). The instructions are straightforward, and the linear nature of pipes and fittings makes it hard to mess up even complex projects. Even if you’ve done little more than hang a coat hook or clean your gutters, you most likely have the baseline expertise to build many of the projects featured in this book. And don’t worry about tools—you’ll only need what’s already in any homeowner’s basic toolbox.

Ease of fabrication and assembly is just part of what makes PVC pipe and fixtures so attractive for home projects such as these. This polymer also represents a low-cost alternative to other, more traditional materials. In most cases, if you build something, such as a desk, out of PVC rather than oak members, you’ll save a considerable amount of money.

A rolling work table is just one of the many wonderful creations you can build with PVC pipe.

Of course, the lowest price is free. If you're willing to scout construction sites and do a little bit of dumpster diving, chances are that you'll find a wealth of PVC pipe scraps that can be reused in a number of ways. However, if you're looking to execute one of the larger or more involved projects in this book, you'll need a variety of sizes and shapes of pipes and fittings that will probably preclude finding everything for the project on a construction site. But whether you salvage your PVC pipe or buy new, the fact that PVC is easy to paint means never having to sacrifice good looks to functionality.

All these attractive qualities are why PVC pipe has risen to the top of the home crafter’s list of hardware-store favorites.

The range of PVC slip fittings makes creating even complex projects a simple case of basic math.

CUTTING THROUGH PLASTIC PIPE CONFUSION

Before you can start tackling projects, though, you need to understand the pipe options you'll find in the hardware store or home center aisle. There are actually several different types of plastic pipes, each with its own characteristics.

- **PVC.** PVC pipe is meant only for cold-water uses, but that doesn't matter if you're making one of the projects in this book or one of your own designs. Depending on the "schedule" (see here for an explanation of PVC pipe schedules), the pipe may be white or gray. For the purpose of crafting furniture or other DIY projects, you'll usually use Schedule 40 pipe, which is most commonly white with black markings. However, you can find suppliers (included in the Resources) of PVC pipe and fittings made specifically for project work, rather than for plumbing. These manufacturers offer colored versions in addition to white, and a few even offer clear pipe and fittings. They also sell custom fittings, such as five-way corners, that are not used in plumbing work. Keep in mind that PVC pipe and fittings are offered in both "slip" and threaded versions. Threaded versions are more difficult to work with (it's extremely hard to cut new threads if you need to trim the pipe to a custom length), which is why all the pieces in the projects that follow are slip fittings.
- **CPVC.** Chemically different from PVC (the first "C" stands for chlorine), CPVC is formulated to withstand higher temperatures than PVC and is consequently used for hot-water pipes and connections. CPVC is usually colored light yellow, distinguishing it at a glance from PVC. Although it can be used interchangeably in projects with PVC pipe and fixtures, it is not normally incorporated into non-plumbing projects because it is more expensive than PVC.
- **ABS.** Made from a plastic (acrylonitrile butadiene styrene) with similar characteristics as PVC, ABS pipe is slightly more rigid but can otherwise be used as a direct replacement in projects. The pipe is black, which usually translates to additional coats of paint if you'll be painting your creation. This material can, however, deform under prolonged exposure to strong direct sunlight.

Among these options, PVC is the best suited for non-plumbing projects because it is affordable, durable, and incredibly easy to modify. But even among PVC pipes and fittings, there are different

modify. But even among PVC pipes and fittings, there are different sizes and grades.

You can identify most types of PVC by color. Left: PVC, center: CPVC, right: ABS.

UNDERSTANDING PVC SIZES AND GRADES

PVC pipes and fittings follow the convention known as “nominal pipe size.” This is a standard set of pipe-opening measurements—which means it’s the opening that determines the stated size, not the outside diameter. You don’t have to worry about confusion, because the sizes are naturally matched between pipe and fittings. For instance, a 1-inch PVC pipe will slide into a slip-joint, 1-inch PVC elbow or tee.

PVC pipe *wall* thicknesses are rated by the term *schedules*. Generally, you’ll find two schedules of pipe at retail: 80 and 40 (other schedules, such as 120 PVC pipe, are much rarer and meant for specialized applications). Schedule 80 pipe is thicker, and meant for heavier-duty applications, where the pipe must withstand higher pressures. The outside diameters of similar Schedule 40 and 80 pipes will be the same, but because Schedule 80 pipe walls are thicker, the interior diameter will be smaller.

You can usually tell them apart at a glance; most Schedule 40 PVC pipe is bright white, and Schedule 80 pipe is usually gray. However, given that PVC pipes are increasingly being produced in a range of colors, it’s always wise to closely check the labels before buying. The projects in this book use Schedule 40 pipe because it is easier to work with.

One of the best things about these projects is that they don’t require a lot of expertise. If you can handle a saw, sandpaper, and a drill, you’ve got all the skill you need to tackle anything in this book. The one caveat is that measurements really count when working with PVC pipe. The carpenter’s rule of thumb, “measure twice, cut once,” applies here. Attention to detail is an important part of making any project as handsome and polished as possible—not to mention keeping it from wobbling or slanting in one direction or another.

Also keep in mind that any of these projects can be a jumping-off point. It’s relatively easy to modify the designs and make a given project larger or smaller to suit your own needs—especially on

projects that use paired supports, base segments, or other duplicated design elements. For instance, you might want to make the Towel Rack shown here shorter, for bathing suits, or taller, for longer beach towels. You can also use any project as inspiration to go in a completely different direction and create your own custom fabrication.

Schedule 80 pipe is easy to tell from Schedule 40, because it's gray. It's also more rigid and a little bit more difficult to work with, but that rigidity can be useful in structural, weight-bearing projects. Schedule 80 pipe is often sold in predetermined lengths threaded on each end.

1 WORKING WITH PVC PIPE

Success in any project involving PVC pipe relies on understanding the material and the best ways to modify it. Choose the right size pipe and fittings and use them in the most structurally sound fashion, and any project you build with PVC will be as solid and last as long as if it were made from metal or wood. Thankfully, choosing the right PVC pipe is a simple task.

SIZE MATTERS

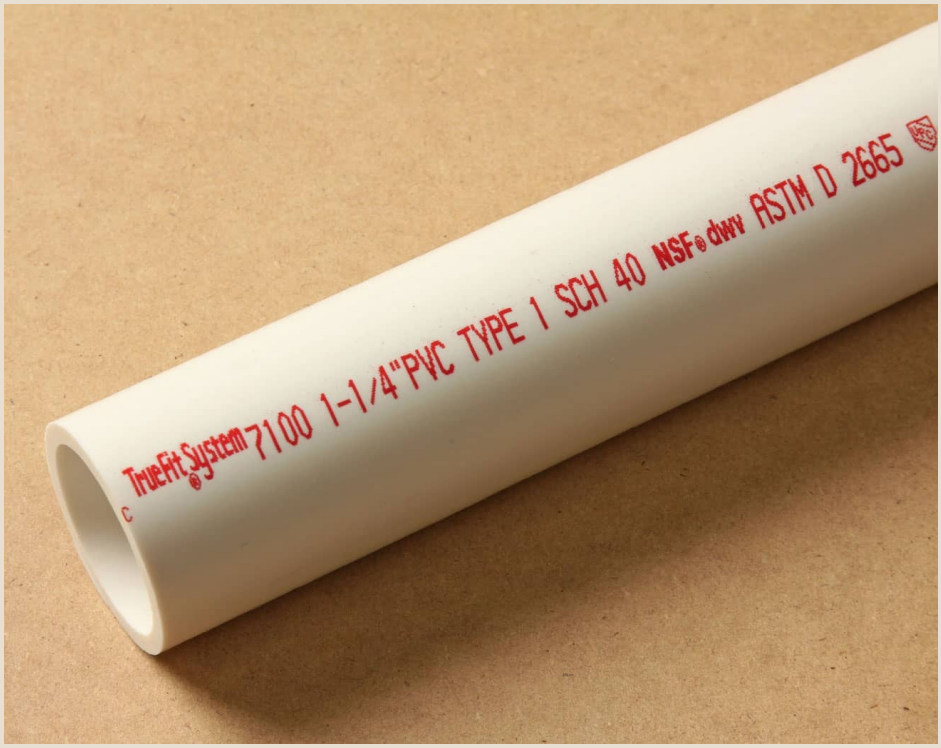
Crafting a project from PVC pipe and fittings means understanding both inside and outside dimensions of the pipe—especially if you plan on adapting a design in this book to your own needs and measurements, or if you feel like designing your own PVC pipe project.

Everything works off the "nominal size." As long as you shop for pipe and fittings that are marked the same size, they'll fit together. For instance, pick out $^1/_2$-inch pipe and you can be sure that it will fit smoothly into any $^1/_2$-inch tee, elbow, or other fitting of the same size and schedule.

However, when you're working with finished dimensions of a project, such as a Yard Caddy or Toy Bin Frame, the "outside diameter" of the pipe can be important. Outside diameter often determines the actual outside measurements of frames, or the actual height of a piece of furniture, such as a desk (where height can determine comfort). The larger the diameter of the PVC pipe, the more radical the difference between the nominal size and the outside diameter. The box opposite provides the outside diameter measurements for the common PVC pipe sizes that are used in this book.

OUTSIDE DIAMETER OF COMMON PVC PIPE SIZES

Nominal	Outside size diameter
1/2"	0.84"
3/4"	1.05"
1"	1.32"
1 1/4"	1.66"
1 1/2"	1.9"
2"	2.38"
2 1/2"	2.88"
3"	3.5"
3 1/2"	4"
4"	4.5"
5"	5.56"



The particular size of pipe used in any given project is chosen based on the rigidity of the pipe and the stresses that will be placed on it. Obviously, thicker, larger pipes are capable of withstanding greater weight and stress. That rigidity and durability need to be balanced against the fact that larger pipes are more expensive, heavier, and slightly harder to work with. For non-plumbing projects, 1-inch PVC pipe tends to fall right into the sweet spot, combining durability, availability, light weight, and ease of modification.

Pipe size is also a consideration when dealing with non-PVC fixtures and components that might be incorporated into a given project—such as the axle running through the crossbrace pipe in the Yard Caddy project. Lastly, different sizes of fittings will have different inlet depths—the length of pipe that will go into the fitting inlet when the pipe and fitting are cemented together. This is a crucial consideration if you start customizing any of these projects or decide to use a different size of pipe.

Regardless of size, all PVC pipes are either threaded (designated MNPT, NPT, or FPT) or slip fitting (Slip). All of the projects in this book, and most all projects involving PVC pipe, use slip fittings. Slip fitting is far more adaptable and forgiving to the dimensions and custom measurements of project work than threaded fittings and pipe could be. It is important to note that the “insert” depth for the same fitting from different manufacturers may be different. The measurements used in the cut lists for the projects in this book were made using fittings from large home centers or nationwide hardware chains. However, always double-check your measurements and dry fit the construction to ensure success with your own fittings.

THE PVC TOOLBOX

Although you certainly don’t need Norm Abram’s workshop at your disposal to build with PVC pipe, having a few essential tools on hand will make crafting any PVC pipe project easier, quicker, and more precise. The tools below are the basics you’ll need, including alternatives. In short, less expensive options that don’t require power

also mean you’re going to put in more effort and sacrifice a measure of precision.

hacksaw

wheel cutter

scissor cutter

file

ratcheting cutters

utility knife

CUTTING

- **Hacksaw.** Easy to use, inexpensive, and efficient, a hacksaw is often the best tool for cutting relatively soft PVC pipe. However, in cases where you have to make a lot of cuts, or where you're working with large-diameter pipe (more than 3"), a hacksaw can translate to a lot of tiring work, extra time, and added frustration. If you've decided to use a hacksaw, use a blade with 18 to 24 teeth per inch. Use a cradle, jig, vise, or guide to ensure as straight a cut as possible. For bigger projects with many cuts, consider one of the other cutting alternatives.
- **Cutters.** There are three types of cutters you can choose from for modifying PVC pipe: scissor, ratcheting, and wheel. All three are more effective the smaller the diameter of the pipe. The first two basically work like scissors and can be hard to control enough to get a perfectly even cut. Scissor types operate exactly as their name implies. Ratcheting cutters look like scissor cutters, but one jaw ratchets to cut larger diameters of pipe. A PVC wheel cutter looks and

operates exactly the same as an iron-pipe wheel cutter does. It's basically a handle and an opposing jaw, with a cutting wheel inside. The cutter is rotated around the pipe, following a marked cutline, and is cumbersome and slow to use. However, it is more exacting than scissor or ratcheting cutters, and when used with a thin cutting wheel, can produce a cut without burrs.

- **Power saws.** The best saws for making multiple PVC pipe cuts quickly and cleanly are a chop saw or power miter saw. These allow for perfect alignment on cutlines. Using a 96-tooth or finer blade will result in a cut with the fewest possible burrs. Given the ease of use, either saw can make quick work of any project involving a large number of cuts.

  Other power saw options are a tablesaw, circular saw, or jigsaw. A tablesaw can be overkill for smaller projects and, depending on the size of the section of pipe and your workshop setup, it can be unwieldy to make cuts on a tablesaw. A circular saw gives you more freedom, but any handheld saw is going to be less precise and likely to tire you out quicker in the case of multiple cuts. A jigsaw is the least desirable option, because precision is extremely difficult with the saw, and you'll be creating a lot of burrs in the process—which translates to a lot more work cleaning up pipe ends.

Power miter saw

- **File.** Not exactly a cutting tool, a basic flat file is a good option for creating start marks to hold any saw blade in place on a cutline. Any handheld saw has a propensity for “skidding” across the surface of PVC pipe as you try to start the cut. This can be frustrating, especially when cutting larger-diameter pipes. Scrape an edge of the file across the cutline and you’ll set a perfect start mark for any saw blade.
- **Utility knife.** This handy, simple workshop staple can be the fastest, most efficient way to remove burrs from the cut ends of PVC pipe. Burrs are not just an irritation; they can make for imperfect connections between pipes and fittings and can skew the final construction of any project—not to mention,

they look horrible. A utility knife equipped with a new, sharp blade can make short work of cleaning up even multiple pipe ends.

- **Sandpaper.** The alternative to a utility knife, sandpaper works slower but is easier and a better choice for minor burrs or imperfections left by an otherwise clean and straight cut. The most common grits to use are 80 and 100. Use sheet sandpaper and, for ease of use, wrap the sandpaper around a smaller pipe or dowel. You can also use the sanding attachment on a Dremel tool.

FASTENING

Connecting the various pieces of PVC plumbing in projects such as those in this book entails making sure they are secure both to one another and to any other materials included in the project. That can be a challenge, not only because it's difficult to weld PVC to a non-plastic material, but also because many projects require pipe and fittings be used in unconventional ways.

- **Pipe clamps and straps.** These are great for holding any size pipe to any type of backing material (or the material to the pipe). These come in a variety of sizes, designs, and materials from plastic, to zinc, to rubber. There are variations that will hold a pipe to a flat surface, such as a wall or board, and others meant to hold two intersecting pipes together. Clamps and straps also come in a wide variety of sizes, so you're sure to find one that suits whatever diameter pipe you're using.

Snap brackets are a handy way to hold PVC pipe in place.

- **Screws.** Although they may seem like an odd choice, screws can often be the best way to attach one pipe to another (side by side or crossed), or even to a different material, such as a wood backer board. The best screws for PVC pipe are those with the finest threads, or self-tapping versions. For projects that will be used exclusively outside, stainless steel or zinc-plated screws are ideal. In any case, keep in mind how the screws will look on the completed project—unless, of course, you're painting the entire project. It's wisest to always drill a smaller pilot hole for any screws you'll be driving into PVC pipe.

Screwing pipes to fittings is one way to assemble a PVC project. Use self-tapping screws for the best results.

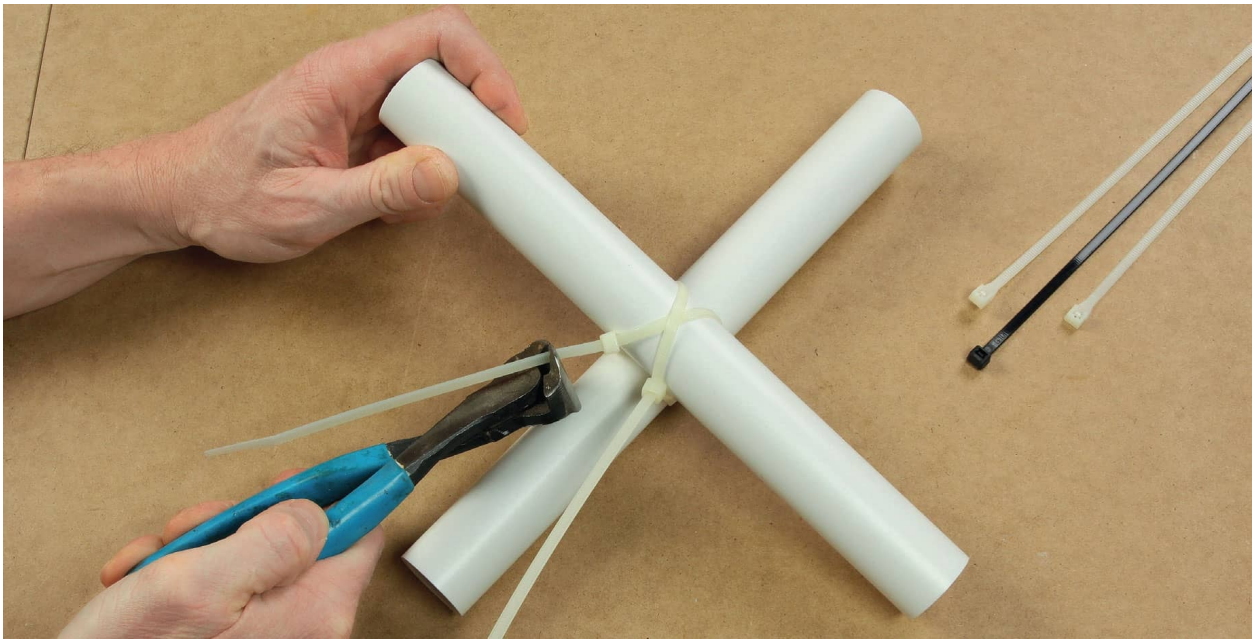
- **Cement.** The most common way to join PVC pipes and fittings is the most traditional—PVC cement. The pipe end and fitting interior are coated with a primer and then coated with the cement (although you can find 2-in-1 products that require only one application) before the two pieces are slipped together. This is perhaps the most solid connection you can make in PVC pipe projects, but it's also the most permanent. The cement actually melts the surface of the plastic so the mating surfaces are physically bonded together. Keep that firmly in mind when working with PVC cement, and be aware that it dries very

quickly; make sure you've checked the design by dry fitting everything together (and making key marks where necessary), and work on only one joint at a time.

Although you may be tempted to grab some other type of adhesive product, it's best to stick with PVC cement. Be aware that different types of plastic pipe require different types of cement. And, unfortunately, the cements come in tins that look remarkably similar. Check the label carefully to ensure that the PVC cement you're buying isn't actually meant for ABS pipe.

Newer primer-and-cement combination products speed up the process of fastening pipes to fittings.

- **Zip ties.** Zip ties can be very simple ways to fasten pipes—especially perpendicular pipes—to one another. The ties can be wrapped around the outside of pipes but are also flexible enough to be run through internal holes, so that the ties are concealed. In either case, zip ties are extremely strong and easy to use, and they are also relatively inexpensive. They come in multiple colors and a range of sizes, usually in 2-inch increments.



Zip ties are a simple tool to secure crossed PVC pipes in a project.

MARKING PVC PIPE

When using PVC pipe and fittings in projects such as the ones in this book (or just cutting PVC pipe for any purpose), you'll inevitably need to mark the pipe. Marking pipe for cuts will be necessary almost anywhere you use the material. Straight and accurate marks are essential for making squared-off cuts that ensure a secure mate in fittings. That can be a bit of a challenge given that you're trying to make a straight mark on a curved surface. See the instructions shown here for marking a cutline, for a quick and easy way to make perfect cut marks every time.

But there are even more important marks you'll need to make to construct three-dimensional projects such as furniture. Those are the "key" marks that align fittings and pipes so that you can dry fit and then disassemble pieces to be cemented together. Key marks are crucially important when constructing projects with surfaces that intersect and will be kept square to one another, such as perpendicular parts of a frame.

Markers are a good tool to make key marks on PVC pipe, and marker writing (as well as the manufacturer's information on many

types of PVC pipe) can be removed with acetone or even most fingernail polish removers. However, if you’re concerned about a mark on a pre-painted or clean PVC piece in your project, you can use a grease pencil as an even-easier-to-remove option.

HOW TO MARK PVC PIPE FOR CUTTING

Marking a round pipe for a straight cut can be a challenge. Here's a shortcut for doing it cleanly every time.

WHAT YOU'LL NEED

Strip of stiff cardboard
PVC pipe
Tape measure
Masking tape (optional)
Grease pencil or non-permanent marker

1 Cut a strip of stiff cardboard from a box (the cardboard should be flexible enough to bend into a circle without crimping). The strip should be significantly longer than the diameter of the pipe you're cutting. Make sure that at least one edge of the cardboard is perfectly straight.

2 Wrap the cardboard around the pipe, lining up the straight edge with the cut mark you've measured. Overlap the cardboard as much as necessary to make a tight fit. *Note: If you find it difficult to hold the cardboard in place and make the mark at the same time, you can always secure the cardboard in place with masking tape.*

3 Use a marker or grease pencil to extend the cut mark all the way around the pipe. Make sure the mark is clearly visible, and then remove the cardboard. Make the cut with a saw, following the cut mark.

CUTTING PVC PIPE

Cutting PVC pipe is necessary for every project in this book. The process of cutting PVC pipe is much easier if you've secured it in place; simply holding it while cutting can lead to irregular ends, ragged cuts, and lots of burrs. There are several ways to hold the pipe in place for cutting. Using a helper can be a quick solution, but helpers can be hard to come by and even a helper sometimes lets the pipe slip when the cutting begins. Fortunately, there are extremely easy options. You don't need technical expertise, but patience and attention to detail will make for certain success.

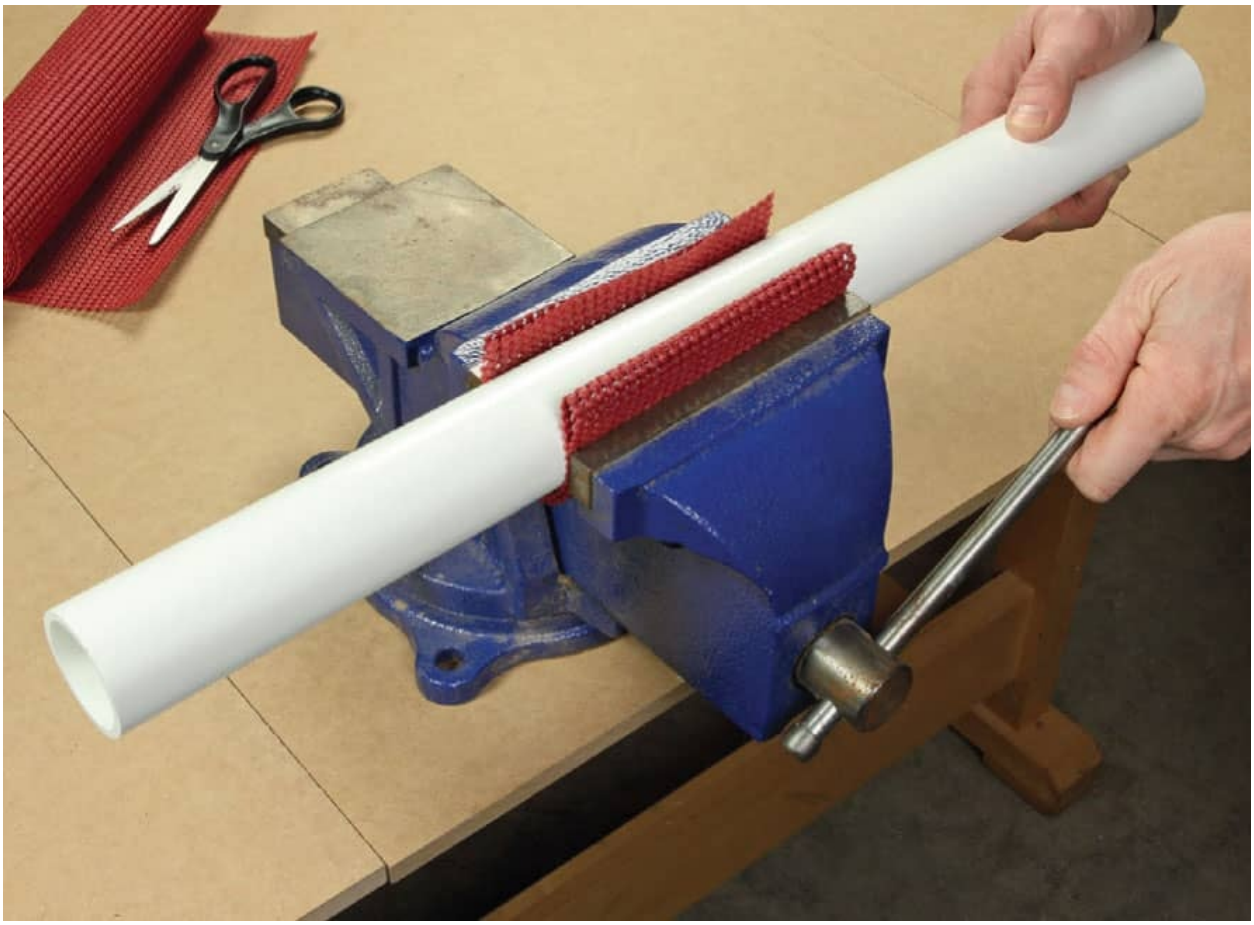
The first step is always to measure and mark *all* the cuts in the project before you ever pick up a saw. This allows you to check identical members side by side and detect any mistakes at a glance before you make them permanent. However, a quick slash mark is not good enough; for the best accuracy and cleanest look in the finished project, you should mark any cuts all the way around the pipe.

The actual process of making the cuts begins with properly securing the pipe. It can be tempting to make multiple cuts in a hurry if you haven't allotted enough time for the project. But making unsecured cuts with whatever saw happens to be on hand is a recipe for inexact cuts that lead to poor fits with the fittings in the final project. It's also a safety issue.

- **Clamps.** All you need is a couple bar clamps and a level work table to take advantage of one of the simplest and most effective ways to hold a PVC pipe for cutting. Position the pipe along one edge, and use two bar clamps to hold the pipe securely to the surface of the table, with the waste section and cut mark extending out over the edge of the table. Be careful when tightening the clamps, because they have to be just tight enough to ensure the pipe doesn't move as you cut it, but not so tight that they deform or crack the pipe.

Bar clamps are an effective way to hold PVC pipe in place for drilling or cutting.

- **Vise.** A bench-top vise can be a handy way to hold and cut shorter lengths of pipe. But, as with bar clamps, you have to be careful when tightening the vise. You should pad the jaws to prevent scarring the pipe surface, and avoid overtightening, which could easily crush the pipe. Also, the positioning of most vises means that you'll have to jury-rig a way to support longer lengths of pipe.



A vise is often the best solution for securing smaller pieces during fabrication.

- **Cradles.** These are homemade solutions that can be customized to accommodate the sizes of pipe you work with most often. Cradles can be as simple as a pair of × legs joined in the center (like a sawbuck for cutting firewood), a special work table fixture, or even a modified 5-gallon bucket (see "A Cheap PVC Cutting Cradle"). The idea is the same: hold the pipe securely in two places, so you can prevent the pipe from turning as you cut it.

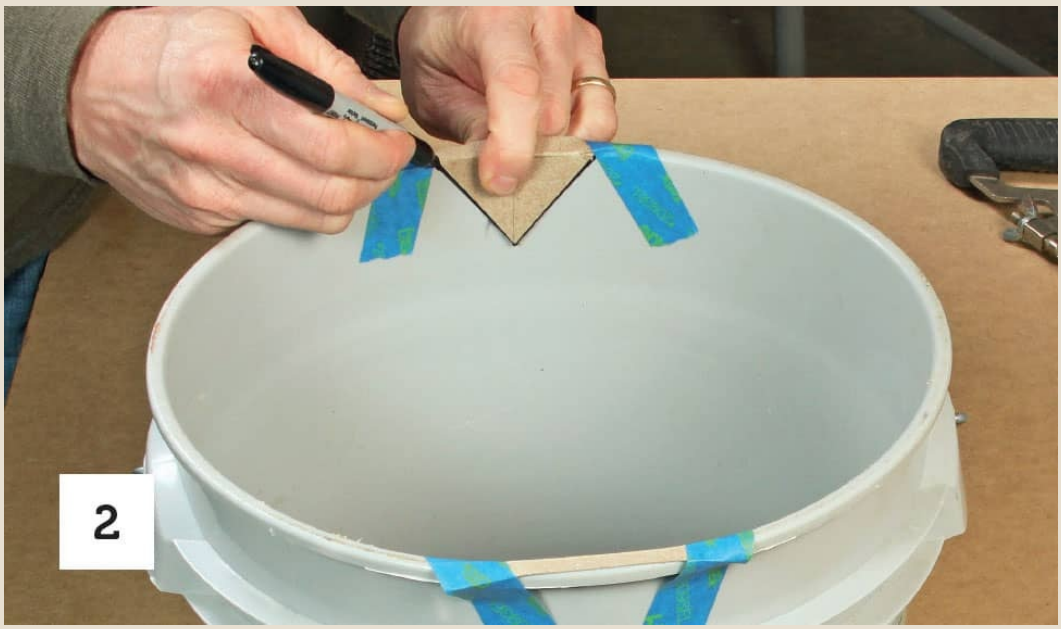
A CHEAP PVC CUTTING CRADLE

If you don't have a fully equipped workshop or garage, space is limited, or your toolbox is a little lean, you may have to improvise your cutting process to adapt to the circumstances. Don't fret; necessity is the mother of invention, and here's a great invention for hand-cutting PVC pipe quickly, easily, and efficiently. As a bonus, it's incredibly portable and can even be used to carry small tools or scrap pieces of pipe.

WHAT YOU'LL NEED

Carpenter's square
Marker
Thin cardboard
5-gallon bucket
Tape
1 piece of PVC pipe, slightly longer than the diameter of your bucket
Jigsaw

1 Use a carpenter's square and marker to draw a 90° isosceles triangle with a 5" base on a piece of thin cardboard or thick kraft paper. Cut out the triangle.



2 Lay a PVC pipe across the center of a 5-gallon bucket. Mark where the pipe contacts the lip of the bucket on both sides. Use one of the marks to position the cardboard triangle upside down, with the base aligned with the lip of the bucket and centered on the mark. Tape the cardboard

with the base aligned with the lip of the bucket and centered on the mark. Tape the cardboard flat against the side of the bucket and then score down each side (or mark with a marker) of the cardboard.

3 Move the cardboard template to the opposite side of the bucket and mark that side in the same way. Cut out both Vs with a jigsaw. The slots should accommodate most sizes of pipes you're likely to use.

CONSTRUCTING THE PROJECTS

There are some very simple ways to avoid unnecessary frustration when working on PVC projects. Start with the cut list. Carefully measure, cut, and deburr the individual pipe sections and compare like sections to each other to ensure they are exactly the same length. Organize all the pieces once they are cut. Always work on a clean, flat, level work surface that leaves you plenty of room to stage the project.

Next, you'll want to dry fit the pieces together. Using slip-fit fittings and pipe makes this a cinch and a great way to test that the design is exactly as you want it. It is also how you ensure pieces are oriented together correctly. For instance, for a PVC pipe shelf support, you would want the elbows at each corner and the pipes to all sit perfectly flat, or the shelf will never sit level and solid. That's another wonderful thing about dry fitting—it's easy to make adjustments.

Once you have all the pieces adjusted and working together, make "key" marks on the pipes and fittings. These can be as simple as thin lines that run from the pipe end onto the fitting inlet. Just keep in mind that they have to be as visible as possible to make lining them up during final assembly as straightforward as possible. This is essential to avoid waste, because once you cement PVC pieces together, it's virtually impossible to separate them without cutting them apart. And once you do that, the fittings are unusable.

CEMENTING PVC SECTIONS

When you're ready to start final assembly of a PVC project, you'll be using PVC cement. The process by which the cement joins two pieces of PVC is called "fusion welding," because it chemically melts and rebonds the plastic surfaces together as one, so that they are actually fused together. That's good news and bad. On the bright side, you can't have a much more secure connection for your projects. On the other hand, you don't get a second chance, so mistakes are a start-all-over proposition.

over proposition.

The process for joining PVC pieces with cement is simple, but the surfaces must be absolutely clean. Simply use the dauber that comes attached to the can's lid to coat the end of the pipe and let the pieces sit for the time recommended on the can. Newer one-step primer-and-cement products are increasingly being used in place of the tried-and-true blue primer and topcoat of clear cement. Hold the cup pieces together without moving for 30 seconds (allow the connection several minutes to fully cure before you put any stress on it).

The process of cementing PVC pieces together is simple, quick, and permanent.

PAINTING AND DECORATING PVC PIPE

Bright white Schedule 40 PVC pipe can be quite attractive and a clean look for most projects. You can sand off the markings quite easily, and if you rough up the entire surface, it will look uniform and plainly handsome. Wiping the marks off with acetone is another option. However, you can also put your own signature on anything you build with PVC pipe by painting it in a color to match your interior or just your own tastes. The slippery-smooth nature of PVC's surface, however, makes most conventional paints poor choices for coating the material. Any paint meant for wood, concrete, or general use will likely peel or scratch off the surface in short order. That's why you should always opt for a paint meant specifically for plastics, such as Krylon or Rust-Oleum products.

Want a unique look for one of your projects? Try striping the pipe sections by taping off stripes and painting the exposed pipe. Or wind painter's tape around the length of pipe sections to create a candy cane stripe.

Create a wonderfully dynamic look by mixing and matching colors. For instance, you can paint the fittings one hue and the pipes another to create a contrasting or complementary scheme that will really draw the eye. This is a great way, in particular, to liven up children's projects and toys, such as those in Chapter 5. You can even stencil a pattern onto the pipe by cutting shapes out of duct tape and taping over the pipe and fittings before spray-painting the entire project.

HOW TO PAINT PVC PIPE

You can prep and paint PVC pipe and fittings unassembled or assembled. However, it's often wiser to wait until the project is assembled because you can't cement a painted PVC surface. If you decide to paint the pieces separately, block fitting inlets with rags, crumpled newspaper, or painter's tape and plastic, and mask off the ends of pipe sections that will slide into inlets.

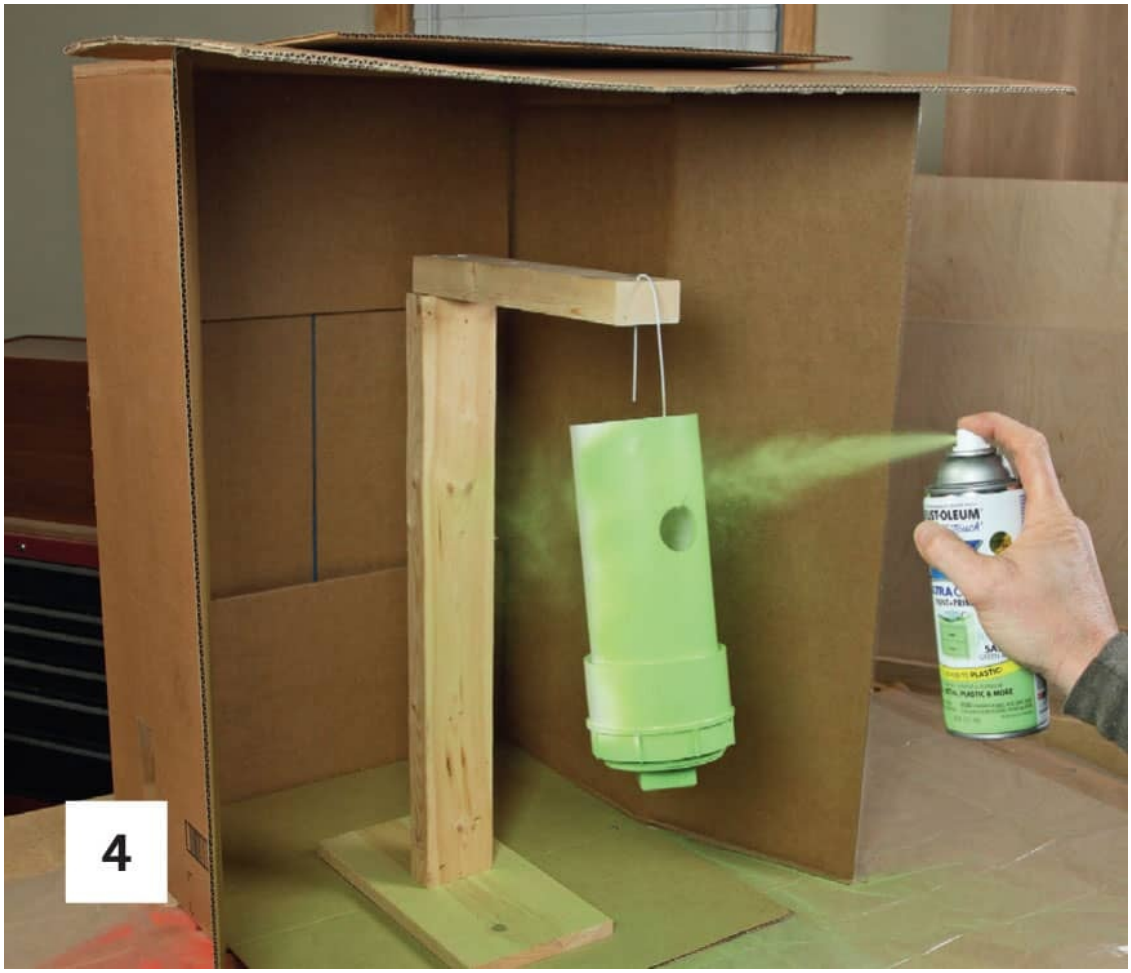
WHAT YOU'LL NEED

- Window cleaner
- Dust mask
- 100-grit sandpaper
- Tack cloth
- Homemade stand or customized support system
- Cardboard for painting backdrop
- Latex gloves
- Spray primer meant for plastic
- Spray paint meant for plastic

1 Clean the pipe's surface with window cleaner. It should be free of any grease, dirt, or debris.

2 Wearing a dust mask, sand the surface of the pipe and fixtures, making sure to rough up all sides and areas of the plastic. The entire surface should be matte after you're finished.

3 Clean the PVC with a tack cloth to remove all sanding dust. Use a homemade stand or customized wire hangers to support the PVC pipe or structure. Create a spray area with a backdrop of cardboard or similar material to prevent overspray from migrating onto adjacent areas.



4 Wearing latex gloves, prime the PVC with a light coat of spray primer. Spray on the top coat sparingly—it's better to spray on two coats than to apply the first coat too heavily. Let the PVC dry completely, according to the recommendations on the can, before working with it.

THE COLOR ALTERNATIVE: WOOD TONING

There’s nothing like a really cool illusion to spruce up one of your PVC projects. This technique helps you make the material look convincingly like wood and can be used on both fittings and pipe. The vast number of stains available means that you can make the plastic look like just about any wood, and any shade from blonde to ebony.

WHAT YOU’LL NEED

Dust mask
60-grit sandpaper
Flat file (optional)
Tack cloth
Window cleaner
Clean, lint-free rag
Latex gloves
Wood stain (not a stain-and-poly mix)

1 Wearing a dust mask, sand the PVC with 60-grit sandpaper, removing any markings. Deeply gouge the pipe in places with a corner of the sandpaper, or use a file to create long gouges.

2 Use a tack cloth to remove all the dust, and then clean the PVC with window cleaner and a lint-free rag.

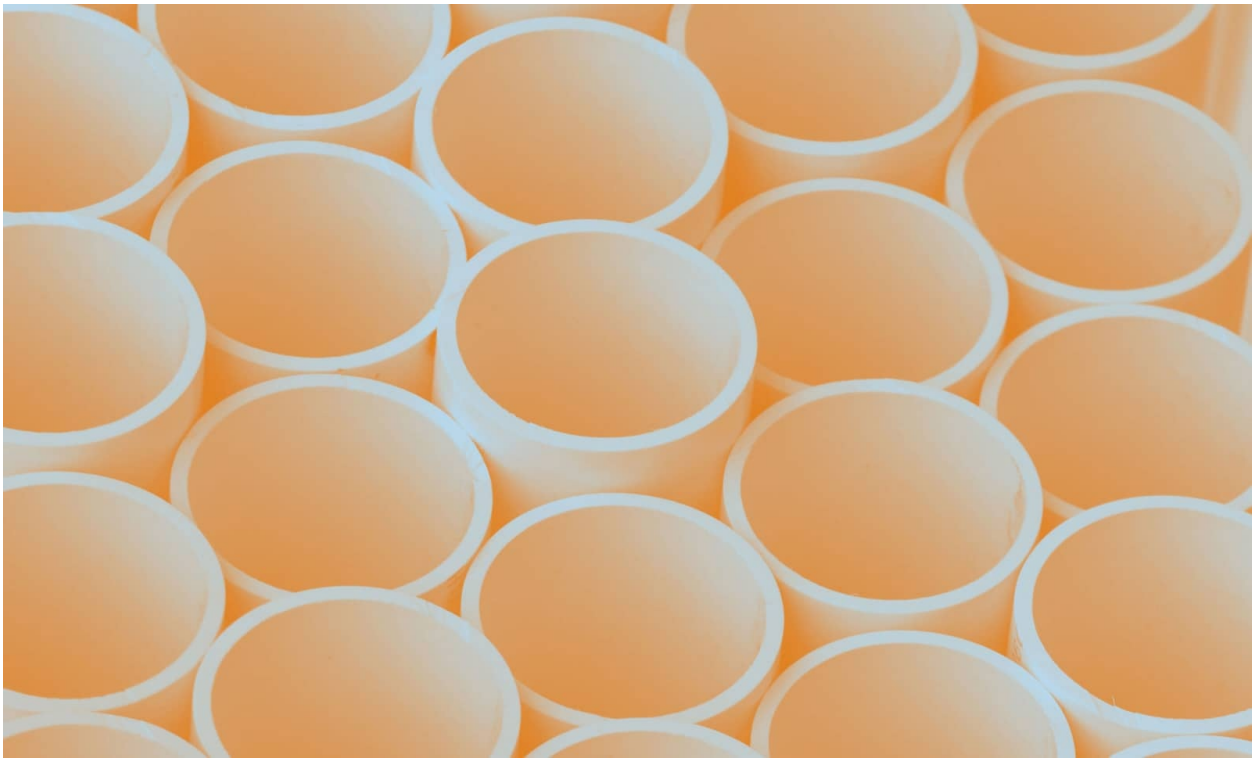
3 Wearing latex gloves, smear the wood stain across the scarred surface of the PVC. Use your judgment and apply more or less to certain areas to create a graining pattern. Once the look is convincingly woodlike, allow the stain to dry completely before using the pipe or project.

2 STORAGE AND ORGANIZATION

If you're going to put everything in its place, you first have to have a place for everything. That's a challenge even in organized households, because needs regularly change and evolve as you accumulate more stuff, and some things just aren't easily stored in a plain cupboard, closet, or shelf.

Because general cabinets and shelving units are inexpensive and widely available, the projects in this chapter focus more on specialized storage for things that have a hard time finding a home in the, well, home. We've also included storage that can easily be moved so that it can do double duty—for instance, a yard caddy can be used to store cans of paint when it's not ferrying bags of topsoil and plants from the car to one bed or another in the yard.

A few of these, such as the Rolling Workshop Table and the Yard Caddy, are complex. But don't be put off by the number of pieces or the number of steps. Even the most involved PVC pipe projects are simple affairs once you get into building them. And these two projects reward the effort with versatility. They can be used to hold a great number of useful items and can be moved to wherever they're needed.



Rolling Workshop Table

Mini Bookshelf

Quick 3

- *Wine Rack*
- *Glass Holder*
- *Long-Handled Tool Holder*

Wall-Mount Bike Rack

Yard Caddy

Fishing Pole Holder

Standing Bike Rack

ROLLING WORKSHOP TABLE

You're not going to come across a more useful piece of workshop furniture than this handy, sturdy table. It's so useful, in fact, that it actually serves three roles: a work-surface table with room to tackle projects and write up plans; a workshop helper that essentially functions as an extra pair of hands when you need them most; and storage for small items that tend to get lost in the busy environment of a workshop.

As a bonus, the table can easily be used indoors or out, making it a great companion for outdoor projects. (However, if you're planning on using the table outside for extended periods of time or over rough terrain, consider finishing the plywood top and upgrading to beefier castors.) The table is intentionally sized for maximum usability. The top is spacious enough to accommodate most workshop tasks you might need to do, and it's sized so that you'll be able to easily reach into the center of the table from any side. An optional shelf underneath can add a lot of usable space as well. You can even modify the shelf to suit your particular storage needs. For instance, screw one or more wood boxes to the shelf to collect odds and ends that don't have a home anywhere else.

As with many projects in the book, this one can also be customized to make it more useful for a particular home craftsperson. It's an easy adjustment to make the table shorter or taller to accommodate petite or tall users. You can even change the dimensions if you need more work space or want to fit the table into a tight corner of the workshop. However, any changes to the dimensions need to be worked out on paper and double-checked before assembly to ensure the math is right.

You'll find other useful modifications shown here, or just build it as specified and enjoy your handy new work surface and "third hand" helper.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw, tablesaw, or hacksaw
80-grit sandpaper
Marker

Hammer

Power drill and bits

Eye and ear protection

Work gloves

MATERIALS

32' × $1\frac{1}{2}$" pipe

(4) $1\frac{1}{2}$" three-way elbows (6) $1\frac{1}{2}$" tee

(4) $1\frac{1}{2}$" cap

(3) 2" bed caster (or similar) with socket

2" locking bed caster (or similar) with socket

PVC cement

8 × 4' sheet $\frac{1}{4}$" plywood

(4) 1" self-tapping screws

CUT LIST

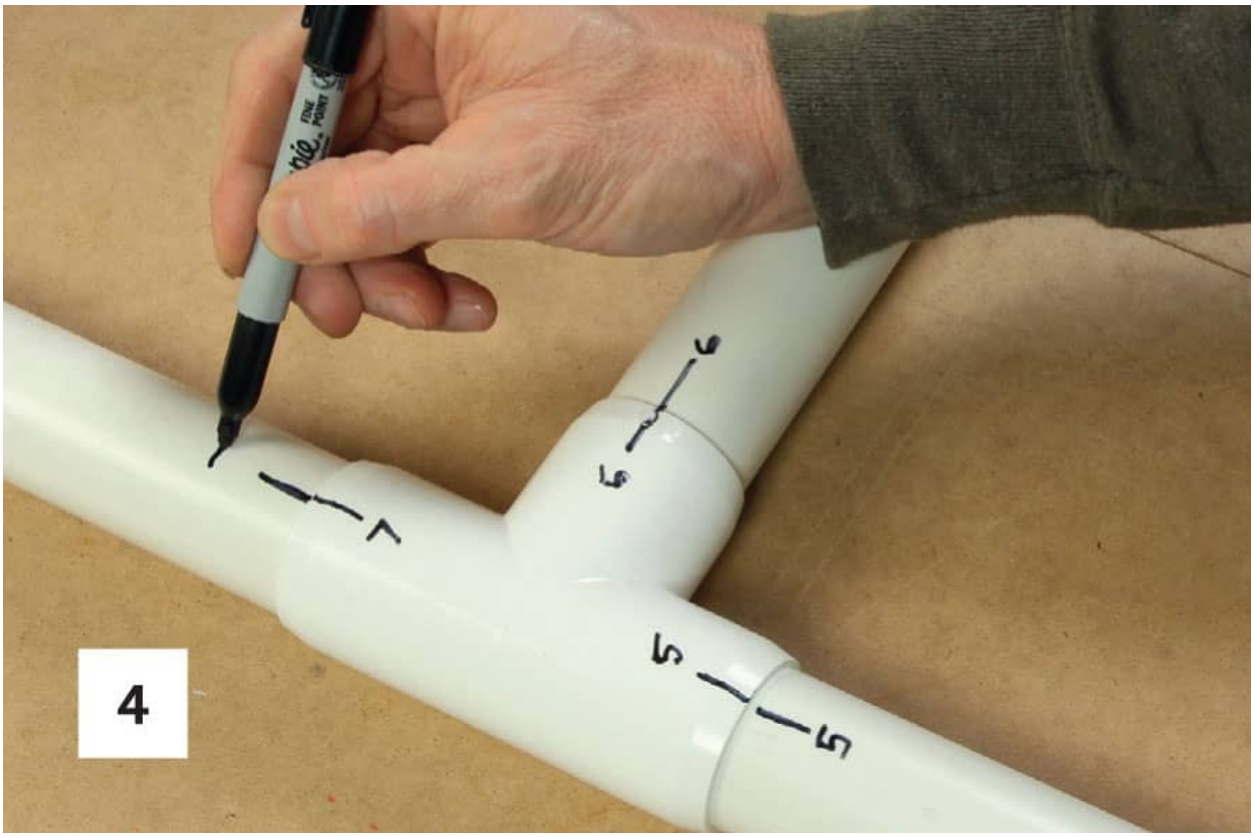
(2) $13\frac{7}{8}$" upper back legs (2) $8\frac{1}{2}$" back leg middles (4) $2\frac{3}{4}$" bottom leg sections (2) $24\frac{3}{8}$" upper front legs (3) $39\frac{1}{4}$" upper and lower crossbraces (front and back) (4) $33\frac{1}{4}$" upper and lower crossbraces (sides)

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. If you don't own a chop saw or a tablesaw, the segments can be cut with a hacksaw. Use sandpaper to smooth the cut edges before assembling the legs or table (the edges don't need to be perfectly smooth—just ensure all burrs are removed).

2 Lay out the back legs, starting from the top down: three-way elbow, 13 $^{7}/_{8}$" upper back leg, 8 $^{1}/_{2}$" back leg middle, and 2 $^{3}/_{4}$" bottom leg section, all separated by tees. (The middle tee points in the same direction as one inlet of the elbow, and the bottom tee points in the direction of the second elbow inlet.) Lay out the two-piece front legs in the same way but with no midsection or middle tee. Each leg should be fit with a cap on the bottom. Dry fit all the pieces together to ensure the proper fit.

3 Connect the legs together with the crossbraces—39 1/4" upper and lower crossbraces between the back legs and front legs, and 33 1/4" upper and lower crossbraces on the sides, between the front and back legs. Ensure all the tees are pointing in the correct directions. Stand the frame upright. Measure the diagonals to check that the structure is square.

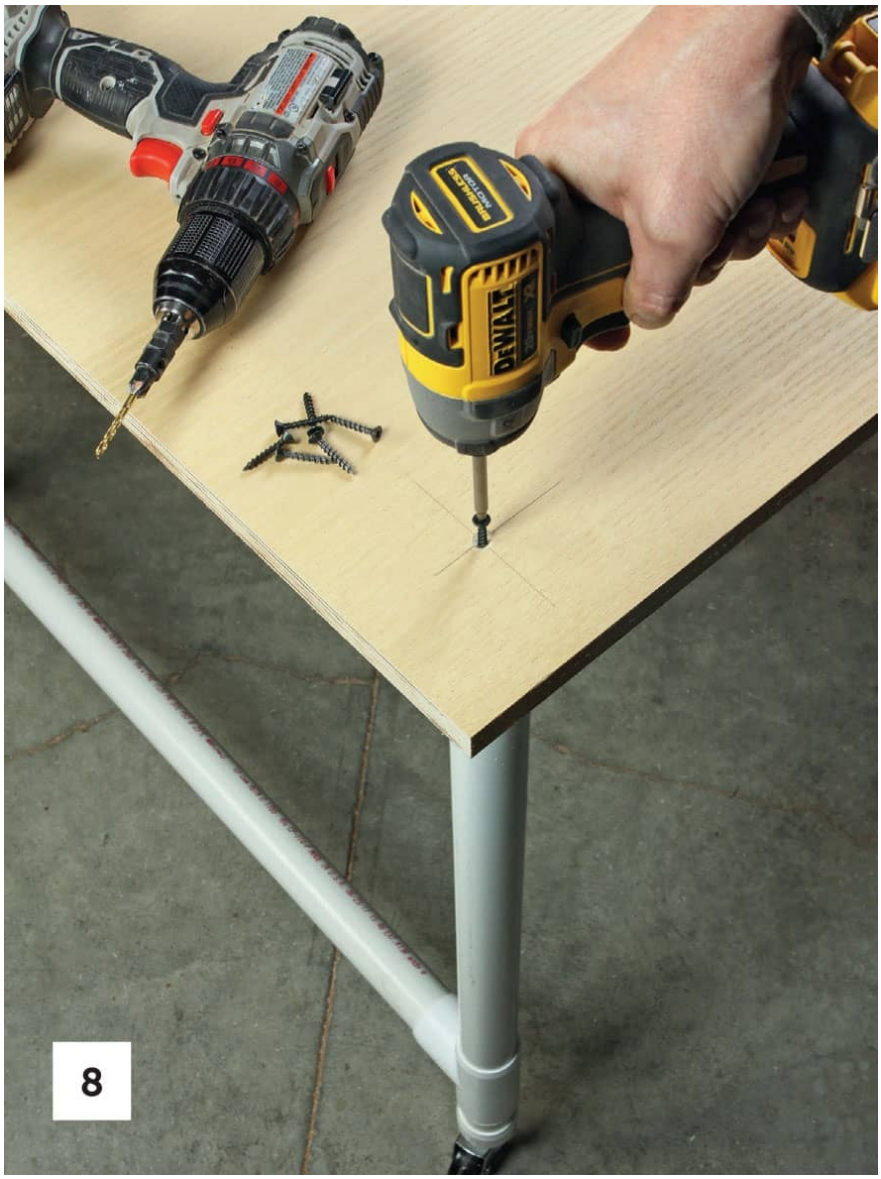


4 Lightly mark the fittings and pipes with numbered key marks to ensure correct alignment when you cement and reassemble the structure. Use a grease pencil or marker unless you're planning on painting the finished table.

5 Disassemble the sections of the table one at a time. Prime one end of a pipe and the companion fitting, and then apply the cement. Slip the pipe into the fitting and twist back and forth, aligning it with the key mark. Hold it in place for about 15 seconds.

6 Once set, continue assembling the pieces, working on the legs first and then connecting the legs with the crossbraces. Check plumb and diagonal measurements as you work to ensure that you're constructing the frame square. Cement the end caps on the legs, and drill holes in the caps to accommodate the sleeve diameters for the casters you've purchased. With the hammer, tap the sleeves into the holes and install the casters.

7 Cut and rip the plywood sheet to 40" × 48". Set it on top of the frame so that it is centered side to side and front to back (there should be a 2" overhang all around). Carefully measure and mark for the screw holes in the top of the plywood, which should be centered over the elbows at each corner.



8 Drill small pilot holes down into the elbows. Screw the plywood top to the elbows with 1" flathead self-tapping screws. Check that the top is securely attached to the frame.

Optional: Prime and paint the top and frame in a color you prefer (paint the frame before you attach the top, if you want to finish the top natural or stained). If you want extra storage, cut a 20" × 48" shelf from the remaining plywood sheet and set the shelf in place across the lower crossbraces.

MODIFICATIONS

The rolling table in this project is awfully useful on its own, but you can make it even more so with the following changes: • **Small-fastener organizers.** Nail the lids of empty, clean baby food jars in a row along the underside of the table's front edge. Then fill the jars with the screws, nuts, and other fasteners you use most frequently, and screw the jars onto the upside-down lids. The hardware will be easy to get to and always organized, and this ingenious solution will save you the money of a store-bought organizer.

- **Shelf organizers.** Customize the lower shelf on this rolling table to hold your tools and materials, whether you plan on using it as a crafts center or as a painting-project staging platform. First, decide what you want to store, such as brushes, screwdrivers, markers, or other odds and ends. Pick a PVC pipe size that suits those things, then cut one end on a 30 to 45° angle. Cut the pipe to the length that will allow whatever you're storing to project up far enough to be grabbed as needed, and then cement a cap on the opposite end of the pipe. Sand the cut end perfectly smooth. Lastly, screw the cap end down to the shelf (or even to the top of the table). This will keep regularly used materials and tools in the line of sight and right at hand.

MINI BOOKSHELF

Never underestimate the utility of a small, portable shelf. This prototypical example is lightweight yet strong, perfectly sized for a child's collection of favorite bedtime books, a series of murder mysteries, or even a collection of DVDs or CDs.

This shelf is wonderfully uncomplicated to build. It is also scalable. You can make it longer with very little thought and few calculations. Want to store larger-format books? Extend the arms out another few inches and mission accomplished. Of course, you can also build several of these to be placed side by side, creating a longer storage structure.

Although this was designed to sit on a flat surface, you could easily attach it to a wall with the help of a few pipe straps. In any case, a small project like this is incredibly easy to prep and paint, and the small size begs for a bright bold color, or even a combination of colors with the pipes one hue, and the fittings another.

WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Chop saw, tablesaw, or hacksaw
80-grit sandpaper
Marker
Eye and ear protection
Work gloves

MATERIALS

7' × 3/4" pipe
(2) 3/4" crosses
(4) 3/4" elbows
(4) 3/4" caps
PVC cement
Primer meant for plastic
Spray paint meant for plastic

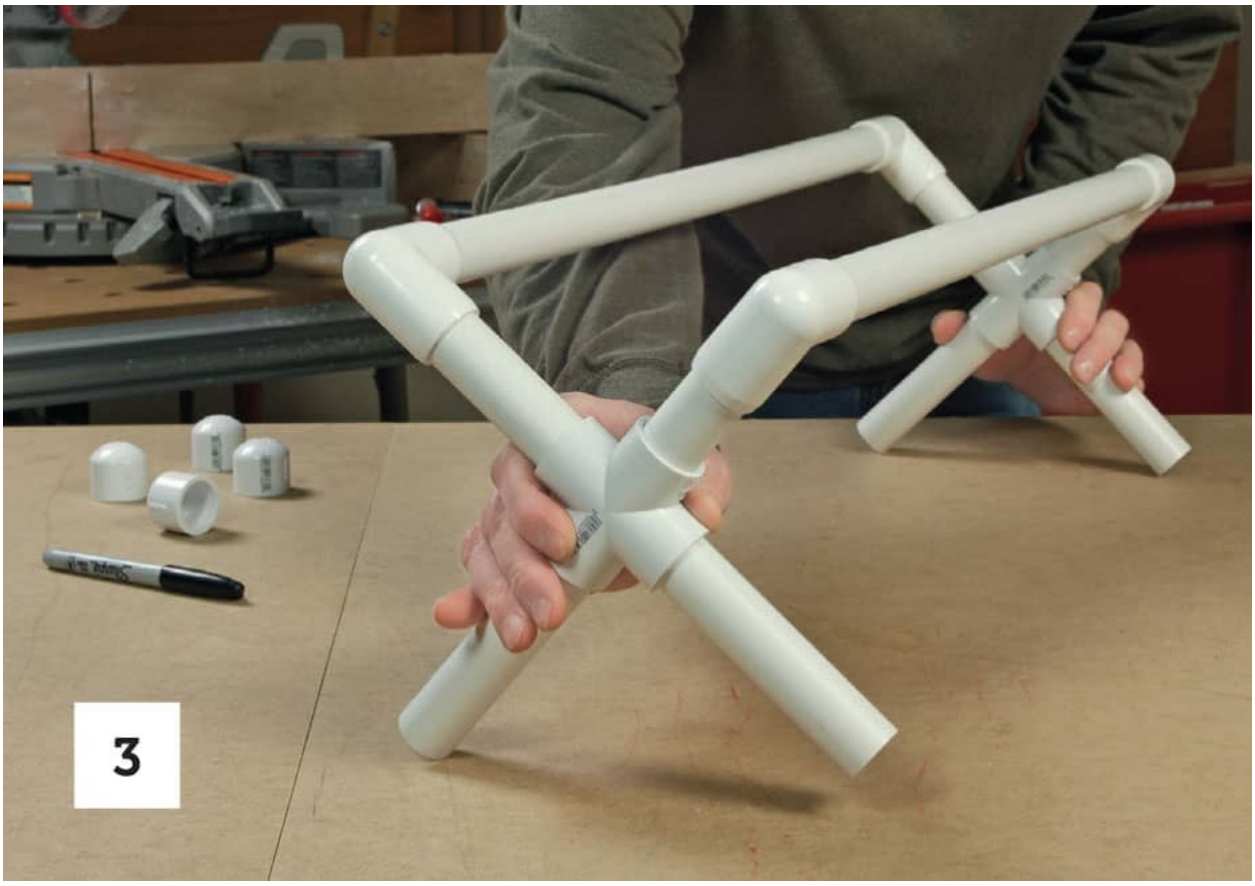
CUT LIST

(4) 5" legs
(2) 3" front arms
(2) 4" rear arms
(2) 25" supports

HOW YOU MAKE IT

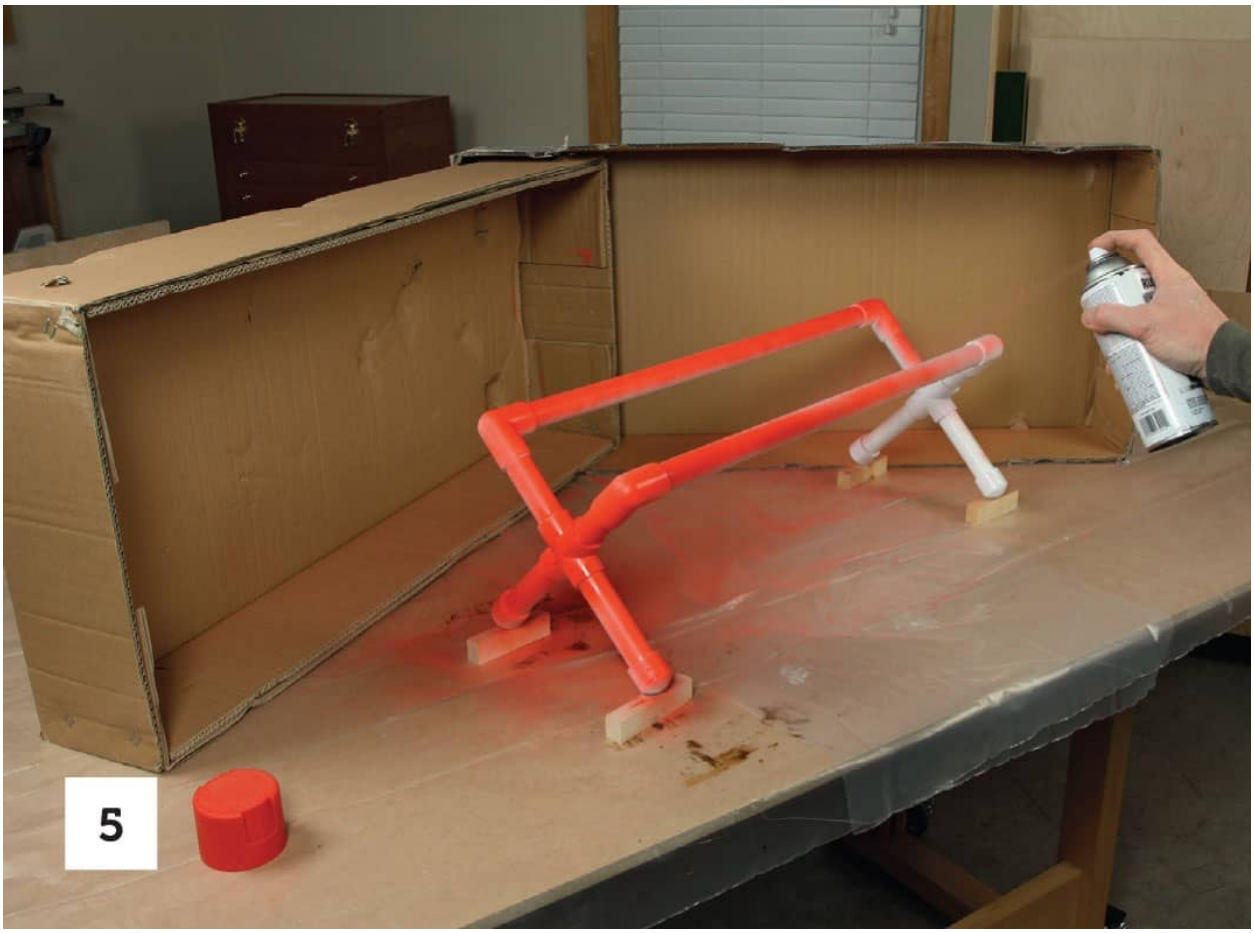
1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand the cut edges smooth.

2 Dry fit the cross leg sets for each end of the rack. The 5" legs will occupy two adjacent inlets on each cross. A 3" front arm and a 4" rear arm will occupy the other two inlets on the cross, with an elbow topping each arm. Lay the leg sets on a perfectly flat surface and ensure that the elbows are pointing straight up, perpendicular to the arms and legs.



3 Dry assemble the rack entirely, with the 25" supports connecting the arms in each cross leg set. Adjust the rack pieces slightly so that the rack sits evenly without wobbling. Once set, make key marks at all the connections with a non-permanent marker.

4 Take the rack apart and reassemble it joint by joint, cementing the pieces together. Follow the key marks when fitting the arms to the crosses and the elbows to the arms and supports. Cement the end caps onto the ends of the legs.



5 Allow the PVC cement to cure according to the manufacturer's instructions. Sand the rack all over, paying particular attention to removing any markings on the pipes. Prime and spray paint the rack in your favorite color or colors.

QUICK 3

Specialized organizers customized for specific articles are some of the best uses for PVC pipe. The following three organizers are all meant to collect in one place things that often don’t have a logical place of their own. The first two are ideal for kitchens or dining rooms and provide a way to display items out in the open, because they can be wonderful decorative elements in their own right. The Long-Handled Tool Holder is a more functional fixture that keeps frequently used tools in one place, out of the weather and ready for use. All of these, though, are about keeping the larger rooms or spaces tidier by storing things in plain view, where it’s easiest to find them when you need them. With that in mind, it’s often a good idea to paint the PVC to suit the space—especially when crafting organizers for use and display inside the house. A little color will make any organizer—and what it stores—harder to miss.

1 WINE RACK

The best way to store wine is lying on its side. And what better way to rest wine bottles on their sides than in tubes that are exactly the right size for the bottles? This simple and eye-catching wine rack does just that, and could not be easier to craft. Cut seven sections of 4" PVC pipe to 7" long. Take care to sand the cut edges absolutely smooth and round them over. Then cut four pieces of 2× or 1× scrap for the frame; the outside dimensions of the arranged pipe sections will be 13 $^{1}/_{2}$" by roughly 13". (The actual length of the frame will depend on the thickness of the scrap you use and whether you’re butt

joining the framing pieces or mitering the joints.) Tape the pipe sections together in the pattern shown, using masking tape. Dry fit the frame around the pipes to make sure you've cut the pieces to the correct dimensions. Then stain or paint the frame, and construct it by drilling pilot holes and fastening the joints with brads. When you've constructed the rack, remove the tape from the pipe sections and clean the pipes thoroughly before storing your wine collection.

2 GLASS HOLDER

Wineglasses are just too beautiful to be hidden away inside some cabinet. Show off those elegant, long-stemmed beauties with a slide-in PVC glass rack that is clever, simple, and handy to use. Cut a section of 4" PVC pipe to 12" long (each pipe section will hold three red-wine glasses or four champagne flutes). Cut a $^1/_2$"-wide slot, end to end along the length of pipe. (You can do this with multiple passes on a tablesaw, or with a jigsaw.) Sand the slot edges and the cut end of the pipe absolutely smooth. Repeat with as many sections as you need for the number of glasses you want to hang. Paint the pipe(s) and the same number of 4" slip-fit caps in the color you prefer. Use a scrap piece of 2× lumber for the mounting board, cutting it to the width necessary to hold the number of pipe sections you'll be using. Screw the caps to the board, using three 2" wood screws per cap. Then cement the pipe sections into the caps, ensuring that all the slots are face down. When you've constructed the rack, screw the wood board into studs to hold it securely.

3 LONG-HANDLED TOOL HOLDER

If you've ever stepped on a rake or a shovel only to have the handle fly up and nearly hit you in the face, you know the value of an organizer for long-handled tools. This ingenious creation stores the tools vertically so that they not only take up a minimum of space out of traffic flow but are also easy to find when you need them. Cut sections (the same number as tools that you want to store) of 3" PVC

pipe to 4" long, cutting one end at a 45° angle. Cut the same number of pipe sections, but without the angle cut. Cut a 2 × 4 long enough to accommodate the angled-cut pipe sections, leaving 10" between each section mounted vertically. Cut a second 2 × 4 to match the first. Measure and mark evenly spaced drill holes along the length one 2 × 4 and transfer the marks to the second 2 × 4. Screw the angle-cut sections, angled side up, to the first board at the marks, using 2" wood screws. Screw the remaining sections onto the second 2 × 4 at the marks. Screw the 2 × 4s to studs in the garage or shed, mounted parallel, level, and with the angled holders 3' above the other set of cut pipes (the bottom pipes should be at least 1' above the floor). If the garage or shed has a low roof that makes pulling the tools out of the holders hard or impossible, you can mount the pipe section boards vertically and store long-handled tools horizontally.

WALL-MOUNT BIKE RACK

Bikes are wonderful conveniences. They are great ways to get exercise, avoid traffic, and help the environment by getting where you're going without gas or pollution. But bikes can also be a challenge around the house when they aren't being used.

Leave a bike outside and you'll need to lock it up to make sure it's there when you want to use it. Even so, thieves are sometimes willing to settle for a wheel or seat if they can't take the whole bike, and a bike without a seat is not much use to the owner. Bikes also don't fare well under exposure to the elements, which can lead to rusted parts and a bike that's less fun and more work.

The answer is to store your bike inside—either in a garage or shed, or inside the house itself. However, a bike is no small thing and is prone to falling over. Unless secured, the bike will always be in the way. You can prevent that with a little bit of free wall space and the ingenious hanger in this project.

The hanger itself doesn't require much room, although it will jut out from the wall almost a foot. You might consider painting it a color if you're concerned that someone may walk into a white pipe projecting from a white wall. The hanger was designed with traditional bike styles in mind; if you own a bike that doesn't have a top crossbar, you can still hang it by the main post, but the bike will hang at angle (or you can mount the hanger with the slots offset to hang the bike level).

WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy TOOLS**

Steel ruler or tape measure
Grease pencil
Jigsaw
80-grit sandpaper
Hacksaw
Stud finder
Carpenter's pencil
Power drill and bits (including a sanding bit)
Eye and ear protection
Work gloves

MATERIALS

12" × 4" PVC pipe
4" female cleanout fitting and cap

(2) 3" heavy-duty washer-head deck screws
PVC cement

HOW YOU MAKE IT

1 Hold the ruler or tape measure across one end of the cut pipe and mark the center on both sides with a grease pencil. Use these marks as starting points to draw slots 4" long × 2 $^{1}/_{2}$" wide down either side.

2 Cut the slots with a jigsaw. Sand all cut edges entirely smooth. Use a hacksaw to cut off the square lug on the cleanout cap so it will sit flat against a wall. *Note: You can smooth the inside end cut of each slot very quickly using a sander equipped with a cylindrical sanding bit.*

3 Use a stud finder to locate the wall studs where you want to hang the bike. Hold the bike up to the wall, centered on a stud, and determine what height you want the bike to hang at while ensuring that the bike won't interfere with door swing or traffic flow. Mark that point on the stud with a carpenter's pencil.

4 Hold the sawn cap in place, top to the wall, centered on the mark. Screw the cap to the wall with two 3" washer-head deck screws. Make sure the screws are driven into the stud.

5 Cement the end of the pipe opposite the slot onto the cleanout cap collar. Let it cure for at least several minutes before screwing the hanger in place onto the cap, rotating it so that the slots are on either side.

YARD CADDY

At first glance, this may seem like a modest structure, but don't let first impressions fool you. It's designed for maximum storage in a completely portable and easy-to-use form. This is an all-purpose tote that you're likely to find so useful you won't remember how you ever did without it.

This helper will quickly make itself indispensable for the many outdoor projects any homeowner needs to tackle. It can be a painting buddy hauling cans of paint and supplies, with custom side holders for roller handles and paintbrushes. Or it can be a gardener's best friend, with room enough for potted plants and bags of topsoil and side mounts for your favorite trowel or garden claw.

The wheels used here are sturdy hand-truck replacement wheels, and they'll be easy to pull over just about any terrain. However, if your yard is particularly rocky and uneven, you might trade up to 13-inch wheels with a more rugged tread (you'll need to lengthen the front legs by 1 inch). You can also add more tool holders along the sides of the caddy—something that will only make the entire structure more stable and solid. However, think carefully before changing the overall dimensions of the caddy. This can be a case of unintended consequences, because any single change in dimension will be amplified across the many different pieces that go into the caddy.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Miter saw, chop saw, or tablesaw
80-grit sandpaper
Marker
Level
Power drill and bits
Padded vise
Wood mallet
Eye and ear protection
Work gloves

MATERIALS

28' × 1" pipe
18" × 1 $^{1}/_{2}$" pipe
(2) 1" crosses

(8) 1" tees

(8) 1" three-way elbows

(4) 1" saddle tees

(2) 1" elbows

(2) 1" caps

PVC cement

(16) 1" self-tapping screws

(2) $^{3}/_{4}$" to $^{1}/_{2}$" reducer bushings $^{1}/_{2}$" × 36" steel rod

(4) $^{1}/_{2}$" flat washers

(2) 8" lawnmower replacement wheels

(2) $^{1}/_{2}$" push nuts

CUT LIST

(2) $7^{7}/_{8}$" bottom side rears (4) $7^{1}/_{2}$" bottom side middles (2) $7^{1}/_{8}$" bottom side fronts (3) $25^{1}/_{4}$" bottom crossbraces and axles (8) $12^{1}/_{4}$" ends

(6) $5^{1}/_{2}$" posts

(2) 35" top sides

(2) $11^{5}/_{8}$" handle posts

$7^{1}/_{2}$" handle grip

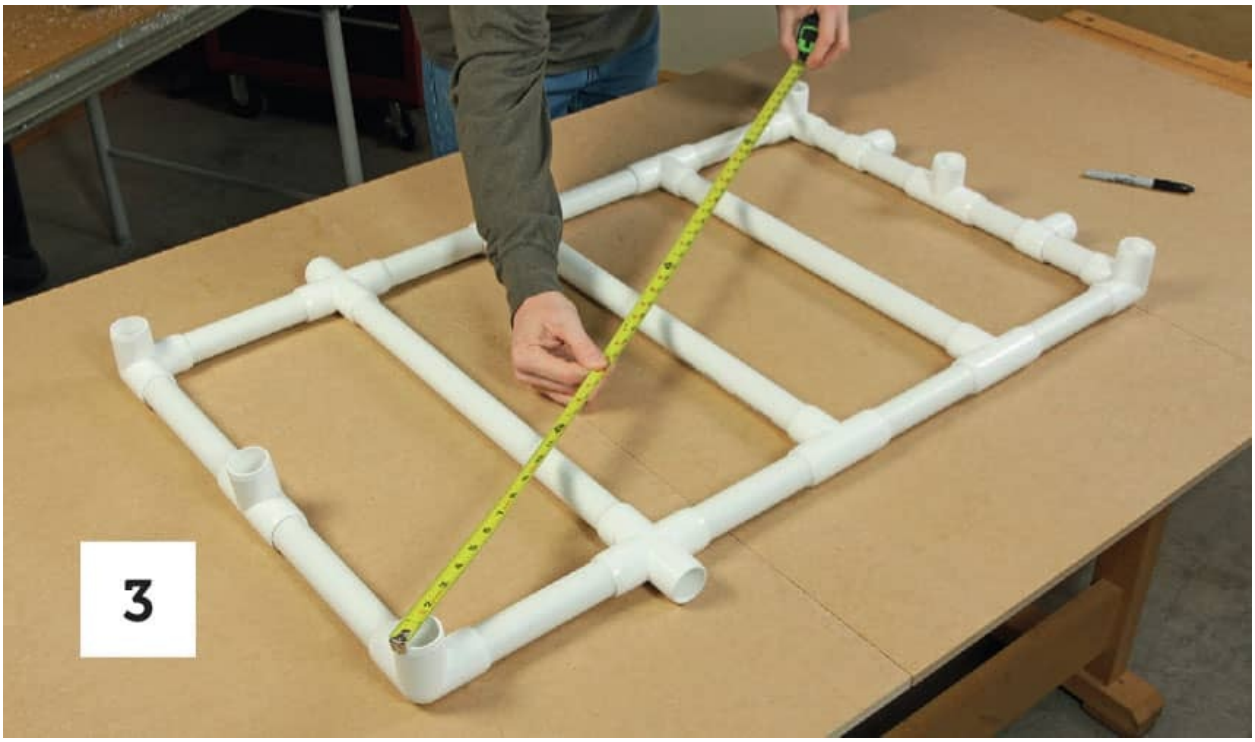
(2) 9" × $1^{1}/_{2}$" support tubes (2) $4^{3}/_{8}$" legs

(2) $2^{1}/_{2}$" nipples

HOW YOU MAKE IT

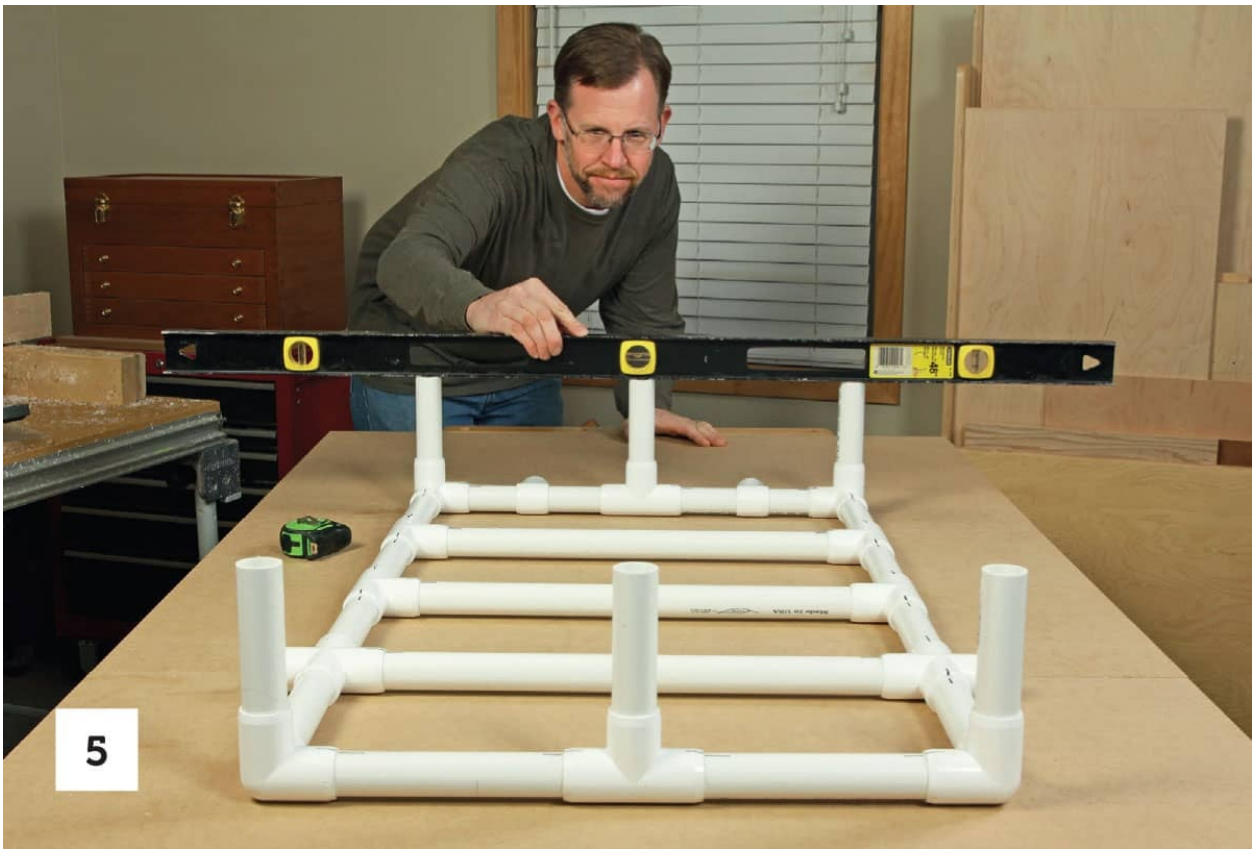
1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand all the cut edges smooth. Start the project with the base, laying all the pieces out in their relative positions on a flat, level work surface.

2 Each base side is constructed with a 7 $^{1}/_{2}$" section separated by a cross and two tees, starting from the back, with two three-way elbows at either end of each side. All the inlets should point in the same direction (the tee inlets should face each other when the sides are placed parallel), except for the top elbow and the outside cross inlets.



3 Dry fit the base sides together with the 25 $^{1}/_{4}$" axle and crossbraces between the crosses and tees, respectively. The ends are constructed of two 12 $^{1}/_{4}$" ends connected by a tee and plugged into the end elbows on each side. (Slide the saddle tees for the legs onto the two front end sections before they are fitted between the sides.) Measure along the lengths of both the sides and ends to detect any out-of-square sections. Adjust as necessary, and measure the diagonals to ensure that the base frame is perfectly square. Make key marks at all the connections with a non-permanent marker.

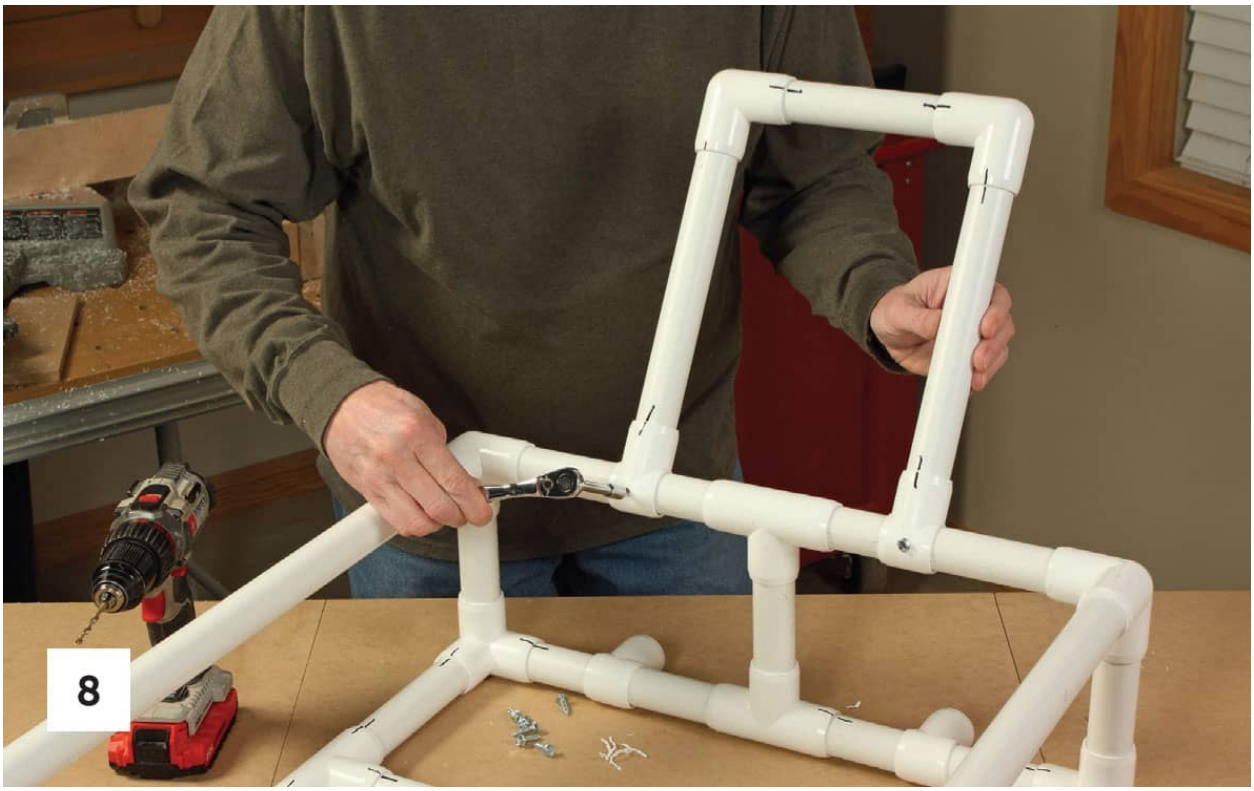
4 Disassemble the base, and, starting with the sides, cement the pieces together. Cement the crossbraces and end pieces into one side, and then cement the opposite side onto the braces and ends.



5 With the base sitting on a flat, level surface, dry fit the 5 $^{1}/_{2}$" posts into the corner three-way elbows and the front and back tees. Check for level across the top of the posts side to side and front to back, and adjust as necessary. Cement the posts in place.

6 Build the top frame by dry fitting the three-way elbows at the corners, upside down, and connecting them on both sides with the 35" top sides and four 12 $^{1}/_{4}$" ends between elbows and tees, at the front and back. Measure diagonals to ensure the top frame is square, and check that the top frame measurements match the base. Make key marks at all the top frame connections and disassemble. Slide the handle saddle tees onto the two rear ends.

7 Cement the top frame together. Allow the top frame to cure completely, then cement it in place on the posts.



8 Dry fit the 11 $^{5}/_{8}$" handle posts into the saddle tees, topping the posts with elbows that are connected with the 6 $^{1}/_{2}$" handle. Center it on the top frame,

and adjust the angle to your preference.

9 Mark the position of the saddle tees, and slide them out to one end of the end sections. Make key marks, and disassemble the handle. Apply cement to the pipe where the tees are to be positioned, and slide them back in place. Drill pilot holes, and screw the tees to the top frame pipes with 1" screws. Cement the handle back together, working up from the saddle tees.

10 Hold the 9" × 1 $^{1}/_{2}$" pipes for the tool holders in place on either side of the frame, and mark access holes top and bottom, about even with the center of the top and bottom side pipes. Use a $^{3}/_{4}$" Forstner bit to drill top and bottom screw access holes in one side of each pipe.

11 Hold the tool holder in position against the side of the top and bottom frame (the holders should be positioned about $^1/_2$" forward of the middle tee in the bottom frame). Check that the pipe is plumb, and then mark drill holes on the inside of the pipe, through the access holes, where the pipe contacts the center of the top and bottom frame pipes. Repeat with the second tool holder on the opposite side.

12 Clamp a tool holder pipe in a vise (with padded jaws) so that the slots are facing up. Drill the pilot holes in the inside wall of the pipe at the marks. Repeat with the second tool holder. Hold the pipes up in position and mark

the top and bottom frames on both sides for the screws. Drill pilot holes at the marks.

13 Screw the tool holders in place with 1" self-tapping screws. Prime the outside of the bushings and the inside of the crosses that will hold the axle. Cement a bushing into each side (tap them in with a mallet as far as they will go). *Note: If you can't find the reducer bushings, you can cement short nipples into the cross and use a reducer fitting to secure the axle in place.*

14 Slide the metal rod through the bushings so that the same amount of rod sticks out on both sides. Slide the wheels onto the rod, sandwiched between two washers, and tap a push nut onto the end of the rod and snug to the wheel (for an easy way to do this, see the box below).

15 With the caddy on a level, flat work surface, cement caps on one end of each leg. Dry fit the legs into the saddle tees at the front of the base. Check that the

caddy sits level, and adjust the legs if it doesn’t. Make a key mark for the tee positions on the frame. Cement the tees in position as you did for the handle.

16 Drill pilot holes on each side of each tee nipple, and then screw the leg tees to the frame with 1" self-tapping screws. Disassemble, and then cement the legs together and into tee inlets. Clean the caddy completely, removing any key marks, or sand and paint as desired.

Optional: You can make the caddy slightly more usable by adding a floor. If you want to go fancy, use expanded metal sheet cut to fit. Or, cut a piece of plywood to the right size, or slip scrap boards in on both sides of the front and back posts. If you prefer to make the floor permanent, screw the floor down to the crossbraces.

SOCKET SECRET

One of the most frustrating tasks for any DIYer is securing a push nut on the end of an axle to hold a wheel in place. Fortunately, there is an easy way to do this—using your socket set. Simply find the socket that matches the nut, seat the nut in the socket, and secure it with a little painter's tape around the rim. Position the nut and socket on the end of the axle, as plumb as possible, and strike the top of the socket with a mallet. If it goes on slightly off-center, tap the opposite side of the socket, until the nut is completely secured on the axle.

FISHING POLE HOLDER

When the fish are biting, you want to grab your rod and go—not scrabble through the clutter in your garage trying to find it. This handy fishing pole holder can serve both purposes: storage when you're not fishing and support when you don't want to hold the rod while you are fishing. PVC is the perfect material for this construction, because it sheds water and dirt better than your favorite waterproof jacket. It's also super lightweight, which makes transporting the holder on your day off a no-sweat task.

This holder is designed for the most common fishing pole grip diameter and length. If you have a specialty grip or have modified your rod, you might need to make some design changes so that the holder accommodates your particular gear. However, for stability's sake, keep the number of holders to at least three.

No matter what, the key to constructing the holder correctly is getting the angle of the rod tubes correct. That requires that you dry fit the entire project together before cementing any individual pieces. Keep in mind that you can lower the top rail by shortening the posts, which will hold the fishing rods at more acute angles, which might work better for the type of fishing you do.

WHAT YOU'LL NEED

TOOLS

Tape measure
Chop saw or hacksaw
Utility knife
80-grit sandpaper
Level
Marker
Eye and ear protection
Work gloves

MATERIALS

21' × $1\frac{1}{4}$" PVC pipe
(5) $1\frac{1}{4}$" tees
(6) $1\frac{1}{4}$" elbows
PVC cement

CUT LIST

(2) $5\frac{1}{2}$" short rear rails (2) $8\frac{1}{2}$" long rear rails
(2) $11\frac{1}{2}$" long legs
(2) $33\frac{1}{4}$" top and bottom (front) rails (2) $8\frac{1}{2}$" short legs
(2) $34\frac{1}{2}$" posts
(3) $13\frac{1}{4}$" rod holders

HOW YOU MAKE IT

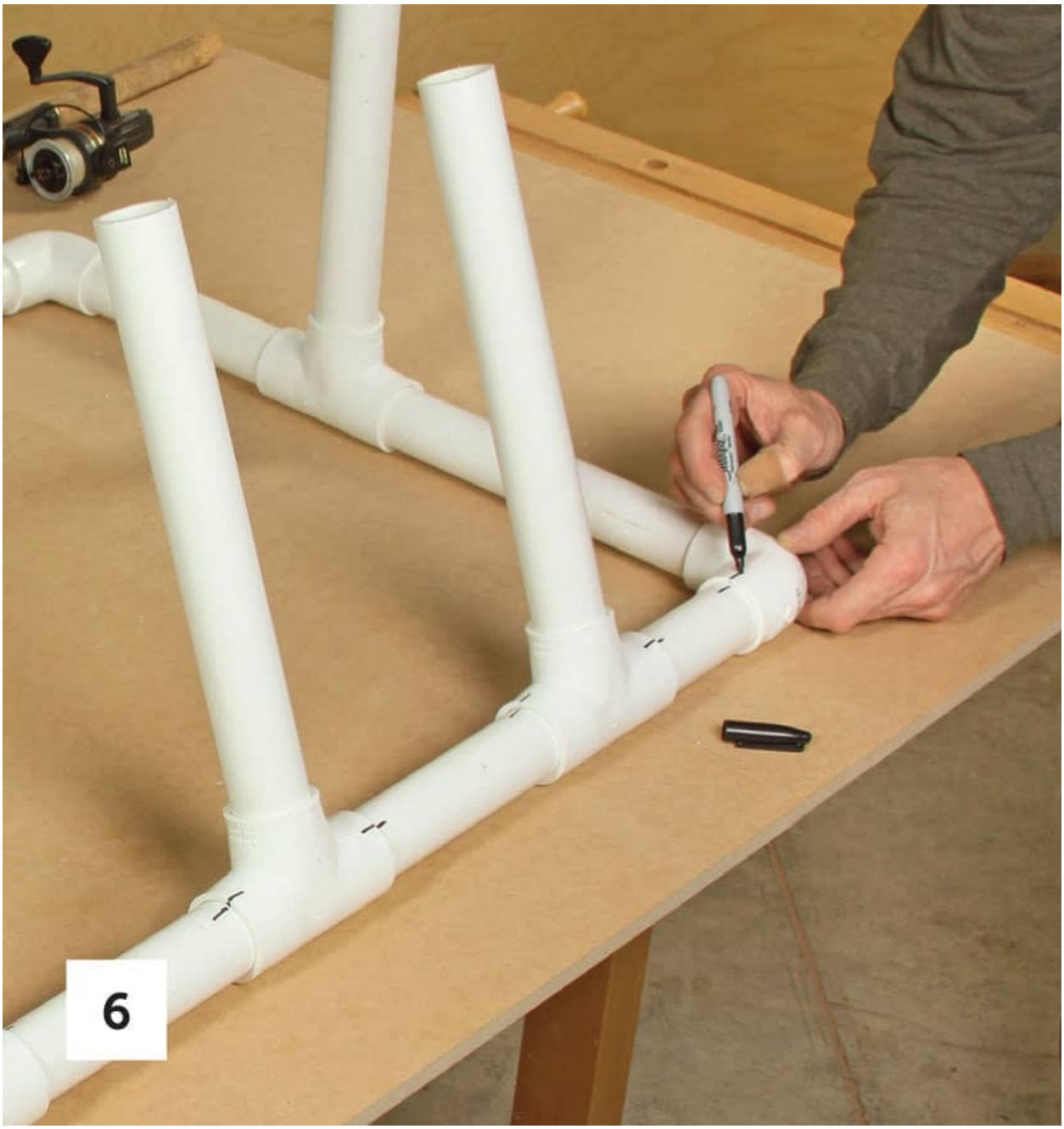
1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Remove all rough burrs with a utility knife, and then sand the cut edges smooth enough so that there are no snags when assembling the project.

2 You'll need to dry fit the entire project together to check the angle at which the rod tubes should be positioned (for the project here, it was roughly 69°). Start by dry fitting the base and the rod tubes together. The rear "rail" comprises two outer 5 1/2" short rear rails on either side, with two 8 1/2" long rear rails on the inside. The rail sections are separated by three tees, and the rear rail is completed with an elbow on either end.

3 The assembled rear rail is connected to the post tees on either end by two 11 1/2" long legs, which are slid into the rear rail elbows. The 33 1/4" front rail is connected to elbows on either end, which are connected to the post tees by 8 1/2" short legs.

4 Dry fit the 34 1/2" posts and 33 1/4" top rail in place to create the center rod support.

5 Adjust the pieces as necessary to make sure the base sits level, the posts are perfectly perpendicular to the rails and legs (check the posts with a level to check plumb), and the rails are all parallel. Place the 13 $^{1}/_{4}$" rod holders in the rear rail tees. Sit a fishing rod in each rod holder, and adjust the angle of the holder until the rod rests on the top rail.



6 Mark each rod holder’s tee with key marks to note the position in relation to the rear rail sections. Mark the rest of the frame’s assembly with key marks at the connections.

7 Disassemble the project. Begin cementing the base together, working from the front back. Cement the posts and top rail in place before completing the back and rod holder placement. Check that the holders are angled correctly one last time before cementing them in place.

STANDING BIKE RACK

If you've grown tired of the kids' bikes cluttering the garage or the front lawn, or you're a biking enthusiast yourself and want to keep your rides upright and well maintained, it's time for you to make an easy, quick, and durable bike stand.

The rack here has been designed for three bikes. It's also the right size to go into a truck bed if you want to take your bikes with you on a weekend outing or camping trip. However, you can always just repeat the pattern of the uprights and base sections between them to increase the capacity of the rack. To ensure stability, don't reduce the size of the unit.

You'll find that the stand is relatively simple to construct. The only mildly challenging part is making clean cuts on all the pipe pieces, because one piece shorter or longer than the rest will throw the rack out of square, causing it to rock on a flat surface. A power saw, such as a miter saw, is the best option for this. You should be careful about cleaning the cut pipe ends of any burrs for the same reason.

Because the stand is meant to be kept outside—and garages are often already too cluttered—the stand is likely going to be placed where it will be visible. For that reason, you might want to paint it. Choose a color or finish to match the bikes or go a little wild to make the stand pop out as a special feature in an otherwise sedate landscape. At the other extreme, a nice matte black will hide dirt and tire scuffs and would be perfect for a trio of rough-and-ready BMX riders. Power pink might be preferable to riders who are looking to show off their Barbie side.

However you decorate it, it's always wise to anchor the stand to increase ease of use. You can follow the optional instructions provided, or use your own imagination to secure the stand in place.

WHAT YOU'LL NEED

Time: **30 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Miter saw, chop saw, or hacksaw
80-grit sandpaper
Power drill and bits
Grease pencil or non-permanent marker
Level
Eye and ear protection
Work gloves

MATERIALS

21' × 1" PVC pipe
(10) 1" elbows
(2) 1" saddle tees (optional)
(8) 1" tees
PVC cement

CUT LIST

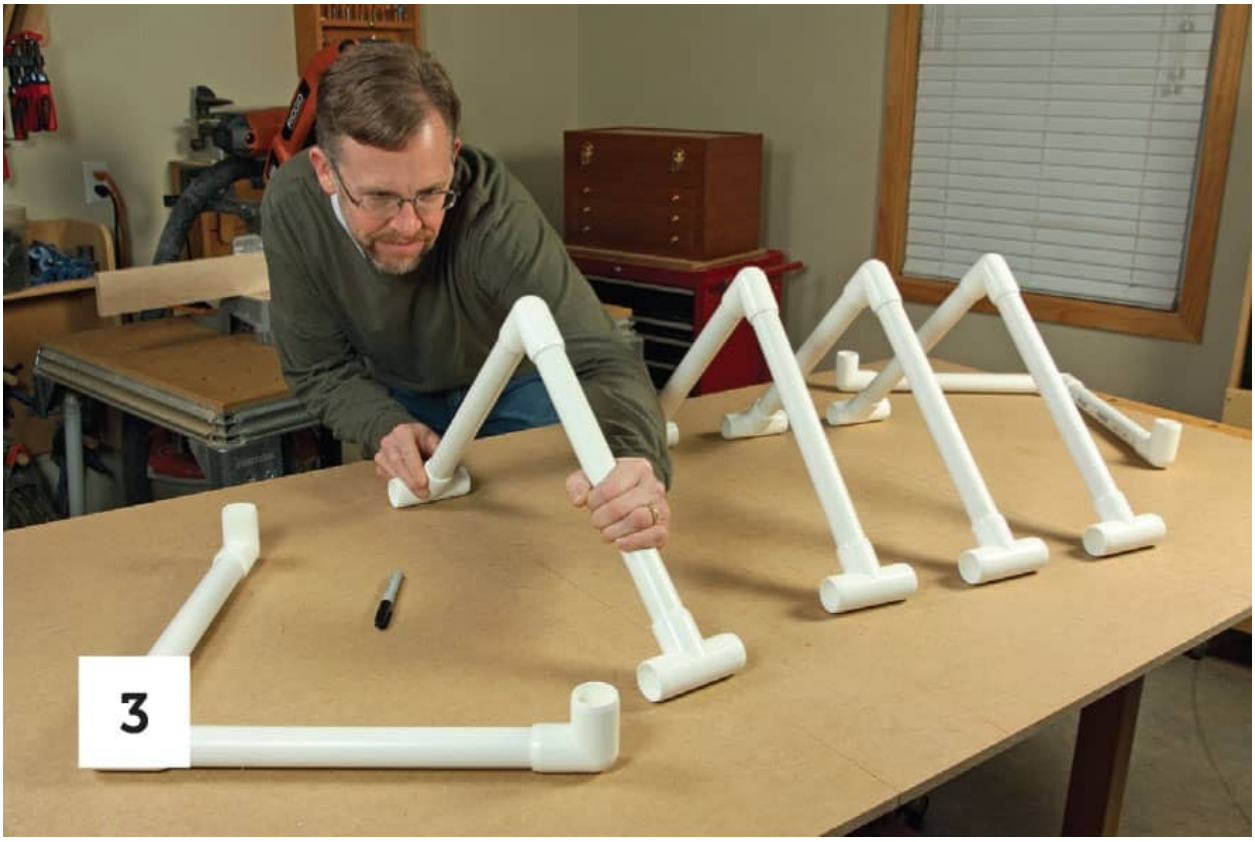
(12) $14\frac{1}{2}$" arms

(6) 3" rail nipples
(4) $12\frac{1}{2}$" base rails

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. *Note: You can make this go faster by measuring the first piece of each kind, cutting it, measuring it again to ensure it's correct, and then using that piece as a template to mark the others.*

2 Sand all the cut edges of the pipe sections completely smooth. Dry fit two 14 $^{1}/_{2}$" arms into an elbow to create an upright. If the pipe goes into the elbow smoothly without any snags, cement the upright together (if not, clean up the ends of the pipes until they slip smoothly in and out of the elbow). Repeat with all the uprights.



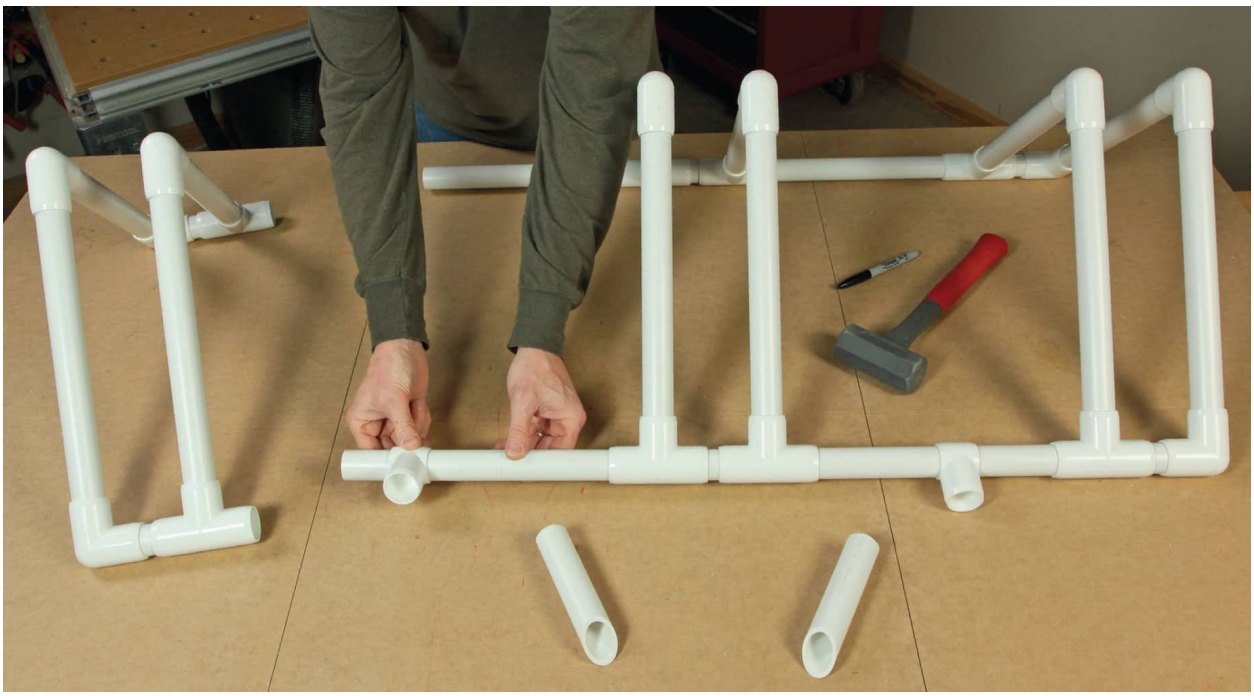
3 Dry fit tees onto the ends of each upright (two of the uprights will be fitted with elbows at the ends, and the elbows should be pointed to the left on one upright, and to the right on the other). Lay the uprights on a flat, level work surface. Make sure the tees are resting flat on the surface so that the uprights will be plumb. Make tiny key marks with a non-permanent marker. Disassemble, and then cement the tees to the ends of the uprights.

Optional: If you think you'll want to stake down the bike rack to secure it from moving when youngsters use it, slide two saddle tees onto two of the 12 $^{1}/_{2}$" base rails. These should be incorporated on the same side of the stand. Cut two 6" pieces of 1" pipe, cutting one end at an acute angle to form a spike.

4 Assemble the rest of the rack, checking for level and cementing the 3" base nipples between the upright tees. Connect each pair of uprights with 12 $^{1}/_{2}$" base rails cemented into the open tee inlets to finish the rack.

Optional: To secure the rack in place, soak the dirt or sod on the site, and tap each spike into the ground—lined up with about 10" between the two—until the top of each is at ground level. Clear out a small margin of dirt around the top of each spike. Adjust the saddle tees on the base to match the location of

the two spikes, and then press the tee inlets down over the spike tops until the rack is firmly in place.



3 HOMESTEAD HELPERS

It doesn't matter whether you have a three-acre spread on the outskirts of town or just a postage stamp backyard in the middle of the city—it's always nice to make the most of your property and everything you're trying to grow there.

This chapter is all about wonderfully creative practicality and getting things done. These creations are specifically designed to help you grow and nurture plants and take care of animals—both farm and domestic. There are few things more rewarding.

PVC is especially handy when it comes to serving the needs of homestead and barnyard animals, such as chickens. The material doesn't leach toxins, is durable and easy to clean, and generally looks neat and trim even when left unpainted. Those same qualities make the plastic ideal for many, many gardening uses. It can form the skeleton of a Hoop Frame Greenhouse that will allow you to garden year-round or grow things that don't normally grow in your zone. A Strawberry Tower is a reusable specialized container for those delectable summer gems that often don't thrive when planted in the ground.

You'll be amazed that even a something as basic as Edging (shown here) can become not only incredibly useful but also stylish and even fun when crafted out of PVC used in a creative way.

Chicken Feeder

Chicken Waterer

Hoop Frame Greenhouse

Quick 3

- *Cold Frame Cover*
- *Trellis*
- *Edging*

Pet Wash

Birdhouse

Hanging Herb Garden

Firewood Rack

Strawberry Tower

CHICKEN FEEDER

The key to maintaining homestead livestock is to make caring for them as easy as possible. When you don't feel overwhelmed with chores, you're likely to take better care of your animals, and you may even find the work more enjoyable. That's the idea behind this "set it and forget it" chicken feeder. Fill the feeder once a week and let gravity do the work.

This feeder should serve one or two chickens quite well. If you have more feathered charges, consider making multiples of the feeder, one for every two adult chickens. To avoid any chance of contaminating the chicken feed, make sure there are no loose burrs on cut pipe ends. For the same reason, be careful not to spread PVC primer or cement on exposed, interior surfaces of the pipes or fittings.

If you prefer not to attach the feeder to a wall with straps, create a base to make the feeder freestanding, as shown. You'll also find instructions for making a handy spill lip to help prevent chickens from flicking feed out of the feeder.

Lastly, although this is designed for chickens, it can easily be adapted as a goat or larger animal feeder by increasing the size of pipe and fittings used: 6-inch pipe and fittings would do the trick.


DUMOR
POULTRY
16% LAYER FEED
PELLET
CALCIUM FORTIFIED
FORTIFIED WITH VITAMINS & MINERALS
FORMULATED WITH PROBIOTICS
10 LB

WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Chop saw or reciprocating saw
Utility knife or 60-grit sandpaper
Level
Marker
Power drill and bits (optional)
Jigsaw (optional)
Eye and ear protection
Work gloves

MATERIALS

48" × 4" PVC pipe
4" wye fitting
(2) 4" slip caps (1 optional)
4" test cap
PVC cement
(3) 4" pipe straps and matching screws
(3) 1" stainless steel wood screws (optional)

CUT LIST

40" top feeder section
8" bottom feeder section

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Use a utility knife or coarse sandpaper to smooth the cut ends of the top and bottom pipe sections.

2 Cement the top (longer) pipe section into the straight end of the Y fitting opposite the mouth of the Y. Be very careful not to spread any PVC primer or cement onto the inner surfaces of the pipe or the fitting.

3 Cement the lower, shorter pipe section into the opposite end of the Y fitting. Cement the other end of the short section into a slip cap. Position the finished chicken feeder against a wall or other flat surface with the longer pipe section at the top. Use a level to check that the feeder is plumb. Measure, mark, and drill pilot holes, then mount it to the surface with pipe straps and wood screws. Fill with feed and cap the top end with the test cap.

Optional: You can make this feeder freestanding and portable by adding a sturdy base rather than strapping it to a wall. Cut a 1' square piece of 1" plywood from scrap (or screw together several 2× scraps to a create the square base). Follow the instructions above, but don’t cement the slip cap in place on the bottom of the feeder. Instead, screw it upside down to the center of the base, using three 1" stainless steel wood screws in a triangular pattern. Then, when the rest of the feeder has been assembled, cement the bottom end into the cap. Fill and top as described above, placing it anywhere that is convenient.

Optional: Feeders such as this can be messy. To make them less so, provide a spill lip for the feeder opening. Drill two access holes in a slip cap top, and then cut out half of the top (a half moon) with a jigsaw. Cement the cap in place over the feeder opening in the Y with the opening on top.

CHICKEN WATERER

Chickens, like humans, have to stay hydrated. But given the hardscrabble, dusty conditions in most chicken coops, drinking water sources often quickly get dirty or polluted with feces and germs. Add to this the fact that chickens simply aren't neat drinkers, and the coop floor around a waterer tends to become a mud pit. All that makes for a whole lot of continual work for anyone charged with tending the hens and keeping them as healthy as possible.

The waterer here can be the answer to any coop owner's hydration dilemma. It keeps water contained, releasing only the small amount each chicken needs for a healthy drink. Feathers, pebbles, soil, and worse are kept out of the water supply.

This creation is also a handy relief for homesteaders who are overwhelmed with garden and barnyard chores. The water tube reservoir holds plenty of water, so it won't need refilling every day as other sources might. The waterer also features end caps and a cleanout that allow you to flush the system whenever the water has become stale, or if dirt or grime somehow make it into the structure.

This unit is meant for two to three chickens and can serve up to four. If you have more, build one or more extra waterers. You can gang the parts of the construction to make short work of the process.

WHAT YOU'LL NEED

Time: **50 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw or hacksaw

Utility knife or 60-grit sandpaper

Marker

Power drill and bits

Eye and ear protection

Work gloves

MATERIALS

4' × 2" PVC pipe

3' × 1/2" PVC pipe

2" cross

2" cleanout assembly

(2) 2" to 1/2" reducer bushings

(4) 1/2" drinking cup-and- tee fittings (2) 1/2" slip-fit threaded couplings (2) 1/2" threaded female caps

2" cap

PVC cement

(3) 2" saddle straps

(6) 1 1/2" wood screws

CUT LIST

43" × 2" water tube

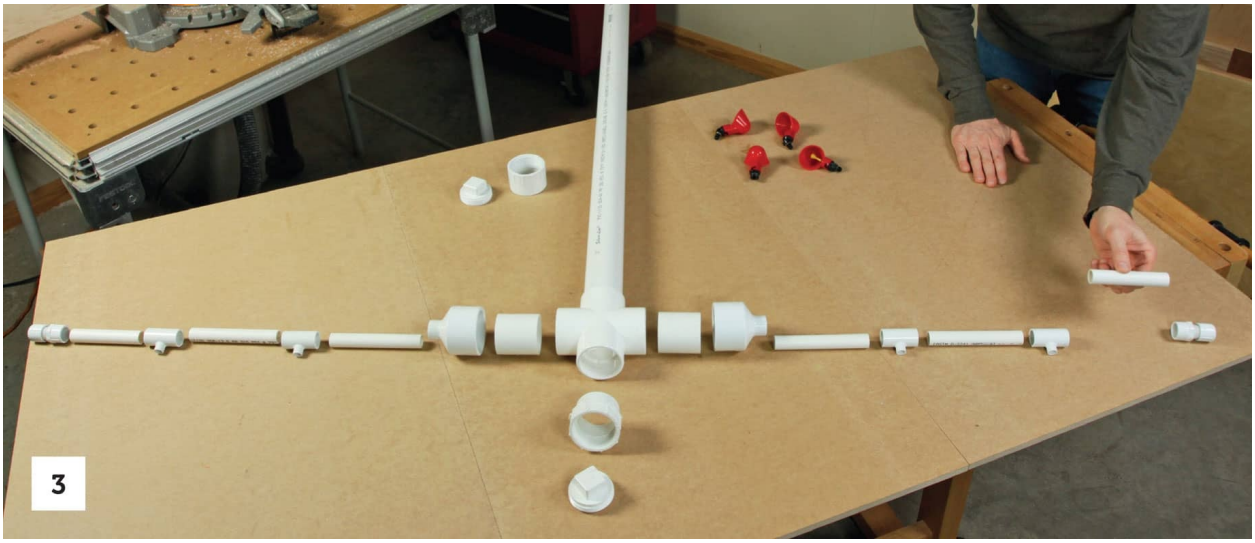
(4) 5" × 1/2" feeder pipe inners

(2) 3" × 1/2" feeder pipe outers

HOW YOU MAKE IT

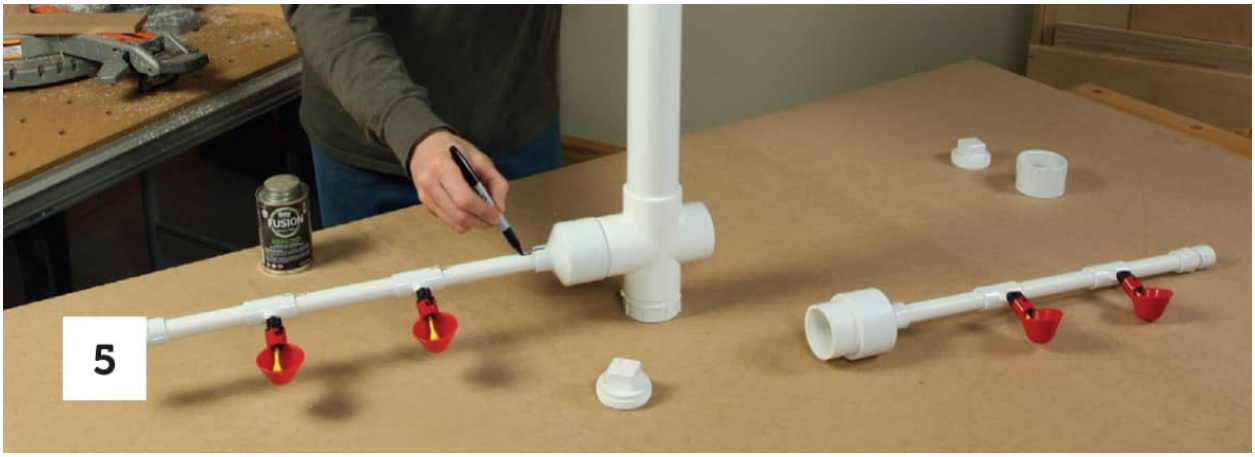
1 With a tape measure and saw, measure and cut the pipe segments to match the cut list, paying particular attention to the 1/2" feeder pipe sections. Given how many chickens you have or their relative sizes, you may want to increase the length of the longer feeder pipe sections. You can also increase the length of the 2" vertical post reservoir to hold more water (for more options to increase capacity, see the box shown here). With a utility knife or sandpaper, trim or sand all the cut edges smooth.

2 Cement one end of the 2" vertical post reservoir into one inlet on the 2" cross. Be careful not to coat any PVC primer or cement on an unmated surface where water will contact it.



3 Lay out all the pieces for the waterer on a flat, level work surface, to ensure you cement the correct fixtures into the 2" cross in the correct relationships, and that the feeder lines are assembled in the right order. The cleanout assembly should be opposite the vertical post reservoir, and the bushing reducers for the feeder lines should be opposite one another on either side of the cross. Each feeder line should be formed by a 5" section of pipe, then a drinking cup-and-tee fitting, repeat, and then terminated in a 3" section capped with a threaded coupling and cap.

4 Cement all the fittings into the cross, again being careful not to spread primer or cement on any surface that will contact the water moving through the waterer.



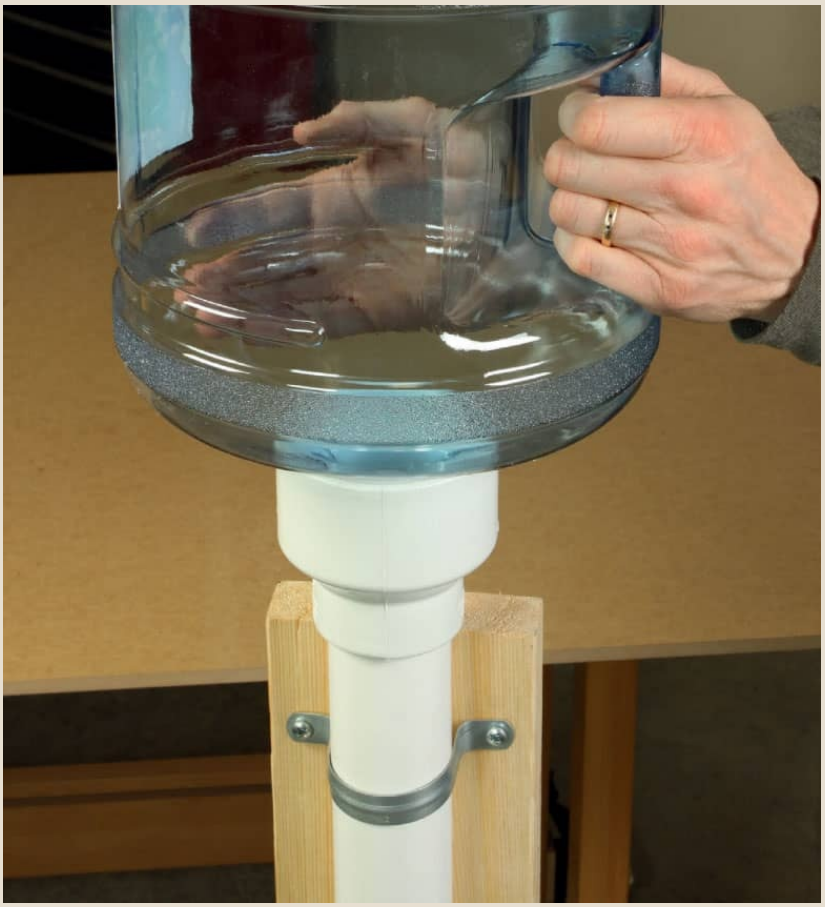
5 Dry fit the two feeder lines together. Ensure that the drinking cups are all perfectly aligned, so that they will be level when the waterer is upright (the best way to ensure this is to hold the waterer upright with the dry-fit feeder lines in place in the bushings). When you're certain that all the drinking cups are positioned correctly, use a marker to make key marks at all the joints, including at the bushings.

6 Cement the feeder lines together, and then cement each into its bushing in the 2" cross. As before, be careful not to spread primer or cement on any surfaces that will come in contact with the water.

7 Using a drill, fasten the waterer in place, plumb, with the saddle straps holding the reservoir tube to a side of the chicken coop, a wall stud, or a freestanding support such as the one shown here. The cups should sit about 5" above ground level. Fill the waterer and test that the drinking cups are each working as they should. Place the 2" cap on the top of the reservoir tube to ensure that no dirt gets inside.

INCREASING CAPACITY

If you prefer to deal with the waterer even less frequently, increase the water-holding capacity with the help of a 5-gallon jug of water. Start by replacing the top cap with a 3" to 2" reducer. Cement the smaller-diameter end into the top of the water tube reservoir. Add pipe straps to more thoroughly secure the tube to the wall or mounting bracket. Then remove the cap on a full, 5-gallon water bottle, and turn the bottle upside down with the spout in the 3" side of the reducer. The bottle will rest securely there and your waterer's capacity will be greatly increased.



HOOP FRAME GREENHOUSE

Simple as this greenhouse might be, it is, like all greenhouses, a backyard luxury and a homesteader's necessity. That's because any greenhouse expands your garden far beyond its size. You can use a greenhouse such as this to get an early start on your crops or keep them growing long after the season has ended. Start seedlings, nurture fussy plants, and tend to sick ones. Use the structure to grow species and cultivars that normally wouldn't grow in your part of the country or in your particular zone.

The greenhouse in this project has intentionally been designed with a small footprint that makes it ideal for just about any yard or garden, small to large. It's easy to scale up the design by lengthening the sides and adding hoops (they are spaced 15 inches on center), and you can even make the hoops themselves longer to give yourself more headroom inside. A little extra arc allows for taller plants and affords the gardener space to move around and perhaps even have a table for seedlings or potting.

Regardless of how you use it, the key in any greenhouse is ventilation. The front and back flaps on this greenhouse allow for quick and easy venting with front-to-back airflow. Be sure to seal the flaps tightly at night so that nocturnal critters don't use your greenhouse as a late-night supermarket.

WHAT YOU'LL NEED

Time: **90 minutes** | Difficulty: **Hard TOOLS**

Tape measure
Chop saw or tablesaw
Utility knife or 80-grit sandpaper
Level
Speed square

Marker

Wood or polyurethane mallet

Eye and ear protection

Work gloves

MATERIALS

65' × 1/2" pipe, NSF, 600 psi

20' × 3/4" pipe

(8) 3/4" tees

(6) 3/4 to 1/2" reducing tees (4) reducing three-way elbows (3/4 × 3/4 × 1/2") (8) 1/2" saddle tees

PVC cement

6-mil plastic sheeting

Snap clamps

Binder clips

CUT LIST

(16) 6 1/8" × 3/4" sides (2) 45 1/2" × 3/4" ends (2) 45 1/2" × 3/4" crossbraces (4) 8" × 3/4" stakes

(5) 10' × 1/2" hoops

(4) 13 1/2" × 1/2" ridgepoles

HOW YOU MAKE IT

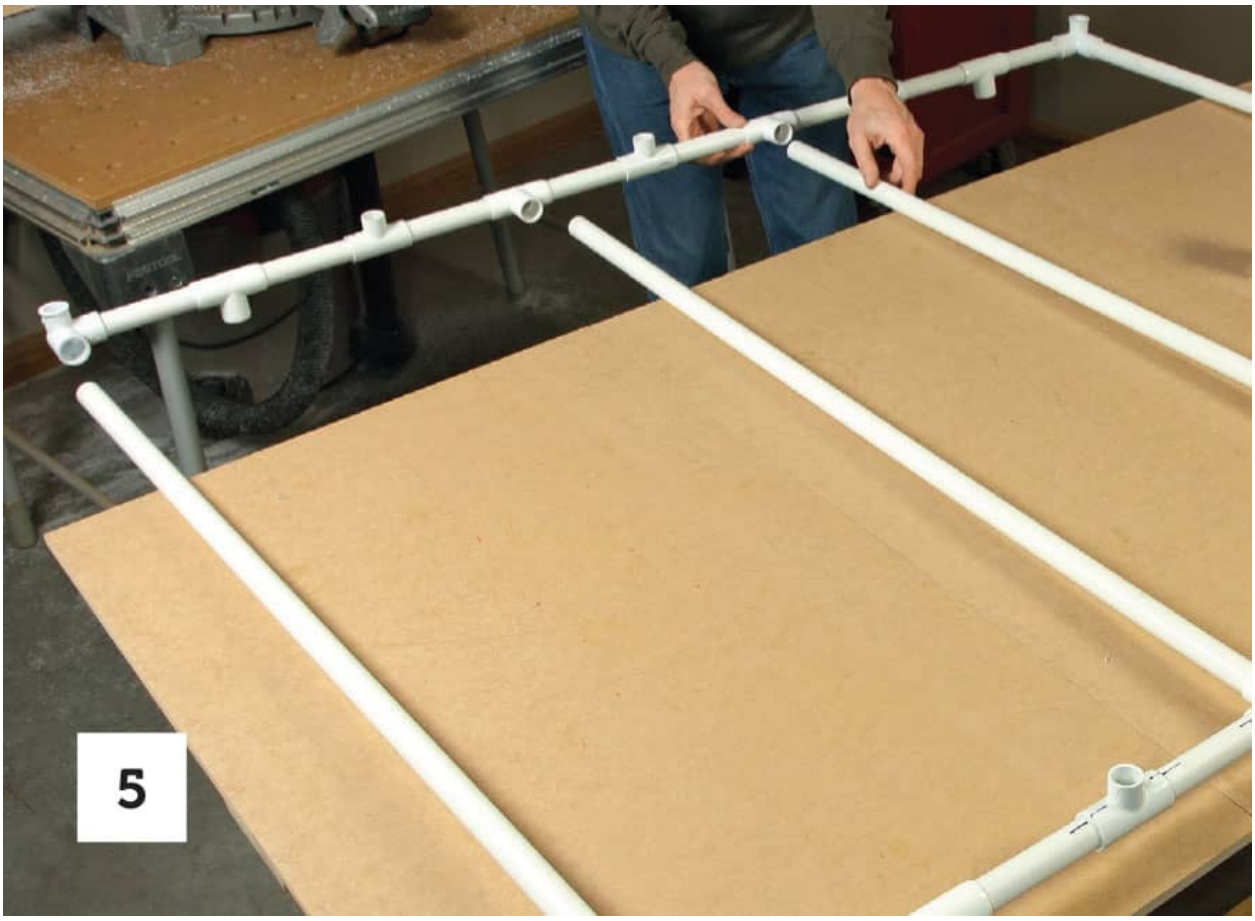
1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.

2 Working on a large, flat, level work surface, lay out the pieces for the base. Each side assembly is formed of eight 6 $^{1}/_{8}$" × $^{3}/_{4}$" sides. The two outside segments on each end are joined with tees, and the inner segments are joined with alternating reducing tees and tees perpendicular to each other. The outside tee on either end—a standard tee—faces down (or the opposite direction from the other tees as the side lies flat).

3 Connect the dry-fit sides with ends comprised of a 45 $^{1}/_{2}$" × $^{3}/_{4}$" end fit with reducing three-way elbows on either end. The elbows are connected to each end of the side, to form the rectangular frame. (For this stage, turn the end, standard tees out to the side so that the frame can sit perfectly flat.) Measure the diagonals to ensure the base is square, and adjust as necessary.

4 With a speed square, check that all tee inlets are facing directly upward (you'll position and cement the staking tees pointing downward after you've completed the rest of the base). With a grease pencil, mark each base connection with key marks. Rotate the stake tees (the outside tees on each side) so that they're facing directly opposite the other tees, and make key marks on their connections. Disassemble, and cement the base pieces

together, section by section. Cement the stake tees in place last, ensuring that they are perfectly parallel to, and pointing in the opposite direction of, the pole tees.



5 Cut one end of each 8" stake at a sharp angle to create a point. Position the base on the final site for the greenhouse. Mark the location of each stake, remove the base, and pound the stakes into the ground with a wooden or polyurethane mallet, until only 1" projects aboveground. (Moisten the ground thoroughly to make it easier to pound the stakes into place.)

6 Position the base on top of the stakes to ensure the stake tees line up with the stakes. Cement the top of the stakes into the upside-down tee inlets.

7 Starting at one end with one 10' × 1/2" hoop, slide a saddle tee onto the center of the hoop, put one end of the pipe into one elbow, and slowly bend the free end over until you can push it down into the opposite elbow. (This will be easier to do if you enlist the aid of a helper to hold the first side down while you bend the other end down into the opposite elbow.)

8 After you've confirmed the fit side to side, cement both ends of the hoop in place, holding both sides down until the cement has set and cured. Repeat with the rest of the hoops, slipping two saddle tees onto each of the three middle hoops, and one on the opposite end hoop, before cementing them into place.

9 Starting at one end, position the saddle tee centered at the top of the hoop, facing in. Move one of the tees on the next inside hoop to the top center, with the inlet facing the end hoop tee. Connect the tees with a 13 $^{1}/_{2}$" × $^{1}/_{2}$" ridgepole, dry fitting the outer into the tees.

10 Finish assembling the ridgepole segment by segment. Check that the hoops are equidistant apart and that the hoops are plumb. When you are satisfied with the alignment, cement each ridgepole section into the tee inlets on both sides.

11 Depending on the plastic sheeting you've purchased, you'll wrap the greenhouse from end to end, or in side-to-side panels overlapped. In either

case, leave enough sheeting to tuck under the base on each side by several inches. Cut the plastic to size as necessary.

12 Once you're happy with the placement of the plastic sheeting panels, secure them in place with snap clamps used every few feet on the hoops and base sides. The panels should create overlapping door openings at the back and front of the greenhouse. Use heavy binder clips or similar to close the door panels and keep the flaps from flying open.

QUICK 3

A garden, or even a small farm, can really take full advantage of the properties inherent in PVC pipe. The material is unattractive to pests such as bugs, who will leave it alone. Time, the elements, shifting ground, and physical abuse won't have much effect on PVC pipe, because it's formulated to resist everything but extreme heat and excessive internal pressure. The material is also easily modified to suit

many different garden uses and a full range of plants. The look is even well suited to the garden; it tends to blend in over time, even as it gets dirty (although it's easy to clean). All that spells success for yard and garden additions such as the projects that follow. If you prefer, it's easy to paint these to provide small splashes of delightful color outside. But no matter what, all of these are specifically designed to use up odds and ends left over from other PVC pipe projects, and any one is easily modified to suit your own needs and garden. Don't be afraid to experiment and play around with the designs.

1 COLD FRAME COVER

The easiest—and often cheapest—way to make a cold frame for a garden bed is to cover it with hoops. Hoops provide for a range of growing heights and are easy to maneuver around. To create a simple and quick hoop cold frame, bend $^1/_2$" pipe in an arc over a garden bed. Repeat with a hoop every 1' or so. If the bed is raised with wooden sides, attach each end of each pipe to the wood sides with a $^1/_2$" pipe strap. If the bed doesn't have sides, cut the ends of each hoop 45° to create stake points. Then drive each end down into moistened dirt on either side of the bed. In either case, the length of the hoops determines how high the center of the arc will be and how tall your plants can grow. Overlap layers of plastic, creating flaps at each end. To control the temperature, open or close the flaps at each end to either increase or decrease cooling airflow.

2 TRELLIS

The best PVC pipe for forming trellises is $^3/_4$", although $^1/_2$" will also work. You can create the trellis in whatever shape makes the most sense for what you're growing. Regardless, there are two ways to effectively bind crossbraces and supports together: screws or zip ties. To screw the pieces together, work on a hard, flat, level work surface. Create a small pilot hole in one pipe, and then drive a drywall or self-tapping screw down into both pipes. It's sometimes easier to

use zip ties, which create a structure every bit as sturdy and durable. Simply create an “X” across each of the joints where pipes cross, and pull the zip ties tight. To stand a trellis in a garden bed or pot, cut one end of each support to a 45° angle to create a stake point, then drive the supports down into the soil.

3 EDGING

Garden edging is a wonderful way to put short PVC pipe scraps of all sizes to beneficial use. You can combine small and large pipe diameters in a single run of edging for great visual effect. Or use scraps that are all the same size, for a more uniform look. In any case, dig a trench so that the pipe segments will be buried to within one-third of their total lengths (different length pipes can be a cool look as well). You can attach the pipes in the edging side to side by driving 1" self-tapping screws down at an angle through the top end of a pipe into the pipe next to it. Or leave them loose, standing them one at a time on end in the trench. Large-diameter pipes can be filled with soil and small plants such as moss or pansies. Smaller diameter pieces can just be filled with soil or gravel to help keep them upright and in place.

PET WASH

Whether you're homesteading mini pigs and goats or you own a couple of dogs, you'll eventually want to clean those animals up. You can grab a hose, bucket, and soap and hope the target of your cleaning efforts doesn't wiggle free, or you can choose the easier solution: a pet wash. It's like a car wash, but for your four-legged friends.

It's no accident that this simple-but-effective contraption uses the same idea as a drive-through car wash. Connect a hose to the washer, and then lead the animal into the center of the frame. Turn on the water to make it spray from above and below. That leaves your hands free to suds up your pet and, more importantly, keep the animal from going on the lam.

Drilling the spray bar holes will take some time; the work will go much more quickly if you have access to a drill press. The rest of the frame, though, is simple and easy to construct. The project is also adaptable to the size of your animal. You can make it taller or shorter, wider or narrower, without much fuss.

As built, the frame is freestanding and portable. This works best for most people who will want to store it out of the way when not in use. It can easily be hoisted up into the rafters in a garage or hung on wall hooks anywhere. But there's something to be said for anchoring the frame so that the animal doesn't move it around as it fidgets or tries to cut bath time a little short. You'll find an option for grounding the frame in the box here.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw or hacksaw
80-grit sandpaper
Padded vise
Metal straightedge yardstick
Marker
Drill press or power drill and bits
Eye and ear protection
Work gloves

MATERIALS

27' × 3/4" pipe
(4) 3/4" three-way elbows
(7) 3/4" tees

(4) 3/4" caps

3/4" hose fitting

PVC cement

CUT LIST

(5) 38" spray bars

(3) 30 1/2" legs

(4) 3" leg bottoms

22 1/4" hose leg section, long

(4) 10" end braces

(5) 38" spray bars

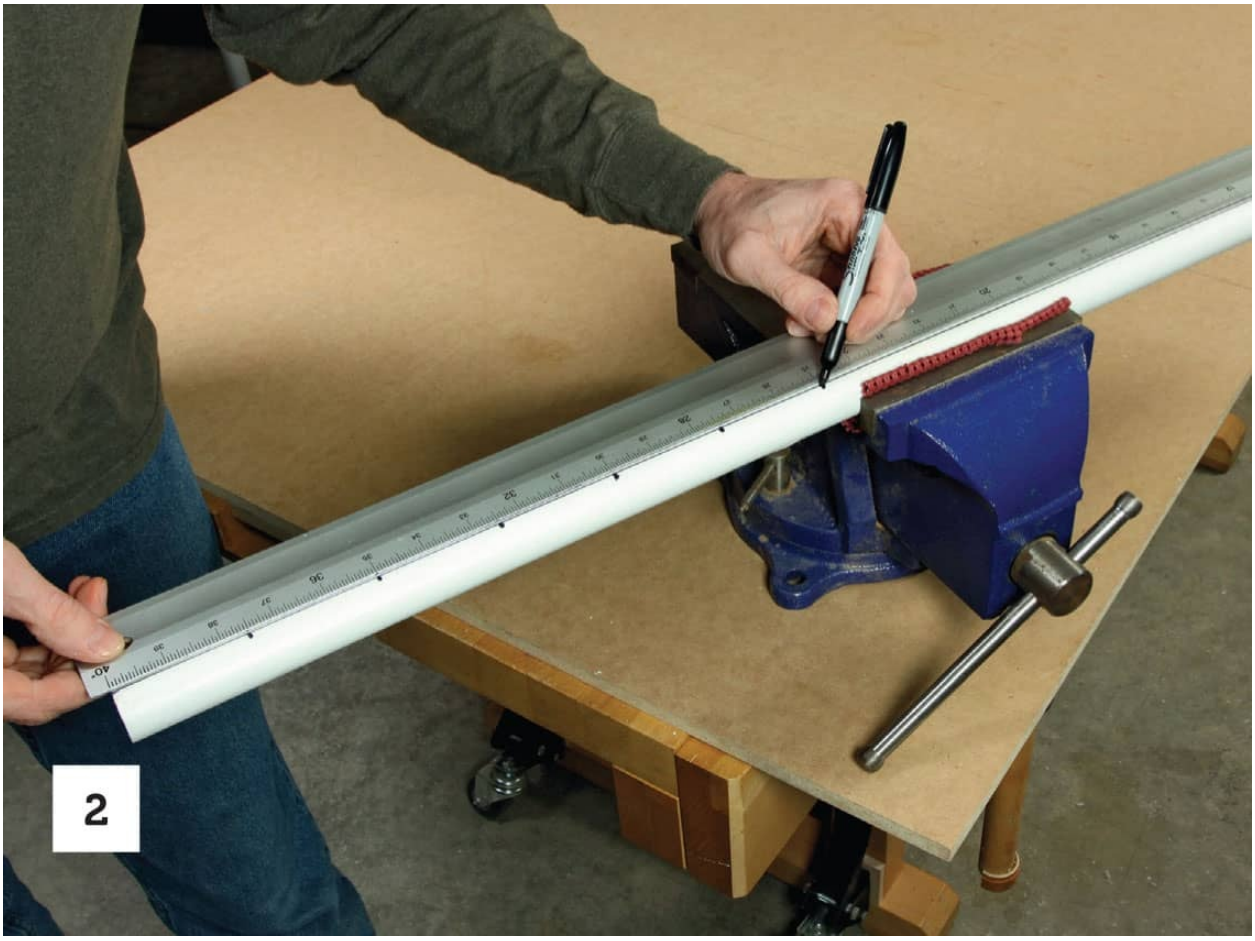
(4) 3" leg bottoms

7" hose leg section, short

(3) 30 1/2" legs

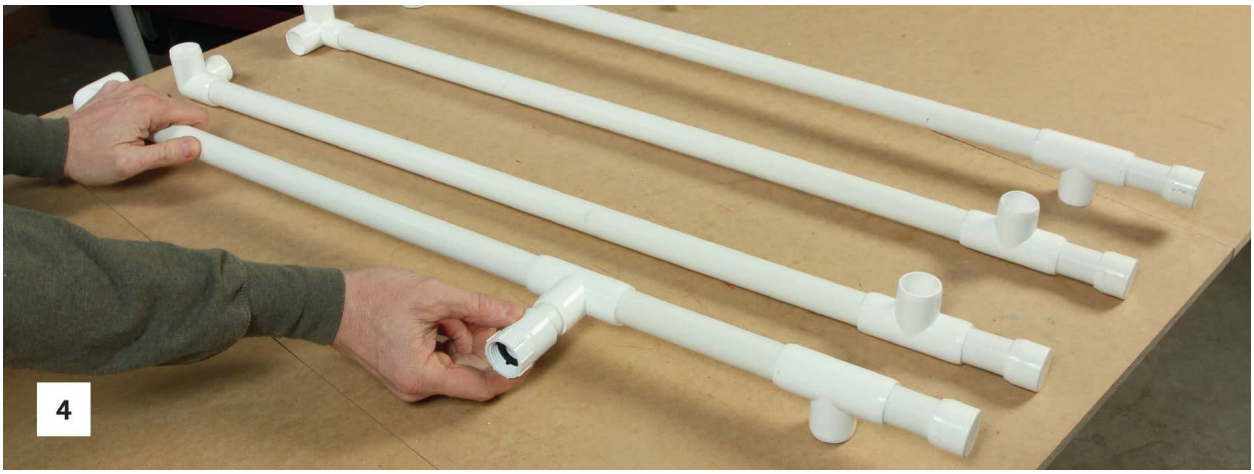
HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand all the cut ends and be careful that no burrs find their way inside any of the sections, or they could block the spray openings.



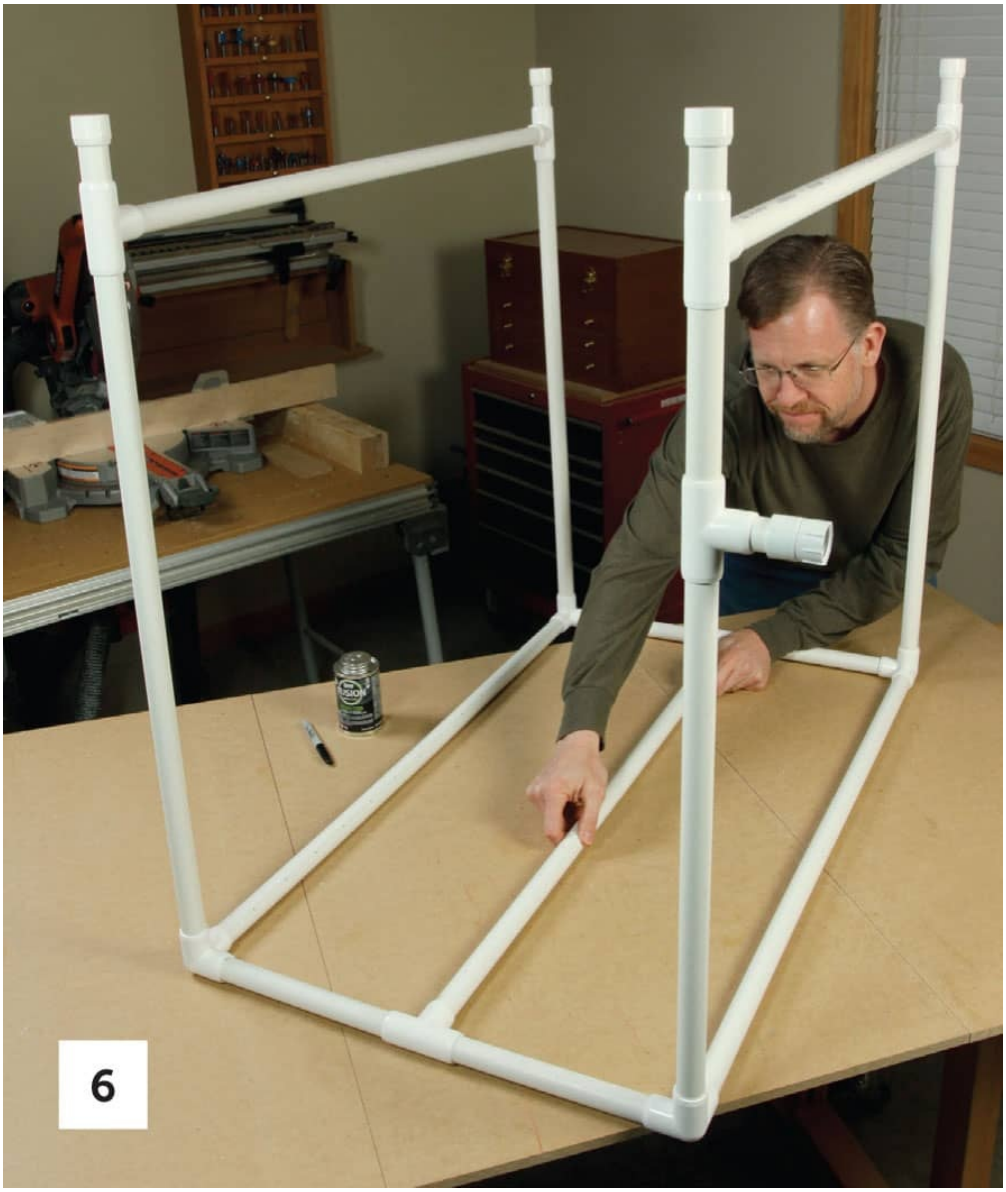
2 Secure a 38" spray bar in a vise with padded jaws. Use a straightedge to mark a straight line from one end to the other. Then measure and mark hole locations every 2 $^{1}/_{2}$".

3 Brace the pipe, with the hole marks facing up, in a drill press (or leave the marked spray bar in the vise if using a power drill). Drill $^{1}/_{16}$" holes at the marks, being careful not to drill through the other side of the pipe. Repeat the marking and drilling process with all the spray bars.



4 Lay out the legs. Connect a three-way elbow to one end of a 30 $^{1}/_{2}$" leg, connecting the other end to one side of a tee. A 3" leg bottom is connected to the tee and finished with a cap to complete the leg. Repeat to construct two other legs. The fourth leg is constructed with the hose connection. The top 22 $^{1}/_{4}$" section is connected to a three-way elbow at one end and to the $^{3}/_{4}$" hose fitting on the other. The 7" section is connected on the other side of the hose fitting, with a tee on its opposite end and then a leg bottom as used in the other three legs. Check that all legs are the same length and that, lying flat on a level surface, the tees and one inlet of the elbows point in the same direction.

5 Connect each pair of legs with a 38" spray bar. Angle the spray holes in the top bars downward and slightly upward in the bottom bars (use your judgment for these angles; they should suit the animals you'll be washing most frequently). When you're happy with the side assemblies, make key marks at all the connections, disassemble the sides, and cement all the parts together.



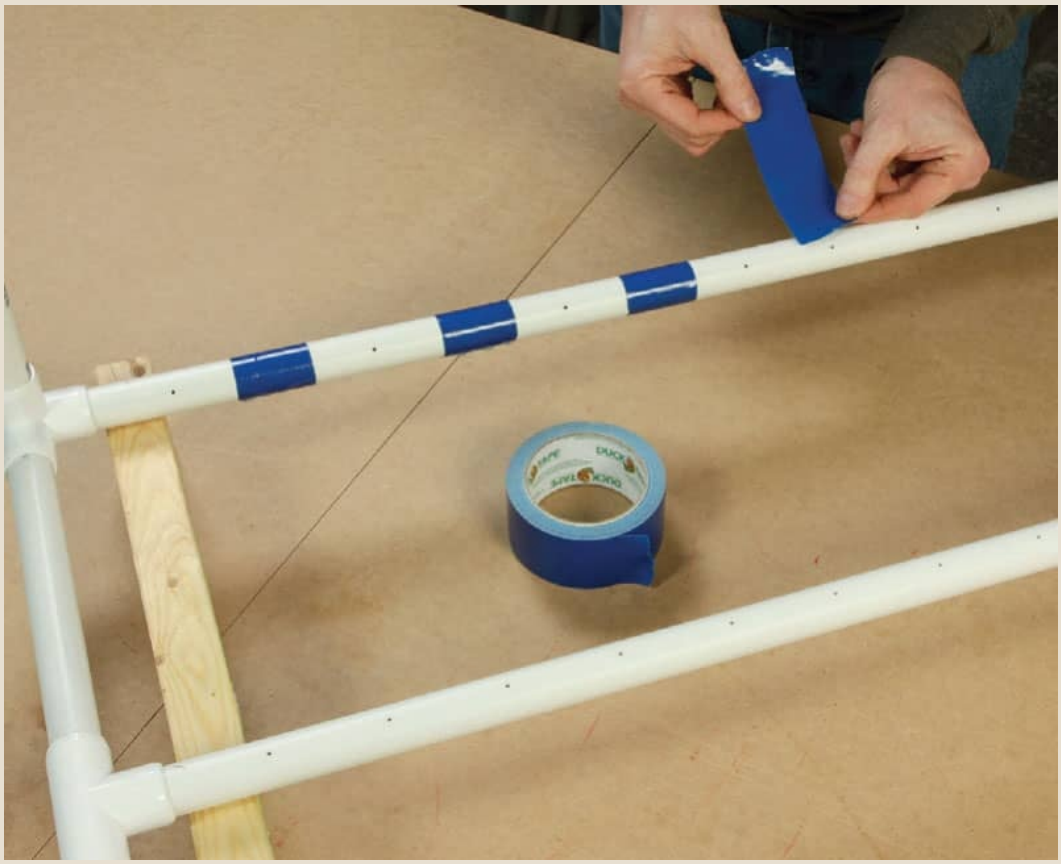
6 Dry fit the top together. Two 10" end braces are connected with a tee, with three-way elbows at the ends. The tee and elbows are connected to the top 38" spray bars (the assembly creates an “H”). Dry fit the assembly carefully onto the leg assemblies. The center top spray bar holes should be pointing directly down. Measure the diagonals to ensure the frame is square. Make key marks at the top connection points, disassemble, and cement the top pieces together.

7 Connect a garden hose to the leg hose fitting and turn the water on full pressure. Check that the spray bars all spray efficiently.

PET WASHER TIPS, TRICKS, AND MODIFICATIONS

Although you can resize this washer to suit your own brood or furry friend, there are other alterations you can craft that may make the washer easier to use and more efficient.

- **Add a base.** A key advantage to using PVC pipe in projects is its light weight. However, that can also be a disadvantage when building something like this washer, which needs to be stationary in use. You can add a stable foundation simply by leaving the end caps off the legs when you cement the legs together. Then, after the washer construction is complete, center the washer on top of an old pallet. Mark the positions of the legs, and screw down the end caps—right-side up—at the marks. Cover the screw heads with a dollop of silicone sealant, and cement the post ends into the caps. The pallet will weigh down the washer and hold it in place, even as your pet moves around under the spray of water. If you don't have an old pallet lying around, you can create a simple frame from scrap wood; use two 2 × 4 skids and 1× or 2× scraps for deck boards.
- **Reduce spray coverage.** Depending on your water pressure, the spray coming out of the holes in the spray bars of the washer may be unacceptably weak. Of course, you'll only find that out once you have constructed the frame. You can, however, correct the problem. Wait for the frame to dry completely after the initial test run, then cover some or all of a given spray bar's holes with duct tape—overlap several turns to ensure it stays on and covers the spray holes.



BIRDHOUSE

Birds rarely visit a backyard by accident. They come for food, water, housing, or all three. You'll have to decide if your garden is set up to supply the first two; the simple project outlined here takes care of the third.

The design of this birdhouse is both uncomplicated and well thought out. Keep that in mind if you decide to modify or customize the design. This one is meant for small songbirds. The trick to a birdhouse like this is to create a home that is sized correctly for the particular species you're looking to attract, with access they will find convenient, while also ensuring the house protects the residents against larger predatory birds, such as bluejays.

This design includes a removable bottom courtesy of a PVC waste cleanout assembly. The center of the fitting can simply be unscrewed when the birds move on to warmer climes, giving you the opportunity to clean the house each year. That will limit any potential for disease transmission or insect infestation and will ensure the house remains comfortable and inviting to potential occupants.

Although this version is meant to be hung by a chain or a cable (both of which are difficult for cats or squirrels to use as a means of access), you can also post-mount the house. Replace the cleanout assembly with a reducer bushing cemented to a 2-or 3-inch nipple, and then cement the nipple to a post made of PVC pipe cut to the desired length. The pipe can be secured in the ground or in a 5-gallon bucket filled with gravel.

This version is also painted. Although this takes a bit more time and effort, it's usually energy well spent, because basic white Schedule 40 PVC pipe can be a stark look in a yard or garden.

WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Chop saw, jigsaw, or hacksaw
Utility knife or 60-grit sandpaper
Marker
Power drill
$1\frac{1}{4}$" hole saw
Bar clamps
80-grit sandpaper
Eye and ear protection
Work gloves

MATERIALS

1' × $4\frac{1}{2}$" pipe
$4\frac{1}{2}$" cap
$4\frac{1}{2}$" waste cleanout assembly
PVC cement
#14 × 2" zinc-plated screw eye
Chain, cable, or twine, to suit
Spray paint meant for plastic

CUT LIST

10" × $4\frac{1}{2}$" pipe

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Remove any large burrs on the cut piece of pipe with a utility knife or coarse sandpaper. Ensure the cap fits easily on one end and the waste cleanout assembly on the other. With a grease pencil, mark the inset (how far the fixtures slide onto the pipe) on each end.

2 Measure and mark 2" down from the cap-end inset mark. This will be the top of the birdhouse hole. Clamp the PVC pipe to a level and stable work surface, and drill the bird hole with a 1 $^{1}/_{4}$" hole saw. Or, if you have a drill press, secure the pipe in a homemade V-block and drill it as shown.

3 Cement the cap on the top end, closest to the hole. Cement the waste cleanout assembly on the bottom. Once the cement has cured, thoroughly sand the house all over with 80-grit sandpaper. Paint the birdhouse your desired color scheme. (Birds will be attracted to a clean, safe, spacious house no matter what color it is, so choose according to your preference.) **4** Drill a pilot hole in the center of the top cap for the screw eye. Screw in the screw eye until it is firmly fixed in the cap. Hang the birdhouse from a tree branch or other support using fine chain, cable, or twine. It should be at least 10 yards from the house.

BIRDHOUSE WISDOM

This project doesn't include a perch for the birds, because larger, predatory birds can use the perch for attacks on the smaller songbird species for which this house is designed. The birdhouse

hole is 1 1/4" in diameter, but different birds prefer different size holes. Consult the chart below for the species you're looking to attract, or that is common to your area.

Bird	Hole Size	Placement Height from Ground
Eastern Bluebird	1 1/2"	8' high, in open area
Tree Swallow	1"	6–8' high, in open area
Purple Martin	2 1/8"	20' high
Tufted Titmouse	1 1/4"	8–10' high
Chickadee	1 1/8"	6–8' high
Nuthatch	1 1/4"	20–25' high
Wren	1"	8–10' high

Placement also affects whether birds will be drawn to a birdhouse. Keep a birdhouse far from any thick shrubs or branch growth that could serve as concealment or access for a cat or other predators. The birdhouse should be hung with a clear line of sight all the way around, to make the birds feel safe.

HANGING HERB GARDEN

Herbs are ideal container plants. They flourish in controlled environments, their growth habits are naturally well suited to confined spaces, and they don’t mind being moved around.

As containers go, the vertical style in this project is a wise choice for anyone who has limited space or just wants to make the most of his or her garden. Not only do the planters take up a very modest footprint, but the top planter also filters water down into those below it.

Like so many projects in this book, these planters are entirely customizable. Change the length of each planter to suit available space, and use fewer or more planters as your need requires. Of course, you can also use them for growing some vegetables or flowers, if you prefer those plants. Just be clear that the planters as designed are fairly substantial. Full of moist soil and plants, they’ll be heavy, and they’ll need proper support to hang safely and securely.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw or miter saw
Utility knife or 60-grit sandpaper
Cardboard template
(2) bar clamps
Marker
Power drill and bits
Jigsaw
Eye and ear protection
Work gloves

MATERIALS

MATERIALS

12' × 4" PVC pipe
(6) 4" caps
Tape
PVC cement
(8) 1/4" × 17/8" zinc-plated screw eyes #12 zinc-plated link chain
(8) zinc-plated S hooks

CUT LIST

(2) 48" planters

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the planter tubes to 4' from a 10' or longer section. (Buying uncut pipe will be much less expensive, especially with the larger diameter pipe used here.) With a utility knife or sandpaper, trim or sand all the cut edges smooth.

2 Measure and cut a planter-opening template from a large piece of stiff but thin cardboard. The template should be 5" × 38". Clamp the ends of one planter tube to a level, stable work surface, and center the template on top of the tube, running its length. Tape the template in place. Use a grease pencil or marker to trace a cutline around the template.

3 Remove the template and drill $^{1}/_{2}$" holes at the corners of the template trace lines. Use these holes as access for a jigsaw, and cut out the template shape from the top of the pipe.

4 With a utility knife or sandpaper, trim or sand all the cut edges smooth. Turn the planter upside down and drill a random pattern of $^{1}/_{32}$" holes along the bottom.

5 Cement a cap onto either end of the tube. Drill pilot holes, and screw a $^{1}/_{4}$" screw eye into the top and bottom of each cap's outer face. Repeat the process to construct the second planter, but the second planter should have screw eyes only at the top of the cap face.

6 If you're using drip irrigation, you can drill an access hole through the cap at this time (although the drip line can be run down the hanging chain and into the cavity after you've assembled and hung the planter). Fill the planter with soil and lightly water the soil. Plant the herbs.

7 Hang a chain from a strong overhead support (using the specified screw eye hooks or beefier sizes, keeping in mind the weight of three planters full of wet soil is significant), and use S hooks to connect the chain between the support screw eye hooks and the top screw eye hooks in the first planter. Then cut a length of chain to hang the next planter from the lower screw eye in each cap, connecting it with another S hook.

Optional: If you don't have a strong overhead support from which to hang these planters, you can attach them to a fence. Use heavy-gauge wire to fasten each planter to a cyclone or other mesh fence, or use heavy-duty pipe straps to attach the planters to a wood or solid fence. If using the pipe straps, drill holes and use bolts rather than screws.

MAKING THE MOST OF YOUR HERBS

Containers like the ones in this project are ideal for growing herbs, but a few simple strategies will ensure that you get the best crop possible after the planters are hanging and planted.

- **Guarantee good drainage.** Add a lightweight medium to the bottom of the planter before filling it with soil. Packing "peanuts" are ideal. Mixing perlite into the potting soil mix will also make for better drainage and lighter weight.
- **Position for sun.** Most herbs benefit from six full hours of direct sun a day, which translates to a south-facing wall or area.
- **Use potting mix.** The best base for your herbs is not potting soil, but potting mix, which is especially formulated for boosting plant growth and aiding drainage. It's also lighter than potting soil—an important consideration in any hanging planter.
- **Provide food.** In containers like these, frequent watering can wash nutrients out of the soil. Adding a little fertilizer will go a long way to ensuring your plants are well fed. A general houseplant water-soluble fertilizer at half strength will be a good once-a-month feeding.
- **Group by conditions.** Using multiple containers means you can create the conditions that best suit individual plants. The trick is to plant herbs that like the same growing conditions in the same planter. For instance, rosemary loves dry conditions with a modicum of water, while basil is a thirsty plant. The two will do best planted apart.
- **Add beauty.** Plant edible flowers, such as pansies, for delightful bursts of color in your planter and in your salads. Or introduce a few trailing foliage plants to soften the look of the planters.

FIREWOOD RACK

You know that big stack of firewood you have drying out alongside the side of your house? That's not just a stack of firewood. It's an insect high-rise. Creepy-crawlies, including some rather nasty characters, such as black widow spiders and all kinds of snakes, love the dark, tight quarters of stacked cord wood. The way to dissuade these tenants from ever taking up occupancy in your wood stack is airflow. When sunlight and air penetrate stacked wood, insects feel less comfortable and safe. That's one of the great advantages of a firewood rack such as this one.

PVC pipe is a perfect material for a firewood rack. The plastic is also incredibly durable, which means the rough treatment of coarse wood being placed and removed from the structure isn't going to phase the PVC one bit.

You can easily scale the rack up to accommodate more wood, but if you intend to appreciably increase the size, you should also increase the diameter of the pipe and fittings you use, from 1 1/4 inches to possibly 2 inches.

WHAT YOU'LL NEED

Time: **30 minutes** | Difficulty: **Easy TOOLS**

Tape measure

Chop saw, reciprocating saw, or hacksaw
Utility knife or 60-grit sandpaper
Speed square
Level
Marker
Eye and ear protection
Work gloves

MATERIALS

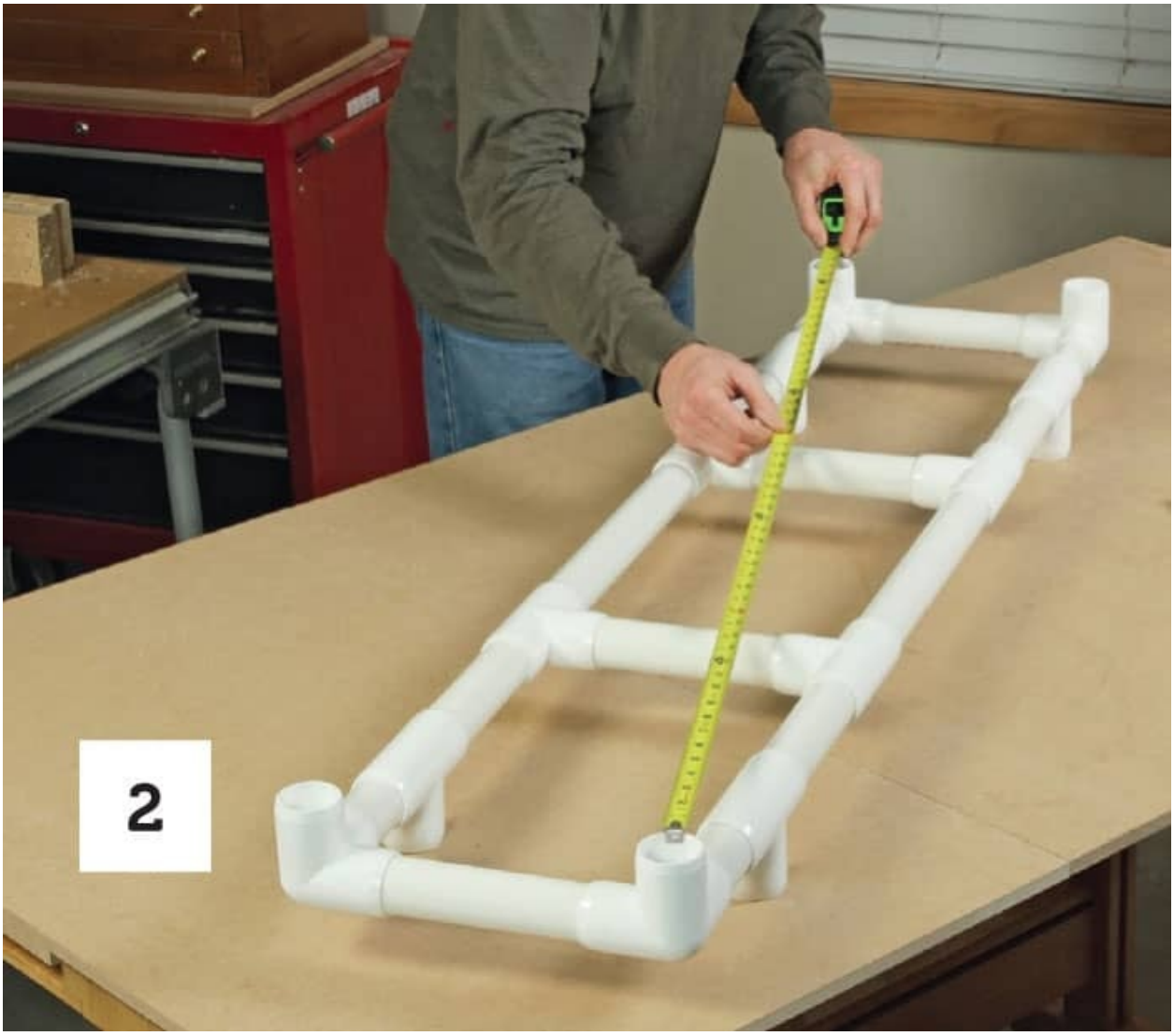
28' × 1 1/4" pipe
(8) 1 1/4" tees
(4) 1 1/4" three-way elbows
(4) 1 1/4" caps
(4) 1 1/4" elbows
PVC cement

CUT LIST

(4) 4 7/8" side end sections
(4) 8" side mid sections
(2) 14 1/4" side centers
(4) 8 1/4" crossbraces
(4) 5" legs
(4) 45 3/8" posts
(2) 8 1/4" handles

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.



2 Construct the base upside down on a flat, level surface. Each side is constructed with a 4 $^{7}/_{8}$" side end on either end, connected to 8" side middles through tees. Those tees are connected to either end of a 14 $^{1}/_{4}$" side center. The sides themselves are connected by 8 $^{1}/_{4}$" crossbraces through three-way elbows at either end and at the two center tees. As constructed, the two other

tees in the frame sides should point up (use a speed square to check that they are perpendicular to the other tees).

3 Cement the 5" legs into the upturned tees. Cement a cap onto each leg. Carefully flip the dry-fit frame over. Measure the diagonals to ensure the base frame is square, and use a level to ensure it is sitting flat and isn't twisted. Using a grease pencil, mark all the connections with key marks, and disassemble the base. Reassemble it joint by joint, cementing the pieces as you go.

4 Dry fit elbows onto each of the 45 3/8" posts, and connect the posts in pairs, with 8 1/4" handles slipped into the open elbow inlets. Measure and compare the handle assemblies side by side to ensure that they are exactly the same dimensions. Insert the posts in the elbows, and stand the posts in the base's three-way elbows. When you're satisfied that they are correct, make key marks at all the connections, disassemble the handles and posts, and cement them back together. Finally, cement them into the base.

Optional: To keep smaller pieces of wood from falling through the bottom of the rack, lay a bed of expanded sheet 11" × 46" along the base of the rack.

You can screw the sheet down to the base sides, but it will likely be heavy enough to not require any fastening.

STRAWBERRY TOWER

The beautiful strawberry is the gem of summer fruits. Unfortunately, gardeners aren't the only ones who think this little treasure is delectable. Strawberries are a favorite target of slugs and snails, not to mention larger critters such as raccoons and deer. That's why many gardeners choose to grow their crop vertically, in a small, sunny spot where they can protect and guard berries as they mature.

This tower provides maximum access to your plants, so that you can detect any damage or pests right away, heading off trouble before it gets worse. The pockets are just holes drilled into the pipe, and the addition of a watering tube makes this garden stunner low-maintenance. The plastic won't degrade under the elements, and no pests are going to eat their way through the material.

This type of tower allows you to completely control the growing culture of your strawberry crop. You'll be using potting mix (potting soil is less nutritious and it clumps, making it less efficient for the tower design), and you'll only have to refill the watering tube every so often to keep your plants hydrated and healthy.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Jigsaw or reciprocating saw
(2) bar clamps
Marker
Power drill and bits
2" hole saw
Utility knife or 80-grit sandpaper
Scrap 2× lumber
Trowel
Eye and ear protection
Work gloves

MATERIALS

4' × $4\frac{1}{2}$" pipe
50" × $\frac{1}{2}$" pipe
$4\frac{1}{2}$" cap
$\frac{1}{2}$" cap
PVC cement
Landscaping fabric roll
Electrical tape
5-gallon bucket, large plastic plant pot, or large terra-cotta pot
Bag river pebbles
(2) bags potting mix
Strawberry starts

CUT LIST

48" × $4\frac{1}{2}$" tower
50" × $\frac{1}{2}$" watering pipe

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Clamp the large pipe to a work surface. Measure and mark for holes every 4" to 5" along the length of the pipe (stopping 10" from one end, which will be the bottom).

2 Use a drill fit with a 2" hole saw to drill holes on the marks. Rotate the pipe, and mark another column of holes staggered with the first. Drill those holes

and repeat the process with a third set of holes.

3 With a utility knife or sandpaper, trim or sand all the cut edges smooth. The edges do not need to be perfectly smooth.

4 Clamp the $^{1}/_{2}$" water tube pipe to the work surface, on top of a scrap piece or pieces of 2× lumber. Drill a random pattern of $^{1}/_{16}$" holes, spaced about 1" apart, all along the length of the pipe. Drill all the way through the pipe, into the wood, to make sure the pipe has holes all the way around its circumference.

5 Cement a cap onto the bottom (undrilled end) of the strawberry tower. Be careful that no primer or cement are applied to the inside surface of the pipe. Wrap the drilled water tube in landscape fabric, and tape the fabric in place.

6 Stand the strawberry tower in the center of the 5-gallon bucket, or whatever container you're using to hold the strawberry tower. Pour gravel around the base of the tower, up to the first set of holes in the tower. This will hold the tower upright.


7

7 Carefully position the watering tube standing in the center of the strawberry tower. Start troweling potting mix in around the watering tube, up to the first holes (this will be much easier if you use an assistant to hold the watering tube).

8 When the soil is up to the first set of holes, plant strawberry starts in the holes, firming them in place. Add more soil on top of the plants and use a long scrap piece of 1× or similar tool to tamp down the potting mix around the newly planted starts. Continue adding potting mix and planting the starts until you reach the top of the strawberry tube. Fill the watering tube with water, and slip a $^1/_2$" cap onto the top of the watering tube. Position the tower where it will receive about 6 hours of direct sun a day.

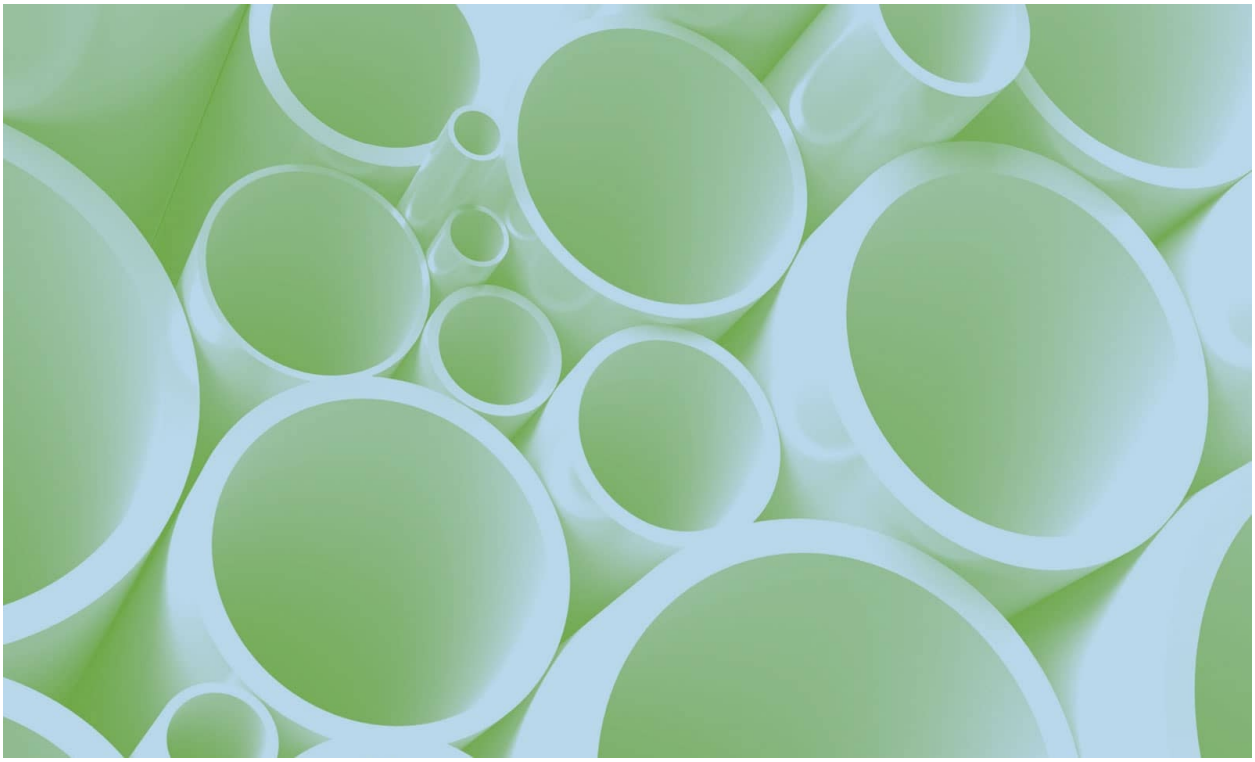
4 AROUND THE HOUSE

Some of the best uses for PVC pipe are furnishings. It's not coincidence that a whole cottage industry has sprung up around selling "furniture-grade" PVC pipe and fittings made specifically for constructing furniture. These include pieces with no markings and a high-gloss finish and fittings with extra inlets that would make no sense to use in plumbing.

Although you can find some suppliers of furniture PVC pipes and fittings in the Resources section shown here, the projects in this book were meant to be as accessible and easy to source as possible, so all the fittings are easily purchased from any well-stocked hardware store. That said, there are still amazing options in furniture design using standard PVC pieces.

The diversity of projects in this chapter is proof positive of those options, but there is no getting around the fact that PVC will never be as handsome as hardwood. That's why the projects here mostly focus on the utilitarian—structures that will make life easier, serve a much-needed purpose, and will take a beating.

As with projects in the other chapters, the designs here are adaptable. In fact, most of these can easily serve as departure points for your own flights of fancy. The underlying logic should be clear and allow you to build on the designs to make them your own. Modify them as you see fit to suit them to your own circumstances and home.



Coffee Table Two Ways

Bookshelf

Large Work Desk

Step Stool

Quick 3

- *Towel Rack*
- *Vase*
- *Shoe Rack*

Puppy Pen

Toy Bin Frame

Table Lamp

Patio Chair

Privacy Screen

Safety Gate

COFFEE TABLE TWO WAYS

There are two basic styles of coffee table: round and rectangular. They are suited to very different spaces and design styles. Traditional rectangular tables are more common and suit a wide range of interiors, from Mid-Century Modern to plain old modern. Round tables are better suited to square rooms and large spaces. They fit in with interior styles that typically value curving forms, such as Art Deco.

But, of course, your living room coffee table should reflect your own design style and tastes. Given that the coffee table is a centerpiece and one of the most important pieces in a living room suite, we've included designs for both styles.

Regardless of which you choose, you'll find the project incredibly easy. You won't spend a lot of time or effort building either of these. You should, however, spend some time on the top for either one. Either table will look its best if the base is painted, but the top will be the icing on the cake. As shown, both tables have high-quality plywood tops, but a glass top is more common to the circular form. You can swap for a different material; just keep in mind that whatever you use for the top needs to look great and hold up to some expected abuse such as spilled food and drink.


1
2

TABLE 1

WHAT YOU'LL NEED

Time: **30 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Chop saw, miter saw, or hacksaw
Utility knife or 80-grit sandpaper
Marker
Speed square
Eye and ear protection
Work gloves

MATERIALS

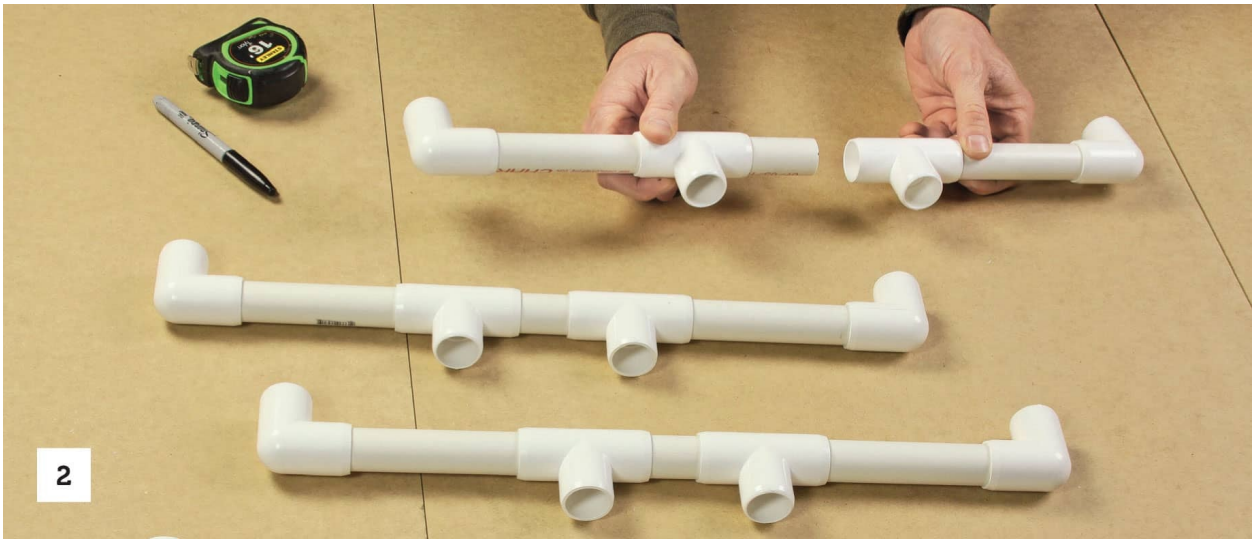
14' × 3/4" PVC pipe
(8) 3/4" elbows
(12) 3/4" tees
PVC cement
Primer and paint (optional)
44" × 24" birch plywood top
(4) 1" felt furniture pads

CUT LIST

(8) 5 3/4" long arms and legs
(4) 3" arm and leg centers
(4) 4 5/8" post tops
(4) 2 1/4" post bottoms
(2) 37 1/4" shelf braces

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.

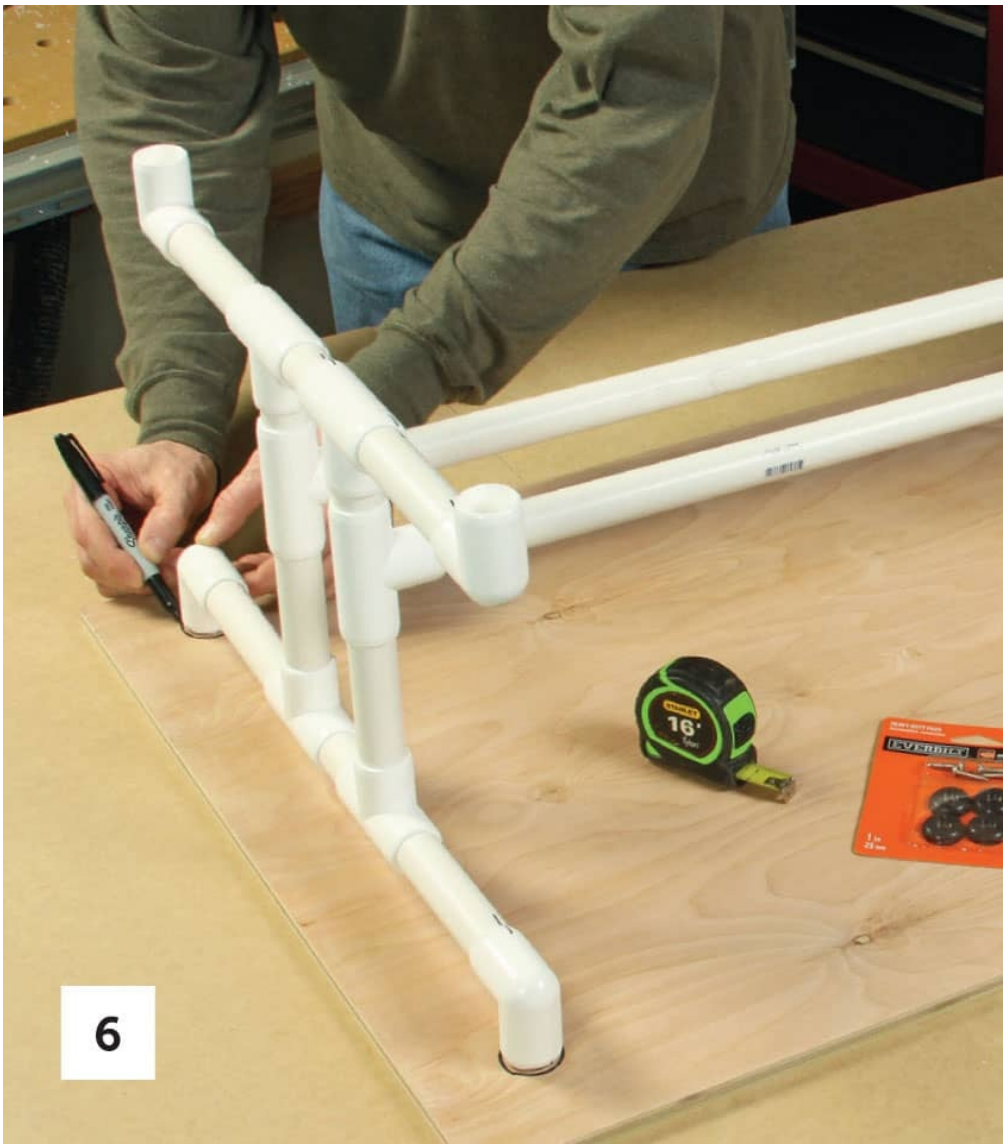


2 Working on a flat, level work surface, dry fit the legs and arms. The assemblies are identical, with elbows at each end connected to 5 $^{3}/_{4}$" arms or legs, which are connected to 3" centers through two tees. The elbow inlets on each assembly should point in the opposite direction of the tee inlets.

3 Measure and check that each arm and leg assembly is exactly the same length as the others. With a grease pencil, mark all the connection points with key marks, disassemble, and cement the pieces together.

4 Lay an arm and leg pair on a flat, level work surface. Dry fit two posts together, each with one 4 $^{5}/_{8}$" post top connected to a 2 $^{1}/_{4}$" post bottom through a tee. Dry fit the posts between the arm and leg tees. Check that the post tees face directly up, perpendicular to the arm and leg, using a speed square.

5 Make key marks at all the post connection points. Disassemble them, and cement them together and into the arm and legs.



6 Dry fit the 37 1/4" shelf braces between the post tees in each leg pair. Check that the frame sits evenly and doesn't wobble. Cement the braces into place. Paint or finish the plywood table top as your prefer. Rest it on top of the legs and position it so that there is equal overhang on the sides and ends. Mark the locations where the leg elbows contact the bottom of the tabletop. Remove the top and stick 1" round furniture pads to the wood at those locations, to hold the tabletop in place on the legs.

TABLE 2

WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Chop saw, miter saw, or hacksaw
Marker
Utility knife or 80-grit sandpaper
Torpedo level
Eye and ear protection
Work gloves

MATERIALS

14' × 3/4" PVC pipe
(2) 3/4" crosses
(8) 3/4" tees
PVC cement
Primer and paint (optional)
30" diameter glass or plywood top
(4) 1" adhesive vinyl surface bumpers

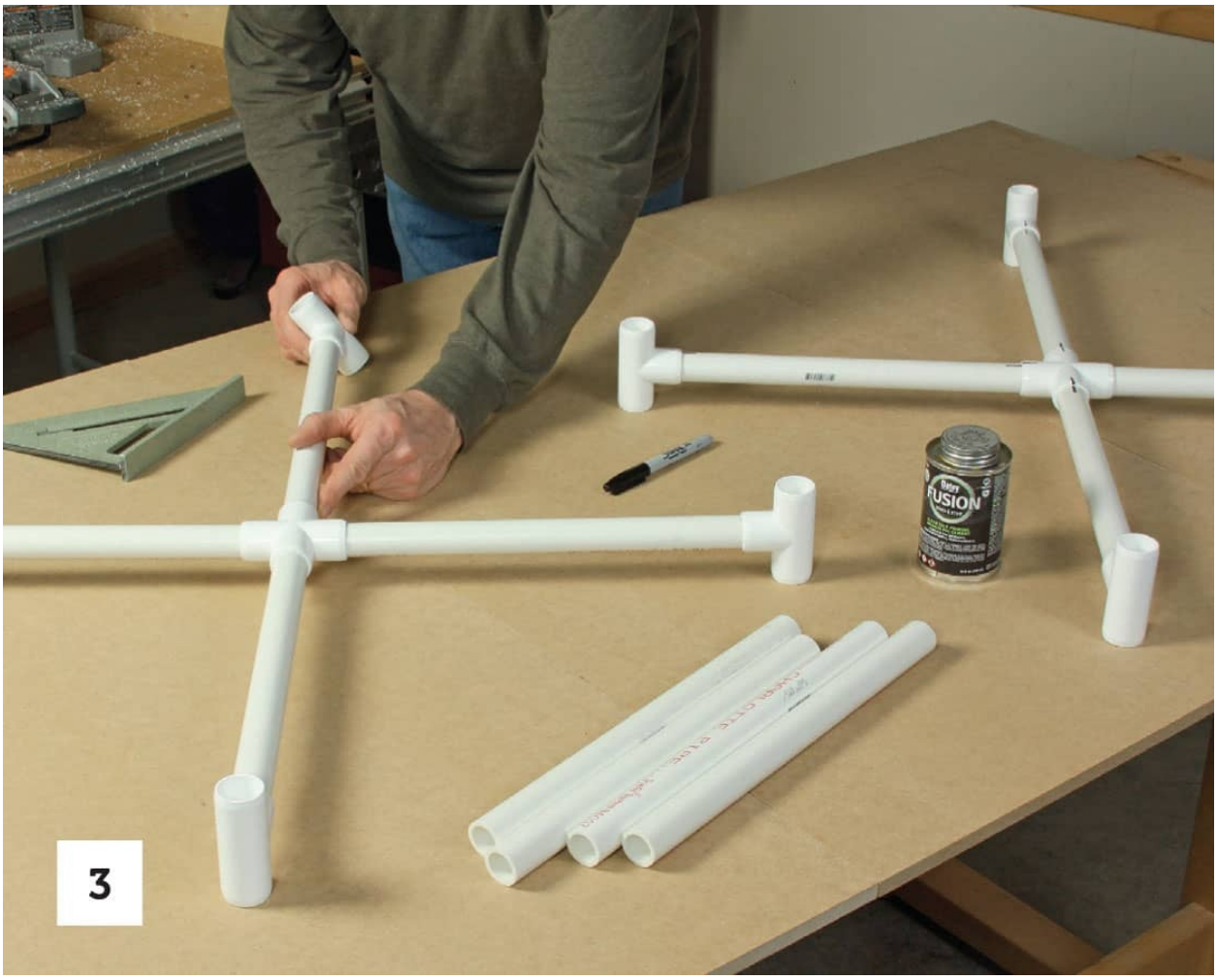
CUT LIST

(12) 13 1/4" sections

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut one pipe segment to length as listed on the cut list, and use it as a template to mark and cut the rest. With a utility knife or sandpaper, trim or sand all the cut edges smooth.

2 Cement a section into each of the inlets on both of the crosses.



3 Working on a flat, level surface, dry fit tees onto the end of each spoke radiating from the crosses, so that the tees are sitting on end holding the cross assembly up off the surface. The two assemblies should sit stable, with the inlets of the tees exactly perpendicular to the cross inlets. Use a torpedo level to ensure that each of the tees is plumb. When you're satisfied that the tees are positioned correctly, use a grease pencil to make key marks on the tees and pipe ends. Disassemble both upper and lower assemblies, and cement the tees onto the ends of the pipe sections.

4 Join the tees of the upper and lower sections by cementing posts between the inlets. Paint the base as desired, and stick a transparent vinyl surface bumper on top of each top tee. Rest the glass top in position with an equal amount of overhang all around.

BOOKSHELF

Despite the name, the best bookshelf isn't limited to holding books. Ideal bookshelf units are adaptable to whatever you want to store and sized perfectly for different areas where you might need that storage. This is just that type of bookshelf.

The design is meant to make the most of PVC's rugged nature, because shelves full of books can be extremely heavy. The unit is consequently durable enough to serve as a utility shelf in a garage, workshop, garden shed, or even in an outdoor area alongside the house (the PVC weathers well, but you'll have to be careful in the material you choose for the shelves if you're using it outdoors).

The dimensions were purposely designed to provide lots of extra space on the shelves. This means that you can store a passel of large books or even a combination of knickknacks and books. But it also means you could feasibly use the shelves to store cans of paint, power tools, gardening supplies of all sizes and shapes, and just about anything else you might need to put on them.

The major variable is the shelving material. The project as shown here includes wood shelves, which are both handsome and supportive. You can paint or finish them as you desire, and they'll hold up over the long run. But you could just as easily use glass shelves, if you wanted the unit to fit into a living room or large bathroom, or expanded sheet, if it will be doing duty in a workshop.

Do keep in mind that because the shelf is tall and relatively thin, it must sit on a stable, level surface. You should also secure it to a wall or exposed studs—you can find more information on doing just that in the box shown here.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Medium TOOLS**

Tape measure

Chop saw, miter saw, or hacksaw

80-grit sandpaper

Marker

Eye and ear protection

Work gloves

MATERIALS

29' × 1" PVC pipe

(4) 1" caps

(20) 1" tees

(4) 1" three-way elbows

(8) Saddle clamps (optional)

PVC cement

Primer and paint meant for plastic and/or wood (optional)

(12) 1 × 4 × 24" clear boards or (4) 10 $^{1}/_{2}$" shelves of $^{1}/_{2}$" plywood or similar material CUT LIST

(4) 4 $^{1}/_{2}$" leg bottoms

(4) 3 $^{1}/_{2}$" leg nipples

(12) 10 $^{1}/_{4}$" leg middles

(4) 11 $^{1}/_{2}$" leg tops

(8) 12" shelf supports

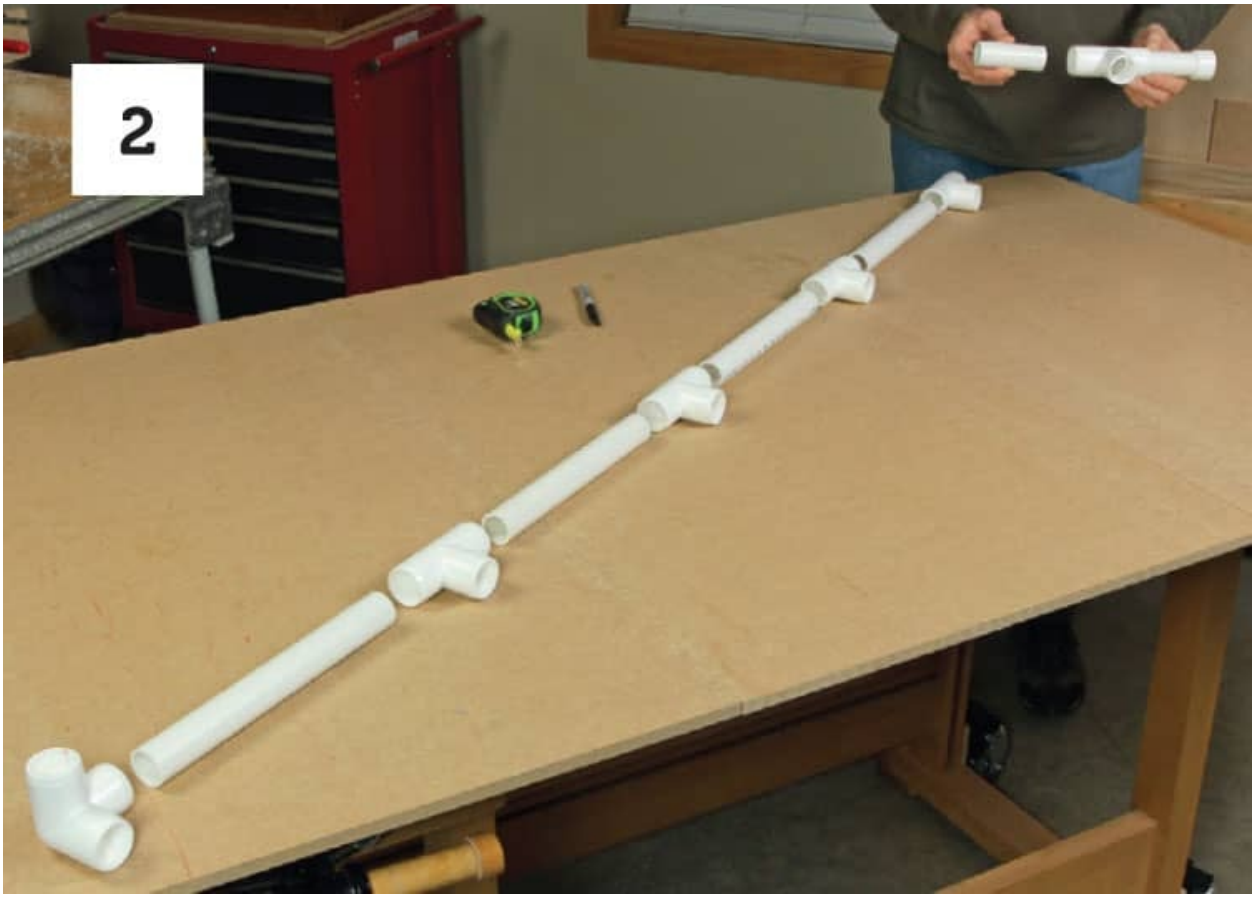
(2) 12 $^{1}/_{2}$" top side braces

(2) 20 $^{3}/_{4}$" bottom braces

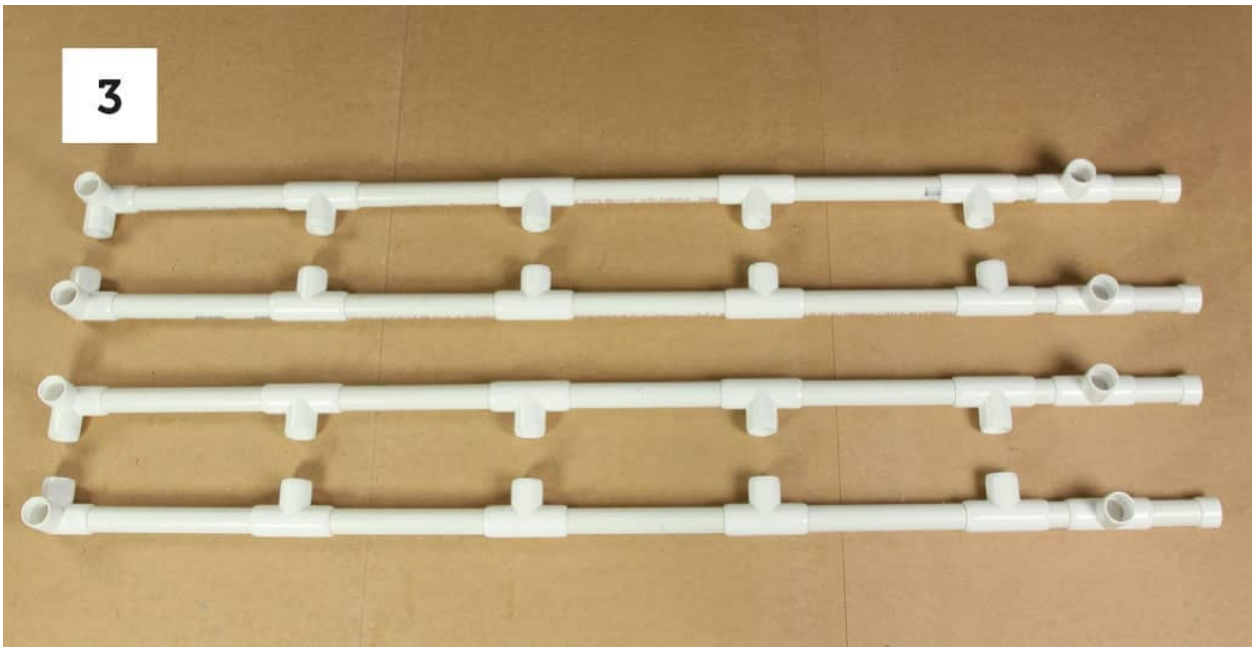
(2) 20 $^{3}/_{4}$" top braces

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand them so that the cut edges are completely smooth. Clear a large work area to stage the construction of the bookshelf.



2 Start by laying out and dry fitting one front leg, with a cap on the bottom of a 4 $^{1}/_{2}$" leg bottom, then a brace tee, a 3 $^{1}/_{2}$" nipple, and then the first shelf tee (pointing perpendicular to the brace tee). From that point alternate the three 10 $^{1}/_{4}$" leg middles with tees, topped with a 11 $^{1}/_{2}$" leg top and a three-way elbow.



3 Carefully dry fit the three remaining legs in the same manner. Pay close attention to the direction of the inlets on the elbows and tees. To ensure that the leg assemblies are plumb when upright, and that the braces and shelf side sections all fit in place, you'll want to construct the legs with one elbow inlet and the bottom brace tee pointing straight up, perpendicular to the other tees' inlets. This can be tricky, so take your time and envision the legs fitting together.

4 When you're certain that all the inlets on each leg are pointing in the correct directions, use a non-permanent marker to mark all the connections with key marks. Completing one leg at a time, disassemble the leg, and cement it back together. Repeat with the remaining legs.

5 Dry fit the 12" shelf supports between a back and front leg pair, fitting the 12 $^1/_2$" top side brace at the top. Measure at several points to ensure the legs are the same distance along their entire length and are parallel with the shelf supports in place. When you're satisfied that the construction is square and stable, cement each shelf support into a front leg tee, and then cement the back leg tees onto the shelf supports.

6 Stand the leg pairs upright and connect them on the bottom with the front and back 20 3/4" bottom braces, and on the top with the front and back 20 3/4" top braces. Measure the internal diagonal distances of the frame to check that the frame is square. Cement the braces into the elbows and tees on one side, and then cement the opposite side onto the braces.

7 Prime and paint the frame if you prefer. Paint or finish the shelves, or leave them natural. Install them loose, or secure them to the shelf supports with screws or saddle clamps.

SAFETY FIRST

Whether you're using this handy creation in the house to hold books and knickknacks or have built it for rugged garage duty, secure the unit to a wall. A tall piece of furniture such as this poses the possibility of falling over if bumped or jostled. That could result in breakage or injury,

consequences that are easily avoided with a simple hardware store solution—a furniture strap. There are many different furniture straps available, but most are meant for solid-surface furniture. That means you may have to customize the version you buy (although some are designed specifically to wrap around legs or poles). In any case, the strap is secured on one end to the shelf unit, as close to the top as possible, and to a wall on the other end. The wall end must be screwed into a stud or a wall anchor rated for the weight of the shelf unit when stacked with whatever you'll be storing on it.

LARGE WORK DESK

It doesn't matter whether you're drafting plans for a new house, running a marketing business, or writing a book on the many wonderful uses of PVC pipe: a large work desk is a true luxury.

The large dimensions of this desk are based on the standard-size hollow-core door that serves as the top. The benefit of using this unusual surface is that it is relatively inexpensive, lightweight, and durable. However, it's an odd surface on which to write, so you might want to plan on buying a desk blotter if you tend to write a lot rather than use your keyboard.

The desk is built from the top of the frame down, and each stage of construction relies on careful measuring and alignment. As with several other projects in this book, any mistake will quickly be magnified. Measure carefully and be very aware of the directions different tee and elbow inlets point, because the last thing you want is a wobbly desk.

FINE FINISH

Although you can leave the desktop in this project unfinished, hollow-core doors usually have a slightly rough surface that is meant to be painted. It's easy enough to paint your door before placing it on or attaching it to the frame, but you can also go in a different direction. Purchase dry pigments from an art or crafts store in your favorite color. Mix the pigment in with polyurethane finish, and then finish the door with the polyurethane. It's a totally unique look that also creates a perfectly smooth top surface that may be more comfortable for you to use.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw or tablesaw
Utility knife or 80-grit sandpaper
Speed square
Marker
Level

Eye and ear protection
Work gloves

MATERIALS

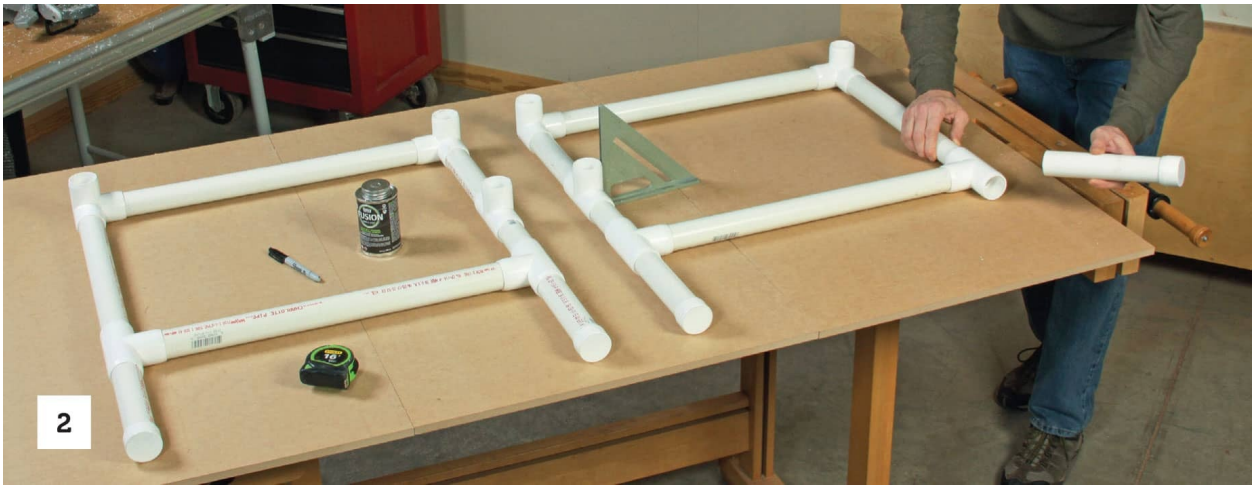
30' × 1 1/4" PVC pipe
(4) 1 1/4" three-way elbows
(7) 1 1/4" tees
(5) 1 1/4" caps
1 1/4" cross
PVC cement
(4) 1/4" self-adhesive vinyl furniture bumpers 30" × 80" hollow-core door
(4) saddle straps (optional)

CUT LIST

(2) 24" top side rails
(2) 17" front leg uppers
(4) 8 1/2" leg bottoms
(2) 24 1/2" leg rails
(2) 9 1/2" rear leg uppers
(2) 5 1/2" rear leg middles
(2) 31" rear bottom rails
15 3/4" rear bottom posts
9 1/2" rear top post
(2) 31 1/8" rear top rails
64" front rail

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.



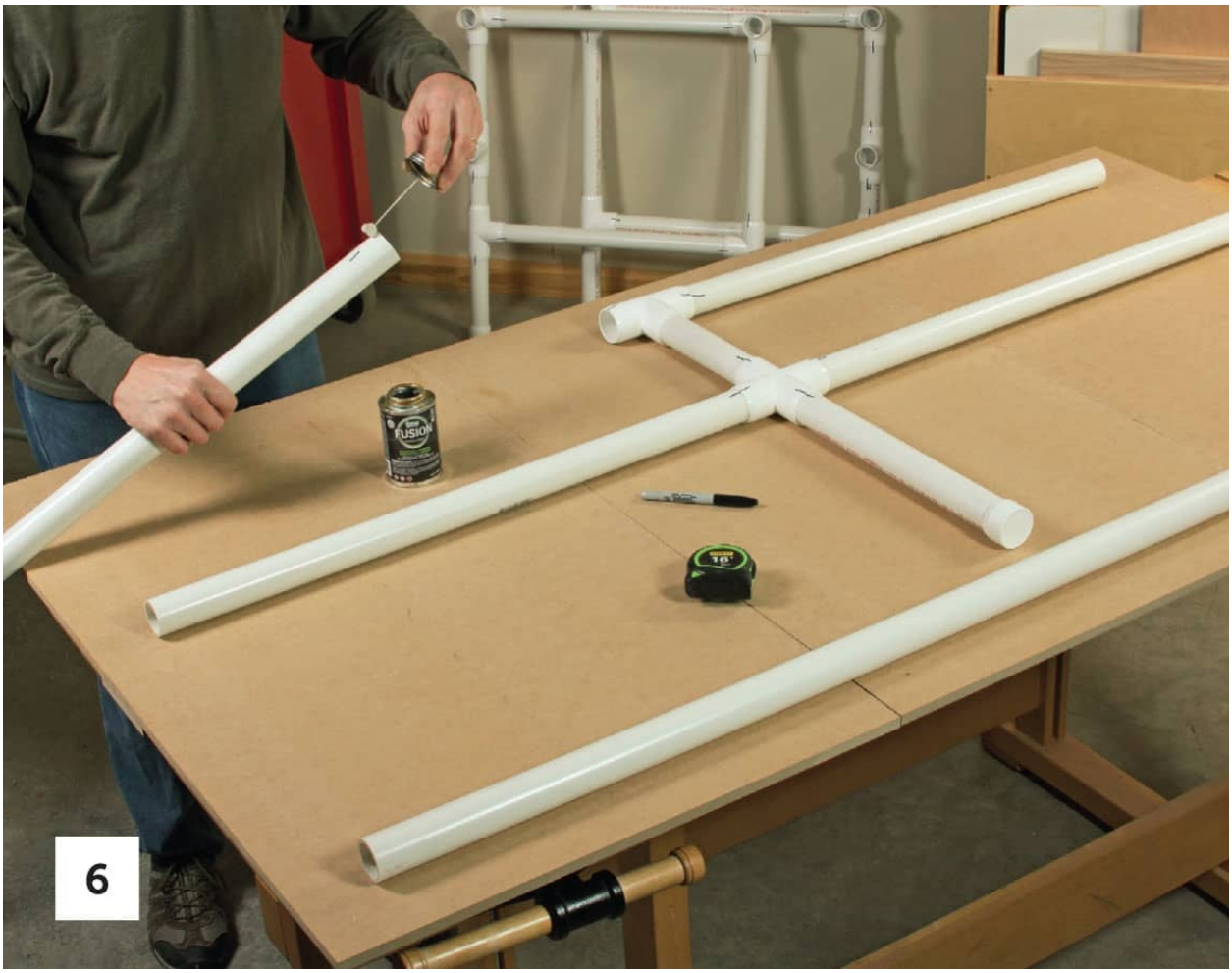
2 On a flat, level work surface, dry fit a leg assembly together, including the top rails. Run a 24" top side rail between two three-way elbows, with one inlet pointing up. Connect the perpendicular inlet of one elbow to the side inlet on a tee with a 17" front leg upper. Insert an 8 $^1/_2$" leg bottom in the open inlet of the tee, and slip a cap onto the other end of the bottom.

3 Slip a 24 $^1/_2$" leg rail into the open inlet on the leg tee. Build the back leg, with a 9 $^1/_2$" rear leg upper connected to a tee. Slip a 5 $^1/_2$" rear leg middle into the other end of the tee, and another tee onto the opposite end of the rear leg middle. Insert an 8 $^1/_2$" leg bottom in the open inlet of the tee, and slip a cap onto the other end of the bottom. Slip the rear leg into place, with the open end of the rear leg upper sliding into the perpendicular inlet of the three-way elbow and the center inlet of the second back leg tee sliding onto the leg rail.

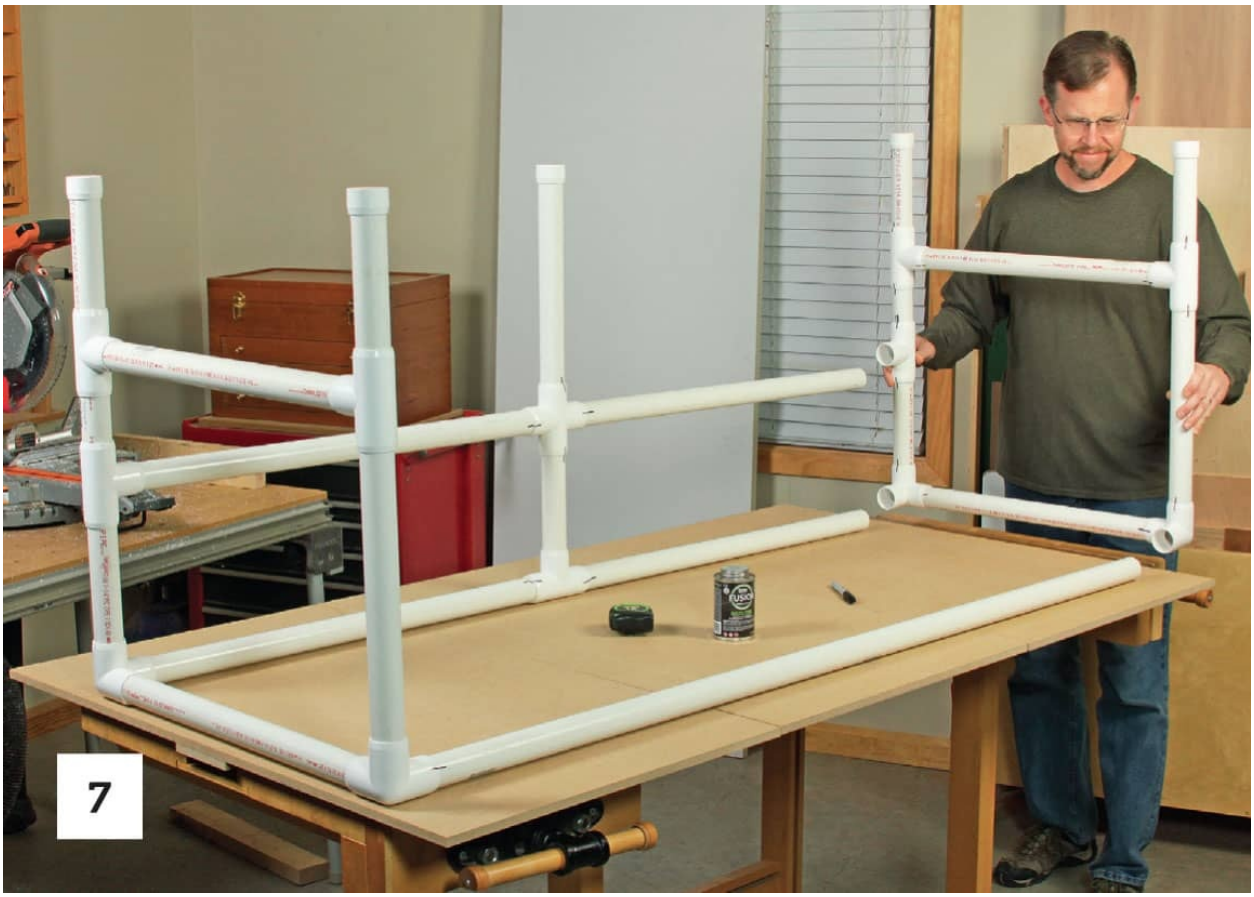
4 Measure the diagonals to ensure the leg assembly is square. One inlet of both three-way elbows and the open inlet on the upper back leg tee should point directly up from the assembly. Check the tee inlet with a speed square to ensure it is correctly oriented. With a grease pencil, make all the key marks.

5 Disassemble the leg and cement it back together. Dry fit the second leg assembly in the same way—but creating a mirror image assembly, because

the two will face each other. Check that the dimensions of both assemblies are identical. Then disassemble and cement the second leg assembly back together.



6 Build the back rail assembly by laying the cross flat and inserting 31" rear bottom rails into either side. Insert the 15 3/4" rear bottom post into the bottom of the cross, and slip a cap on the opposite end of the post. Slip the 9 1/2" rear top post into the remaining cross inlet, and slip the center inlet of a tee onto the other end of the top post. The cross and the tee should both be lying flat. Make key marks on the top post at the cross and tee ends. Disassemble the back and cement it back together. Cement one 31 1/8" rear top rail into each side of the top post tee. Allow all the cement and assemblies to fully cure.



7 Stand up the rear assembly and dry fit the rear leg tee and three-way elbow of a leg assembly onto either side. Join the front legs by dry fitting the 64" front rail between the two front leg three-way elbows. Measure the diagonals to ensure the frame is square and that the frame does not wobble. Adjust as necessary.

8 Position the frame where you want to put the desk. Stick four self-adhesive vinyl bumpers (or felt pads) centered onto the top of each frame elbow. Position the door in place on top of the frame, and measure to ensure that the overhang is the same on both sides, and front and back.

Optional: If you want to more firmly secure the door in place on the frame, use saddle straps to secure the top frame rails to the underside of the door.

STEP STOOL

A step stool is one of those small but essential pieces of furniture that homeowners don't know they need until they need it . . . and then they really need it. This useful boost can save you back injuries, falls off of rickety chairs, and breakage from the occasional dropped item. Start using a step stool and you'll find yourself turning to it regularly to make your life easier and safer. It offers big benefits for such a small home addition.

The hallmark of any step stool worthy of consideration is stability. It has to be rock solid or what's the point? That quality was the starting point for the design of the step stool in this project. It's built from hefty 1-inch PVC pipe and fittings for just that reason. This step stool is sturdy enough to use in the kitchen, anywhere there's a closet, and even rough-and-tumble duty in a workshop or garage.

If you or whoever is going to use the step stool is particularly large or heavy, you may want to upgrade to 1 $^1/_4$-inch or even 1 $^1/_2$-inch pipe and fittings. Adjusting the design should be fairly easy because it's all straight lines, and if you miss the mark by an inch, it's not going to change how easy the step stool is to use.

The version shown in this project isn't painted, and the wood steps aren't stained or otherwise finished. But that doesn't mean you can't beautify your version. Because of its compact structure, spray painting the step stool would be a fairly easy task requiring only a masked-off corner of a garage or utility shed. The steps, of course, can be painted, stained, or finished natural, as you prefer.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw, miter saw, or tablesaw
80-grit sandpaper
Padded vise
Metal ruler or other straightedge
Marker
Paintbrush (optional)
Power drill and bits
Eye and ear protection
Work gloves

MATERIALS

26' × 1" PVC pipe
(16) 1" three-way elbow
(6) 1" crosses
(6) 1" tees

1 × 8 × 48" board

Wood finish or paint (optional)

(18) #8 × 2" hex head machine screws

PVC cement

CUT LIST

(14) 9 1/4" rails

(9) 9 1/2" tread braces

(18) 5" legs

(4) 4" short rails

(3) 1 × 8 × 12" wood steps

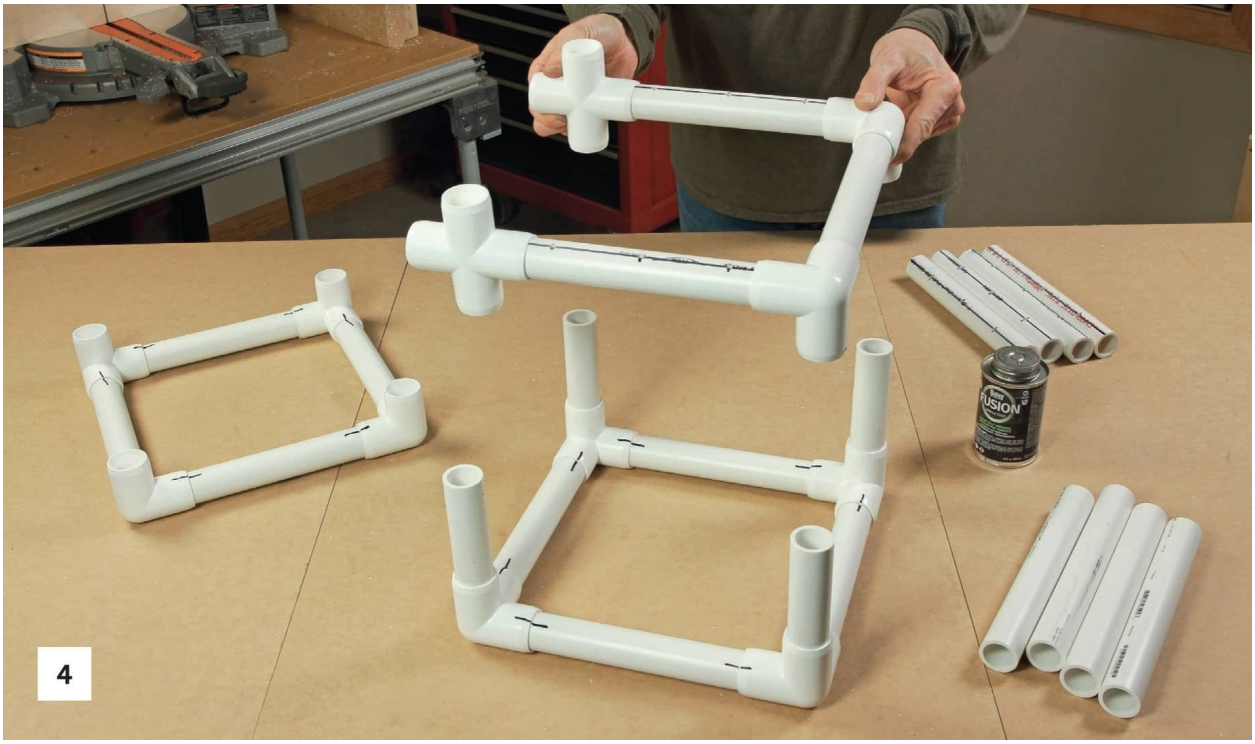
HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand them so that the cut edges are completely smooth.

2 Clamp one 9 $^{1}/_{4}$" rail in a vise with padded jaws (or bar clamp it to a work surface with a waste piece of 2× stock underneath). Use a straightedge and grease pencil to draw a straight line along the length of the pipe. Mark a hole on the line 2" in from one end and then two others spaced equally along the

line. Carefully drill pilot holes at the marks, using a bit smaller than the 1 3/4" Torx screws. Repeat with five other 9 1/4" rails.

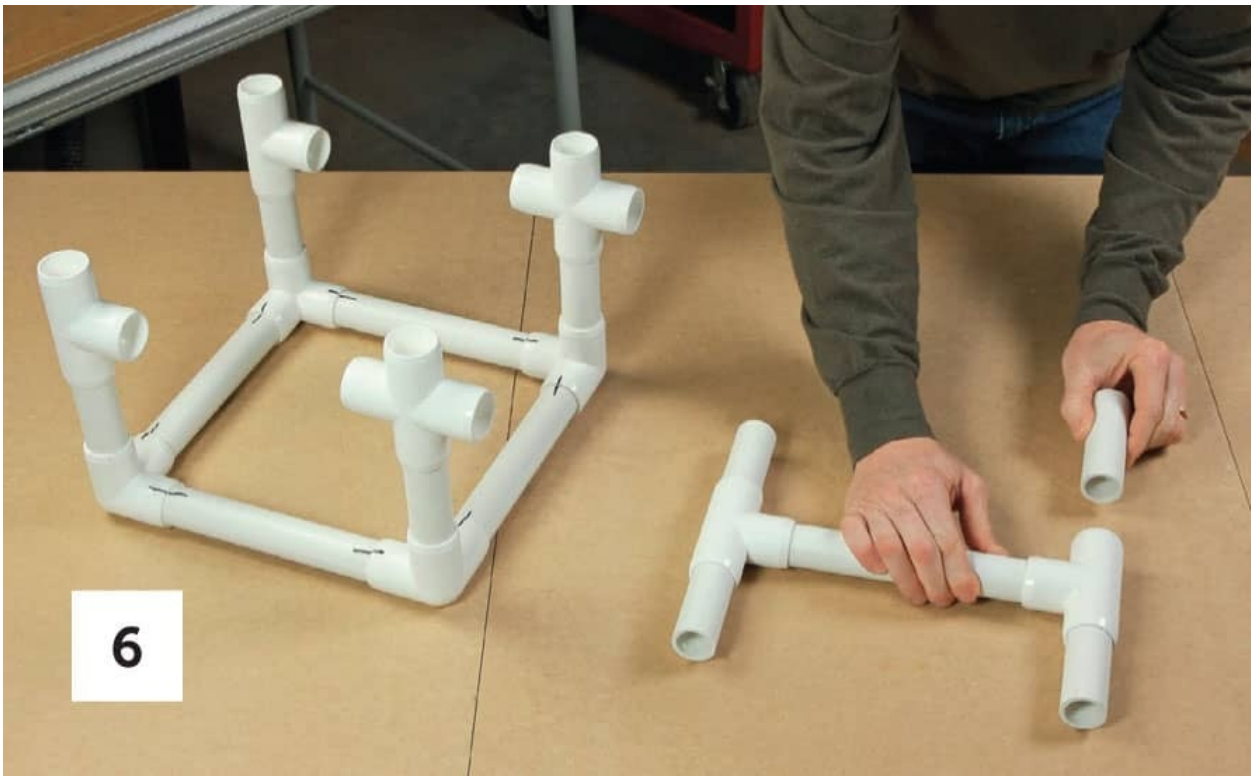
3 Dry fit the bottom frames for the front and back steps, consisting of two undrilled 9 1/4" rails on the sides and two 9 1/2" tread braces front and back, all joined by three-way elbows. Build the frames on a flat, level work surface, and check the diagonal measurements to ensure square. Make sure that the frames sit absolutely flat, and then use a marker to mark all the connections with key marks.



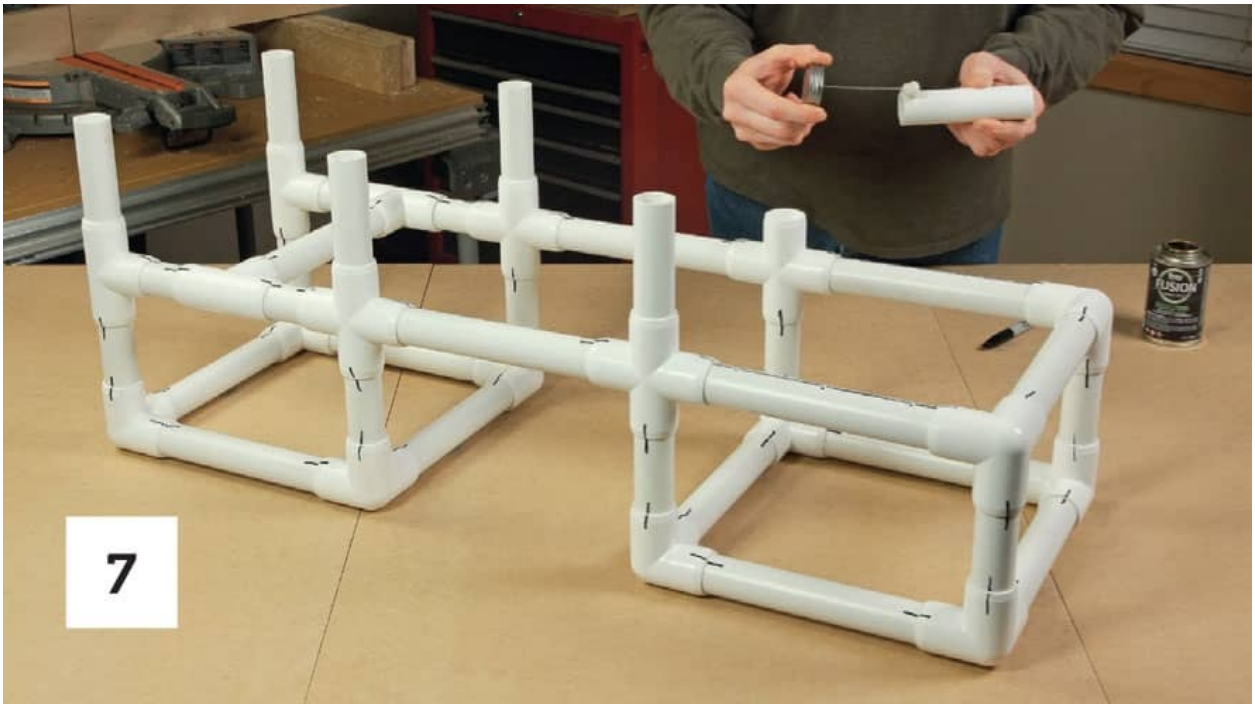
4 Disassemble both bottom frames and cement the pieces together. Construct the first step by dry fitting a 5" leg into each open three-way elbow inlet on one bottom frame. Top two of these legs on either side of a tread brace (the front of the step) with three-way elbows and the opposite two legs with crosses pointing at the inlets of the elbows. Insert a drilled 9 1/4" rail between each cross and elbow, with the holes pointing directly up and down. Insert a 9 1/2" tread brace between the elbows. Check the diagonal measurements to ensure the top is square. Mark each joint with key marks, disassemble, and cement the pieces back together.

5 Insert a 5" leg into each open inlet in the three-way elbows, forming the second bottom frame. Top the two legs along one longer tread brace with crosses. Top the other two legs with tees. Install undrilled 9 1/4" rails between

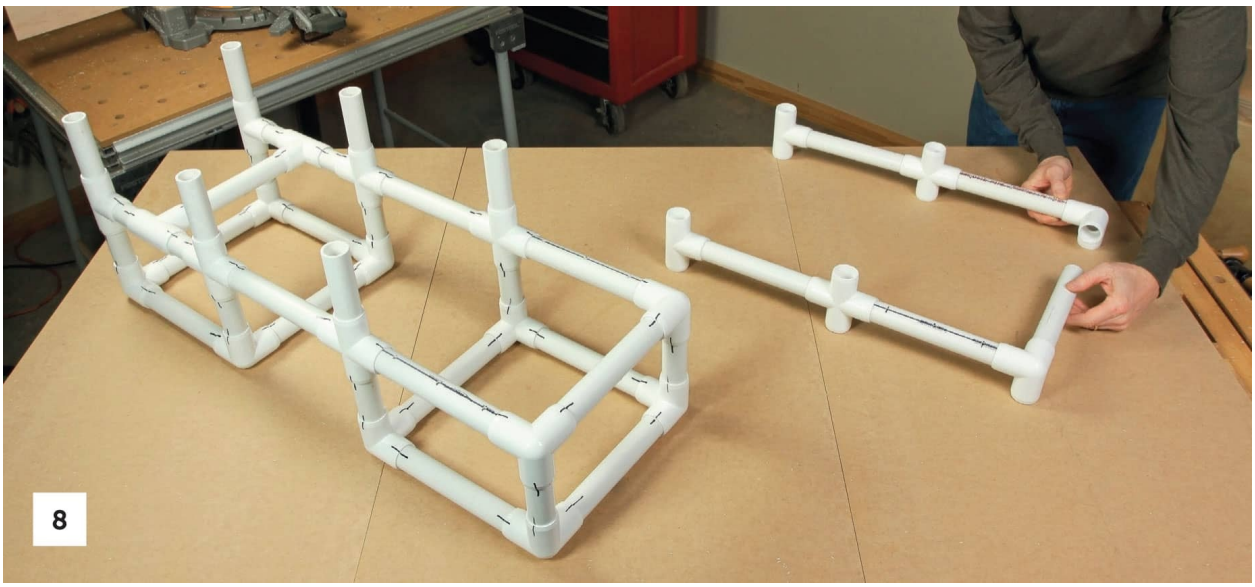
the tee and the cross on each side. Measure diagonally between the tee and crosses to ensure the fittings are lined up correctly. When you're happy that the frame is absolutely square, make key marks at all the connections. Disassemble the pieces and cement them back together.



6 Dry fit an "H" by inserting four 4" short rails into either ends of two tees and joining the two tees with a 9 $^{1}/_{2}$" tread brace. Insert the H between the tees and the crosses in the second base frame. Make key marks at all the connections on the H, remove and disassemble it, and cement the pieces back together and into the tees and crosses of the base frame.



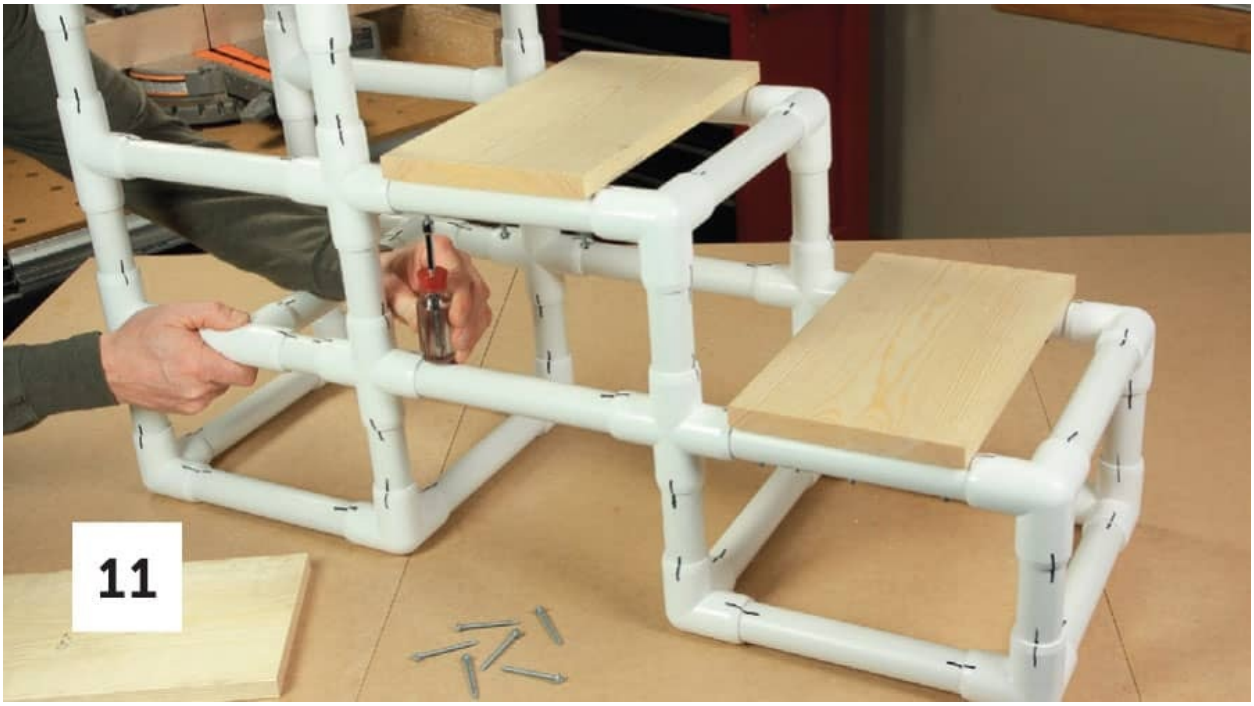
7 Join the two base frame assemblies by cementing undrilled 9 $^{1}/_{2}$" rails between the crosses of both base frames. Cement 5" legs into the crosses.



8 Place three-way elbows on the front-side legs and crosses on the back legs. Dry fit two drilled 9 $^{1}/_{4}$" rails between the three-way elbow and cross on each side. The holes should be pointing directly up. Install a tread brace between the two three-way elbows, and then mark all the connections on this second-level frame with key marks. Disassemble and cement the pieces together.

9 Cement two undrilled 9 1/4" rails into the horizontal, rear inlets of the crosses. Cement two 5" legs into the rear tees, and top them with two tees, cementing the tees vertically, to the leg and the rail.

10 Cement four 5" legs into the open inlets of the crosses and tees. Dry fit four three-way elbows on top of the legs, and then dry fit two drilled 9 1/4" rails between the front and back tees (with the holes facing directly up) and two 9 1/2" tread braces side to side. Make key marks on all the connections, disassemble, and cement the pieces together.



11 Finish or paint the wood steps, if desired. Set the wood steps in place on the stepstool. Stick a screw up through each hole in each step, to mark the underside of the wood steps. Remove the steps and drill starter holes at each mark. Replace the steps and screw them to the stepstool.

QUICK 3

Simple home storage and accents are some of the best uses for PVC pipe. These are especially good uses for leftover odds and ends from other projects. The Towel Rack shown here will require the purchase of a certain number of pipes and fittings, but the Vase and Shoe Rack can both be constructed from the remains of other projects, or even from scraps scavenged from construction sites. All three are handy fixtures that you won't know you really needed until you find yourself using them all the time. No matter where you get the material, all these are surpassingly easy and speedy to create.

1 TOWEL RACK

This towel rack is a useful addition poolside or in a busy bathroom where towels seem to pile up on the floor. To make the project as shown, you'll need about 24' of $^{3}/_{4}$" PVC pipe, six elbows, and four tees. This rack is basically two uprights contained in a very

simple, rectangular base frame. The base frame is constructed first, with elbows on either end of two 28" end sections. The sides are three 6" sections separated by two tees, with inlets pointing up. The lower, front upright is constructed with two 35" legs, topped with elbows, which are connected by a 28" crossbrace. The second upright is constructed in the same way, except that the legs are 47" long. (You can easily change the length of the legs to accommodate your own towels or other textiles.) Work slowly and measure diagonals as you move along to ensure the frame and uprights are all square.

2 VASE

This decorative project could not be simpler, but done right, it looks like a designer creation. The idea is to use the very nature of the PVC to create a one-of-a-kind look. You'll need a 5" to 10" section of PVC pipe that is at least 4" (and up to 8") in diameter. Smaller pipe sections will work as bud vases but will not be as stable as wider pipe. Stand the pipe section on end on a concrete or metal surface. Keeping safety first and foremost in mind, use a torch (a mini-torch, a weed torch, or a full-blown torch) to heat the middle of the pipe section. Wear heavy work gloves and eye protection, and slowly rotate the pipe as you heat the middle, moving the torch flame very quickly over the surface (you just want to heat it, not actually melt or blister the surface). As an alternative, you can heat the vase as it rests in a bed of aluminum foil, using a hair dryer on its hottest setting. When the middle seems to slightly deform, extinguish the torch. Lightly press down on the top of the pipe, while very gently twisting it side to side. This action should create curvy wrinkles in the center of the pipe. If you're careful, you may be able to actually control the shape and size of the wrinkles (practice your technique on a waste scrap of pipe first). Once you've manipulated the pipe to a look you like, let the pipe cool completely. Then sand it thoroughly, including in the inside of the wrinkles. Clean the pipe with a tack cloth or a white, lint-free cloth and window cleaner. Finally, prime and paint the pipe with a plastic spray paint in your favorite color. You'll be surprised at how

polished the result looks.

3 SHOE RACK

This is a wonderful repurposing of scrap ends cut from 6" or wider PVC waste pipes. Look for 10" to 12" scraps on a construction site or cut your own from a long segment of pipe you purchase. With a utility knife or sandpaper, trim or sand all the cut edges smooth (how smooth you get them depends on how polished a look you're after). Lay a long cinching tie-down strap across a clean, flat, level work surface. Ask a helper to hold one end of the strap while you hold the other and align the pipe segments on their sides (two or three along the bottom will create a good base). Play with the configuration of pipes, and, when you're happy with it, loop the strap around all the pipes, joining the two ends and cinching it tight. You can now place the shoe "rack" in your mudroom or even outside the back door so that friends and family don't track dirt, water, or mud into the house.

PUPPY PEN

It doesn’t matter if you’re breeding dogs, hosting kittens, or just want to confine any smaller animals from roaming the house, this pen will do the job admirably.

This project is easier to build than it may look, because it is actually constructed of repetitive sections. The assembly is ganged for optimal efficiency, and to make ensuring correct measurements easy. The linear nature of the design makes altering the dimensions to fit your own space or furry friends a simple matter.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Chop saw, miter saw, or tablesaw
80-grit sandpaper
Speed square
Marker
Eye and ear protection
Work gloves

MATERIALS

75' × 1" PVC pipe
(20) 1" elbows
(20) 1" tees
(30) 1" crosses
PVC cement

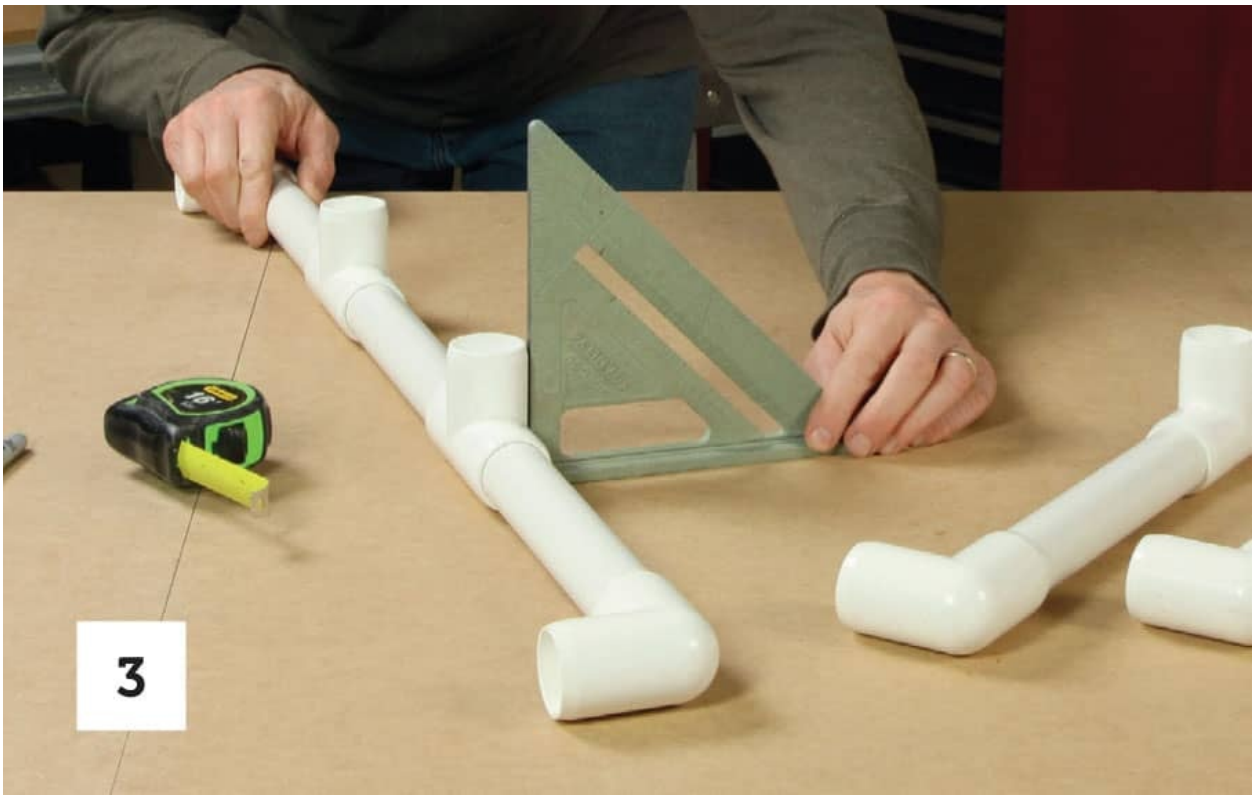
CUT LIST

(20) $9\frac{3}{4}$" end outer rails
(10) $10\frac{1}{8}$" end mid rails
(20) $10\frac{1}{4}$" side outer rails
(20) $9\frac{3}{4}$" side mid rails
(40) 5" posts

HOW YOU MAKE IT

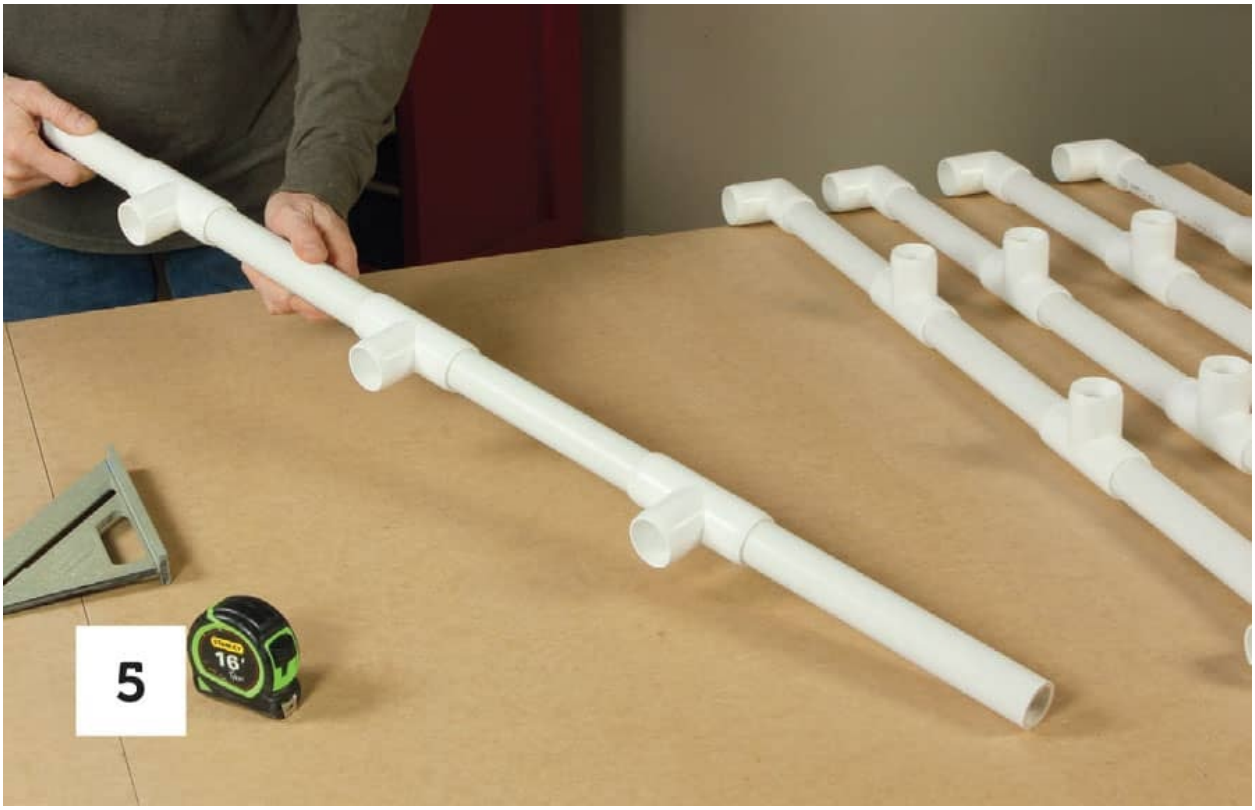
1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand them so that the cut edges are completely smooth. Clear a large, flat, level work area.

2 Form the two ends by dry fitting them side by side. Connect a 9 3/4" end outer rail between an elbow and a tee, connecting a 10 1/8" middle rail on the other side of the tee. Finish with another 9 3/4" end outer rail, capped with an elbow.



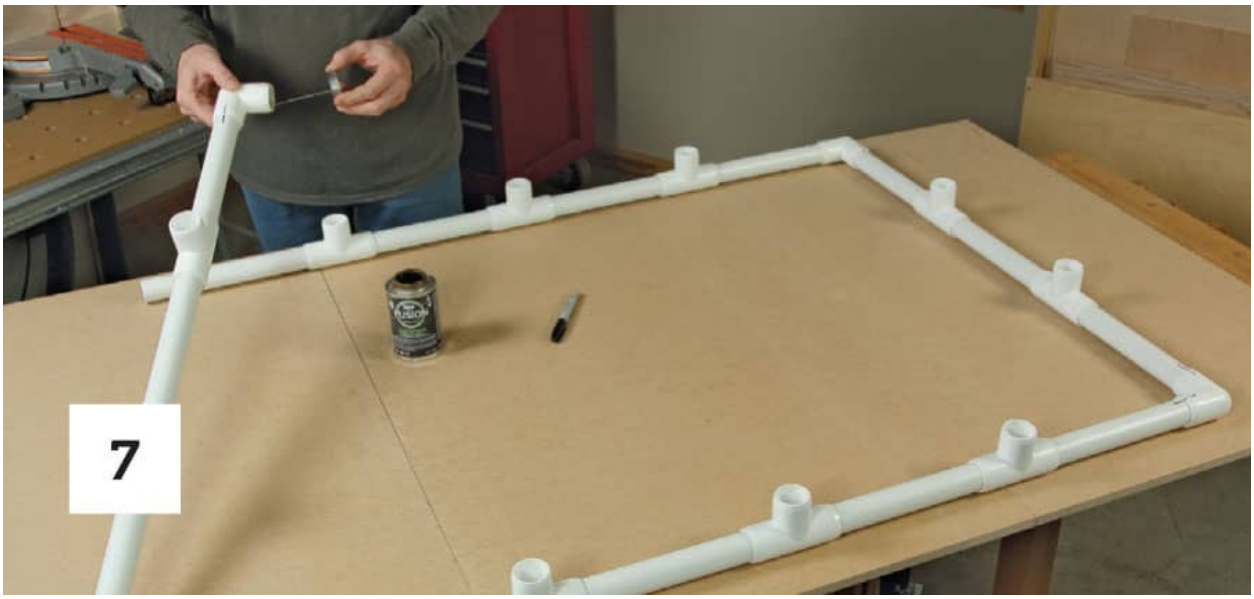
3 Dry fit three more ends in exactly the same manner. Compare each to the others to ensure that they are all the same length. Check with a square to ensure the open inlets of the tees are all perfectly vertical, pointing straight up.

4 With a grease pencil, mark all the end section connections with key marks. Disassemble each end, one at a time, and cement them back together. Repeat with all the ends.



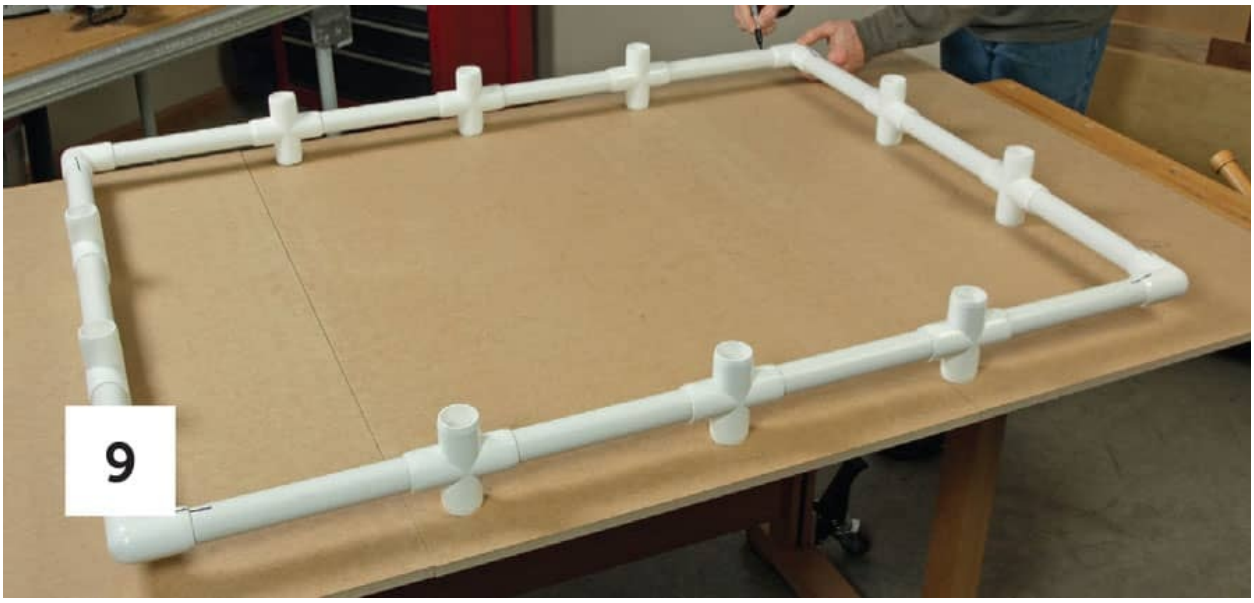
5 Using the same method, construct the frame sides, starting with one 10 1/4" side outer rail connected to a tee. Connect the other side of the tee to a 9 3/4" side middle rail, with a tee on the opposite end. Connect another 9 3/4" middle rail to the tee, add a tee to the end of that, and finish with a 10 1/4" side outer rail. The tees should all lie flat, pointing in the same direction.

6 Dry fit three more sides in exactly the same manner. Compare each to the others to ensure that they are all the same length. Mark all the side section connections with key marks. Disassemble each side, one at a time, and cement the side back together. Repeat with all the sides.



7 Dry fit the top and bottom frame, connecting each side into the elbows on two ends. Check that the tees are all perfectly perpendicular to the elbows. Make key marks at each corner connection. Disassemble and then cement the frames together.

8 Cement six frame ends from two 9 $^{3}/_{4}$" end outer rails connected to a 10 $^{1}/_{8}$" end middle rail via crosses on either end of the middle rails. Assemble the ends with the crosses lying perfectly flat, face down. Cement six sides with three crosses separating two 10 $^{1}/_{4}$" outer rails from two 9 $^{3}/_{4}$" side middle rails. As with the ends, construct the sides with the crosses lying perfectly flat, face down.



9 Carefully assemble one middle frame level by sitting two sides and two ends in place, standing each upright on the cross inlets. Dry fit elbows at the corners to complete the level, and then measure the diagonals to ensure square, and check with the speed square to ensure the crosses are all perfectly plumb and parallel to one another. Make key marks at the elbows, disassemble, and cement the level together. Repeat with the other two levels.

10 Sit the bottom frame on a flat, level work surface. Cement 5" posts in all the tee inlets. Sit the next frame level on top of the posts. Check that the second level is square and level and that it is not askew from the base frame. Remove it and cement it to the tops of the posts. Repeat until you've cemented all the frames in place.

TOY BIN FRAME

Of all the clutter in a family household, toys are perhaps the most ubiquitous. Not only do they migrate to every room, carried by young members of the household, but they also seem to magically find the most inconvenient places to rest. You're walking to the bathroom late at night only to be unhappily surprised by a sharp toy car biting into the sole of your foot. You sit down on the sofa for a relaxing episode of *Friends*, only to be startled with a squeaky stuffed animal hiding in between the cushions. The toys just seem to travel, as if they had come to life and walked out of your child's room.

Take heart. There is a simple way to not only kill the clutter but also train youngsters to be tidy and responsible. It's just a matter of turning the drudgery of picking up into a whimsical fun exercise, one that requires next to no effort.

One of the main challenges, particularly with young children, is that they forget where things are supposed to go. But an array of colorful bins is impossible for young eyes to miss, and bins are all-purpose for toys small and large.

That's where this toy bin frame—and the bins that sit in it—comes in. The frame is built to hold the bins at an angle, making putting away (or retrieving) toys as simple as possible. There are lots of bins to choose from on the market, but rough-and-tumble plastic bins are the most durable option, and they are widely available in the primary colors that go so well in a youngster's bedroom or play space.

The frame in this project was designed specifically for inexpensive bins available from a major retailer. The size of each bin is 16 1/4 inches long, by 11 3/4 inches wide, by 5 inches tall (including a 1/2-inch curled lip on which the bins rest in the frame). You may need to adjust the design to suit the bins most convenient for you, but in any case, these measurements are precise. Pay close attention when you cut the pipes for the frame, and measure as you dry fit the sections

together to ensure that the finished frame will perfectly accommodate your bins.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Hard TOOLS**

Tape measure

Chop saw, miter saw, or hacksaw

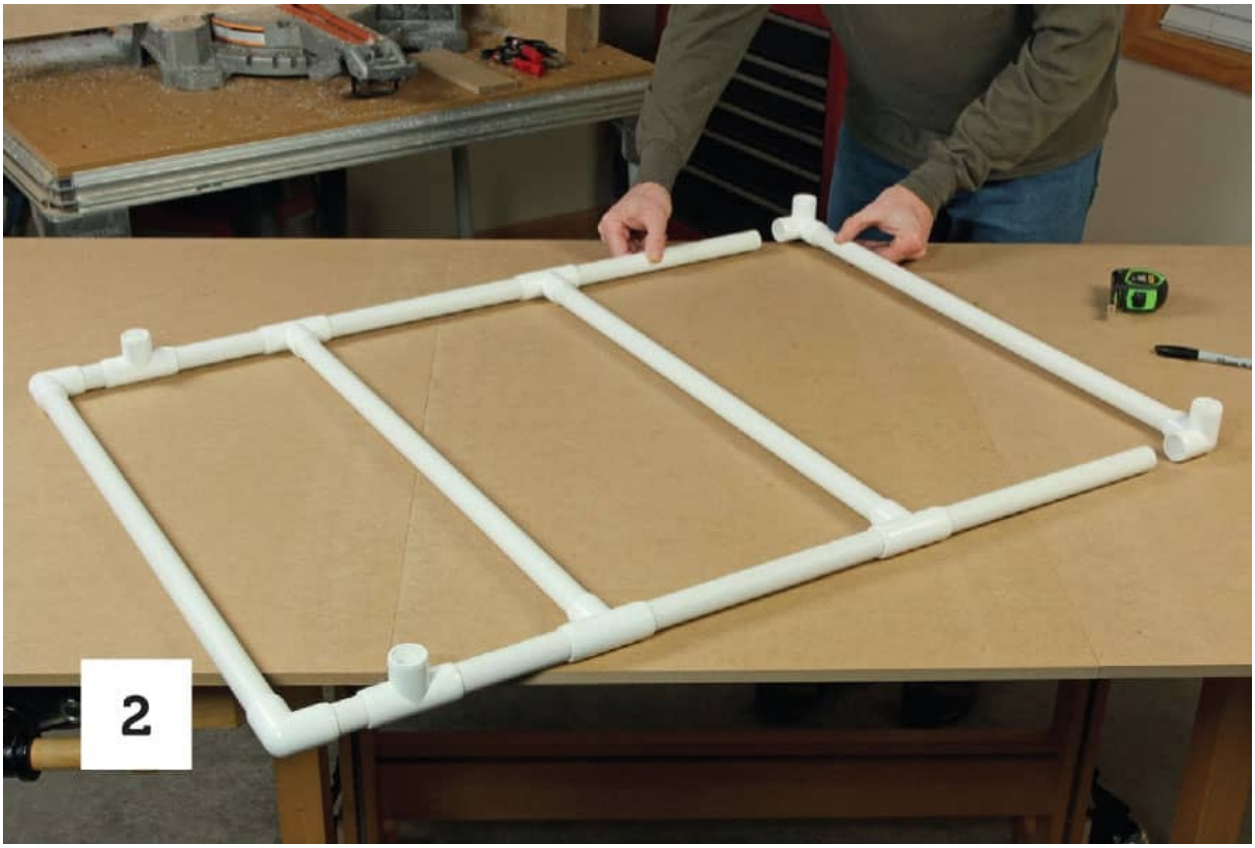
Chop saw, miter saw, or hacksaw
Utility knife or 80-grit sandpaper
Marker
Eye and ear protection
Work gloves

MATERIALS

35' × 3/4" PVC pipe
(4) 3/4" three-way elbows
(4) 3/4" elbows
(14) 3/4" tees
3/4" cross
PVC cement
(6) 16 1/4" long × 11 3/4" wide × 5" tall plastic bins CUT LIST
(4) 26 3/4" back rails
(2) 3" back leg tops
(2) 6" back leg uppers
(2) 12" back leg middles
(2) 12" back leg bottoms
(2) 12 3/4" front center rails
(2) 12" front center posts
(4) 12 3/4" front rails (top & bottom) (4) 12" front legs
(2) 6" front leg bottoms
26 3/4" crossbrace
(2) 5" side upper rails (rear)
(2) 7 1/4" side upper rails (front) (2) 13 1/2" side bottom rails

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.



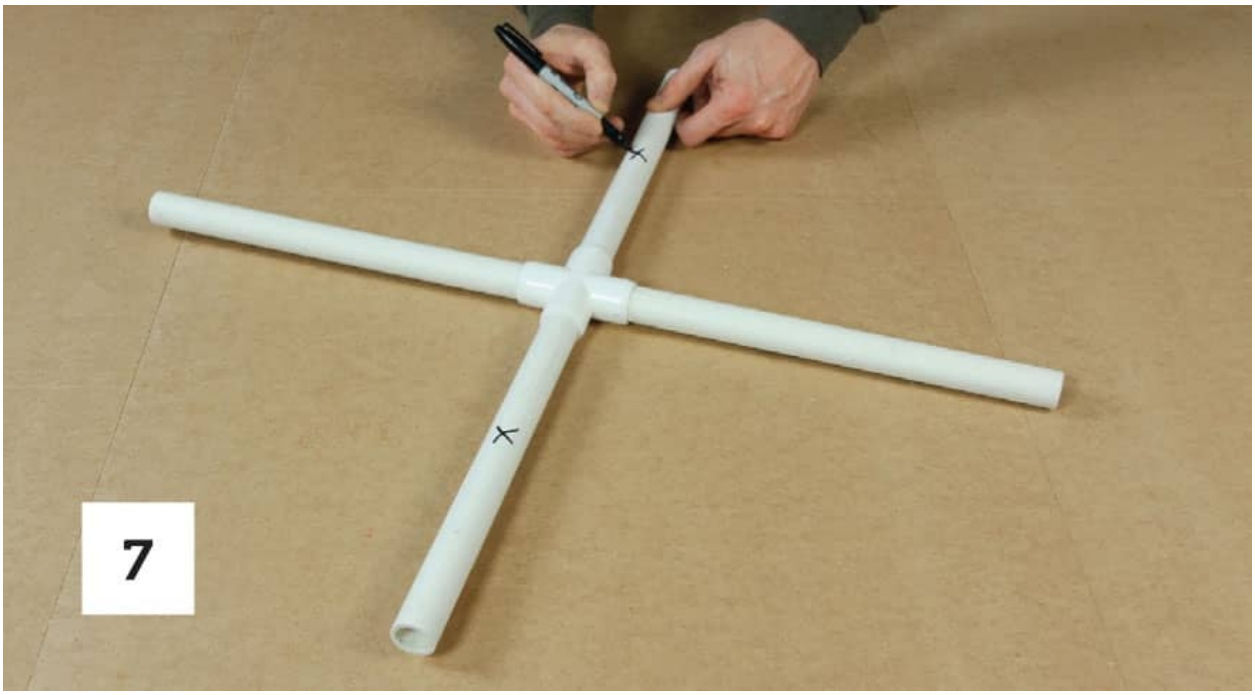
2 Build the back ladder style, starting from the top. Dry fit one 26 3/4" back rail with three-way elbows on either end and one with standard elbows on either end. Fit the two other rails with tees on either end (rails in the tee nipples).

3 Working on a flat, level work surface and starting at the top, connect the handle rail that is fit with standard elbows to the two 3" leg tops. Connect the other end of the leg tops to tees, then connect the 6" back leg upper sections into the other side of the tees. Next, fit the tees of a middle rail to the back upper legs, followed by a 12" leg middle connected on the other side to the tees of the second middle rail. Finish with 12" leg bottoms connected to the bottom rail’s three-way elbows. The first tee from the top and the bottom rail’s three-way elbows should both point up, directly perpendicular to the rails and legs.

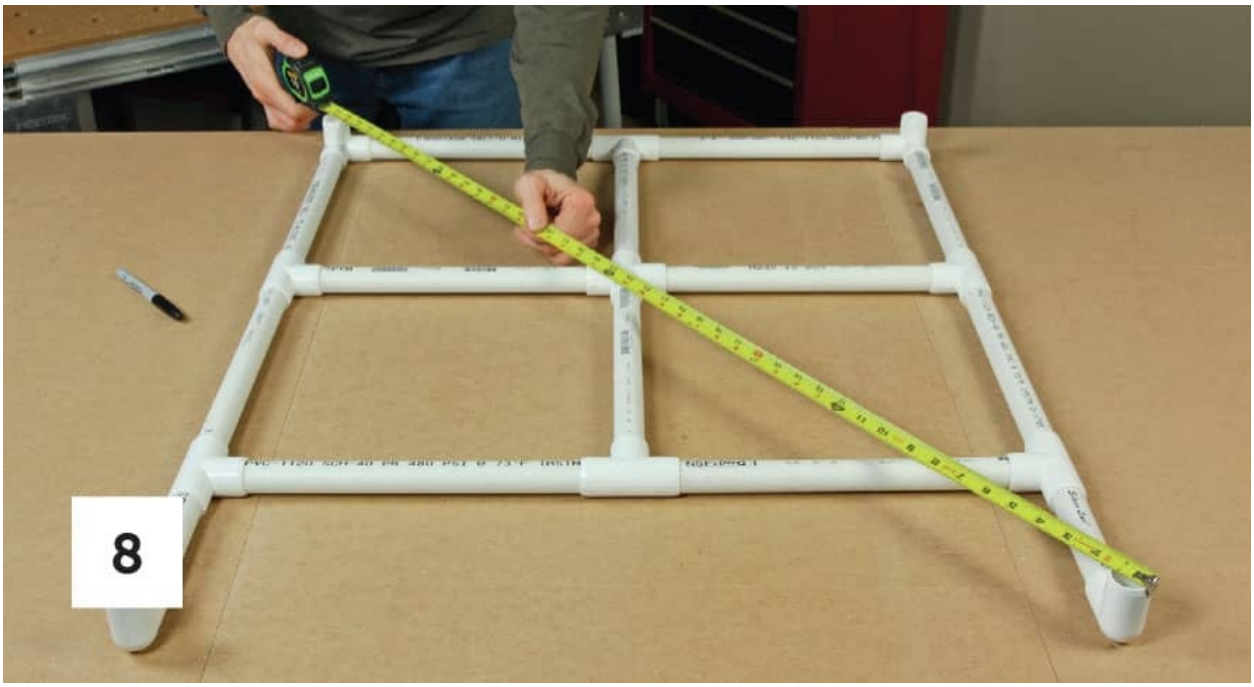
4 Measure the diagonals to make sure the back is square. With a marker, carefully make key marks at all the connections, and disassemble the back. Cement all the pieces back together, working down from the top.

5 Construct the front by cementing two 12 3/4" center rails into opposite sides of the cross and two 12" center posts into the other cross inlets. Mark each post with an “X.”

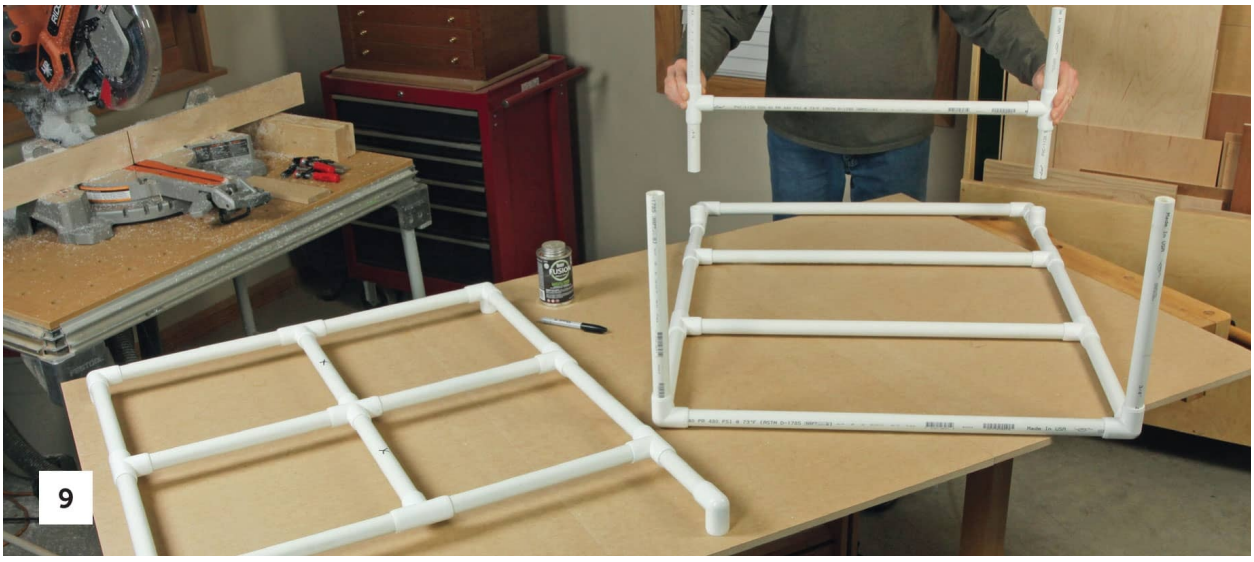
6 Working on a flat, level work surface, dry fit tees (nipple side) onto the ends of the cross posts and rails. Install the 12 3/4" front rails on each of the tees connected to the posts. Slip three-way elbows onto the rails on one side; slip tees (nipple side) onto the rails on the opposite side.



7 Complete the front frame by dry fitting the 12" front legs into place between the three-way elbows and outside tees, as well as two outside tees. Finish with the 6" front leg bottoms, capped with standard elbows. The open inlets of all the elbows should point upward, directly perpendicular to the legs and rails.



8 Measure the diagonals to ensure the front frame is square. Measure the width and height and compare to the back frame to ensure that they match. Make key marks on all the uncemented pieces, and disassemble. Cement the front frame together, from top to bottom.



9 Slip tees (nipple) onto either end of the top 26 3/4" crossbrace, and dry fit a 5" side upper rail and a 7 1/4" side upper rail on either side of each tee. This assembly should lay perfectly flat. Carefully fit short and long side rails into the front and back frame three-way elbows (long side rail to the front), and

connect the bottom of the front and back frames with a dry fit 13 $^{1}/_{2}$" side bottom rail.

10 Once you’re sure that the frame sits stable, check that the bins you’ve purchased fit correctly between the front and back frames. Make key marks on the connections for the top and bottom side rails, disassemble them, and cement them together.

TABLE LAMP

Let there be light. A good table lamp is a handy piece of furniture to have around. It can provide ideal illumination for reading your favorite book or magazine, it makes working on small crafts a more exacting hobby, and it can add a bit of fill lighting to a dark corner of any room.

The design here is simple, bordering on elegant. We've glammed up the lamp with a paint job in brilliant blue and a special bulb and bulb cage. There are many different decorative bulbs and cages or shades available, so the options for personalization are nearly unlimited. You don't necessarily have to finish it, though. If you're using it in a workshop or crafts room, basic white and a bare, fairly strong bulb might serve the purpose just fine.

WHAT YOU'LL NEED

Time: **30 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw or hacksaw
80-grit sandpaper
Speed square
Marker
Screwdriver
Eye and ear protection

Work gloves

MATERIALS

7' × 3/4" PVC pipe
(4) 3/4" caps
(4) 3/4" tees
(2) 3/4" elbows
PVC cement
Lamp cord
Painter's tape
3/4" to 1/2" reducer bushing Lamp socket
Edison bulb
Decorative bulb cage
Primer and paint meant for plastic (optional)

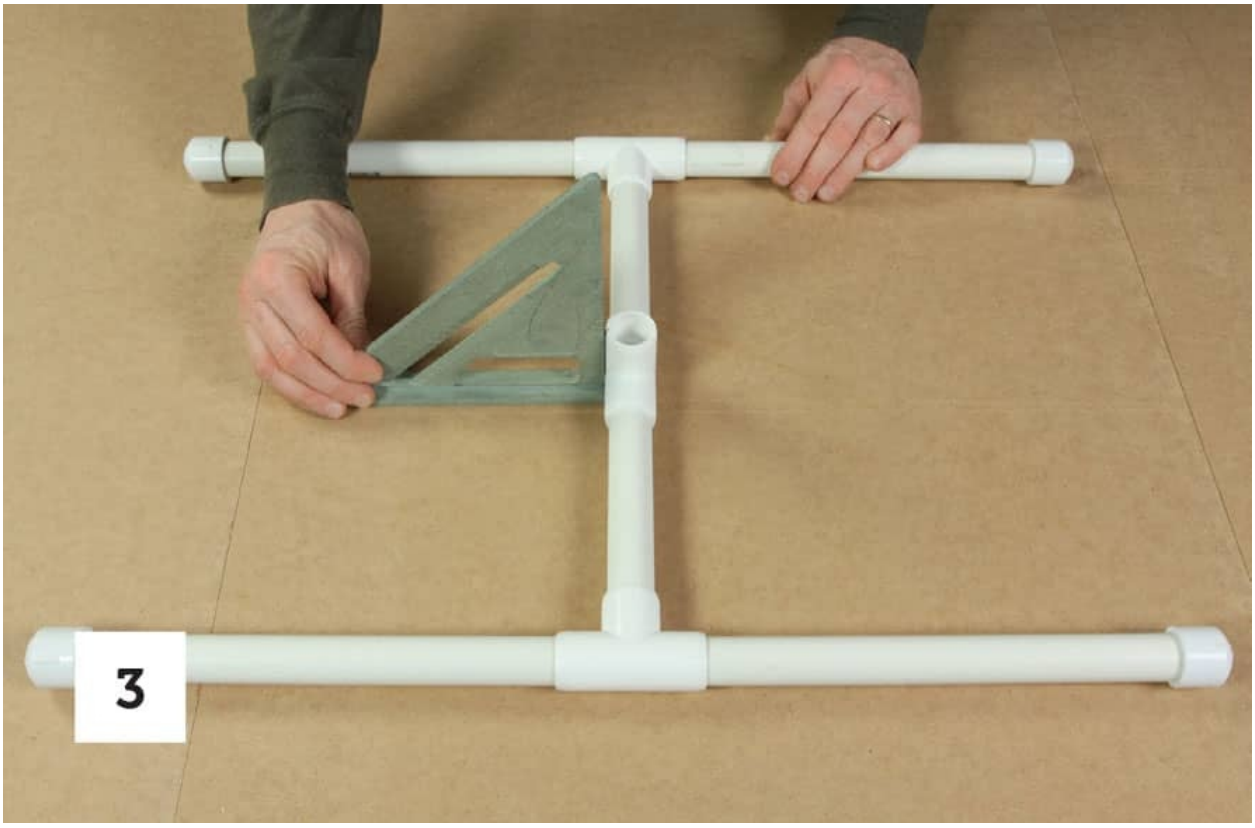
CUT LIST

(4) 12" legs
(2) 7" crossbraces
2 1/4" neck bottom
13 1/4" neck
5 1/4" neck extension

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand all the cut edges completely smooth.

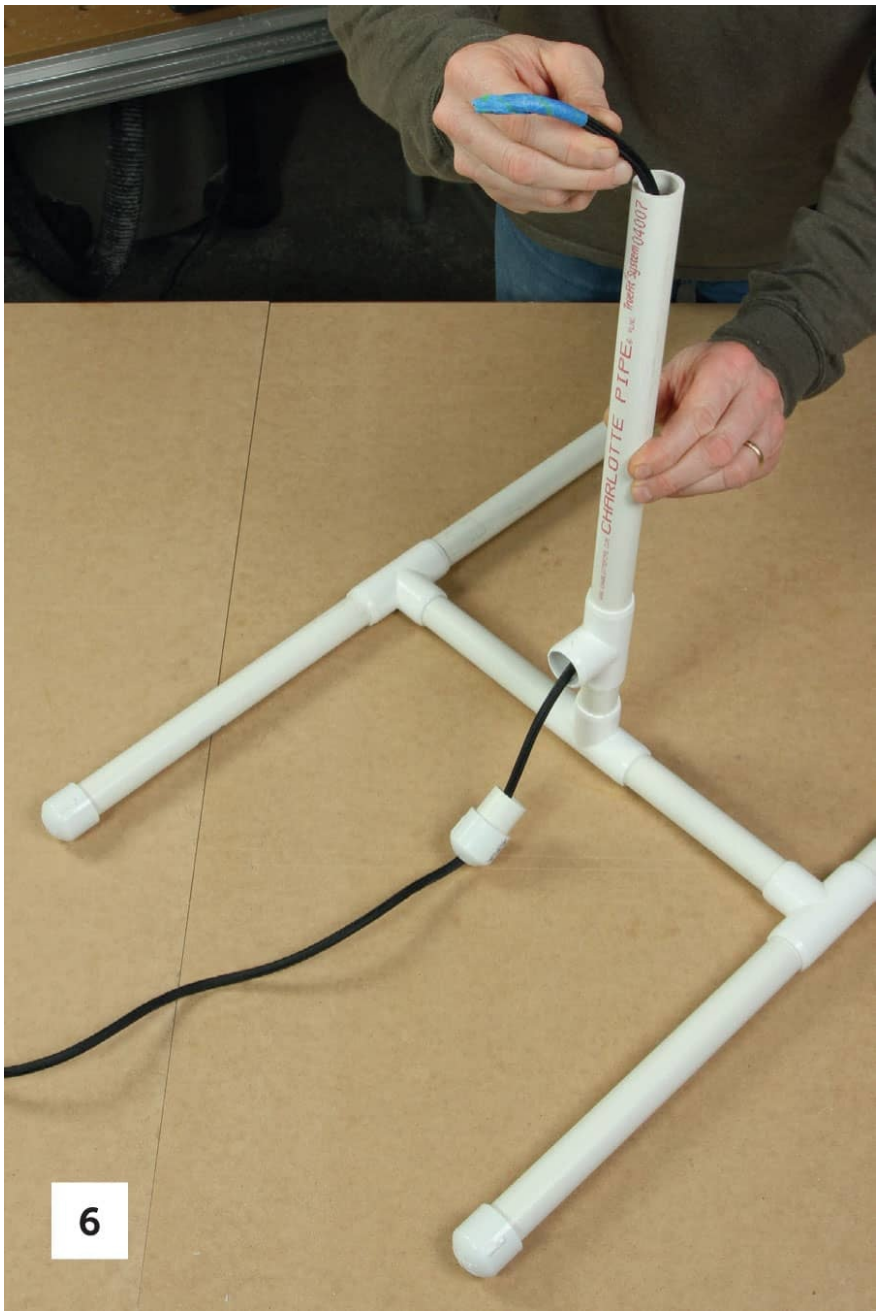
2 Begin the lamp with the base by cementing a cap on one end of all four 12" legs. Cement the other end of each leg into one of the opposing sides of a tee to make two legs.



3 Dry fit one end of each 7" crossbrace into one of the nipple inlets on the leg tees. Join the crossbraces with a tee. The base should be sitting flat as it will in use, and the central tee between the two crossbraces should be perpendicular to the base, pointing vertically. Check it with a speed square and tape measure.

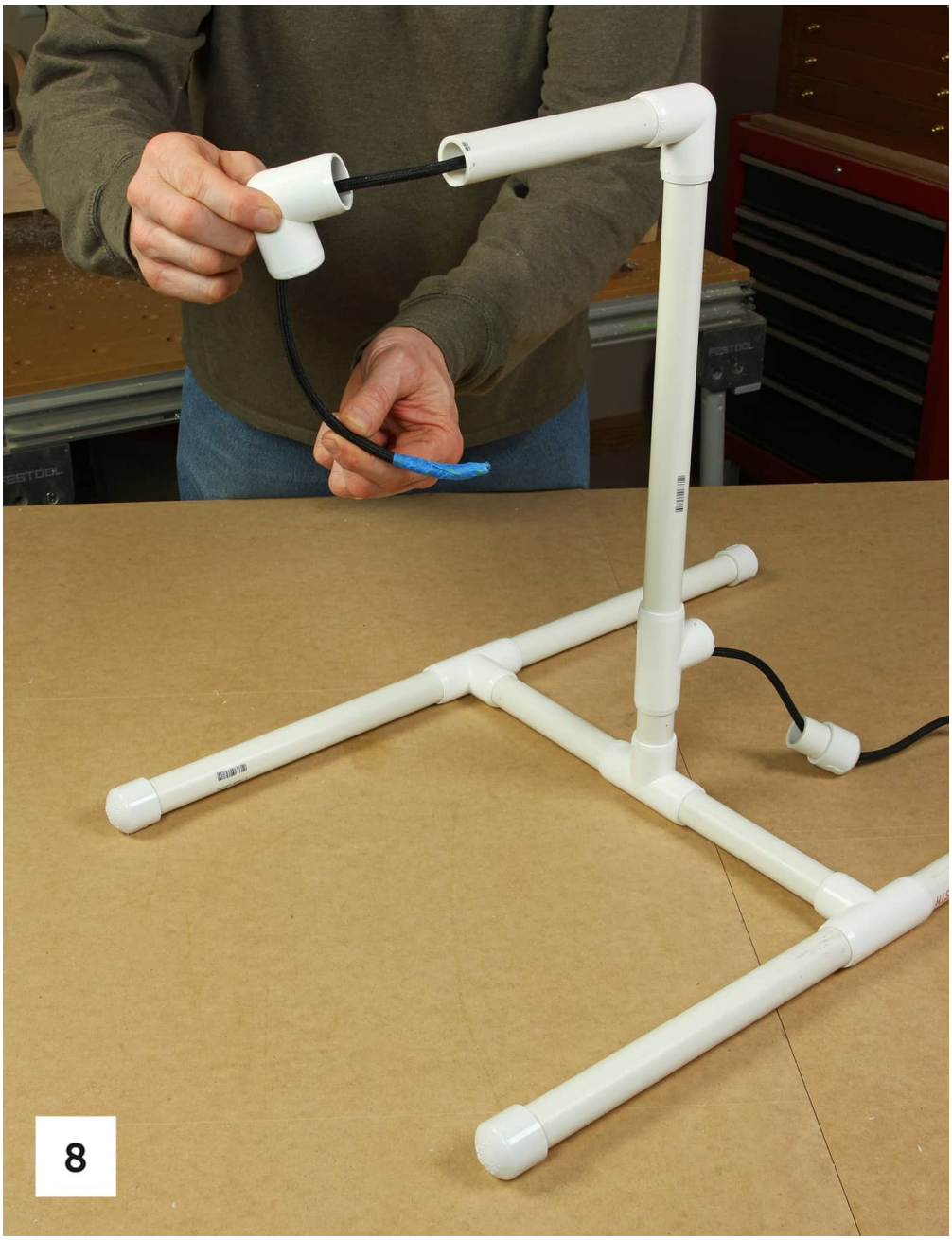
4 With a marker or grease pencil, make key marks on the crossbraces and tees, disassemble, and cement them back together.

5 Cement the 2 $^{1}/_{4}$" neck bottom into place in the crossbrace tee. Slip one side of a tee onto the other end of the neck bottom and adjust it so that the nipple is parallel to the legs. Make a key mark, disassemble, and cement it in place.



6 Wrap the exposed wires at the end of the lamp cord in painter's tape to make a tapered end. Thread the taped end through the reducer bushing and into the neck tee nipple, pushing a length of it up through the top of the tee. Run the taped end through the 13 $^{1}/_{4}$" neck. *Note: If you can't find the reducer, or just have scrap pipe and an extra cap, replace the bushing with a cap drilled with a $^{1}/_{4}$" hole, and then cement it onto the end of a 2" nipple. The nipple is cemented in place in the same way the reducer bushing is.*

7 Thread the taped end through an elbow. Slip the elbow onto the neck and adjust it so that it is parallel to the legs but pointing in the opposite direction from the tee inlet at the base of the neck. Make a key mark on the connection, remove the elbow (keeping it threaded on the cord), and cement it in place.



8 Thread the cord through the 5 $^{1}/_{4}$" neck extension and cement the extension into the elbow. Thread the cord through another elbow, and dry fit the elbow onto the end of the extension and adjust it so that it is in line with the first

elbow but pointing straight down. Make a key mark, disassemble, and cement it in place.

9 Remove the tape on the end of the lamp cord and screw the wires to the lamp socket. Cement the reducer bushing into the rear tee inlet, and then gently pull the lamp cord taut. Screw in the decorative bulb and clamp the bulb cage to the lamp socket. Paint the lamp if desired. *Note: If the weight of the bulb and cage pull the lamp socket down out of the elbow, wedge the cord in place in the reducer bushing with a piece of rubber, or cut a rubber washer.*

PATIO CHAIR

The common denominator to enjoyable backyard activities, from neighborhood cookouts to simply reading the newspaper at a table with a large, sun-blocking umbrella in the middle, is comfortable, durable seating. Unless you're fond of resting cross-legged on the ground, or standing at all times, you'll need chairs. Given the expense of buying manufactured options, why not just build your own?

Don't let the title of this project fool you. While it is meant to be the perfect partner to any patio table, this chair could fit equally well into a man cave or even in a rural summer cottage kitchen. No matter where you use it, you'll find that the basic design is sturdy and stable. For that reason, it's best not to try to mess with the measurements or attempt to customize the chair.

You should, however, manipulate the look to suit your own tastes. You may want to paint the frame to help it blend in with other deck or patio furniture. You can also paint or finish the boards that serve as the seat and seat back. Paint them a contrasting color to the frame, or substitute chic hardwood for a more upscale look.

In any case, if you think you may want multiples of the chair, it's best to build them all at the same time. There is less likelihood of measuring variations chair to chair when you gang the fabrication of the chair parts, and you'll realize economies of scale. Four chairs make a nice set to go with a simple patio table.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw, miter saw, or hacksaw

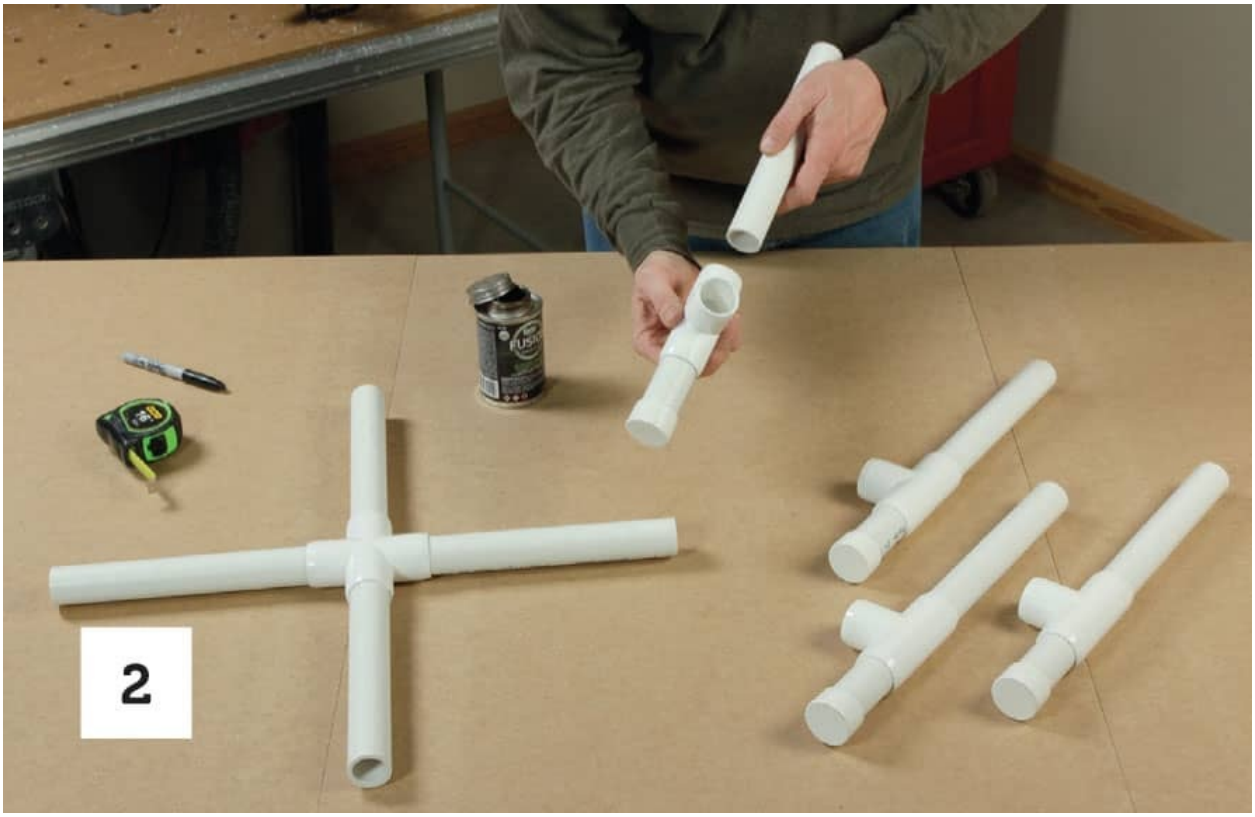
Utility knife or 80-grit sandpaper
Marker
Level
Power drill and bits, including Torx driver
Eye and ear protection
Work gloves

MATERIALS

16' × 1" PVC pipe
1" cross
(4) 1" caps
(8) 1" tees
(2) 1" three-way elbows
(2) 1" 22.5° elbows
(2) 1" elbows
PVC cement
52 × 8 × 1" cedar (or substitute 17" × 8" piece of $^1/_4$" exterior-grade birch plywood) Paint or wood finish
(14) $1^1/_2$" Torx screws or similar CUT LIST
(4) $9^5/_8$" leg braces
(4) 4" leg bottoms
(4) $9^1/_2$" upper legs
(3) $14^1/_4$" seat back and front crossbraces (4) $6^1/_2$" seat rails
(2) $4^1/_2$" seat back risers
(2) $10^1/_2$" seat back posts
(2) 17 × 6 × 1" seat slats
17 × 8 × 1" seat back (or two 17 × 4 × 1")

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments and the cedar to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.



2 Cement the four 9 $^{5}/_{8}$" leg braces into the cross. Cement the legs together one by one, starting with a cap on one end of a 4" leg bottom and a tee on the other end. Cement a 9 $^{1}/_{2}$" upper leg into the other side of the tee. Repeat to construct all the legs.

3 On a flat, level work surface, finish the bottom frame by dry fitting the crossbrace into the tees on the legs. Check that the assembly sits level and doesn't rock. With a grease pencil, make key marks on all the connection points. Disassemble and cement the leg assemblies and crossbrace back together.

4 Dry fit the top frame beginning with the two three-way elbows that are placed on top of the longer front legs. A 14 $^{1}/_{4}$" crossbrace connects the elbows, and each side is assembled with a 6 $^{1}/_{2}$" seat rail running between a three-way elbow and a tee and a seat rail on the other side of the tee connecting to the nipple of a tee positioned on top of each rear leg. Once assembled, check the seat for level side to side and front to back, and adjust as necessary. Mark each top frame connection with key marks, and disassemble. Cement the seat top in place.

5 Cement the 4 1/2" seat back risers into the tees atop the back legs. Dry fit the 22.5° elbows onto the risers, and complete the seat back with the 10 1/2" posts in the 22.5° elbows topped with a standard elbow on each side and the elbows connected with a 14 1/4" crossbrace. Make sure the pieces are not skewed, and then make key marks at the connections. Disassemble and cement the seat back assembly in place.

6 Paint or finish the wood seat and seat back as desired, and let them dry. Place the 6" × 1" seat slats across the seat sides, centering them and making sure they sit on the fittings on both sides and in the middle. Drill and countersink pilot holes down into the fitting inlets on both ends and at the tee. Drive a 1 $^{1}/_{2}$" Torx screw into each hole.

7 Lay the chair on its back and position the seat back in place. Drill and countersink pilot holes (two per side) as you did with the seat, and screw the seat back slat in place to the fitting inlets on either edge.

PRIVACY SCREEN

The Constitution may not say so, but we all know you have a right to privacy. Problem is, a lot of spaces inside and outside the home just aren't as private as we'd like them to be. It's nice to have a wide-open backyard where sunshine and air are free to flow and reach all parts of the yard. But when your neighbor is outside while you want to enjoy a bagel and the newspaper and a quiet, discreet Sunday morning without any chitchat, you're going to want a bit of a social barrier.

Privacy screens—especially portable versions—are just the thing to keep your solitary moments solitary. They can be set up when and where you please and can even be used to visually divide spaces into different areas dedicated to different purposes.

This handy creation can be used inside or out. Even the fabric part of the screen is weatherproof, and the PVC pipe frame could not be more durable. It is also super customizable. As with all PVC projects, you can paint the frame to suit your home or your particular tastes. You could use drapery or upholstery fabric, solid-color sheets that you stencil with a homemade design, or even high-end textiles, such as velvet, sewn into divider panels for this particular use. Secure the panels to the frame with cord, decorative chain, or cool wire for an industrial look, or chrome or metal hangers (which will also be incredibly easy to use).

The possibilities extend to the actual size and shape of the screen. You can easily add additional screen panels for even more privacy, or change the height or width of the frame to outside dimensions that better suit your available space or needs.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Medium TOOLS**

Tape measure
Chop saw, miter saw, or hacksaw

Utility knife or 80-grit sandpaper
Marker
Power drill and bits
Scissors
Eye and ear protection
Work gloves

MATERIALS

54' × 1 1/4" PVC pipe
(12) 1 1/4" tees
(8) 1 1/4" caps
(6) 1 1/4" elbows
(12) 5" lengths of 1 1/4"-diameter PVC snap clamps PVC cement
(6) 12" zip ties
(6) 1/2" panhead sheet metal screws 72" × 72" opaque white shower curtain liner

CUT LIST

(8) 10" legs
(6) 23 1/4" rails
(6) 60" posts
(4) 9 1/4" outer frame risers
(2) 11 1/4" center frame risers

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.

2 Construct four leg assemblies by cementing two 10" legs into either side of tee and cementing caps onto the open ends of the legs.

3 Construct a panel frame on a large, flat, level work surface. Dry fit elbows on either side of a 23 1/4" rail, and dry fit tees (nipples) onto each end of another rail. Connect the rail assemblies with 60" posts on either side. Measure the diagonals to ensure the frame is perfectly square. When you're certain the frame is square, and it lays on the work surface without rocking, use a marker or grease pencil to make key marks at each connection and disassemble. Cement the pieces back together, working from the top rail. Repeat this process to construct two more panels.

4 Connect two leg assemblies to the bottom tees of a panel with 9 1/4" risers, and stand the panel up. Adjust the legs so that they are perfectly perpendicular to the panel frame. Make key marks at both ends of the risers. Disassemble and cement the leg assemblies to the panel frame. Repeat with the other outside frame and remaining leg assemblies.

5 Cement the 11 1/4" risers into the bottom tees of the center panel.

6 On two of the panel frames, measure and mark the post about 4" down from the lip of the elbow and the same distance up from the bottom tee. Measure and mark the center of the post. Mark both posts of the center panel frame in this way.

7 Stand an outside panel next to the center panel (it will be easier if you use a helper for this). Fasten the panels together at the marked posts, wrapping zip ties around both posts at the three marks you made on the posts.

8 Secure the zip ties from sliding around by screwing each to the post with $^1/_2$" panhead screws driven through one of the holes of the strap. Cut the excess tongue of each strap off for a clean look.

9 Cut the shower curtain into three equal 2'-wide strips. Hold the top of one shower liner panel centered in a panel frame and wrap it once around the top rail. Secure it in place with two 1 $^{1}/_{4}$" snap clamps. Roll the bottom of the sheet in the same way, around the bottom panel, and clamp it in place. Repeat with the remaining two panels.

SAFETY GATE

Safety gates have become ubiquitous in modern homes. Whether you're looking to childproof your house or you simply want to corral that brand-new puppy, a safety gate is an easy way to ensure peace of mind.

Store-bought expandable gates can be unstable. Depending on the surface to which you're mounting them, they may not hold as tightly as you would like, and nobody wants to see a safety gate fail when it's needed the most. That's why a great number of parents looking out for resident toddlers—and pet owners who want to restrict the movement of animals—often choose to install a more permanent, fixed solution, such as the safety gate in this project.

This gate is designed for a fairly wide hallway opening. You will most likely need to customize the gate width to go in whatever doorway, stairway, or opening that best serves your need. The design has been developed to be scalable, so making it your own should not be difficult.

Keep in mind when preparing for the assembly that the measurements must be exact. Use one piece as a template for the others so that you can match them as closely as possible.

Lastly, it's always good to check local codes and regulations. Your municipality may dictate how and where safety gates may be installed, and may even outline what size they need to be (this won't be a necessity if you're penning in pets). You can also paint the gate to better blend into the surroundings.

WHAT YOU'LL NEED

Time: **30 minutes** | Difficulty: **Easy TOOLS**

Tape measure
Miter saw, chop saw, or hacksaw
80-grit sandpaper
Power drill and bits
Grease pencil or non-permanent marker
Level
Eye and ear protection
Work gloves

MATERIALS

28' × 3/4" PVC pipe

(4) 3/4" elbows

(20) 3/4" tees

PVC cement

(2) 1" metal pipe strap clamps

1/2" self-tapping or wood screws 2" gate hook

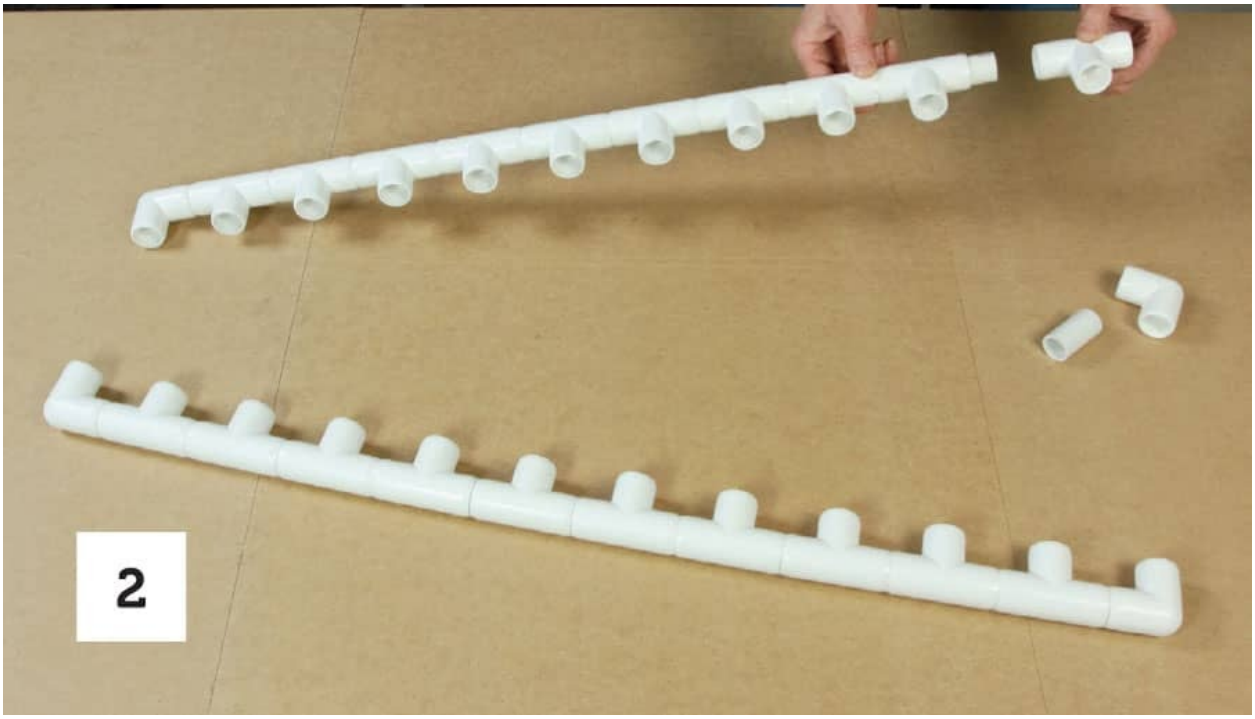
CUT LIST

(22) 2" rail nipples

(12) 24" posts

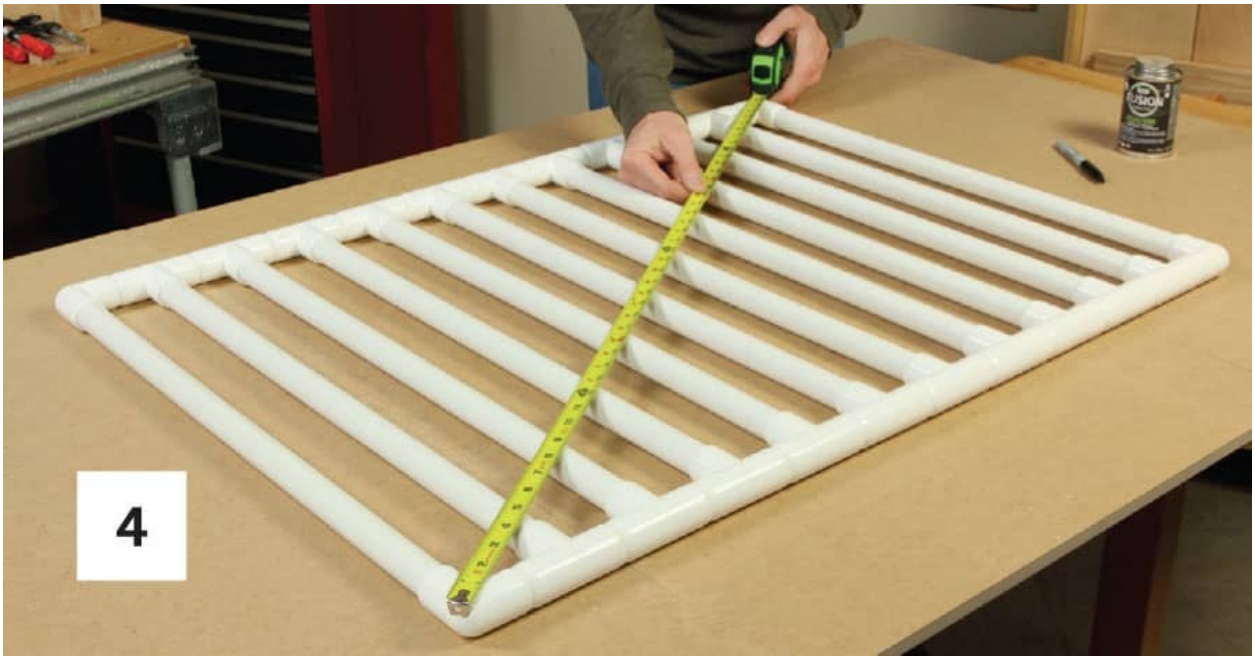
HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.



2 Working on a flat, level surface, build the top and bottom of the gate with all the fittings lying on their sides. Start with an elbow, connected to a 2" rail nipple, which is in turn connected to one side of a tee. Connect nine more tees in line, dry fitting rail nipples between each, and connect an elbow to the opposite end with a rail nipple. Repeat the process to construct the bottom. Measure to check that the top and bottom are exactly the same. Adjust as necessary.

3 With a grease pencil, make key marks at all the connections on the top and bottom. Disassemble and cement all the pieces together following the key marks. (Work on the top and bottom one at a time so that the pieces don’t become mixed up.)



4 Dry fit all the posts between the top and bottom tees and elbows. Measure diagonals and check that the structure is not skewed. If necessary, adjust one or more of the posts. When the assembly is entirely square and lies flat, number each post from one side to another. Disassemble and cement the posts in place between the top and bottom.

5 Wrap the 1" metal pipe strap clamps around the post on one end of the gate and, holding the gate in place (or with the aid of a helper), mark and drill

pilot holes for the clamp flanges. Screw the clamp flanges to the stair post or wall (screwing into solid wood).

6 On the opposite side of the gate, mark the end post one-third of the way down its length for the gate hook screw eye. Drill a pilot hole and screw in the screw eye.

7 Hold the gate in place where it will be mounted. Check for plumb and then mark the screw holes for the hinges. Drill starter holes and then screw the gate to the wall, staircase newel, or doorway jamb. Screw the gate hook to the opposite surface, at the level of the screw eye on the post.

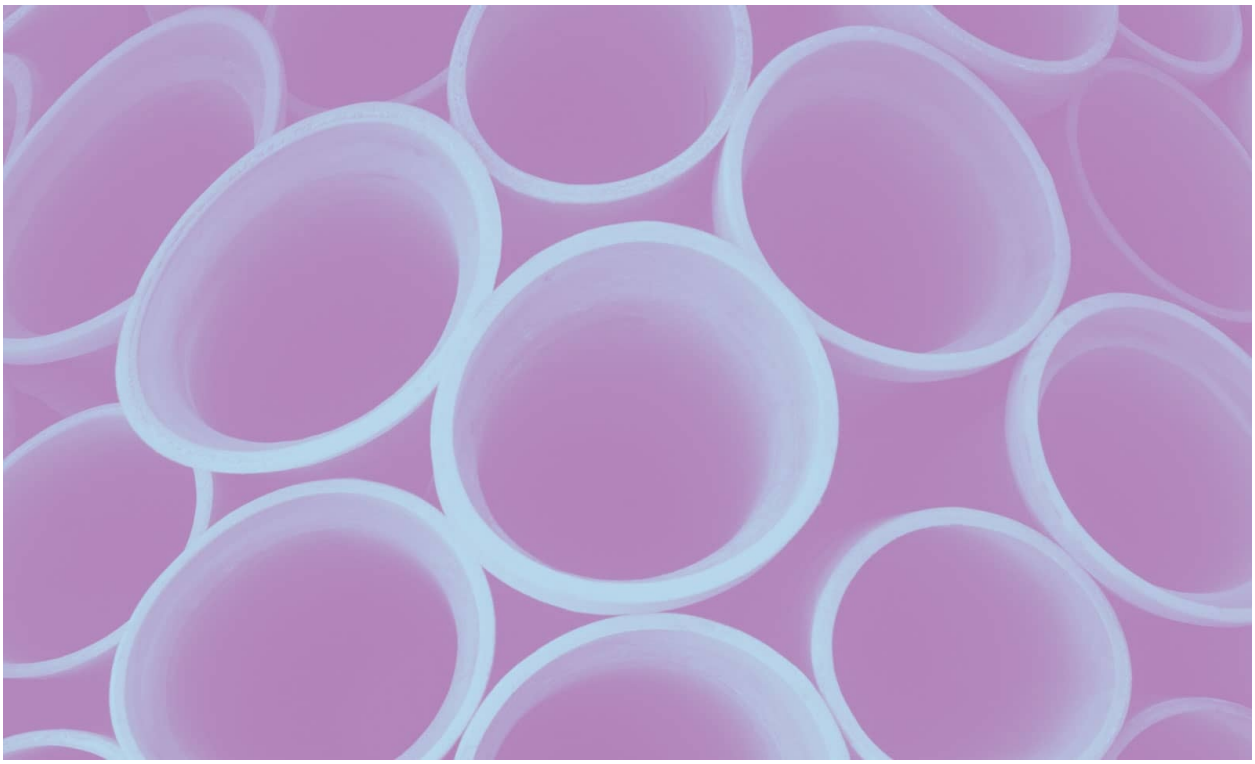
5 JUST FOR FUN

It’s a testament to the incredible adaptability of PVC pipe that some of the most creative uses for this material are some of the most fun. And who doesn’t want to have fun?

The projects in this chapter are somewhat less challenging than elsewhere in the book, and they are also more forgiving of variations or the occasional measurement error. That means they are well suited to youngsters who want to get their hands dirty. Which is to say, just about every youngster.

The toys in this chapter are a chance for young DIYers to learning about project construction, science, workshop basics, and more. Making a PVC Archer’s Bow will teach the young archer not only about the tools of their trade but also about tension, trajectory, and velocity. Building a Giant Xylophone is the opportunity for a child to discover basic principles about music, while diving into the pure thrill of making up songs. All these creations allow for flights of imagination and a sense of accomplishment. And, ultimately, they translate to hours of wholesome fun. They can also be a chance for parents to bond with kids over shared interests.

There are also projects that nurture more adult hobbies such as photography. Some may be slanted toward an older audience, but that doesn’t mean they’re any less enjoyable. In fact, tackle a few of the projects in this chapter and you just may rediscover the kid inside of you.



Photographer's Helper

Archer's Bow

Soccer Goal

Toy Car Garage

Summer Soaker Water Cannon

Water Table

Quick 3

- *Toss Across Game*
- *Flute*
- *Craft Organizer*

Sword & Light Saber

Giant Xylophone

Bottle Rocket Launcher

Quick 3

- *Simple Slingshot*
- *Arrow Slingshot*
- *Water-Balloon Launcher*

Marshmallow Shooter

Camera Tripod

Egg Catapult

PHOTOGRAPHER'S HELPER

The modern explosion of digital technology—from miniature digital cameras, to high-definition camera phones, to mobile body cams—has led to a profusion of amateur photography. But just because you're not paid for your photos doesn't mean they have to look amateurish. The right lighting can go a long way toward making anything you photograph beautiful. The simple setup in this project takes advantage of lighting principles professionals use in their studios, but at a fraction of the cost.

Basically, this "photo booth" is designed to disperse light evenly and eliminate shadows. The scrim screen diffuses the light, making it softer and more even. That, in turn, makes everything from small crafts you're photographing for your online store to newly prepared dishes you want to shoot for your food blog look like the photo just stepped out from the pages of a magazine.

The measurements are forgiving. Although the frame should be relatively square, you can make this bigger or smaller as your needs demand. The idea is to create a photo cube over which scrim paper (special white opaque paper designed to diffuse direct light) can be taped. However, depending on local availability, scrim paper can be pricey. You can achieve a similar result using thick white bed sheets cut to suit the frame. In fact, you can save quite a bit of money if you find the bed sheets at a charity store or garage sale. Of course, you may even have an old sheet set in your linen closet. You can even use fabric shower curtains or most any thick, white, opaque fabric.

The clip lamps are available in varying intensities online and at most major home centers and lighting stores. The cost isn't prohibitive, and the lamps should last for as long as your photographic hobby does.

WHAT YOU'LL NEED

Time: **40 minutes** | Difficulty: **Medium**

TOOLS

Tape measure
Miter saw, chop saw, or hacksaw
80-grit sandpaper
Level
Marker
Eye and ear protection
Work gloves

MATERIALS

25' × 3/4" PVC pipe
(4) 3/4" caps
(4) 3/4" three-way elbows
(6) 3/4" elbows
(2) 3/4" crosses
(4) 3/4" tees
PVC cement
4' scrim paper or white sheet cut to fit
Clear tape or clear glue
(3) clip-on lamps

CUT LIST

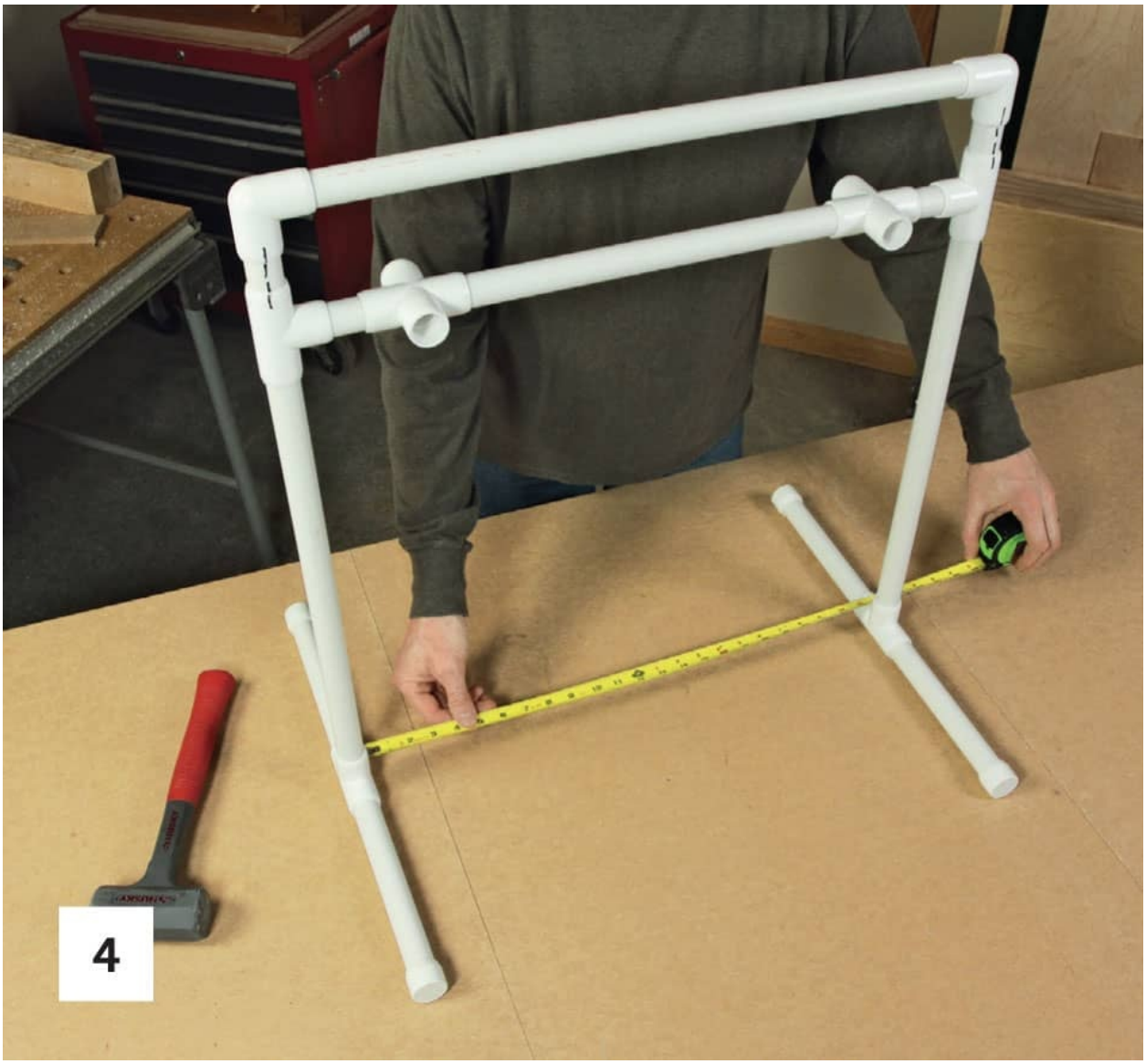
(4) 9 3/4" legs
(2) 19 7/8" frame support uprights (lower)
(2) 3" frame support uprights (upper)
23 1/4" frame support crossbrace
(2) 3" scrim frame crossbrace outers
(3) 14 3/4" scrim frame crossbrace centers
(2) 11 3/4" scrim frame top rails (front)
(2) 4 1/2" scrim frame top rails (rear)
(4) 20" scrim frame posts
(2) 17 1/2" scrim frame bottom rails

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.

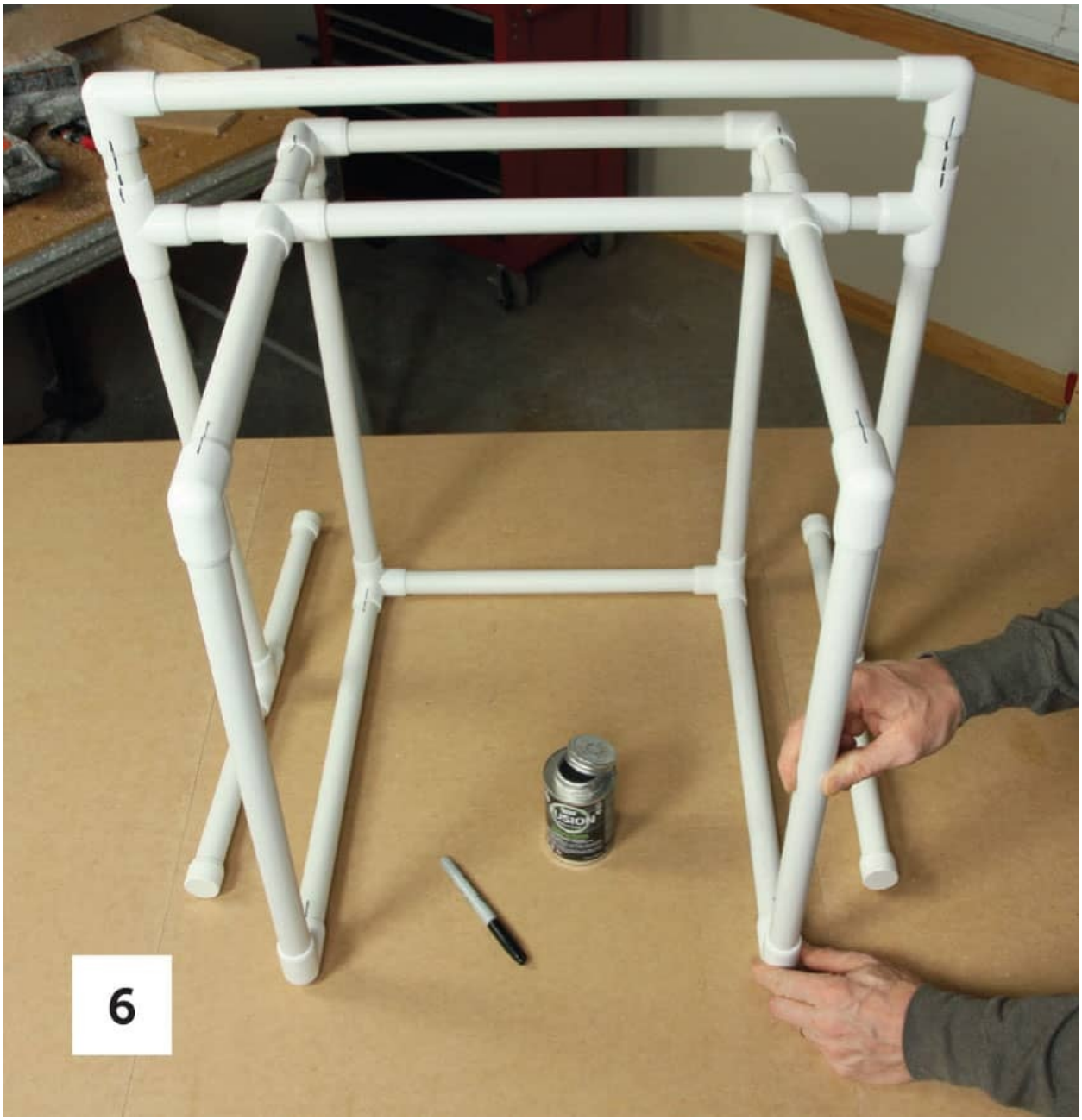
2 Build each leg assembly by cementing a cap on one end of each 9 3/4" leg and connecting the free ends in either side of a tee.

3 Construct the uprights and top support, working from the legs up. Cement a 19 7/8" upright into each leg tee, and dry fit a tee on the other end of the upright. Add a 3" upper upright on the other side of the tee and an elbow on the other end of the upper upright. Connect the elbows by dry fitting the 23 1/4" support crossbrace between them.



4 Check that the frame is square (eyeball it at this point). Dry fit the top of the scrim frame together, with 3" outer crossbrace sections fit into separate crosses and the crosses connected with the 14 $^{3}/_{4}$" center crossbrace. Carefully dry fit this assembly between the upright tees to ensure the tee inlets are in line. Measure top to bottom and side to side to ensure the frame is completely square.

5 Use a level to check that the open inlets of the cross in the scrim top frame are perfectly horizontal. With a marker, make key marks at all the connections in the supporting frame and scrim top frame. Disassemble the structure and cement the pieces back together.



6 Cement the 11 3/4" scrim frame top rails into the inlets on one side of the crosses. Cement the 4 1/2" scrim frame top rails into the opposite side. Dry fit three-way elbows onto the ends of all the top rails. Dry fit 20" scrim frame posts into all the elbow inlets point down and a 14 3/4" crossbrace connecting the three-way elbows. Add three-way elbows on the bottoms of the posts, and connect the elbows with a 14 3/4" crossbrace. The bottom edges of the bottom elbows should sit flush with the bottom edges of the legs. Adjust if they do not.

7 Use a level to check that the posts are all plumb, then connect the bottom elbows with 17 $^{1}/_{2}$" scrim frame bottom rails. Make key marks at all the connections for the scrim frame. Disassemble and then cement the pieces back together.

8 Carefully tape scrim paper sections (or white sheet) over the scrim frame, including underneath it. Clip a lamp to each upright and one on the top frame support crossbrace.

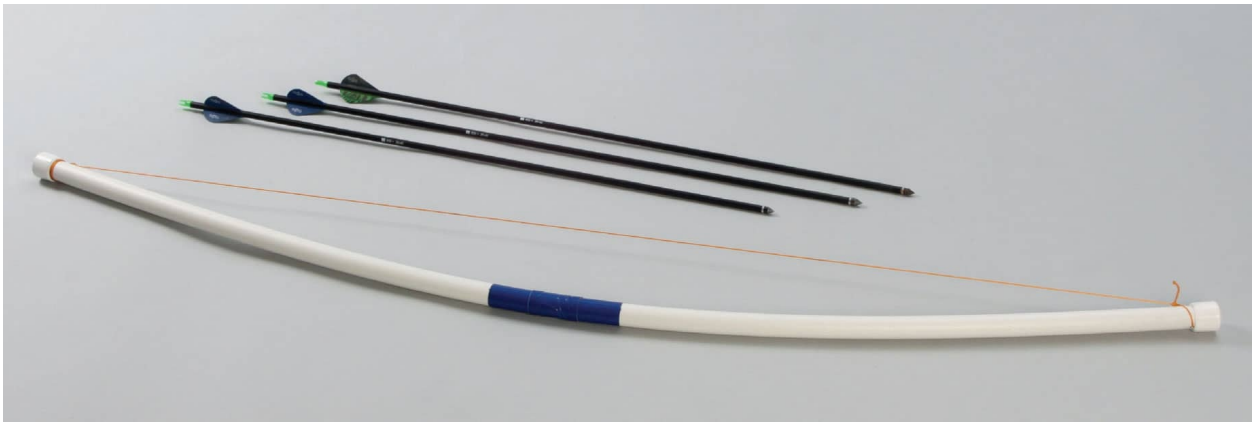
ARCHER'S BOW

Archery is a time-tested sport that was a necessary skill for people once upon a long time ago and has always been a favorite of kids from ancient would-be warriors to modern sleepaway campers. If you want to provide an interesting outdoor activity that will get your child out of the house and away from the TV and other electronic devices, you could do a lot worse than build your own backyard archery range.

This bow uses the simple basic principles that make all archery bows work. The natural tension in the pipe resists flexing, creating "draw weight" that gives the bow power when the string is pulled back. Because of the modest size of the pipe, the bow is moderately powered, meaning fewer broken windows and errant arrows. The "string" used is actually braided nylon twine that is less prone to snapping or fraying than standard string or twine.

Because it's easy to heat PVC pipe enough to be malleable, you can modify the bow as you see fit; for instance, you could heat and flatten the ends for a more traditional recurve shape. You can also paint the bow to customize it, or decorate it with colored tape.

The bow will accept any type of nocked arrow, but for safety's sake, it's best to use arrows with padded tips.



WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy**

TOOLS

Tape measure
Chop saw or hacksaw
80-grit sandpaper
Marker
Metal straightedge
Speed square
Drill and drill bits
Rattail file
Eye and ear protection
Work gloves

MATERIALS

4' × 1/2" PVC pipe
(2) 1/2" caps
Duct tape (use colored duct tape to add a little punch to the look of the bow)
Braided nylon twine
PVC cement

CUT LIST

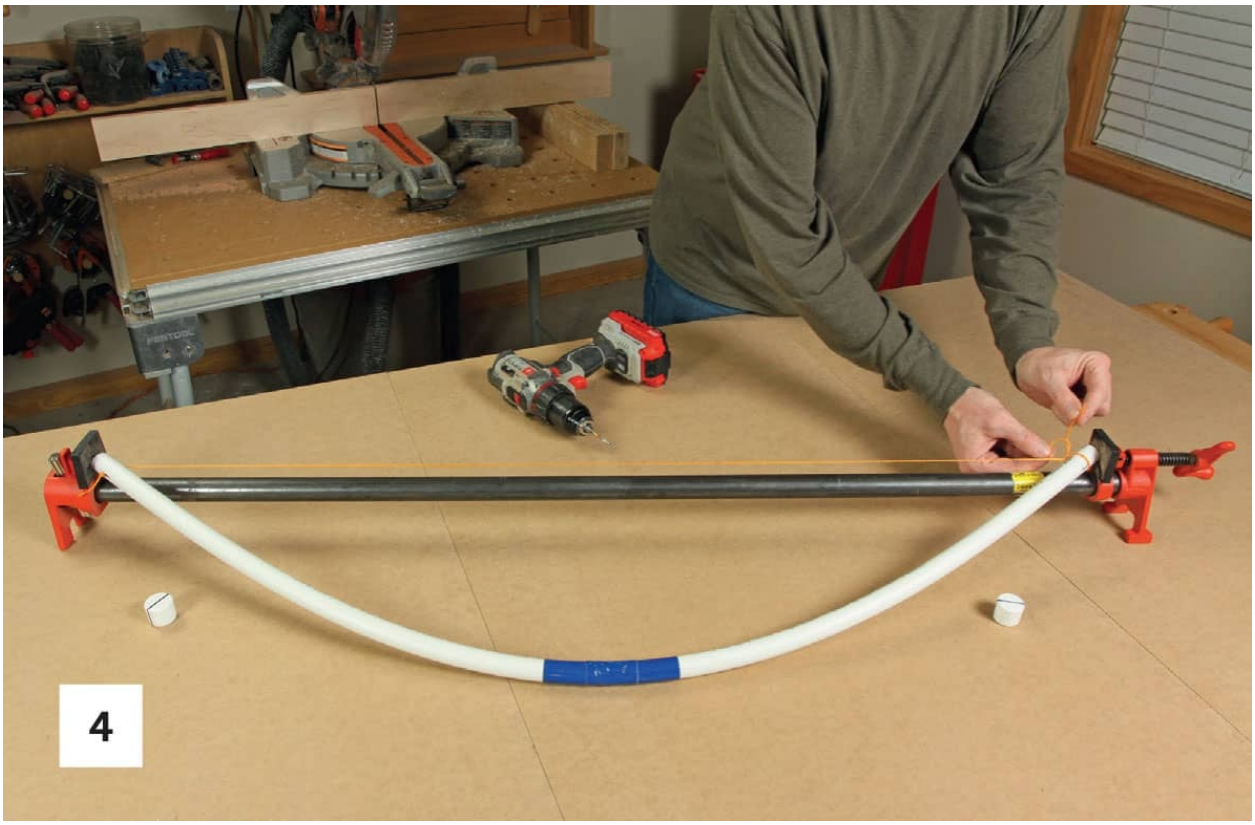
46" bow

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand the cut ends of the pipe absolutely smooth. Measure to the center of the bow, mark the center point with a grease pencil, and wrap duct tape at this point (centered on the center point), to create a grip.

2 Slip a cap on either end of the bow. Use a long straightedge and a speed square to mark matching centerlines across each cap, and then trace the lines over onto both sides of the caps. Mark the end points on each side of the lines on the bow itself.

3 Remove the caps and drill $^1/_8$" holes all the way through the bow at the marks at each end. Use a $^1/_8$" rattail file or similar to smooth the holes.



4 Tie a tight knot in one end of the nylon twine. Thread the twine through the holes in one end of the bow and then down and through the holes in the other end. Have a helper slightly bend the bow, and tie a tight knot in the other end, to secure the twine. Cement the caps on the end of the bow.

THE BASICS OF SHOOTING AN ARROW

Although it looks exceedingly simple, archers can spend a lifetime perfecting their art. Teach your youngster starting with good basic habits, and he or she is sure to become an enviable archery marksperson.

1 **Stand ready.** The archer's stance is balanced, with the feet about shoulder-width apart, weight evenly distributed, and body held perfectly perpendicular to the target. The posture should be erect but not stiff.

2 **Nock the arrow.** Slip the arrow nock (notch at the end of the shaft) onto the slack string with the arrow point at the ground. Hold the arrow shaft in place with the first two fingers of the draw hand. The third finger should help pull the string, and the pinkie and thumb are held off the string and curled.

3 **Draw the bow.** Grip the handle firmly without squeezing. Raise the bow to the target until your draw arm is parallel to the ground. Draw the string to the "anchor point," with the hand right at your cheek and your eyes on the target.

4 **Aim.** Steady the arrow and look exactly at the point you want to hit.

5 **Release.** Let the string go in one quick, sure motion. Don't take your eyes off the target. Watch the flight of the arrow towards the target, to judge how close you were and how to make adjustments.

THE BIG ARCHER BOW

The draw weight and power of the bow in this project were purposely designed to suit a smaller, weaker archer. But if an adult in your house likes firing arrows and would like a bow more suited to serious target shooting, you can up the ante with the following design modifications to make a more serious-minded bow: • **Beefier PVC.** Rather than the $^1/_2$" pipe specified in the project, use $^3/_4$" pipe for more bend resist and more power in the shot.

- **Stronger string.** The nylon line used in the kid's version will not serve you well for an adult bow. Better to turn to paracord. Rather than drill string holes through the pipe, use a rattail file or similar to create a groove that slopes slightly downward toward the shooter's side (the grooves need to be identical on both ends of the bow). Then just tightly tie the cord in the groove on one end, use your body as a fulcrum to bend the bow, and tie the cord in the groove on the other end.
- **The stiff trick.** You can increase the draw weight and power of the bow by creating a bundle of three nylon highway markers (available from large home centers) and threading the bundle down inside the bow before you cap both ends.
- **Go recurve.** A more traditional "recurve" design adds strength to the bow. You can create a bow in this shape by heating the pipe in a cradle of aluminum foil and using a blow dryer set on its hottest setting. Work on one end at a time, and when the end is warm enough to be workable, flatten about 12" of it and form it into one side of a curvy "W" shape. Repeat with the opposite side. Then drill the holes for the string in the flat portions, and construct the bow as you would otherwise.

SOCCER GOAL

Soccer is the most popular game in the world, and America has caught the fever. Boys and girls of all ages are discovering the fun that can be had on their own soccer pitch with nothing more than a bicolor ball. Of course, in soccer as in life, it's always nice to have a clear goal to shoot for.

The goal in this project boasts a silhouette that is incredibly similar to professional soccer goals, if somewhat slimmed down. It couldn't be easier to build. The hardest part is making the decision of whether to leave it in two pieces for easy transport or to cement the whole structure together so that it is always ready for action.

The steps include an option for weighting down the base, which is something you should seriously consider. The goal is lightweight and can easily be knocked out of place on the field during gameplay.

You can also paint the structure to make it more visible. The netting used here is extremely inexpensive and comes in several colors, so it's another way to put a unique touch on the goal and make it easier for young players to locate. Modify the size of the goal to suit older players; the size as designed is best suited to players ages five to eight.

WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy**

TOOLS

Tape measure
Miter saw, chop saw, or hacksaw
80-grit sandpaper
Speed square
Marker
Level
Eye and ear protection
Work gloves

MATERIALS

32' × $1^1/_4$" PVC pipe
(6) $1^1/_4$" elbows
(6) $1^1/_4$" tees

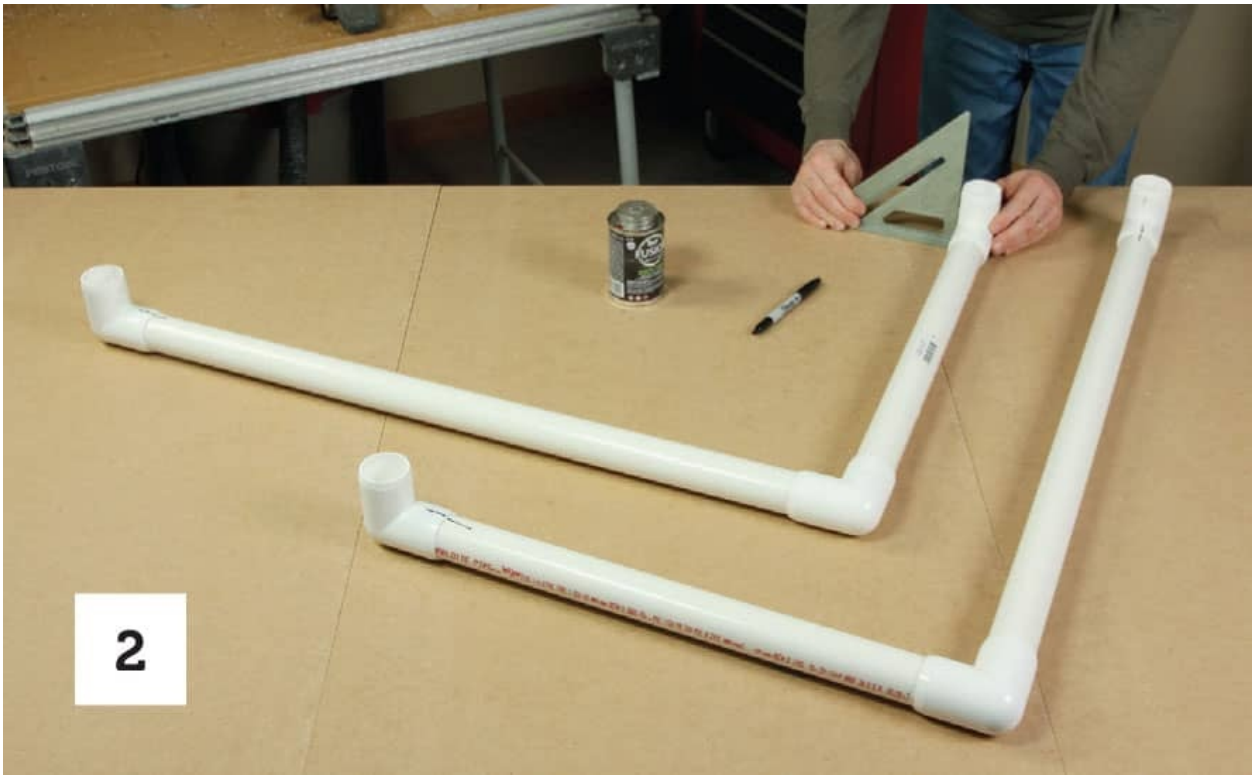
(18) snap clamps (5" long, cut from two 48" × 1 1/4" clamps) PVC cement
54 × 44 × 24" bungeed soccer net
Sand (optional)

CUT LIST

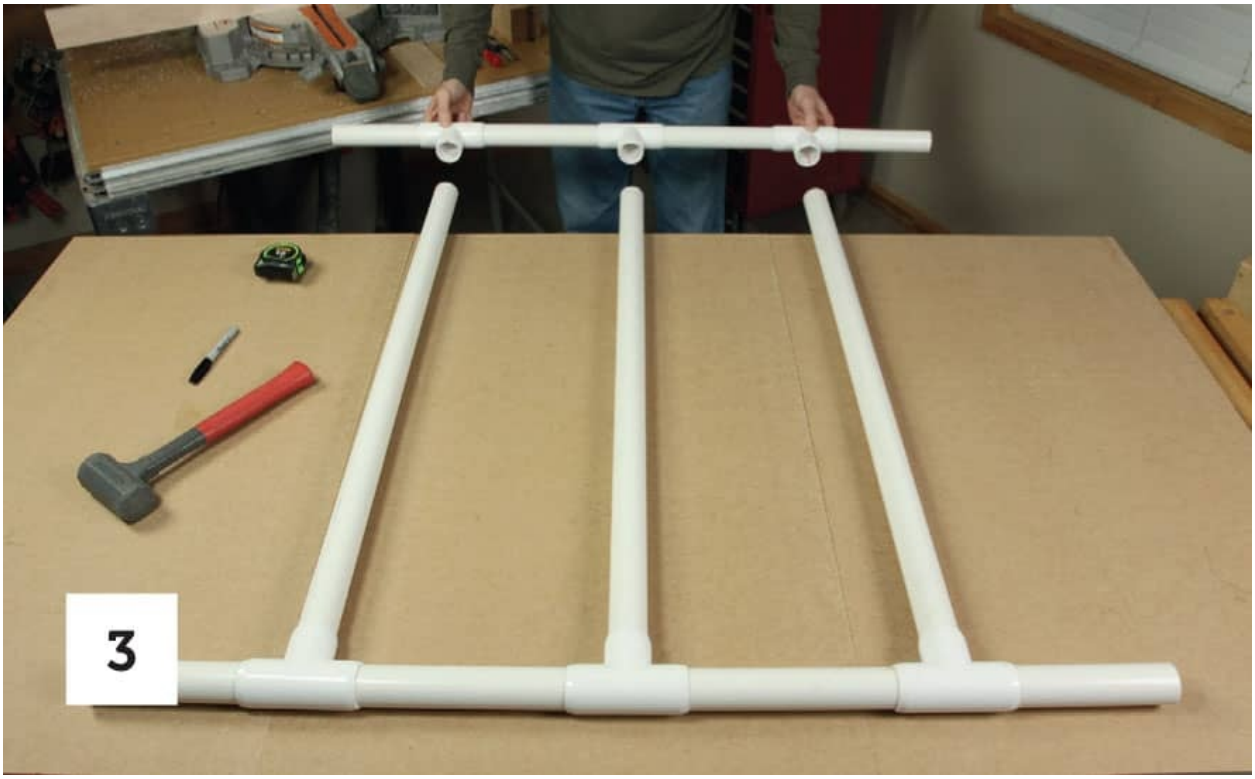
(2) 20 1/4" base sides
(2) 32 1/4" posts
(4) 8" back outer rails
(4) 11 1/4" back inner rails
(3) 39 1/4" back supports

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand the cut ends of all the pipes smooth.



2 Working on a flat, level work surface with plenty of space to spread out, cement a 20 $^{1}/_{4}$" base side into one side of an elbow and a 32 $^{1}/_{4}$" post into the other. Slide elbows onto the open ends of the side and base, so that the open elbow inlets are perfectly perpendicular to the other pieces—check them with a speed square. With a grease pencil, mark the joints with key marks and then cement the elbows into position. Repeat the process with the second side.



3 Build the top of the back frame with an 8" back outer rail, a tee, an 11 $^{1}/_{4}$" back inner rail, a tee, another inner rail, a tee, and finish with a second outer rail. The tee inlets should all lie flat. Make key marks, disassemble, and cement the pieces together. Repeat to build the back frame bottom.

4 Cement the 39 $^{1}/_{4}$" back supports between the tees in the back frame top and bottom.

5 Dry fit the side elbows onto either end of the back assembly. Use a level to check that the goal sits stable on a flat surface and isn't skewed. Make key marks at the connections, disassemble, and cement the sides to the back.

Optional: You can leave the connections between the sides and back uncemented to make transporting the goal easier.

6 Wrap the netting around the frame, leaving the front opening clear, and use snap clamps to secure the netting all the way around the frame.

THE SAND TRAP

One of the advantages of a PVC pipe soccer goal is its light weight. However, in the rough-and-tumble action of a game, that can also be a disadvantage, as an attempted shot bounces off a post and skids the goal out of position. Fortunately, there's an easy way to anchor the goal: sand. When constructing the goal, leave the bottom unattached (cement the posts and back supports into the top only). Then when it's game time, pour sand into the base, using a bag of sand and a funnel. The sand can be poured out of the base after the game by just removing the top and tilting the base. Of course, you can also make this a permanent solution by just filling the base with sand before you cement the back supports and posts into place on the base. In either case, the base will be much steadier and more stable than it otherwise would have been.

TOY CAR GARAGE

Few toys get underfoot faster in a busy family household than toy cars that have raced away from where they belong. There are normally so many of these cars in any home with an enthusiast that they begin to pop up everywhere. But, like the car in the driveway, if you want to keep them in order, you need to garage toy cars.

A simple organizer such as the one in this project is not a challenge—it's even simple enough that you could get your young car lover involved in the actual fabrication. The individual car park tubes are just cut segments of 2-inch PVC pipe, layered in rows, one on top of the other. To perfectly accommodate the pipe, the interior of the plywood box used here was 9 1/2 by 10 3/4 inches. The result is not only a "garage" that keeps the toy car fleet organized, but it's also a fun and fascinating way for little ones to display some of their favorite cars. The idea of showing off these colorful scale models will spur the youngster to pick up the cars and replace them in the garage when playtime is over.

If you want to add a little decorative interest, you can paint the tubes, although the colorful cars show up better against the white. You can also scale the garage to accommodate the number of toy cars in your child's collection—but always leave a few extra slots for expansion, because these collections inevitably grow.

You can use a wood box as is done here, or use a plastic or pressed cardboard box from a crafts store. Just make sure that the box has rigid sides—and the best interior dimensions for the garage itself is 11 7/8 by 20 inches (which will accommodate 10 rows of tubes for a total of 45 parking spaces). Lastly, you'll find instructions for a PVC pipe racetrack to put all those garaged cars to good use.

WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy**

TOOLS

Tape measure
Miter saw, chop saw, or hacksaw
Pipe wrap insulation (optional)
Self-adhesive 80-grit sandpaper (optional)
Tack cloth
Eye and ear protection
Work gloves

MATERIALS

7' × 2" PVC pipe

Primer and paint meant for plastic (optional)

$9^1/_2$" × $10^3/_4$" wood box (or substitute thick cardboard box with sturdy sides) PVC primer and cement

CUT LIST

(18) 4" car tubes

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Deburr and sand the cut ends by cutting a 4" section of pipe-insulating foam sleeve and sticking self-adhesive-backed 80-grit sandpaper to one side. You can then quickly sand the cut pipe sections smooth. It’s important that they be absolutely free of any snags or rough sections. Use a tack cloth to remove all the sanding dust once you’re done.

2 Paint the tubes and the box at this time, if you’re finishing them. Otherwise, sand the box smooth as necessary to ensure that it won’t cause splinters.

3 Set the box on its end (or on its side, if that's how you'll be storing the cars), and begin layering the car tubes in the box. Fit them as tightly as possible, with each successive row nesting in between the tubes below. Dab PVC primer and cement to join the side of tubes layered on top of other tubes, to hold them in place as you build the rows. If necessary, at the top of the garage, you can use smaller diameter PVC pipe scraps to fill in.

THE PVC RACETRACK

Why stop at a garage? All those toy cars need to a place to race every bit as much as they need a place to park, and so why not make a racetrack that matches the garage? Here's how to make a simple drag racetrack to test the limits of toy car speed.

simple drag racetrack to test the limits of toy car speed.

1 Mark the centerline on both sides of a 4' to 8' length of 2" PVC pipe. First mark across the diameter at one end of the pipe, using a speed square, so that clear marks show on either side of the opening.

2 Use a clear 1× board that is perfectly straight and as long as the pipe you're using, and line it up next to the pipe (edge to edge). Draw a cutline along the length of the pipe. Do the same on the opposite side.

3 Use a tablesaw to cut along the cutlines, cutting the pipe in half lengthwise.

4 Cement this half-pipe into both sides of a 45° elbow. Cement a cap onto the end of the track.

5 Create a second racetrack in the same way.

6 To use the tracks, clamp the elbows to a chair, table, or even a tall box using bar clamps, so that the beginning of the track is elevated and the capped end sits on the floor. The racers simply pop the cars into the starting gate (the open side of the elbow) and let them fly!

SUMMER SOAKER WATER CANNON

The best kind of summer fun involves water. If you don’t have a pool, don’t let the kids sweat and get a bad case of the grumpies. Instead, arm them with these super simple handheld water cannons and let them soak each other for cooling relief and busy fun all in one.

The hydraulic principle behind this water gun is so basic that you’ll pretty much never have to worry about the gun breaking down. Whether kids use it for a running water battle through suburban streets or it serves as a readily available pool toy, the soaker will hold up to whatever young water warriors can dish out. As a bonus, the spray strength from the gun is just enough to be refreshing, but not enough to hurt anyone. You won’t have to worry about injuries or tearful complaints!

Make it just as it is, or make multiples and let each kid paint or decorate his or her own weapon to personalize the water cannon and make for even more fun.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Medium**

TOOLS

Tape measure
Miter saw, chop saw, or hacksaw
Fine-tooth file or 80-grit sandpaper
Marker
Power drill and drill bits
$1\frac{3}{4}$" hole saw
Eye and ear protection
Work gloves

MATERIALS

3' × 2" PVC pipe
3' × $1\frac{1}{4}$" PVC pipe
(2) 2" caps
(2) $1\frac{1}{4}$" caps
$1\frac{1}{4}$" coupling
2" tee
$1\frac{1}{4}$" tee
1.6" O ring
PVC cement
Waterproof silicone grease

CUT LIST

2" × $1\frac{1}{4}$" compression sleeve
22" × $1\frac{1}{4}$" plunger
$8\frac{1}{4}$" × 2" barrel nozzle
13" × 2" barrel body
6" × 2" front handle
6" × $1\frac{1}{4}$" rear handle

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand down the edges until they are perfectly smooth—the success of the water cannon will rely on this.

2 Measure and mark the exact center of one of the 2" caps, and drill out a centered hole in the cap with the 1 $^{3}/_{4}$" hole saw. Sand the edges of the hole

perfectly smooth.

3 Cement the 1 1/4" cap to one end of the 2" × 1 1/4" compression sleeve. Work the O-ring over the open end of the compression sleeve, so that it is snug against the lip of the cap.

4 Cement the coupling to one end of the 22" × 1 1/4" pipe. Cement the open end of the compression sleeve into the open end of the coupling. Cement each barrel section into one side of the 2" tee. Cement one end of the front handle into the open inlet of the tee.

5 Drill a 1/4" hole in the center of a second 2" cap (this will create one direct stream of water from the gun; for a more diffuse spray, drill a triangle of 1/8" holes, or any combination). Cement the cap onto that end of the barrel.

6 Spread silicone grease around the inside of the open side of the 2" barrel. Slide the 1 1/4" plunger assembly, O-ring side first, into the opening in the 2" barrel. Push the plunger all the way into the barrel.

7 Very carefully cement the center-hole 2" cap onto the back of the barrel, sliding it over the plunger assembly without getting any cement on the plunger.

8 Cement one side of the 1 1/4" tee onto the back of the plunger. Cement the 1 1/4" rear handle into the nipple of the tee. Cement caps onto the end of the 1 1/4" handle and the end of the front 2" handle. Test the water cannon out by depressing the plunger as far as it will go, immersing the nozzle of the barrel into a bucket of water, and slowly drawing the water in by pulling the plunger back. Then blast away!

WATER TABLE

Outdoor play should always be the order of the day in the summer. There's no reason not to take advantage of beautiful weather, and the bane of every parent is the drone of the TV in the daylight hours. It may be hard to compete with electronic diversions, but you can entice your youngsters outside with a most unusual playground—the undersea world of their imaginations.

This water table is a little slice of the beach brought right into the backyard. It might seem like a simple idea, but children take to it just as readily as they do a swimming hole, and right where you can keep an eye on them. The table uses a repurposed plastic storage bin held in place by a sturdy frame. The bin is filled half full of water and has overhead spouts for more water and sand. Just add bath toys (or just about any toy), stand back, and let the fun begin.

The best part? Easy cleanup. To tidy the table after a long day of use, simply remove and dump the plastic basin, spray it out with a hose, spray the frame clean, and the whole setup is ready to go for the next day.

The frame is designed to be sturdy enough to not only hold the weight of the water, but also put up with the excited movements of kids at play. It's specifically sized to be manageable, so that even young children can easily reach into the basin to play with toys. (Using the overhead spouts may require a stepstool for younger or smaller children; see here for how to make one.) Be aware that that although not difficult to build, there are many pieces in this construction and they need to work together for everything to fit properly. Dry fit everything before final construction, and make adjustments as necessary.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Medium**

TOOLS

Tape measure
Chop saw or tablesaw
Utility knife or 80-grit sandpaper
Marker
Torpedo level
Eye and ear protection
Work gloves

MATERIALS

30' × 1" PVC pipe
(4) 1" caps
(13) 1" tees
(4) 1" three-way elbows
(2) 1" crosses
(3) 1" elbows
PVC cement
(2) 1" to $^1/_2$" reducer bushings
(2) funnels (optional)
$32^1/_2$" × $17^3/_4$" × $6^1/_2$" plastic bin CUT LIST
(4) $16^3/_8$" lower legs
(4) $4^3/_4$" upper legs
(4) $6^1/_2$" ends
(2) $32^1/_8$" upper sides
(4) $4^3/_4$" lower side outers
(4) $8^7/_8$" lower side inners
(3) $14^1/_4$" crossbraces
(2) $13^1/_2$" top posts
$10^1/_8$" long top support (outer)
$10^1/_4$" long top support (inner)
10" short top support
(2) 7" water feeder tubes

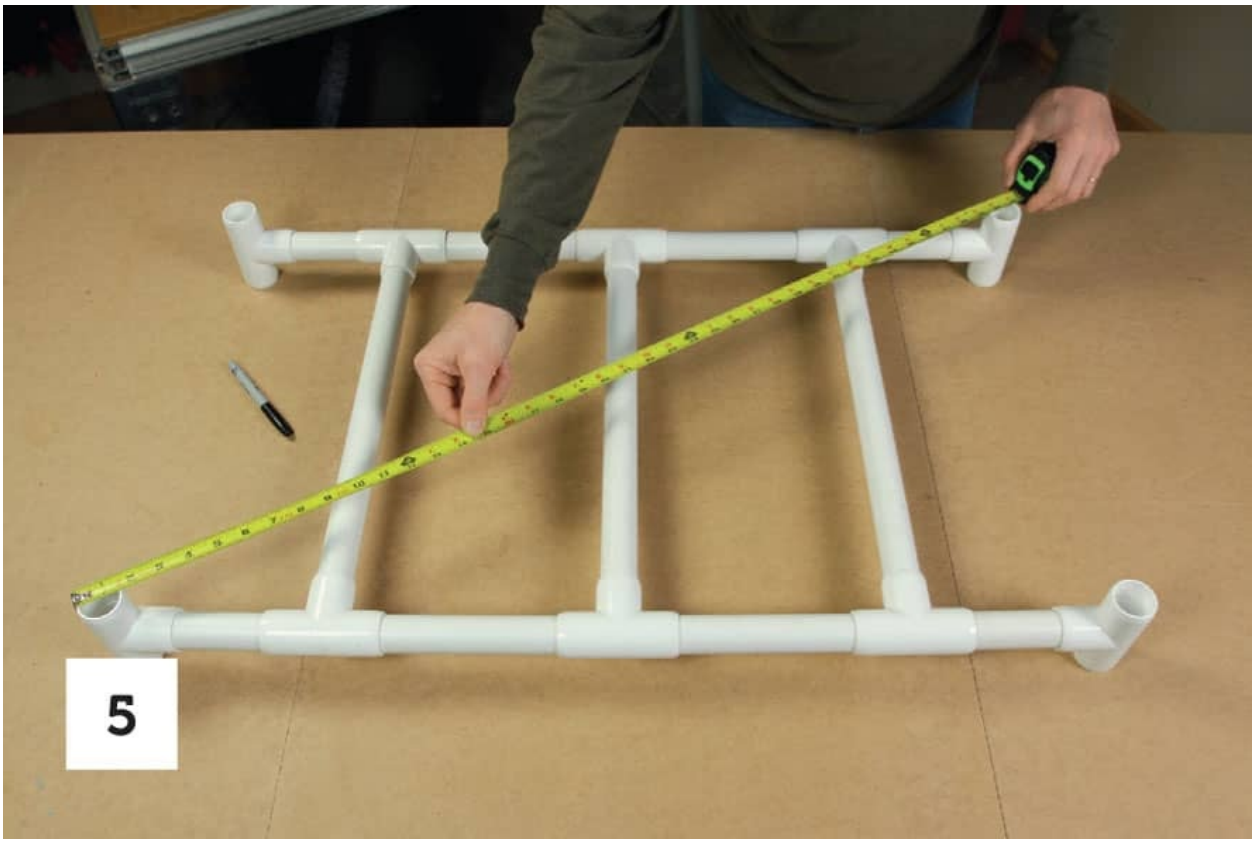
HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth. Measure segments in the same components (i.e., leg to leg) next to each other, to ensure they are exactly the same.

2 Build the legs for the table frame by cementing caps onto each 16 3/8" lower leg and cementing one side of a tee onto the other end. Cement a 4 3/4" upper leg into the opposite side of each of these tees.

3 Start the tabletop frame by cementing each 6 1/2" frame end section into a three-way elbow. On a flat, level work surface, complete the two top frame ends by dry fitting the open ends of the frame end sections with tees. The nipple of the tees should point in the exact opposite direction of one nipple of the three-way elbows (the other nipple will point straight up from the work surface, perpendicular to the tee nipple direction). When you're sure the orientations of the elbows and tees is correct, use a grease pencil to make key marks at the connections. Disassemble, and cement the frame end assemblies together.

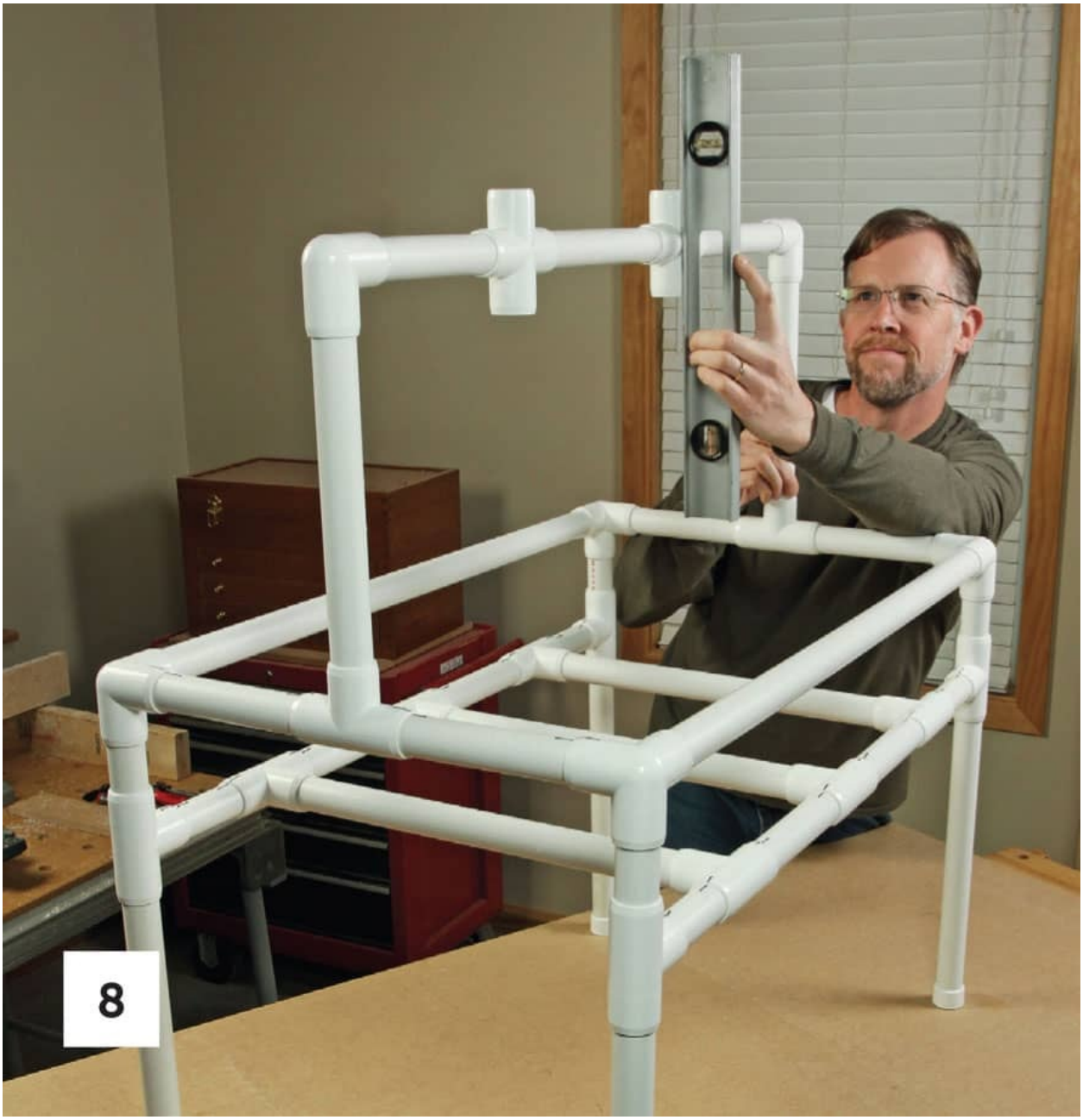
4 Connect the two top frame end assemblies with the 32 1/8" upper sides, dry fitting the long pieces between the elbows of both assemblies. Sit the completed frame on the level work surface (resting on the open elbow inlets) and measure the diagonals to ensure the frame is square. Check that the frame doesn't rock and isn't skewed and that the end tee nipples are pointing straight up. Disassemble, and cement the sides between the frame end assemblies.



5 On the flat, level work surface, dry fit the lower frame side by plugging a 4 3/4" lower side outer in one end of a tee with an 8 7/8" lower side inner on the other end of the tee. Build four of these pairs, and then connect the longer inners with tees. Finally, join the sides you've just assembled with the 14 1/4" crossbraces fit into the open inlets on the tees. Measure diagonals to make sure the lower frame is square and that it sits flat. Make key marks at the connection points, disassemble, and cement the frame back together.

6 Turn the top frame upside down on the work surface. Dry fit the legs into the elbows, with the tees on each side pointing in toward each other. Dry fit the lower table frame outers into the leg tees. Stand the frame upright to ensure it stands without wobbling. Make key marks at the connection points, disassemble, and cement the pieces of the lower frame to the legs.

7 Cement the 13 $^{1}/_{2}$" top posts into the upward-facing tees on both ends of the top frame. Assemble the top water features together by cementing the top support sections in a line, separated by crosses (the crosses should lie flat on the work surface).



8 Dry fit the top support assembly into elbows placed atop the posts. Check with a torpedo level that the open cross inlets are plumb. Make key marks at the elbows, remove the top support, and cement it back into place. Cement the water tubes into the bottom inlets of the crosses. Cement a tee on one tube and an elbow on the other (align them by eye, so that they are roughly parallel to the top support).

9 Cement the reducer bushings into either side of the tee. Place the funnels in the tops of the water tube crosses, and place the plastic bin into the frame. Now just add water and have fun!

QUICK 3

When it comes to enjoyable downtime, it can usually be made more enjoyable with the help of PVC pipe. For instance, you can create a multitude of yard games using nothing more than odds and ends from other PVC projects. The Toss Across Game is just one example. It is exceedingly simple to craft and to play, and the basic idea (teams facing one another across a lawn, throwing things at a target) translates to other yard games, such as ring toss.

When it comes to PVC fun, though, it's not just about games. PVC pipe has its musical side as well. The pipe makes an excellent Flute, and thinner pipes can be coupled with overturned 5-gallon buckets, to make a portable drum set. You can even make more exotic instruments, such as the Giant Xylophone. Of course, the pipe's nature lends itself to the more practical side of fun, such as organizing art and craft supplies, gift wrapping material, or other hobby items.

1 TOSS ACROSS GAME

Some of the simplest summertime fun, especially at a cookout or other backyard party, is a quick game of toss across. The game involves tossing a beanbag or tennis ball across a field of play (usually about 15’ long, but do what makes the most sense for your crowd)

into tubes that have been cut to different heights and given values based on how hard they are to hit. The PVC pipe version involves cutting 3 1/2" pipe into nine sections of the following lengths: one at 3", two at 4", three at 5", two at 6", and one at 7". All the tops should be cut at a 30° angle. Arrange them in a diamond pattern as shown, in ascending heights. Drill holes through the pipes at the bottom and zip tie the tubes together in formation. Then use stick-on numbers to assign the values as shown. Make two sets of tubes for a true toss across game (each team stands next to one unit, for their turn throwing), and use beanbags, juggling balls, or tennis balls.

2 FLUTE

If you're just looking to create a noisemaker for your very young musician, you can create a crude flute by cutting a 3/4" PVC pipe to 16". Cork one end and drill a 1/2" mouthpiece hole about 1/4" from that end. Then drill 3/8" holes at 6 7/8", 8", and 9 1/8" from the end, offsetting the third hole slightly off center of the other two. Drill three more holes: an 1 1/32" opening 10 3/4" from the end, a 7/16" hole 11 1/2" from the end, and a 5/16" hole 12 3/4" from the end. Make sure you sand all the holes and the entire pipe completely smooth. Let your children discover their own tunes, or get a beginner music book and begin building a repertoire.

3 CRAFT ORGANIZER

Nothing is more frustrating than starting a crafts project and discovering that you can't find anything you need. Disorganization is the enemy of fun in crafts. But a few PVC pipes can whip your crafting area into shape with very little fuss and muss. You can make the most versatile organizers from 4" pipe, but size the pipe to accommodate what you need to store. For instance, if you're looking for a container to corral all your art pencils, a 3" pipe might work better. In any case, measure the length of what it is you will store, then cut the pipe to three-quarters of that length. Cut one end to a 30°

angle and sand the cut ends smooth. Mount the organizers to a separate board, or directly to a wall, by drilling a countersunk pilot hole through the edge of the pipe at the angled end, then screwing the pipe to the surface (shorter side on top). Make as many organizers as you need to keep your art or crafts area neat as a pin.

SWORD & LIGHT SABER

Like it or not, few kids can resist the lure of a good weapon and some imaginary battle. But swords are always better for the imagination than guns, and here are two options that can lead to hours of mock dramatics and epic battles. The first is a classic broadsword and the second is a fun light saber.

Either one of these won't take more than a few minutes to throw together and can be completed for about the price of a couple large coffees at the local coffeehouse.

Although the sword is durable and, with the rounded tip courtesy of a PVC cap, shouldn't be dangerous, you may want to wrap the blade in pipe insulation or a similar padding for younger children or those who tend toward the rambunctious.

SWORD

WHAT YOU'LL NEED

Time: **15 minutes** | Difficulty: **Easy**

TOOLS

Tape measure
Chop saw or hacksaw
80-grit sandpaper
Eye and ear protection
Work gloves

MATERIALS

5' × 3/4" PVC pipe
(4) 3/4" caps
3/4" cross
PVC cement
Primer and paint meant for plastic (optional)

CUT LIST

31" blade
8" handle
(2) 6" guards

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand all the cut edges smooth.

2 Cement a cap on one end of each of the cut pieces.

3 Cement the open ends of each of the cut pieces into the inlets of the cross; the blade and handle must be opposite each other. Sand and paint the sword as desired.

LIGHT SABER

WHAT YOU'LL NEED

Time: **15 minutes** | Difficulty: **Easy**

TOOLS

Tape measure
Chop saw or hacksaw
80-grit sandpaper
Eye and ear protection
Work gloves

MATERIALS

2' × 1/2" PVC pipe
1' × 3/4" PVC pipe
3/4" to 1/2" reducer coupling 3/4" cap
Primer and paint meant for plastic in silver and gloss black
PVC cement
Duct tape
Electrical tape
Silicone adhesive
Pool noodle (in your desired color—bright yellow or neon green works well for a light saber)

CUT LIST

24" × 1/2" blade
8" × 3/4" handle

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand all the cut edges smooth.

2 Prime and paint the coupling silver, masking off the interior and protecting it from any overspray. Cement the blade in the smaller inlet of the coupling and the handle in the larger side.

3 Prime and paint the cap gloss black, being careful to protect the inner surfaces from any overspray. Let the cap dry and then cement it onto the end of the handle.

4 Wrap the handle in a random pattern of alternating bands made by winding duct tape and electrical tape around the handle. Cut the pool noodle to a length matching the blade, dab a little silicone adhesive on the top end of the blade, and slide the pool noodle down over the blade.

GIANT XYLOPHONE

There is a not-so-fine line between kids making noise and kids making music. The instrument in this project balances on that line, offering relatively pleasing tones for anyone within earshot, and still delivering loads of satisfying noisemaking fun for kids—whether they have any musical aptitude or not.

This is similar to many basic oversized metal pipe xylophones available for children, although the instrument makes a more muted, lower register sound. The construction is, though, a rough approximation of an actual professional xylophone. If you want to create an exactly correct instrument on which your child can develop an ear for tones, you'll find tables of lengths and diameters of pipe as they relate to actual keys online.

But really, any music education starts with the love of making sounds that please the ear. That is the goal with this xylophone. The relationship of tones between pipes is the same as any professional-quality xylophone. And the beauty is, beating on the tubes is pure fun for any child.

To foster a sense of joy and love of music, it helps if the instrument looks like fun. That's why you should strongly consider painting each tube a different color, or decorating them with colored tapes, stencils, stickers, or some other fun look. Ultimately, the more fun the child finds in using the xylophone, the more music he or she will look to make.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Medium**

TOOLS

Tape measure
Miter saw, chop saw, or hacksaw
80-grit sandpaper
Paintbrush (optional)

Paintbrush (optional)
Power drill and bits
Marker
Level
Eye and ear protection
Work gloves

MATERIALS

26' × 3/4" PVC pipe
1' × 1/2" PVC pipe
(2) 3/4" tees
(4) 3/4" caps
1/2" cap
1 × 4" × 8' pine
Paint meant for wood (optional)
PVC cement
(12) 3/4" pipe straps
(24) #10 × 3/4" panhead sheet metal screws
Scrap fabric, weatherstripping, or other foam
Duct tape
Colored duct tape or craft tape (in 8 colors)

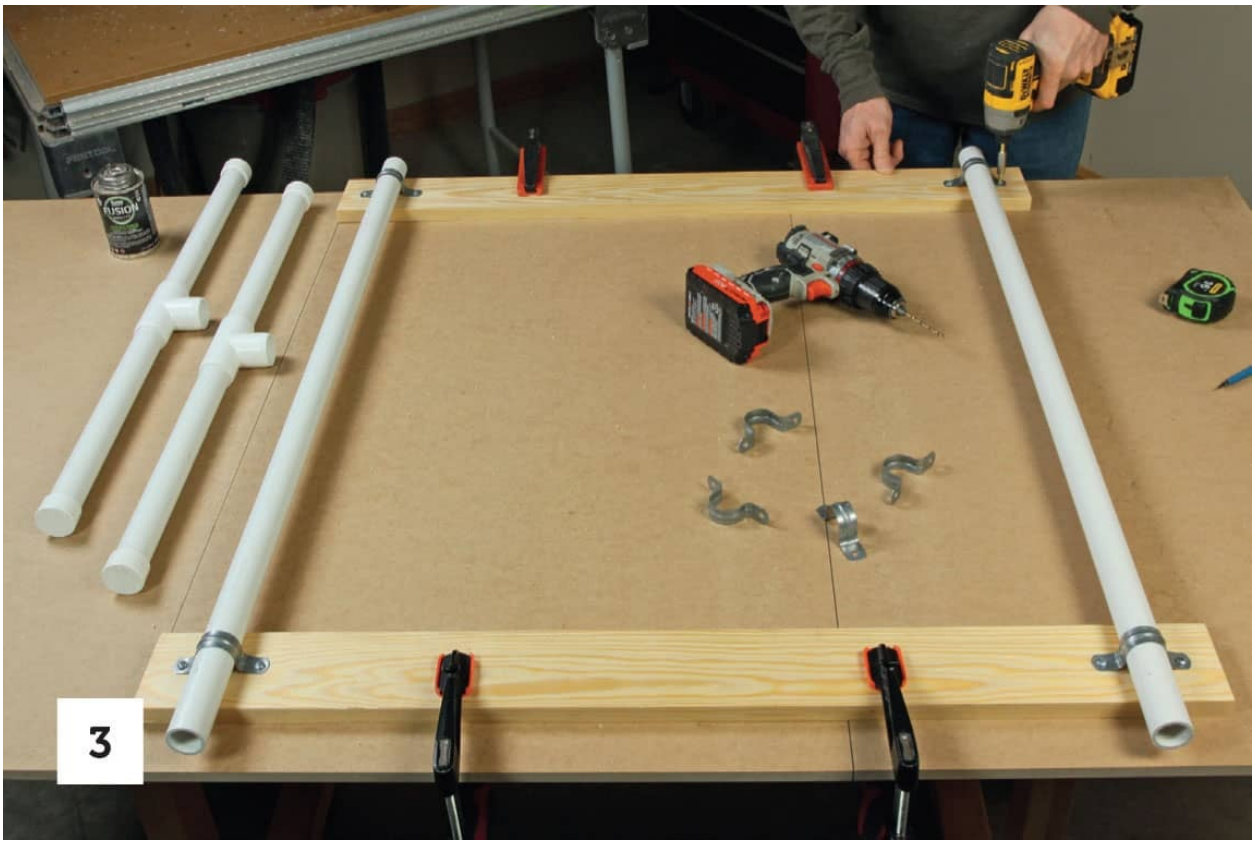
CUT LIST

(4) 14" feet
(2) 40" legs
8" first pipe
12" second pipe
16" third pipe
20" fourth pipe
24" fifth pipe
28" sixth pipe
32" seventh pipe
36" eighth pipe
(2) 1 × 4 × 36 1/2" wood braces

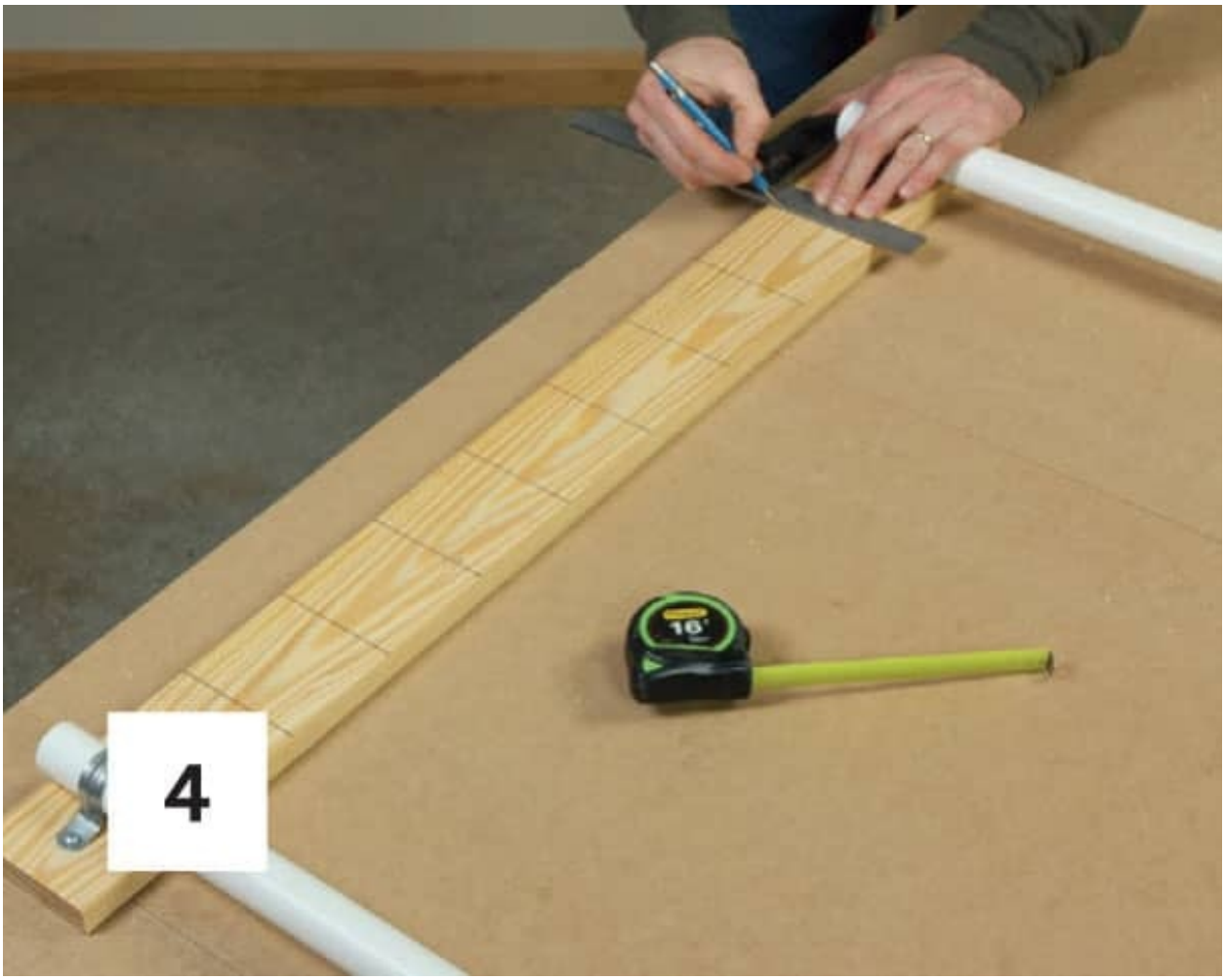
HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the 3/4" pipe segments and wood to match the cut list. Sand all the cut edges smooth. If you're painting the wood, paint it now and let it dry.

2 Cement the 14" feet into the two opposite sides of the two tees. Cement the 3/4" caps onto the open ends of the feet.

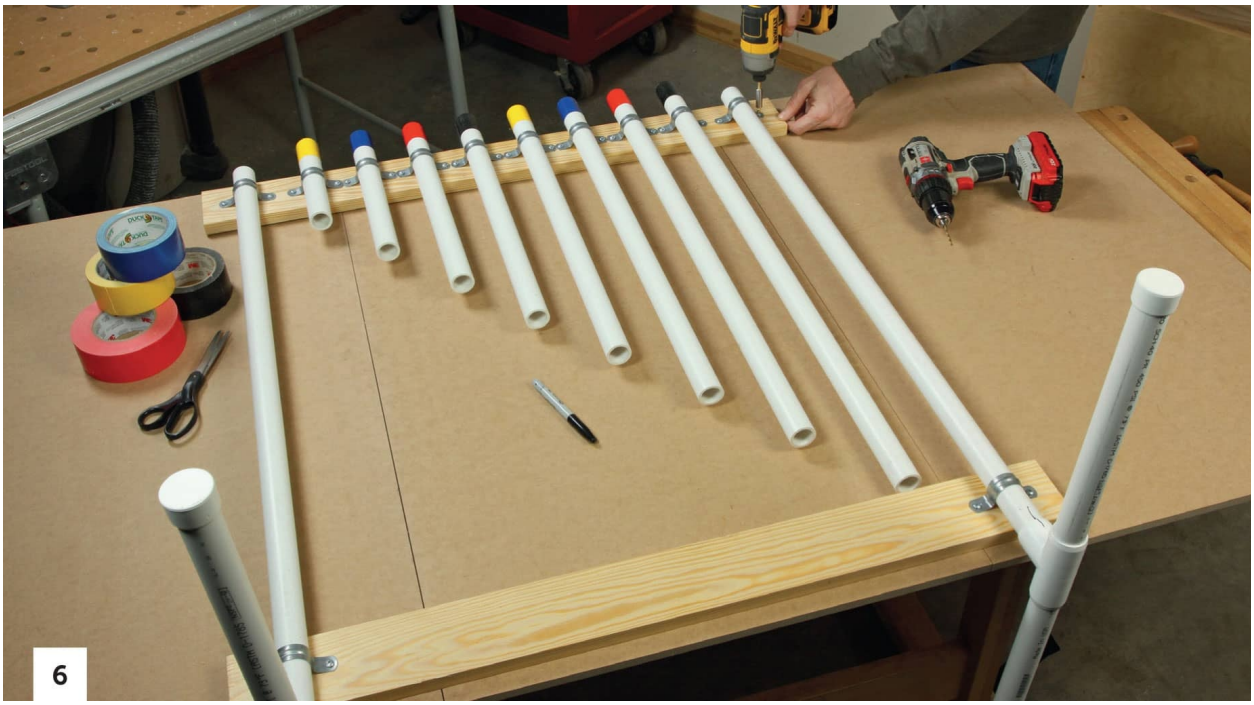


3 On a flat, level work surface, lay out the wood top and bottom braces, parallel and about 31" apart. Lay the first 40" leg across the braces, with its top edge aligned with the top of one brace and in 2" from the ends of the braces. Position the opposite leg in exactly the same position at the other end of the braces, and check that both the legs and the braces are correctly aligned perpendicular to one another. When you're satisfied with the positioning, use a power drill to fasten the legs to the braces with pipe straps.



4 Measure and make the first mark $3^{1}/_{4}$" from the brace end, and then space the other seven layout marks $3^{5}/_{16}$" apart. These marks serve as centerlines for installing the eight pipes evenly over the 36 $^{1}/_{2}$" brace length.

5 Attach the feet to each leg and stand the xylophone frame upright. Adjust the feet as necessary so that they are perpendicular to the faces of the braces, and so that the frame does not wobble. Make key marks at the tee connections, remove the legs from the feet, and cement them back in position.



6 Carefully align the xylophone pipes from shortest to longest, along the marks you made on the top brace. Use a level to check plumb, and attach each pipe to the top brace with a pipe strap and screws so that the pipe projects above the top brace’s top edge by about 2". Note: Do not overtighten the connection holding each pipe in place; if the clamp is too snug, the pipe will not sound its “note.”

7 Wrap the end of the $^{1}/_{2}$" pipe in several turns of scrap fabric (or use weatherstripping or other foam), and tape it tight to the pipe to make a padded xylophone hammer. You can decorate the tops of the tubes with colored tape; although only four colors have been used here, you can use different colors or markings for each tube to establish patterns if you are planning on playing songs.

BOTTLE ROCKET LAUNCHER

Anybody who has ever watched the launch of a rocket from Cape Canaveral knows just how exciting watching a guided spacecraft burst from its base can be. It's a fascination for adults and children alike. What could be better than bringing that fascination right into your own backyard, with your own launch pad and spaceship made from nothing more than a recycled plastic bottle?

This is one of those fun toys that every kid will appreciate—and will become involved in right from the initial stages of fabrication. That appreciation is the basis for a lot of learning while having fun. This launcher illustrates basic principles about pressure, velocity, volume, and more.

The construction is relatively simple, although the actual launch mechanism is a little bit complicated and needs to be crafted correctly to hold down the pressurized bottle. You'll find a lot of instructions online for similar launchers that are simpler and require the bottle be held in place until launch. You'd be wise to use a true hold-down device such as the one in this project, because the pressure buildup that launches the bottle can be significant. Holding the bottle can lead to injuries. On that note, always keep in mind that pressurized containers can be dangerous. This launcher should only be used with adult supervision, and everyone should stand far back from the launcher when launching the bottle.

Experiment with different amounts of pressure to determine the best launch dynamics for the highest flight. The potential to create future astronauts is nearly unlimited.

SAFETY FIRST!

Any time you're dealing with pressurized containers, there is a potential for injury or accidents. Follow these rules—and teach them to your children—to make sure everyone has safe fun with this interesting, science-based launcher.

1 Never use the launcher without adult supervision.

2 Do not use this launcher indoors.

3 Be careful where you stand to watch the flight of the bottle, so that you never look directly into the sun.

4 Allow plenty of free area around the launcher so you can track and retrieve the bottle without disrupting neighbors.

5 Make sure that everyone present is standing away from the launcher before launching the rocket, to avoid any mishaps that might result in injury.

WHAT YOU'LL NEED

Time: **60 minutes** | Difficulty: **Hard**

TOOLS

Tape measure
Chop saw or hacksaw
Utility knife
80-grit sandpaper
Padded vise
Marker
Drill press or power drill and bits
Level
Bicycle tire pump with air gauge
Eye and ear protection
Work gloves

MATERIALS

4' × 1/2" PVC pipe
1/2" cap
1/2" elbow
1/2" cross
(2) 1/2" plugs
1/2" coupling
1" coupling
Schrader auto tire valve
Oil or silicone lubricant
PVC cement
(4) 1/2" pipe straps

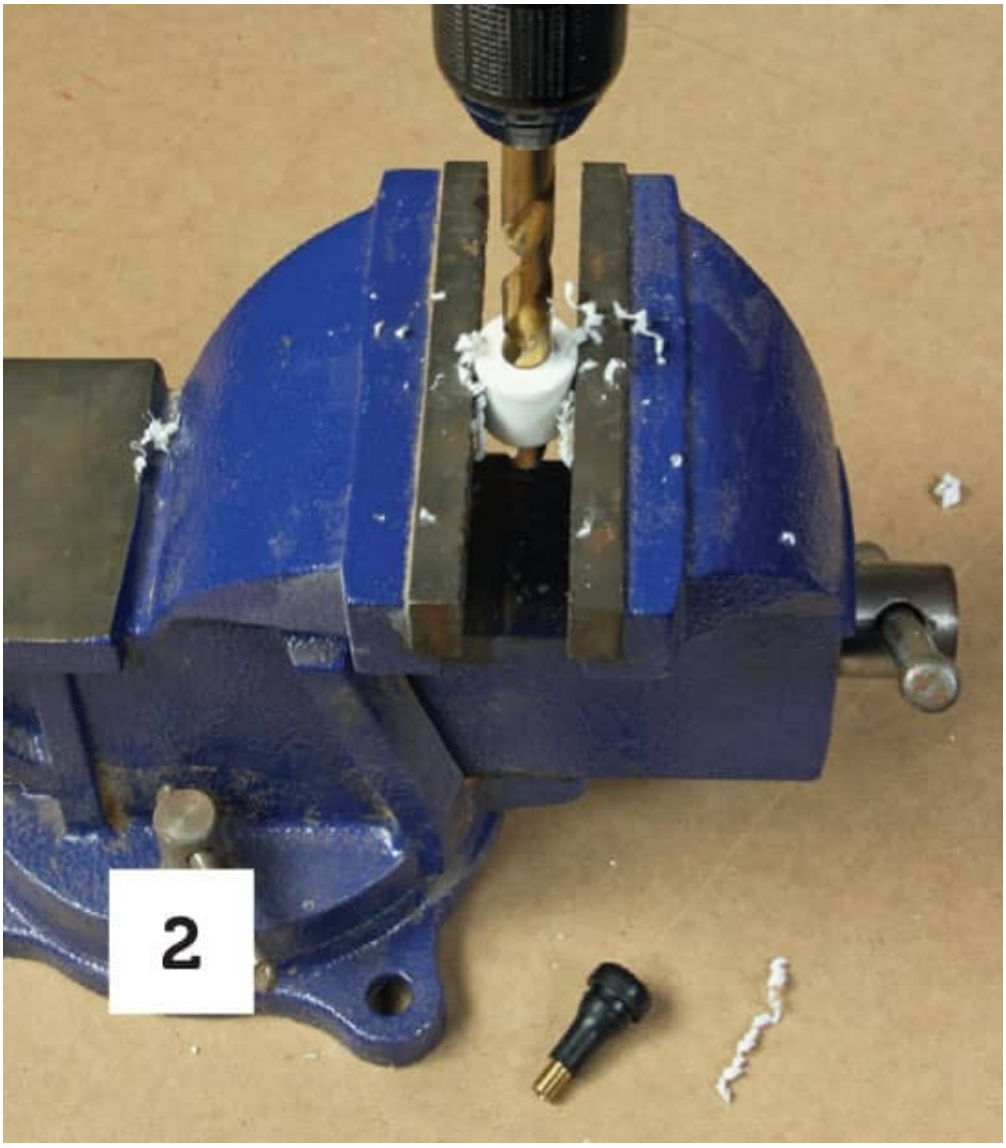
$1^1/_{16}$" ($^7/_8$" OD) O-ring Empty plastic bottle
(7) 7" zip ties
(2) rubber bands
Duct tape
3' piece of strong string or fishing line
(2) $^1/_4$" screw eyes

CUT LIST

$18^1/_2$" air line
$11^1/_2$" launch base
8" launch mechanism nipple
8" launch post
(2) 1 × 4 × 15" base boards

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. With a utility knife or sandpaper, trim or sand all the cut edges smooth.



2 Secure the cap in a vise with the end facing up. Use the top of the Schrader valve as a template to mark a drill hole in the center of the cap (the hole may need to be slightly larger to allow the base to pass through, but start small so that you don’t drill too large a hole; the valve must fit snugly and securely in place). Drill the hole. Sand the hole thoroughly inside and out to eliminate any sharp points that might damage the valve. Coat the hole with a small

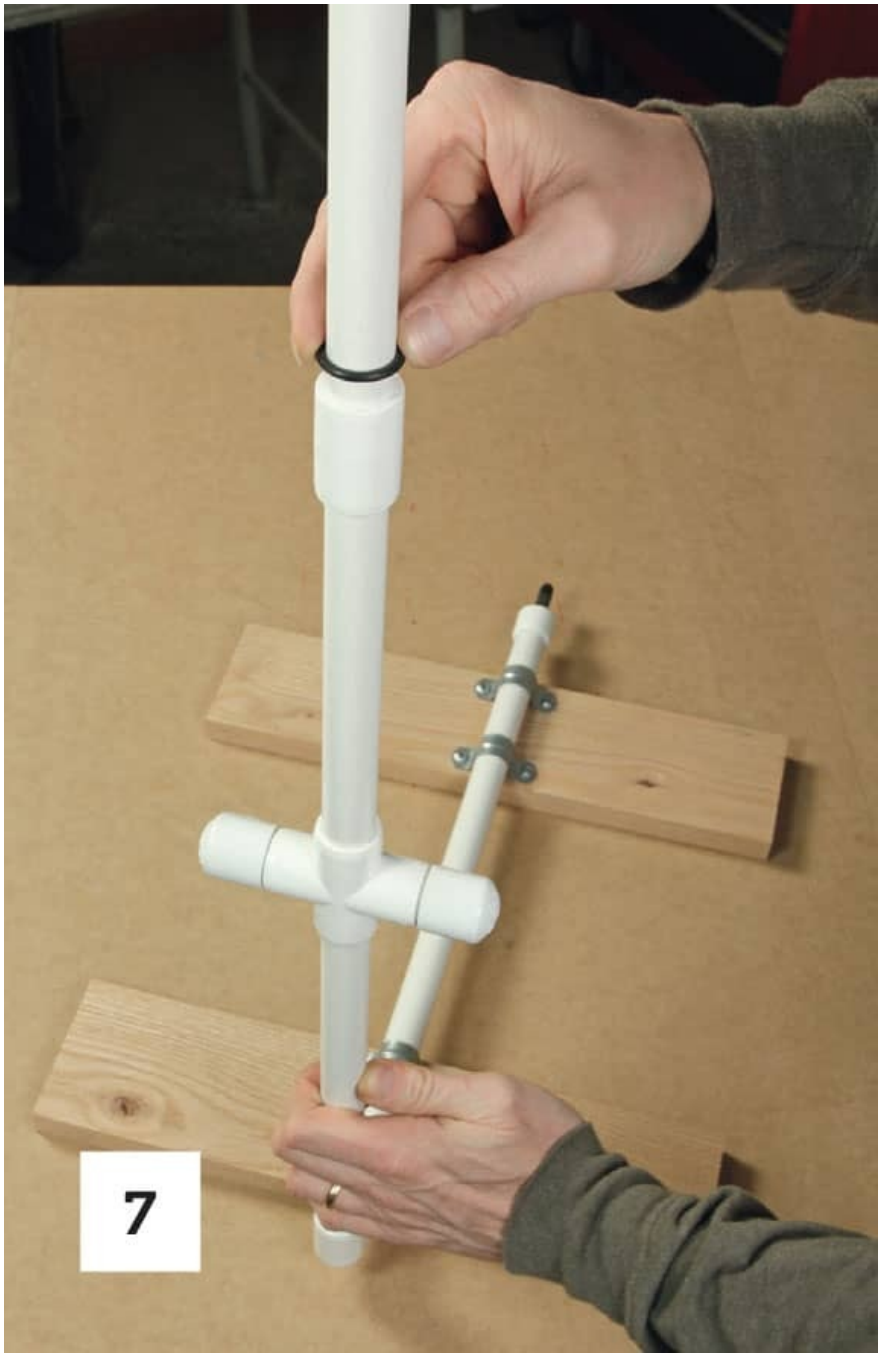
amount of oil or silicone lubricant and push the valve through from inside the cap, securing the valve's mounting flanges on either side of the cap hole.

3 Cement the cap onto one end of the 18 $^1/_2$" air line leading to the launcher. Avoid getting any PVC cement on the tire valve. Cement an elbow onto the opposite end of the air line.

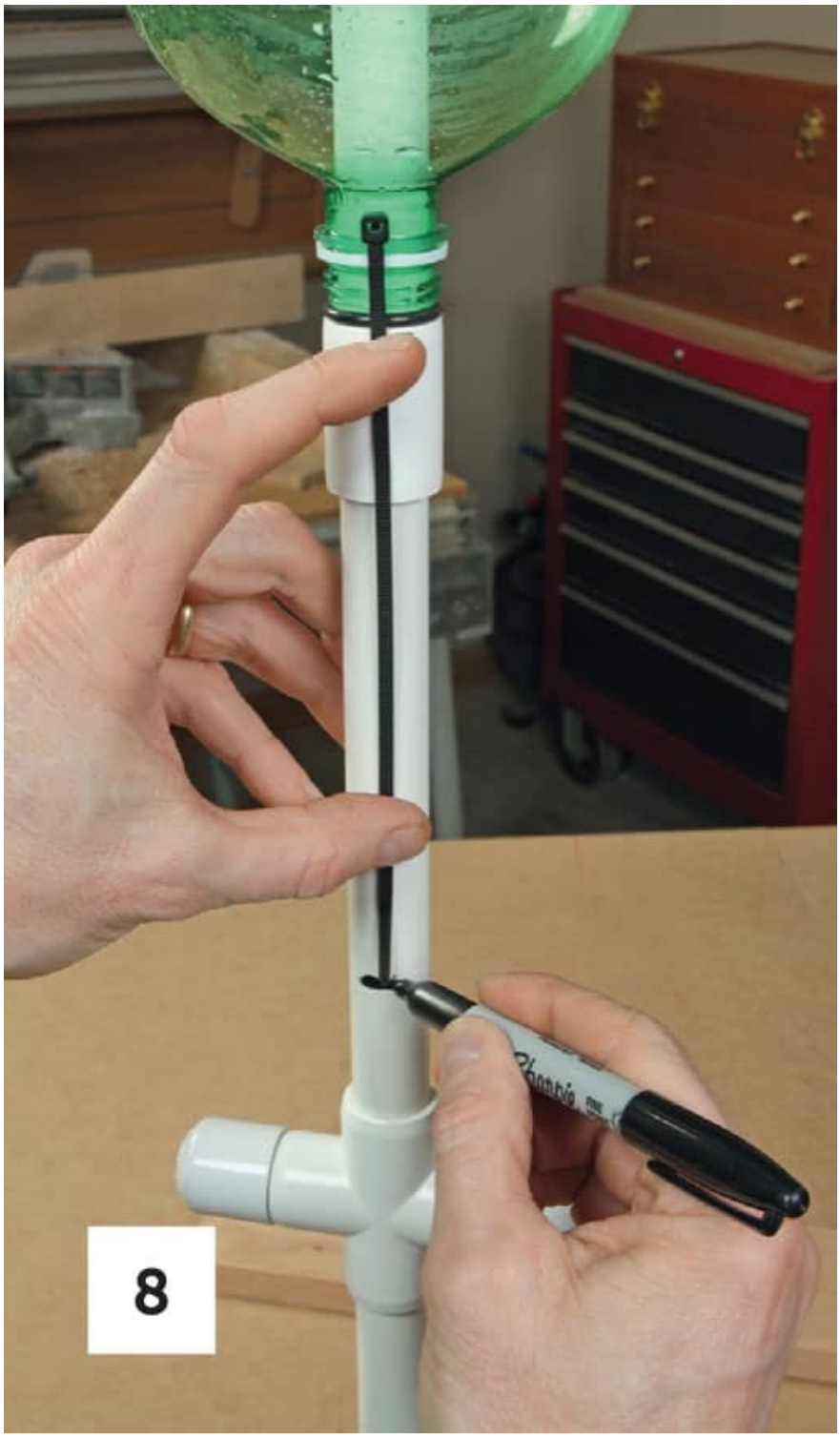
4 Cement one end of the 11 $^1/_2$" launch base into the open inlet of the elbow. Position the two base boards at either end of the air line, perpendicular to the line, with the air line centered over the boards. Screw the air line to the boards with pipe straps, leaving the straps just loose enough that the air line can move.

5 Use a level to check that the elbow and launch base are pointing up and perfectly plumb. Adjust the air line if they are not, and then tighten down the pipe straps.

6 Build the launch mechanism very carefully to ensure the bottle will sit correctly and launch safely. Start by cementing the cross onto the open end of the launch base pipe. Now cement plugs in each side (horizontal) inlet on the cross. Cement the 8" launch nipple into the top of the cross, and cement the $^{1}/_{2}$" coupling to the top of the nipple.

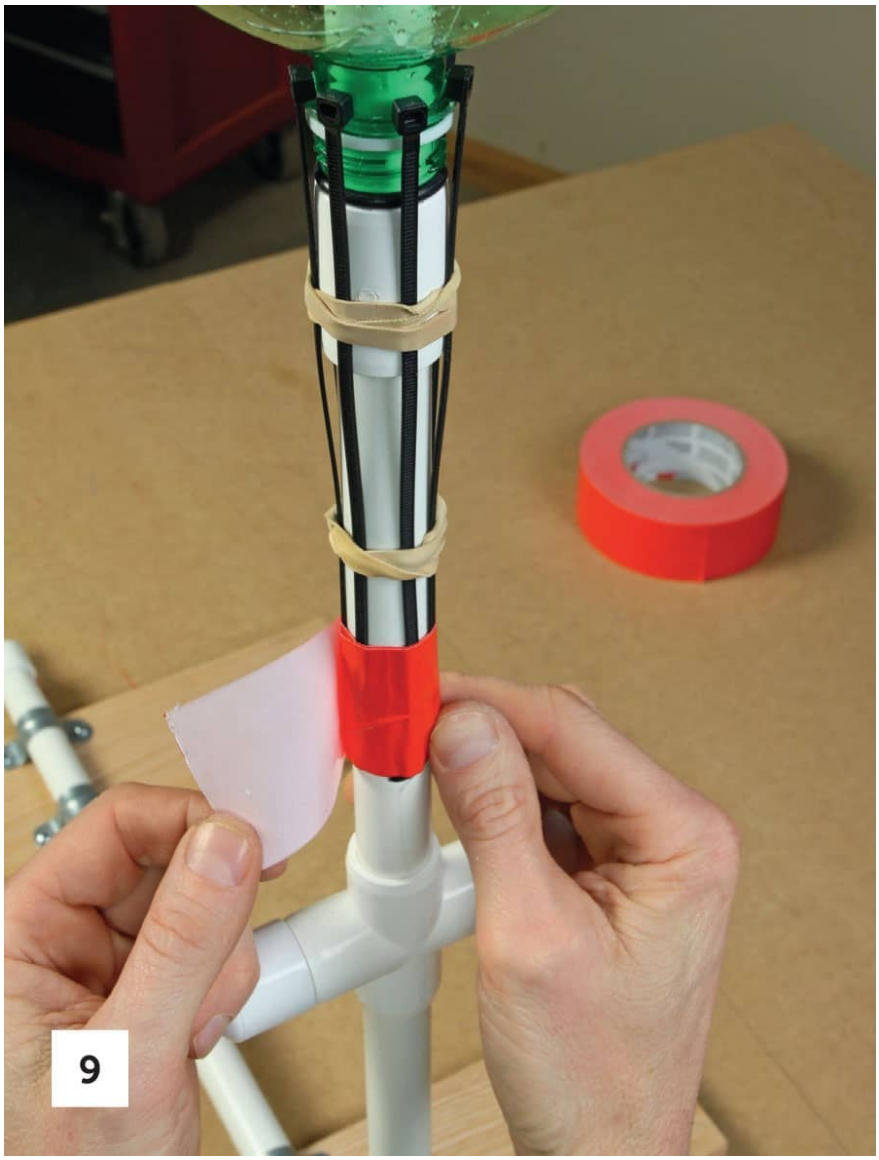


7 Roll the O-ring over the 8" launch post. Dry fit the launch post into the top of the coupling. Snug the O-ring down on top of the coupling lip. Slip an empty plastic bottle upside down onto the launch post, and guide it down so that the top lip of the bottle sits on the O-ring.

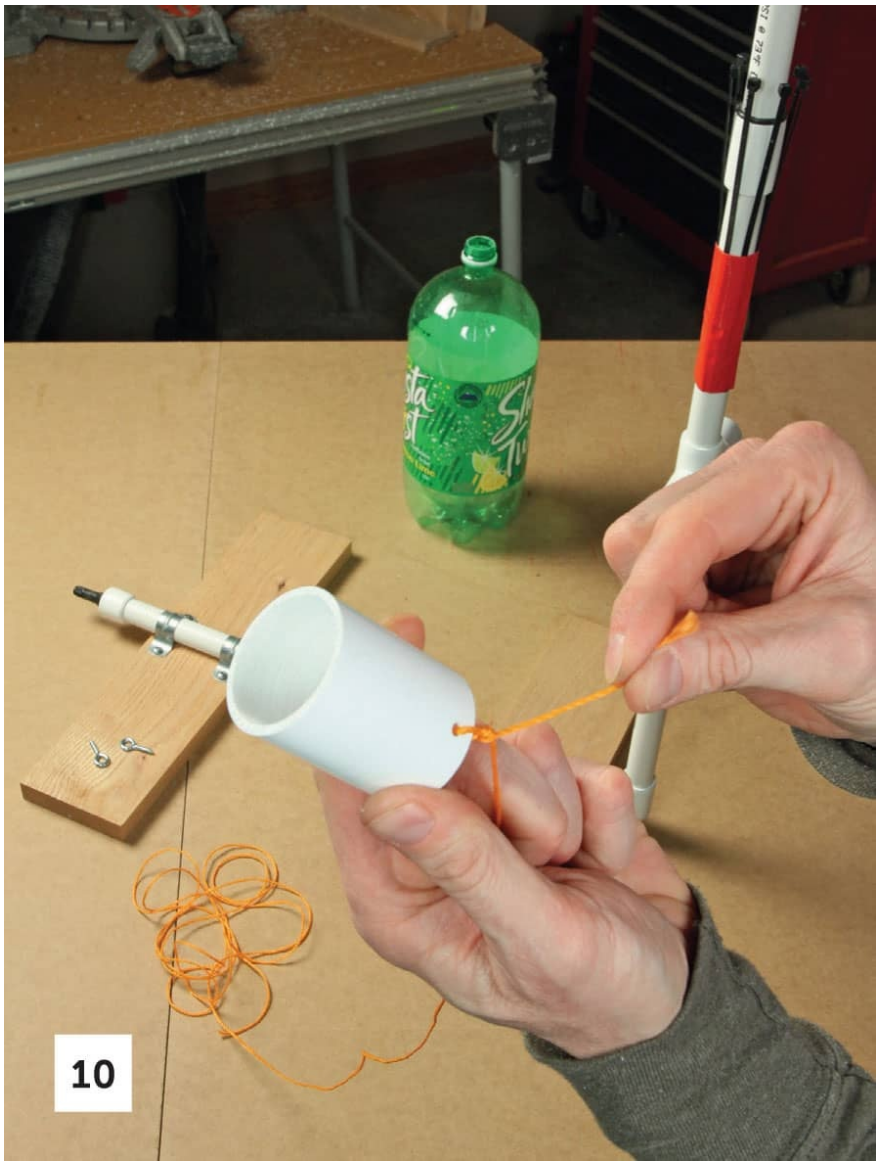


8 Hold a zip tie upside down and press the top (tongue end) to the nipple just above where it goes into the top of the cross. Press the zip tie against the coupling and bottle top, and check that the receiver clicks into place just above the bottom ridge of the bottle's neck. If it doesn't, adjust the position

of the zip tie until it does (it can be off by $^1/_{16}$" to $^1/_8$"). Mark the exact location of the zip tie tongue tip on the nipple.



9 Use two rubber bands to hold the seven zip ties in place around the 8" launch post. Align the bottom of the ties with the mark you made on the nipple, and wrap duct tape around the bottom to secure them in place. Wrap another layer of duct tape over the first to completely secure the ties to the nipple.



10 Drill a 1/8" hole at one end of the 1" coupling. Guide one end of the 3' length of string through the hold and tie the string to the coupling, knotting it securely. Compress the top of the zip ties and slide the 1" coupling over them, over the 1/2" coupling, and down onto the shoulders of the cross. Cement the launch post into the top of the 1/2" coupling.

11 Screw a screw eye into the top of each base board, and thread the launch string through the eyes. To use the launcher, fill a plastic soda bottle half full with water, and quickly turn it upside down over the post and down onto the O-ring. Pull the larger coupling up over the zip ties to compress them over the bottom of the bottle's cap threads, holding the bottle in place. Connect a bike pump with a gauge to the valve and pump up to about 15 psi. Release

the rocket by pulling the string. Adjust the air pressure to get a higher or lower launch altitude.

QUICK 3

Backyard PVC pipe weaponry is a parent's way of avoiding toy guns while giving kids a chance to work out pent-up aggression and excess energy against targets small and large. The three projects here all use different projectiles, but all are meant to be used for target practice. They all cost very little and take a modest amount of time and expertise to construct; in fact, these are all good kid-friendly projects that you can use to build a youngster's workshop skills.

1 SIMPLE SLINGSHOT

A slingshot is one of the uncomplicated joys of childhood and can lead to many happy hours plinking cans off a fence or shooting targets in the backyard. This sturdy design, made of $^1/_2$" PVC pipe and fittings, will hold up over the long term and is inexpensive to make. Craft the handle out of a 6" piece of pipe with a cap cemented on one end and a tee on the other. The 2 $^1/_2$" crossbars are cemented into

either side of the tee, with elbows on the other ends (both pointing in the exact opposite direction from the handle). Cement 4 1/2" arms into the elbows and top with caps. Now just loop a slingshot replacement band around each arm and your backyard marksperson is ready for action (you might want to secure the loops with zip ties for added safety). Just be sure to institute the safety first rule: no shooting at anything alive!

2 ARROW SLINGSHOT

Not ready to commit the time and energy to construct the archery bow shown here? Never fear, there is a quicker way. This arrow slingshot is simply an 8" tube of 2" PVC pipe with holes drilled through one end. A slingshot replacement band is threaded through both holes and tied off, and the arrow is positioned inside the tube, with the back notched onto the band for firing. This can be more of a challenge to hit targets accurately than a bow would be, but it is also more portable and a lot of fun.

3 WATER-BALLOON LAUNCHER

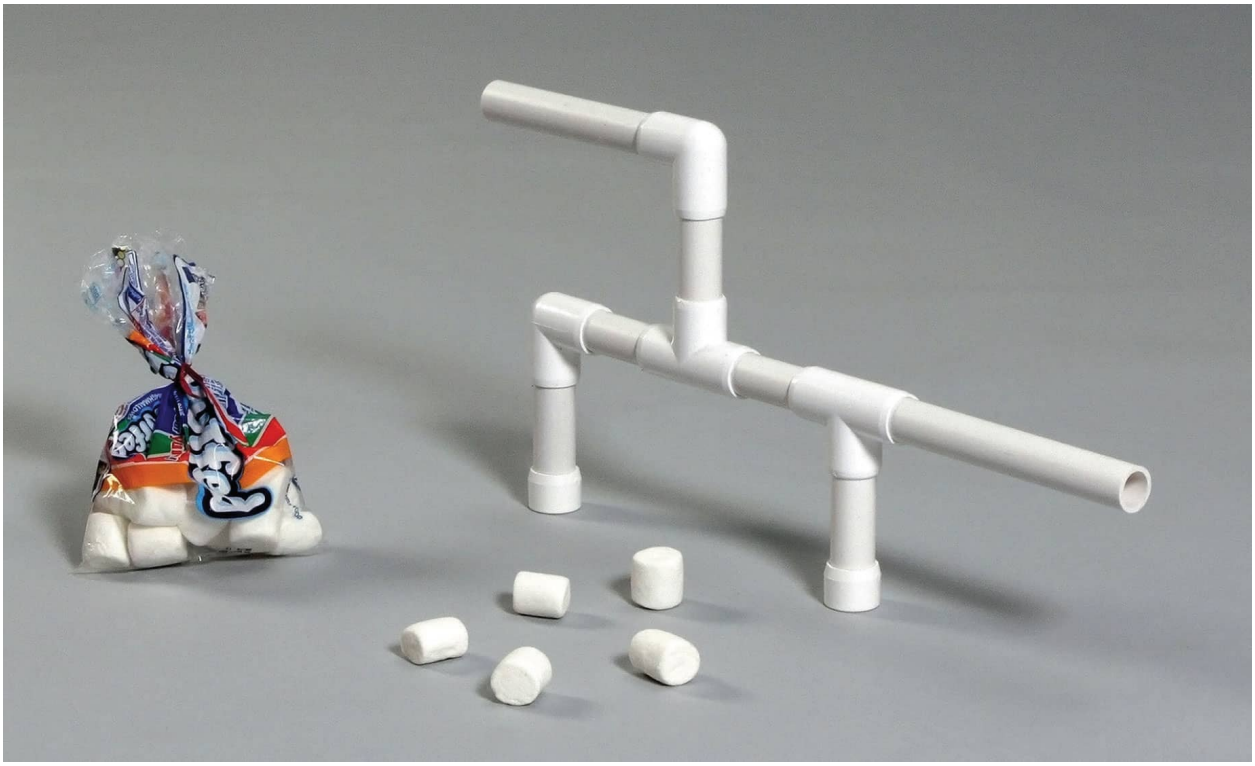
Few things can tickle a youngster’s funny bone quite like launching a water balloon into the air, just to watch it splat against some unsuspecting surface. The base of this launcher is formed of two 3' long sections of 3" PVC pipe joined by a tee, and covered on each end with caps. Each base leg is filled with sand to hold it down. Each upright is made from a 5" section of the pipe cemented into a base leg tee and topped with a tee (a 3' crossbrace connects the tees on both sides). A 3' section is cemented into the other side of the tee, with holes drilled in the top end. String surgical tubing through the holes, and use an old dishtowel or cut up fabric from an old dress or pants for the cradle.

MARSHMALLOW SHOOTER

The problem with today's toy guns—even those that shoot plastic or foam darts—is that they have become increasingly powerful. That power presents risks to children playing with the guns, even if the fun looks fairly harmless. But a marshmallow gun is about as benign as a shooter can get, and the projectiles could never be accused of being dangerous—just delicious.

This weapon relies on air power to shoot the puffy ammo. Although the gun may not be terribly accurate, it is pure, unqualified fun. There's just something amusing about shooting at each other with the most angelic of foodstuffs.

There is really no need for any modifications of the design, because it is so simple. It is also forgiving of errors and will stand up to many, many backyard battles, even if it's left out in the rain and the snow in between wars. You can, however, add some zing to this simple weapon by painting everything but the mouthpiece in a color or otherwise decorating the shooter to reflect the individual tastes of the warrior using it.



WHAT YOU'LL NEED

Time: **20 minutes** | Difficulty: **Easy**

TOOLS

Tape measure
Chop saw or hacksaw
80-grit sandpaper
Marker
Eye and ear protection
Work gloves

MATERIALS

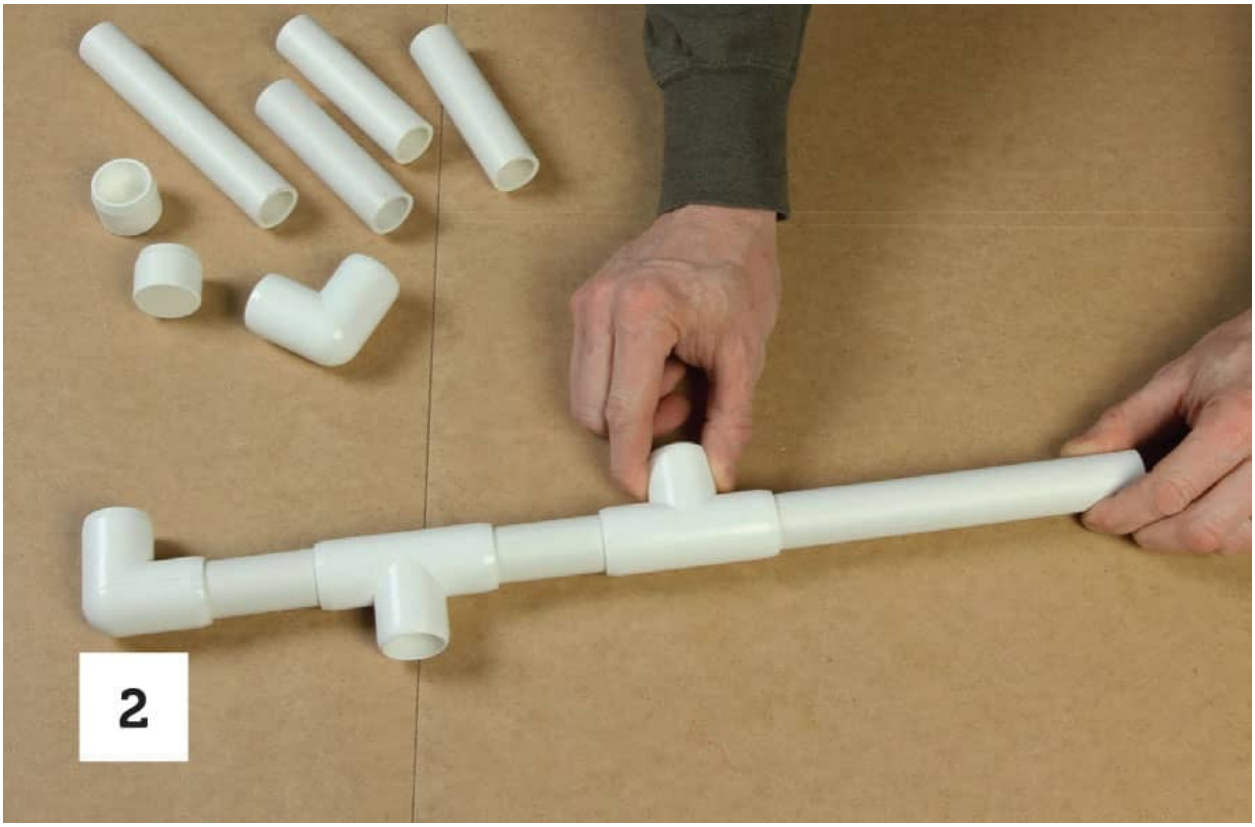
3' × 1/2" PVC pipe
(2) 1/2" elbows
(2) 1/2" caps
(2) 1/2" tees
Large marshmallows
PVC cement

CUT LIST

6" blow tube
4" blow tube post
(2) 4" barrel body segments
8" nozzle
(2) 4" handles

HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand all the cut edges smooth.



2 Assemble the barrel on a flat, level work surface. Lay out, from left to right, an elbow with one inlet horizontal and the other pointing forward; a 4” barrel segment; a tee with the nipple pointing away from you (opposite the elbow inlet); a 4” barrel segment; a tee with the nipple pointing toward you; and the 8” barrel nose.

3 Dry assemble the pieces when you’re sure the orientation is correct. Make key marks at all the connections, and then disassemble the barrel and cement it back together.

4 Cement the front and back handles into the elbow and parallel tee, and cement caps on the end of each handle.

5 Dry fit the post, elbow and blow tube into the upward facing tee. Lay the shooter on the work surface and ensure that the blow tube assembly is perfectly aligned with the shooter body and handles. When you're satisfied that the pieces are all correctly aligned, make key marks at all the blow tube connections and disassemble the blow tube and post. Cement the pieces back in place in the shooter.

CAMERA TRIPOD

In this world ruled by smart phones and their on-board cameras, there is still room for the contemplative, high-quality images that can only be accomplished with a true SLR or digital camera. However, those cameras and the images they make rely on a steady base. That's why a camera tripod is an absolute necessity in any serious photographer's tool kit.

The problem is, full-featured aluminum tripods are pricey items. They can also be finicky and fragile; bumping them around your long-distance hikes to get that one-in-a-million shot of a flying hawk, wild bear, or deep-forest orchid is a sure way to trash a store-bought tripod.

The answer is this easy-to-build, super durable PVC tripod. Like the best tripods on the market, this one is adjustable. But it is also up to any challenge, from an urban photo scouting session, to a long drive in a pickup on a search for that ideal waterfall image. It's a great alternative to expensive and daintier pro versions and idea even, if you just want to photograph family gatherings or backyard beauty scenes.

WHAT YOU'LL NEED

Time: **45 minutes** | Difficulty: **Hard**

TOOLS

Tape measure
Chop saw or hacksaw
80-grit sandpaper
Level
Marker
Metal ruler or other straightedge
Drill and bits
Pliers (optional)
Caulk gun (optional)
Eye and ear protection
Work gloves

MATERIALS

7' × 3/4" PVC pipe
2' × 1/2" PVC pipe
2' × 1" PVC pipe
(2) 3/4" elbows
3/4" 45° elbow
3/4" cross
(3) 3/4" caps
1/2" cap
1/2" to 1" bushing
1" to 3/4" adapter
1/4" threaded tripod screw adapter
3/16" × 3" cotter pin
1/4" machine nut
PVC cement
Silicone adhesive (optional)

CUT LIST

(2) 21 3/4" × 3/4" back legs 24 3/4" × 3/4" front leg 1 5/8" × 3/4" front leg nipple (2) 5" × 3/4" shoulders

3" × 3/4" post nipple
13" × 1" post tube
13 1/2" × 1/2" post

HOW YOU MAKE IT

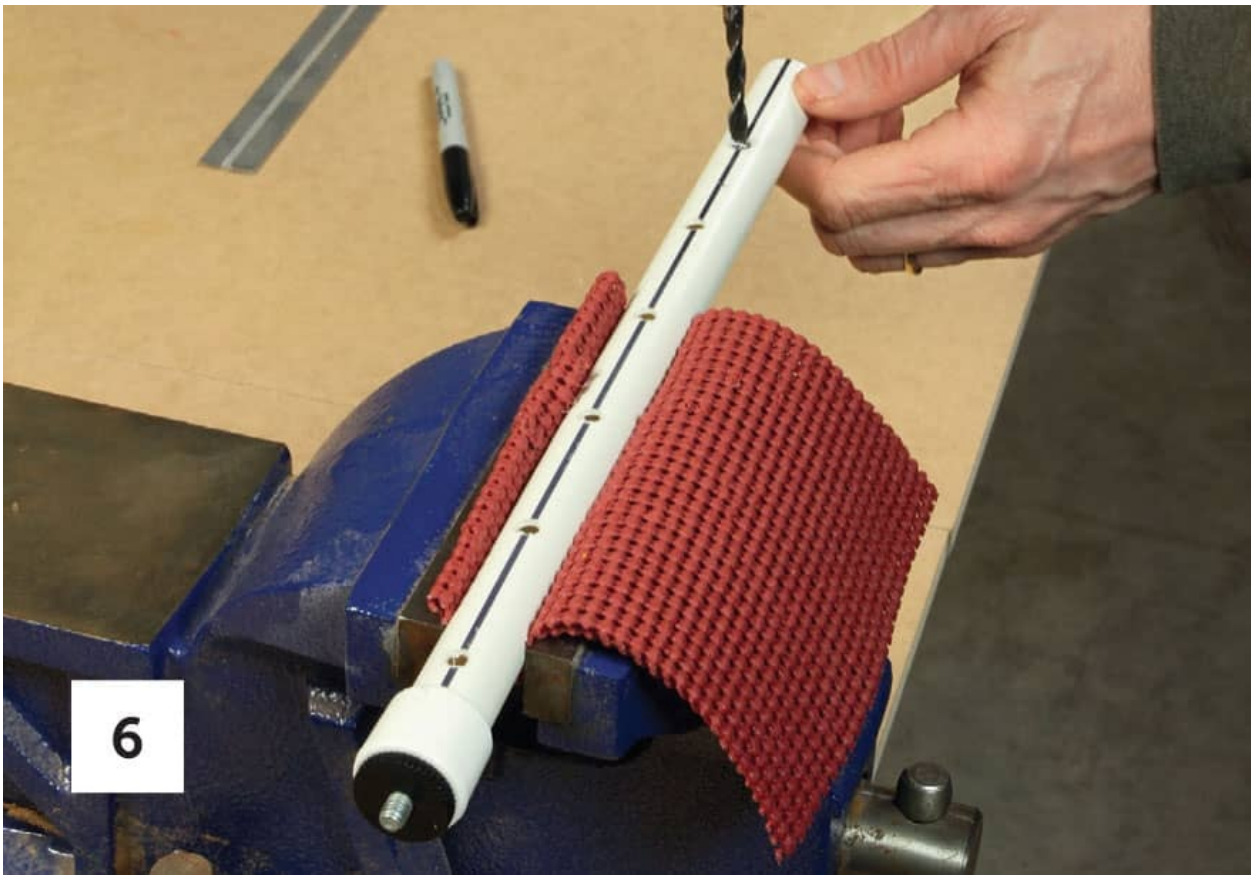
1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand the cut ends smooth.

2 Cement 3/4" caps onto the ends of all three front and back legs. Cement the open end of the 24 3/4" front leg into one end of the 45° elbow. Cement the open ends of each 21 3/4" rear leg into an elbow. Cement a 5" × 3/4" shoulder into each rear leg elbow.

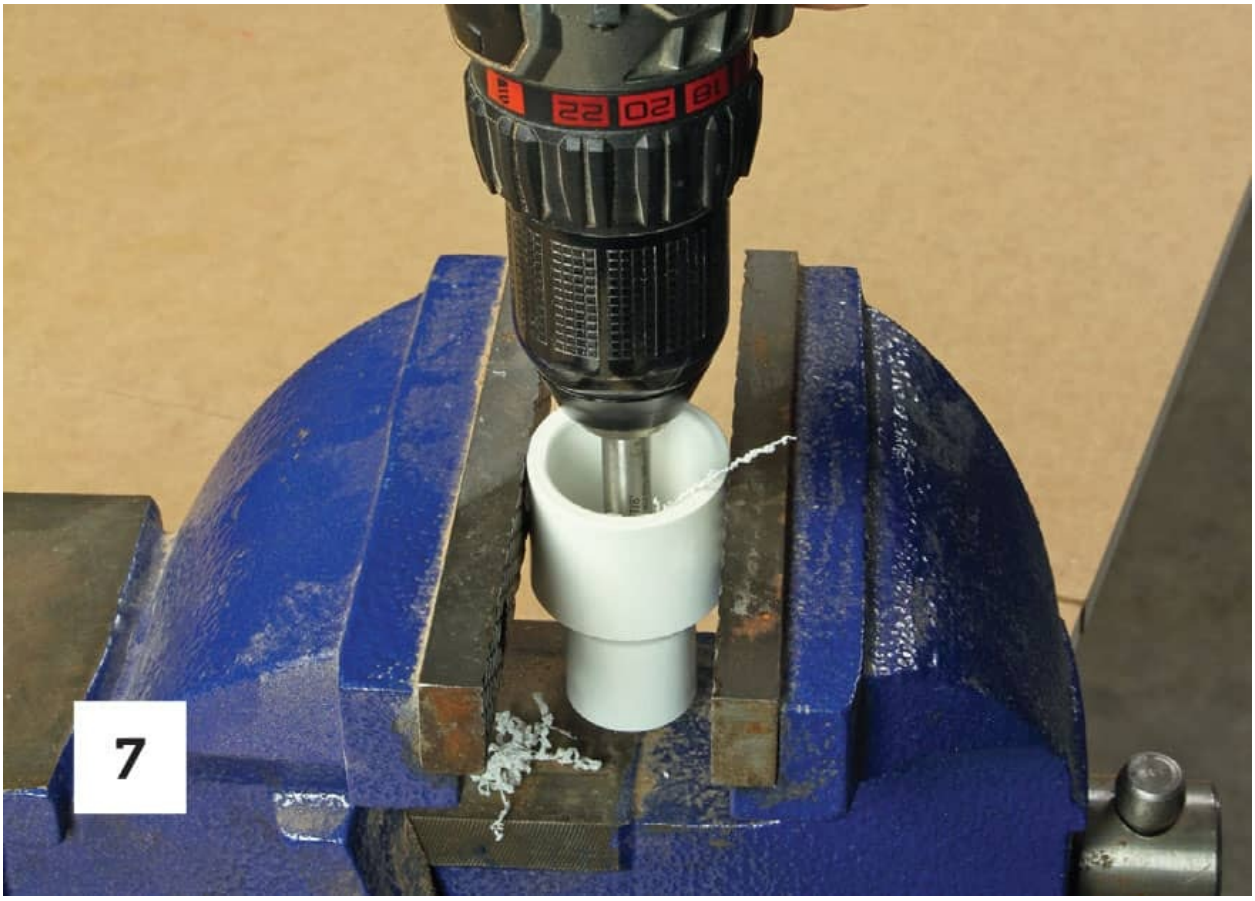
3 Working on a flat, level work surface, dry fit the open ends of the shoulders into opposite sides of the cross, and dry fit the 1 5/8" × 3/4" front leg nipple between the bottom of the cross and one end of the 45° elbow. Dry fit the open end of the front leg into the open inlet of the 45° elbow.

4 Adjust the legs so that the top and bottom inlets of the cross are perfectly plumb. Once you're satisfied with the positions of the legs, make key marks at all the cross and elbow connections. Disassemble the base, and then cement the pieces back together.

5 Check that the threaded tripod screw adapter works with the camera you own (if not, replace it with the appropriate size). Mark and drill a $^1/_4$" hole in the center of the $^1/_2$" cap. Attach the threaded tripod screw adapter to the cap by putting one end down through the hole and fastening a machine nut to the post on the inside of the cap.



6 Cement the cap onto the 13 $^{1}/_{2}$" × $^{1}/_{2}$" post. Secure the post in a vise or drill press. Use a straight edge to measure, and mark a line down the length of the tube. Mark six holes, starting right below the lip of the cap and continuing every 2" down the length of the tube. Drill $^{1}/_{4}$" holes at the marks, all the way through the opposite wall of the tube.



7 Carefully use a $^{7}/_{8}$" spade bit to drill out the opening in the 1" to $^{1}/_{2}$" bushing, removing the lip at the bottom of the $^{1}/_{2}$" opening. Cement the 1" side of the bushing onto the end of the 13" × 1" post tube. Secure the tube horizontally in a vise or drill press, and drill a $^{1}/_{4}$" hole through the end of the tube and the bushing, completely out the other side. Slide the post into this post tube and check that the cotter pin will easily pass through the hole in the post tube and one of the holes in the post, locking it in place. If not, re-drill the holes to accommodate the cotter pin.

8 Cement one end of the 3" × 3/4" post nipple into the top of the base cross and the other end into the 3/4" end of the 1" to 3/4" adapter. Cement the open end of the post tube into the top of the adapter. Position the post in the post tube to the height you prefer, and lock it in place with the cotter pin.

EGG CATAPULT

Building a catapult is a common school science project and for good reason. Not only is the mechanism a fundamental study in how stored energy can be used to hurl a projectile considerable distances, it's just plain and simply fun.

There are lots of catapult designs, which use different forms of energy to create thrust and velocity, but all include a few basic features: a stable base, a long throwing arm, and a receptacle to hold the projectile. In the case of this very fundamental project, the energy is supplied by the user; the operator loads the cup and then slams the opposite end of the throwing arm down, launching the payload. The base has been purposely designed large and thick to accommodate the long throwing arm and the torsional forces produced.

You or your junior scientist can scale this catapult up to launch even larger projectiles. But as designed, it's meant to hurl eggs. The satisfying splat the missile makes upon landing is all part of the fun. However, regardless of what you're hurling, it's wise from a science perspective to have a target and a way of measuring the distance achieved with any single shot. There are many experiments to be conducted, and the learning that goes along with them is all part of the fun.

WHAT YOU'LL NEED

Time: **30 minutes** | Difficulty: **Medium**

TOOLS

Tape measure
Chop saw or hacksaw
Marker
80-grit sandpaper
Speed square
Utility knife or scissors
Eye and ear protection
Work gloves

MATERIALS

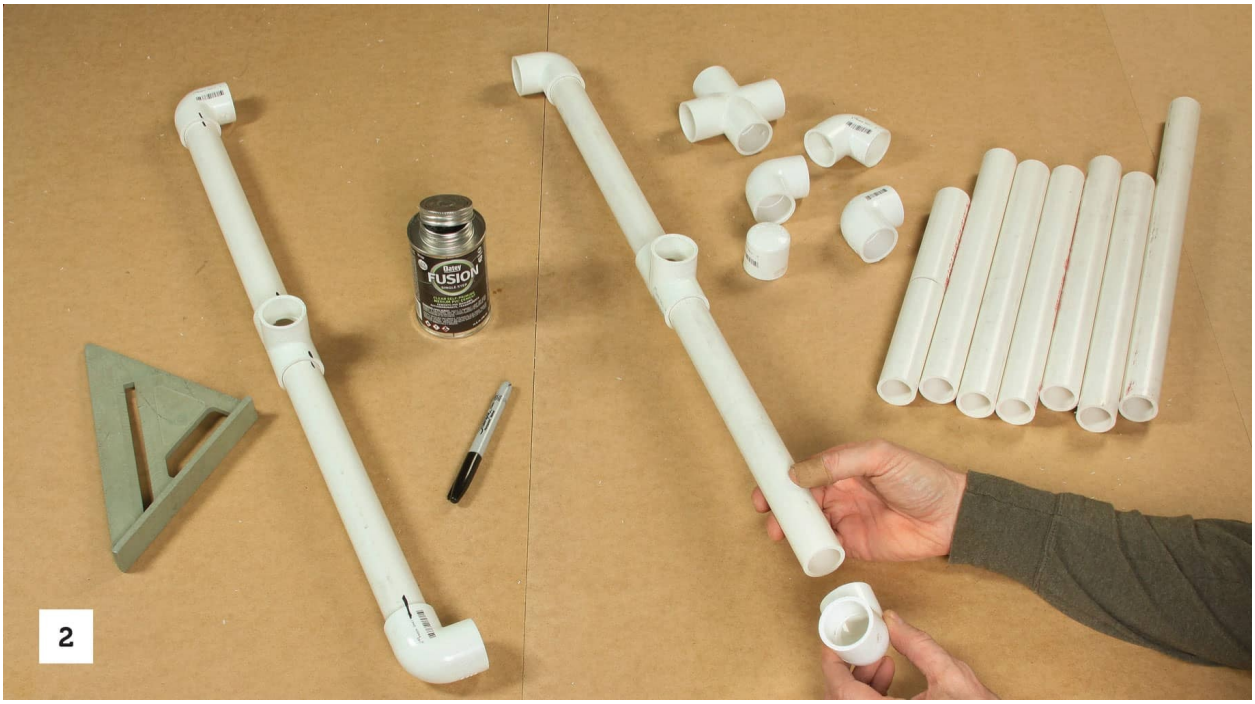
12' × 1 1/4" PVC pipe
1 1/4" cross
1 1/4" cap
(7) 1 1/4" elbows
(2) 1 1/4" tees
PVC cement
Foam pad
Utility knife or scissors

CUT LIST

17" upper arm
12 1/2" lower arm
(4) 12 1/2" sides
(2) 12 1/2" posts
(2) 5 1/4" fulcrums
(2) 12 1/2" ends

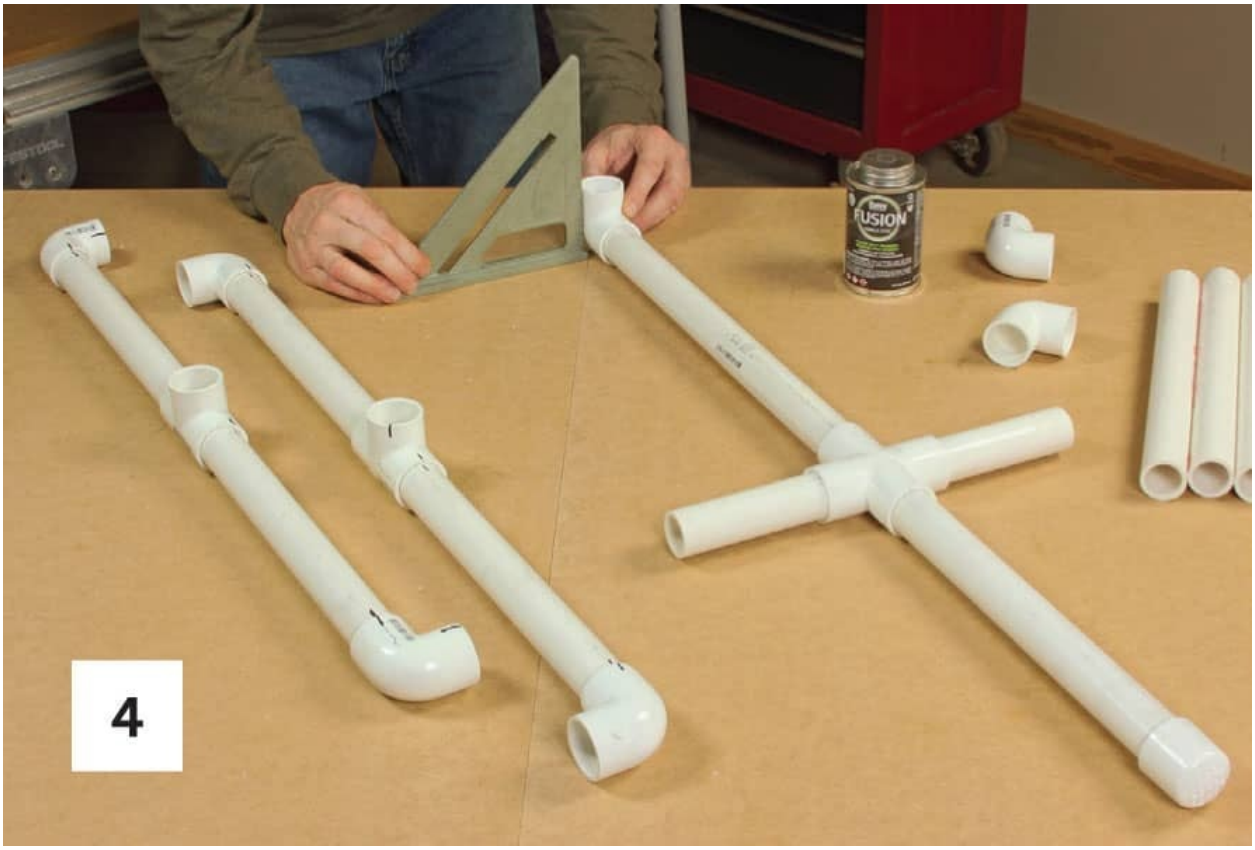
HOW YOU MAKE IT

1 With a tape measure and saw, measure and cut the pipe segments to match the cut list. Sand all the cut edges of the pipe sections completely smooth. Use the mouth of one elbow as a template to cut a circle out of the foam pad.

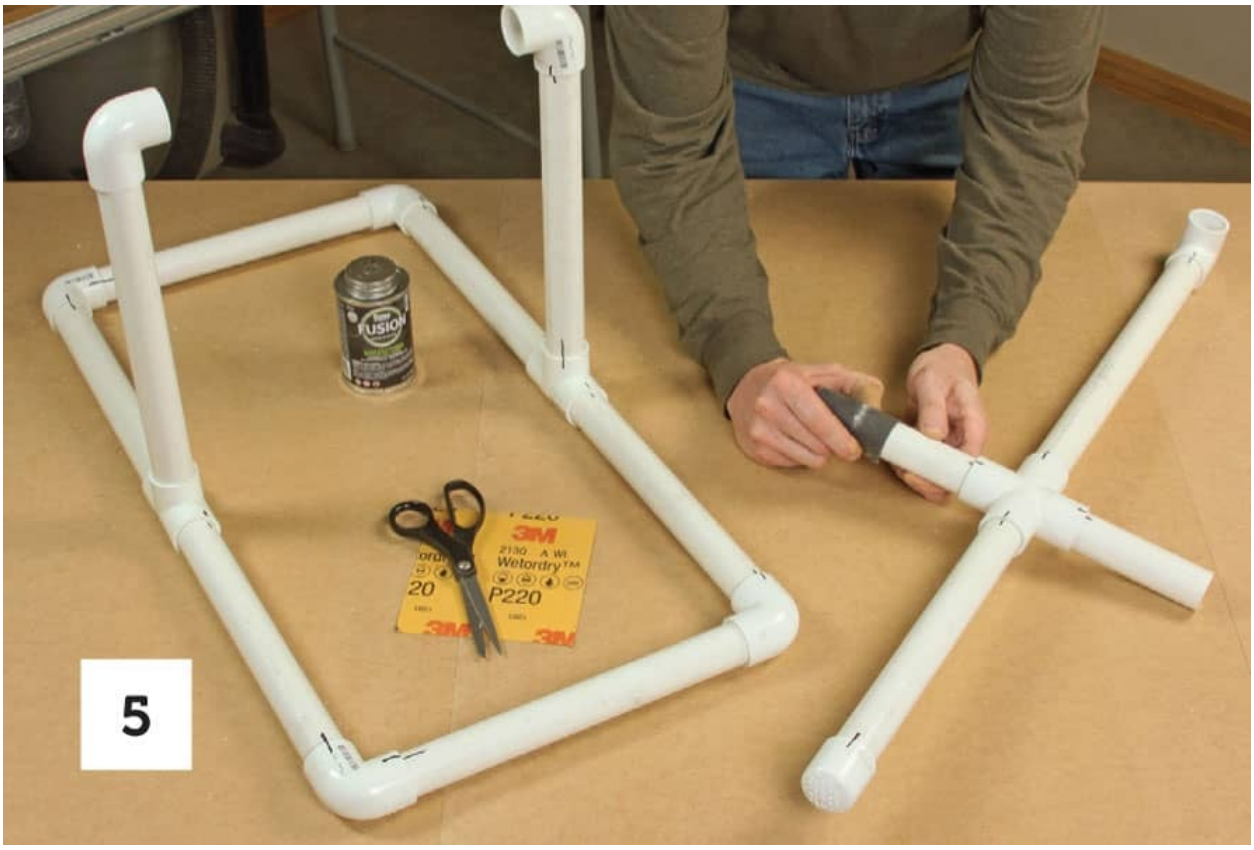


2 Build the sides on a flat, level work surface. Each side is constructed of two 12 $^1/_2$" sides joined by a tee and finished with elbows on either end. Dry fit the sides first, with the elbows lying flat and the nipple of the tee pointing directly up (check that it is plumb with the speed square). Both sides should be exactly the same length. Make key marks at the connections, and then disassemble and cement the components of each side together.

3 Cement a 12 $^1/_2$" end into the elbows of one side. Cement a 12 $^1/_2$" post into the tee nipple in each side.



4 Construct the throwing arm on a flat, level surface, with the central cross lying flat on the surface. Cement the 12 $^{1}/_{2}$" lower arm and the 17" upper arm in opposite inlets on the cross. Cement a cap onto the end of the lower arm. Dry fit an elbow onto the free end of the upper arm and use a speed square to ensure it is plumb and exactly perpendicular to the arm itself. Make a key mark and then cement it to the arm.



5 Cement a 5 $^{1}/_{4}$" fulcrum segment into the cross's two open inlets. Sand the open ends of the fulcrum segments to ensure they will move freely in the top elbow inlets. Dry fit elbows onto the top of the posts, and dry fit the entire catapult together. Ensure that it doesn't wobble and that the assembly isn't skewed in any way. Make key marks at the connections for the top post elbows, and disassemble the catapult. Cement the elbows into place on the top of the posts.

6 Slide the one side of the fulcrum into the side top elbow (the side with the ends already cemented into position). Carefully cement the two lower elbows of the opposite side into position, leaving the top elbow-fulcrum connection dry. Stuff the foam circle down into the catapult elbow cup.

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RESOURCES

C&S Plastics

Supplier of furniture-grade PVC pipe, including clear and colored versions • candsplastics.com

FORMUFIT

Supplier of all things PVC, including pipe and fittings, project plans, advice and guidance on working with PVC pipe, and more.

• formufit.com

Krylon

Manufacturer of spray paints formulated for use on plastic

• www.krylon.com

RustOleum

Manufacturer of spray paints formulated for use on plastic

• www.rustoleum.com

Savko Plastics

Supplier of an incredibly wide range of pipe and fittings, including white and clear PVC, ABS, threaded and slip, and much more

• www.savko.com

ABOUT THE AUTHOR

Chris Peterson is a freelance writer and editor based in the Pacific Northwest. He has written extensively on home improvement and general reference topics, including books in the Black & Decker Complete Guide series; *Building with Secondhand Stuff: How to Reclaim, Repurpose & Reuse Salvaged & Leftover Building Materials; Practical Projects for Self-Sufficiency: DIY Projects to Get Your Self-Reliant Lifestyle Started;* and *ManSkills: How to Avoid Embarrassing Yourself and Impress Everyone Else.* When he's not writing or editing, Chris spends his time hiking, baking, and rooting for the New York Yankees.

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