

Free Woodworking Plans

Six beginner projects with cut lists, material lists and step-by-step instructions

Six projects, in the order we would hand them to a friend who has never cut a board. Each one is a complete plan: what to buy, what to cut it to, and what order to put it together in. Every dimension in this pack is a real dimension, worked out against the actual size of the lumber you will find at the store, so the parts fit each other when you get to the assembly step. Print the pages, take them to the shop, and write on them.

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Before you start

Every project in this pack is a weekend or less, and the first three can be done in an afternoon with a hand saw, a drill and a square. Start with the birdhouse even if you want the workbench, because the birdhouse teaches you to cut to a line and the workbench assumes you already can. Nothing here needs a table saw, a router or a shop full of clamps.

Read the cut list before you buy the wood. The cut list is the plan; the steps just tell you the order. If you cut all the parts on the list to the sizes on the list, the assembly steps will work, and if a part does not fit, the answer is almost always that the board was not as wide as the label claimed.

Every plan in this pack is written for someone picking up tools for the first time, with clear steps and minimal specialized equipment. Print them, take them to the shop, mark them up, and build at your own pace.

- Dimensions are given as thickness x width x length, in inches.
- Nominal lumber sizes are not actual sizes. A 1x6 measures 3/4" x 5 1/2", a 1x8 measures 3/4" x 7 1/4", a 1x10 measures 3/4" x 9 1/4", and a 2x4 measures 1 1/2" x 3 1/2".
- Cut one part at a time and check the fit before cutting the next.
- Measure the actual board you bought before you cut it. Mills vary, and a board that is 1/8" narrower than the chart will throw off every part that has to meet it.
- Every cut list here assumes the boards are straight and the ends are square. Sight down each board in the store and put back anything that curves or twists.
- Cost estimates are rough US figures for common pine, cedar and plywood, and they move with lumber prices. Treat them as a shopping guide, not a quote.
- When a step says to cut a part to fit, trust the assembly in front of you over the number on the page.

Shop safety in one page

- Wear safety glasses for every cut, every drill and every minute of sanding. Sawdust in the eye is the most common shop injury there is, and it happens on the cut you thought was too small to bother with. If you are using a circular saw or a router, add hearing protection, because both of them run well past the level that damages hearing over time.
- Keep both hands behind the blade and never reach across a running saw. On a circular saw, clamp the workpiece down and let both hands stay on the tool. On a hand saw, hold the board with the hand that is not sawing, and keep it a full hand's width from the cut line. If a cut needs your fingers close to the blade to hold the piece, the piece is too small to cut safely - clamp it to a longer scrap and cut them together.
- Support the offcut. Most kickbacks and most torn boards happen because the falling piece pinched the blade at the end of the cut. Put the board on two supports with the cut line between them and clamp it down.
- Sanding dust from any wood is a lung irritant, and finishes give off solvent for hours after they look dry. Sand and finish outdoors or with a window and a fan running, keep a dust mask on for the sanding, and lay oily rags out flat to dry rather than balling them up, because a wadded oil rag can catch fire on its own.
- If a child is helping, give them a job that is not a cutting job. Sanding, laying out parts, sorting screws and applying finish are all real work a five-year-old can do well. Do the cutting yourself, with the child out of the shop, and hand the pieces over. This matters most on the toy car, which is the project a child will most want to be part of.

The mistake almost every beginner makes is rushing the last inch of a cut. The board is nearly through, the offcut starts to sag, the blade binds, and either the wood tears or the saw jumps. The habit that prevents it: slow down for the last inch and support the offcut so it cannot drop. That single change removes most of the bad cuts and most of the close calls at the same time.

The starter tool kit

Buy in this order: a tape measure, a combination square, a hand saw, a drill and four clamps. Those five will build every project in this pack. Everything after that is a convenience, and the convenience is real - a circular saw turns the workbench from a long afternoon into an hour - but none of it is a prerequisite. Buy the square from a name you recognize even if it costs three times the bargain one, because a square that is not square makes every joint slightly wrong and you will never know why. Everything else can be the cheap version until it annoys you enough to replace.

Tool	Why you need it	Budget option
Tape measure	Every part in every cut list starts here. A 16 ft tape with a wide blade stays rigid when you extend it, which matters when you are measuring alone.	Any 16-25 ft tape, \$8-12. Buy one and keep it in the shop rather than sharing it with the kitchen drawer.
Combination square	Marks a square line across a board and checks that your cuts and assemblies are actually at 90 degrees. This is the tool that decides whether your box closes.	\$15-25 for a machined steel head. Check it against a factory board edge in the store before you buy.
Hand saw or circular saw	All the cuts in this pack are straight crosscuts and a handful of diagonals. A sharp hand saw does them all; a circular saw does them faster.	A 15 in. hardpoint pull saw, \$15-20, cuts cleaner than most beginners expect. A corded circular saw runs \$40-60.
Cordless drill	Drills pilot holes, drives every screw and bores the birdhouse entrance. One 12V or 18V drill covers all of it.	A 12V drill-driver kit with one battery, \$50-70. Add a set of brad-point bits, \$15.
Four clamps, minimum	Glue needs pressure and boards need holding while you drill. Four is the number where you stop improvising with your knee.	6 in. F-clamps or spring clamps, \$5-8 each. Two long bar clamps or a band clamp help on the picture frame.
Miter box and backsaw	Only the picture frame truly needs it, but it is the cheapest way to cut a repeatable 45 degree angle without a power miter saw.	A plastic miter box with a backsaw, \$18-25. Clamp the box to the bench or it will slide mid-cut.
Countersink bit	Sinks the screw head flush so it does not stand proud and split the wood. Turns rough assembly into work that looks finished.	A single #8 countersink, \$6-10, or a five-piece set for \$15.
Sandpaper, 80 to 220 grit	80 to flatten and shape, 120 to clean up, 220 before finish. Skipping grits leaves scratches the finish makes more visible, not less.	A variety pack of sheets, \$10-15. A sanding block or a scrap of 2x4 wrapped in paper works as well as a sander.

Tool	Why you need it	Budget option
Wood glue	In almost every joint here, the glue is the strength and the screw is the clamp that holds it while it dries.	Interior PVA glue, \$6-8. Buy the waterproof grade for the birdhouse, which lives outside.
Safety glasses and a dust mask	Not optional and not expensive. Keep them where you will actually reach for them, which means on the bench, not in a drawer.	Wraparound safety glasses, \$5-10. A box of dust masks, \$10.

Beginner Birdhouse

A classic first project. Simple cuts, minimal tools, finished in an afternoon.

Time	Skill	Cost
2-3 hours	Beginner	\$15-25

Material list

- One 1x6 x 6 ft cedar board, for the front, back, sides and floor. Cedar is the right choice here because it survives weather unfinished; untreated pine works but will need a coat of exterior finish and will not last as long.
- One 1x8 board at least 12 in. long, for the roof. A single offcut is enough, and most stores sell 2 ft craft boards in this size.
- About twenty 1 5/8 in. exterior wood screws, galvanized or coated. Ordinary interior screws will rust and stain the cedar within a season.
- Waterproof wood glue for the four wall joints. Do not glue the floor.
- Exterior stain or oil for the outside faces only. Nothing goes on the inside.

Cut list

Part	Qty	Dimensions (T x W x L)	Notes
Front	1	3/4" x 5 1/2" x 10"	1 1/4" entrance hole, centered side to side, hole center 6" up from the bottom edge
Back	1	3/4" x 5 1/2" x 13"	Straight crosscut. The extra 3" over the front is what makes the roof slope
Sides	2	3/4" x 5 1/2" x 13"	Cut the top edge on a diagonal: 10" tall at the front edge, 13" at the back. The 5 1/2" runs front to back
Floor	1	3/4" x 5 1/2" x 7"	Four 1/4" drainage holes near the corners. Screws only, no glue, so it comes off for cleaning
Roof	1	3/4" x 7 1/4" x 9"	From the 1x8. The sloped edge measures about 6 1/4", so set it to overhang 3/4" at the front and 1/4" at the back, and 1" at each side

Tools

- Hand saw or circular saw, for five crosscuts and two diagonals
- Drill with a 1 1/4 in. spade bit, a 1/4 in. bit for the vents and drains, and a 1/8 in. bit for pilot holes
- Combination square and pencil
- Two clamps and a scrap board to back up the drilling

Step by step

1. Lay the 1x6 flat and mark your crosscuts in this order from one end: 10 in., 13 in., 13 in., 7 in. Cut them and label each piece in pencil on the face that will end up inside - front, back, side, side, floor - because once they are sanded they all look alike.
2. Cut the roof piece from the 1x8 at 9 in. and set it aside. That is the last part you will touch.
3. Take one 13 in. side blank and turn it so the 5 1/2 in. width runs left to right on the bench; that width is the front-to-back depth of the finished house. Measure 10 in. up the left-hand edge and make a mark. Draw a line from that mark to the top right corner, and saw along it. You now have a side whose front edge is 10 in. tall and whose back edge is 13 in. tall.
4. Lay that finished side on top of the second blank, line up the bottom and both edges, trace the diagonal, and cut it. Two sides that match each other matter far more than two sides that match the drawing.
5. Mark the entrance hole on the front: centered across the 5 1/2 in. width, with the hole center 6 in. up from the bottom edge. Clamp a scrap board underneath, drill with the 1 1/4 in. spade bit, and let the bit do the work. The scrap underneath is what stops the far side from blowing out into a ragged hole.
6. Drill the ventilation and drainage holes with the 1/4 in. bit: two holes near the top of each side, about 1/2 in. below the sloped edge, and four holes near the corners of the floor. Birds need both - the vents keep the box from cooking in July and the drains keep a nest from sitting in rainwater.
7. Dry fit before any glue. Stand the front and back on the bench with the front piece facing you, then hold the two sides against their outer ends so that the sides wrap around the front and back and the diagonals slope down toward the front. The assembled box should be 7 in. across the front and 5 1/2 in. deep. Check that everything sits flat with no rocking.
8. Drill 1/8 in. pilot holes through the sides where they meet the front and back, two per joint, about 1 in. in from the top and bottom. Cedar splits easily near the ends and pilot holes are what prevent it.
9. Glue and screw the four wall joints with the 1 5/8 in. exterior screws. Work on a flat surface and check the box for square with your combination square before the glue sets, because a box that dries out of square will not take a flat floor.
10. Turn the box upside down and screw the floor onto the bottom edges, four screws, no glue. This is the one joint you want to be able to take apart, so you can pull the floor each fall, empty the old nest, and put it back.
11. Center the roof on the sloped top edges so it overhangs about 3/4 in. past the front and about 1 in. beyond each side. Drill pilot holes and drive three screws down into each side's top edge.
12. Sand the entrance hole smooth inside and out, knock the sharp corners off the roof and the base with 120 grit, and finish the outside faces only. Let it air out for a week before you hang it.

Tips that save the build

- The mistake most people make on this build is drilling the entrance hole too big. A 1 1/4 in. hole invites chickadees, nuthatches and titmice and keeps starlings out. Go to 1 1/8 in. if you specifically want house wrens, and only go to 1 1/2 in. if you are building for bluebirds and have open field nearby. Once the hole is oversized you cannot take it back.
- Do not add a perch below the hole, however much it looks like a birdhouse should have one. The

birds do not need it and it gives predators something to stand on.

- Leave the inside completely bare - no stain, no oil, no paint. The rough interior is what lets the chicks climb out when they fledge, and any finish inside the box is a hazard to them.
- Mount it 5 to 10 ft up, facing away from the prevailing wind and out of full afternoon sun. A box on a pole is safer from cats than a box on a tree.

The 1 1/4 in. spade bit will want to grab and spin the workpiece as it breaks through. Clamp the front panel to the bench, back it with scrap, and start the hole at a slow trigger speed until the point bites.

Floating Shelf

Clean, modern, and practical. Learn hidden-bracket mounting and finishing.

Time	Skill	Cost
4-5 hours plus finish drying	Beginner	\$30-45

Material list

- One 1x8 x 6 ft board, for the top and bottom skins. Poplar takes paint beautifully; pine is cheaper and fine under a stain.
- One 1x2 x 6 ft board, for the front edge and the two end caps.
- One 2x2 x 4 ft, for the hidden cleat frame. Measure it before you build - a 2x2 should be 1 1/2 in. square, but some are milled to 1 3/8 in., and the shelf cavity is sized to whatever yours actually is.
- Wood glue, a handful of 1 1/4 in. finish screws or 1 1/4 in. brad nails, and four 3 1/2 in. #10 wood screws for the studs.
- Wood filler, sandpaper to 220, and the finish of your choice.
- A stud finder and a level. Neither is optional on this project.

Cut list

Part	Qty	Dimensions (T x W x L)	Notes
Top skin	1	3/4" x 7 1/4" x 24"	From the 1x8, straight crosscut
Bottom skin	1	3/4" x 7 1/4" x 24"	Same as the top. Cut both from one 48" length
Front edge	1	3/4" x 1 1/2" x 24"	From the 1x2. Sits between the two skins, flush at the front
End caps	2	3/4" x 1 1/2" x 6 1/2"	From the 1x2. Fill the ends behind the front edge
Cleat back rail	1	1 1/2" x 1 1/2" x 22 1/2"	From the 2x2. This is the part that carries the load into the wall
Cleat ribs	3	1 1/2" x 1 1/2" x 5"	From the 2x2. Run forward from the back rail to the back of the front edge

Tools

- Hand saw or circular saw
- Drill with a 1/8 in. bit, a countersink and a 3/16 in. bit for the mounting screws
- Four clamps
- Stud finder, 24 in. level, combination square

Step by step

1. Cut the two 24 in. skins from the 1x8, then the 24 in. front edge and two 6 1/2 in. end caps from the 1x2. Cut the 2x2 into one 22 1/2 in. back rail and three 5 in. ribs. That is ten parts and it is the whole shelf.
2. Build the cleat frame first, because the shell is built to fit it. Lay the 22 1/2 in. back rail on the bench and glue and screw the three 5 in. ribs to it at right angles: one 3 in. from each end and one at the center. Drive a 2 1/2 in. or 3 in. screw through the back of the rail into each rib. The finished frame looks like a short comb.
3. Check the frame against your parts: it should be 22 1/2 in. long, 6 1/2 in. from the back of the rail to the front tip of the ribs, and 1 1/2 in. thick. If your 2x2 measured under 1 1/2 in., the frame will be thinner than the cavity and you will shim it in step 10 - note it now so you are not surprised later.
4. Dry assemble the shell around the frame with no glue. Lay the bottom skin down, stand the front edge along its front edge, set the two end caps in behind the front edge at each end, drop the cleat frame into the middle, and lay the top skin on. Everything should be flush at the front and at both ends, and the frame should slide in and out freely.
5. Take the frame back out and glue the shell. Run glue along the bottom skin's front edge, set the front edge piece on it, and add the two end caps. Clamp and let it set for 30 minutes, then glue and set the top skin on. Use a few 1 1/4 in. brads or finish screws through the top and bottom into the front edge to hold everything while the glue cures.
6. Do not glue or nail anything to the cleat frame. The shell has to come off the frame to be finished and has to go back on at the wall.
7. Sand the shell to 220, easing the front corners slightly so they are not sharp. Fill any nail holes, let the filler dry, and sand the patches flush. Finish now, with the shell off the wall, and give it every face including the underside - an unfinished underside will take on moisture differently and can cup the shelf over time.
8. Find the studs. Mark the center of each one, then hold the shelf up and slide it left or right until the 22 1/2 in. back rail spans two studs if it possibly can. This is the decision that determines whether the shelf is strong, and it is worth moving the shelf 6 in. along the wall to get it.
9. Draw a level line for the top of the back rail. Drill two 3/16 in. clearance holes through the rail at your stud marks, hold it to the line, check level one more time, and drive the 3 1/2 in. screws home. Push down hard on the mounted rail; it should not move at all.
10. Slide the shell over the frame. It should be snug. If your 2x2 came in thin and the shell rocks, slip a strip of cardboard or a thin wood shim on top of the ribs until it is tight, then remove it, add a dab of glue, and put it back.
11. Fix the shell to the frame with two 1 1/4 in. screws driven up through the bottom skin into the end ribs. They sit underneath where nobody looks, so the shelf still reads as floating, and they are what stops it lifting off if someone knocks it.
12. Load it gradually and watch the wall. A rail screwed into two studs will carry a row of hardcover books without complaint. If only one stud landed inside your span, add a heavy-duty toggle at the other end and keep the shelf to picture frames and light decor - the strength here comes from the studs, not from the wood.

Tips that save the build

- The mistake most people make on this build is measuring the shelf cavity from the chart instead of from their own 2x2. The cavity height is set by the 1 1/2 in. width of the 1x2, and if your 2x2 is fatter than that, the shell will not go on at all. Measure the 2x2 the day you buy it.
- Finish the shell before it ever goes on the wall. Trying to stain a mounted floating shelf means finishing the underside upside down with your arm at a bad angle, and it always shows.
- If you want a thicker, more substantial look, use 1x3 instead of 1x2 for the front edge and end caps and pack the cavity out with a second 2x2 laid on top of the frame. Do not just make the skins thicker - the cavity has to match the cleat.
- Scale it up carefully. At 36 in. or longer, add a fourth rib and make sure the rail catches three studs. Length is what makes a floating shelf sad.

Anything that hangs on drywall alone will eventually pull out. Toggle bolts are a fallback for one end of the rail, never a substitute for finding at least one stud.

Portable Workbench

A sturdy, mobile bench you can build in a weekend.

Time	Skill	Cost
6-8 hours over two days	Confident beginner	\$95-140

Material list

- Six 2x4 x 8 ft studs, kiln dried. Pick through the pile and take the six straightest ones you can find; sight down each board from the end and reject anything with a bow or a twist.
- One 4 x 8 sheet of 3/4 in. plywood. Ask the store to rip a 24 in. wide strip off the long edge for you - it is usually free, it makes the sheet fit in a car, and it turns the single most dangerous cut of this project into someone else's problem on a panel saw.
- Four 3 in. locking swivel casters with a 3 3/4 in. mounted height. If yours measure differently, adjust the leg length: leg = 34 in. minus 3/4 in. for the top, minus 3/4 in. for the caster pad, minus your caster's mounted height.
- About sixty 3 in. construction screws and thirty 1 1/4 in. screws, plus the screws that come with the casters.
- Wood glue, and a 1/8 in. bit for pilot holes.

Cut list

Part	Qty	Dimensions (T x W x L)	Notes
Legs	4	1 1/2" x 3 1/2" x 28 3/4"	From 2x4. Length depends on your casters - see the material list
Long stretchers	4	1 1/2" x 3 1/2" x 48"	From 2x4. Two at the top, two low for the shelf
End rails	4	1 1/2" x 3 1/2" x 18"	From 2x4. Two at each end, top and bottom, between the legs
Center braces	3	1 1/2" x 3 1/2" x 21"	From 2x4. Two under the top, one under the shelf
Top	1	3/4" x 24" x 48"	Plywood. Sits flush with the outside of the frame all around
Shelf	1	3/4" x 24" x 41"	Plywood. Drops between the legs onto the lower stretchers
Caster pads	4	3/4" x 3 1/2" x 3 1/2"	Plywood offcuts. They give the caster plate something to bolt to

Tools

- Circular saw strongly preferred - there are fifteen 2x4 cuts here and a hand saw will make it a very long day
- Drill with a 1/8 in. pilot bit and a driver bit
- Four clamps
- Combination square, 4 ft level or a long straightedge, tape measure
- Safety glasses and hearing protection

Step by step

1. Cut all the 2x4 parts first and stack them in labeled piles. The cutting plan wastes almost nothing: from four of the studs cut one 48 in. stretcher and one 28 3/4 in. leg each; from the fifth cut four 18 in. end rails; from the sixth cut three 21 in. center braces. Cut a fresh square end on every board before you measure from it, because factory ends are rarely square.
2. Build the two end frames. Stand two legs on edge 18 in. apart, lay an 18 in. end rail between them at the very top so its top edge is flush with the leg tops, and glue and screw through the legs into the rail ends - two 3 in. screws per joint into 1/8 in. pilot holes. Add the second 18 in. rail lower down, with its top edge 10 in. up from the bottom of the legs. Repeat for the second end frame.
3. Check both end frames for square by measuring corner to corner both ways. The two diagonals should read the same. If they do not, loosen a screw, push the frame square, and re-drive it. Everything you build from here inherits whatever error you leave in these two frames.
4. Stand the two end frames up and set them so the outer faces of the legs are exactly 48 in. apart - that is the distance a 48 in. stretcher has to bridge. Clamp a top stretcher across the front so it laps onto the outside faces of the two front legs, flush at the top and flush at both ends. Glue and screw it with three 3 in. screws into each leg. Do the same on the back.
5. Add the two lower stretchers the same way, lapped onto the outside faces of the legs with their top edges 10 in. up, matching the lower end rails. The frame will feel solid the moment the fourth stretcher goes on - that is the whole structural idea of the bench.
6. Fit the three center braces. Two go under the top, measured 16 in. and 32 in. along the length, and one goes at the midpoint of the lower stretchers. Each is 21 in. long and screws through the outside of the stretchers into the brace ends, top edges flush with the stretchers. These are what keep the plywood from flexing under a mallet.
7. Turn the whole frame upside down. Glue and screw a plywood caster pad to the bottom of each leg with three 1 1/4 in. screws - the pad is wider than the leg on purpose, because a caster plate needs about 3 in. of flat surface and a 2x4 end only gives you 1 1/2 in.
8. Bolt or screw a caster to each pad, then turn the bench right side up and roll it. Lock all four casters and push the bench sideways at the top corner. A small amount of flex is normal; a wobble means a loose joint, so find it and add a screw before you put a top on it.
9. Drop the 41 in. shelf panel in between the legs so it rests on the two lower stretchers and the center brace. It should clear the legs at both ends with a little room to spare. Screw it down with 1 1/4 in. screws every 10 in. or so.
10. Lay the 24 x 48 in. top on and line it up flush all the way around. Screw it down with 1 1/4 in. screws into every stretcher, every end rail and both center braces, spacing them about 8 in. apart and

countersinking each head just below the surface. A screw head standing proud of a bench top will scratch every project you build on it.

11. Break the sharp plywood edges with 120 grit and leave the top bare. A finished bench top is a bench top that glue will not scrape off cleanly.
12. Set it where it will live and check that all four casters touch the floor. If it rocks, shim under one caster pad rather than chasing the joints - shop floors are rarely flat.

Tips that save the build

- The mistake most people make on this build is cutting all four legs at slightly different lengths. Cut the first one, then use it as the template for the other three instead of measuring each from the tape. The same goes for the four 48 in. stretchers and the four 18 in. rails - matched parts make a square bench, accurate parts do not.
- Have the store rip the plywood sheet. Breaking down a full sheet of 3/4 in. plywood alone with a circular saw is the single riskiest thing a beginner can do in a home shop, and it is a free service at most lumber counters.
- Buy locking casters, not plain swivels. An unlocked bench slides away exactly when you lean on it, which is the moment you least want it to.
- If you would rather have a fixed bench, skip the casters and pads and cut the legs at 33 1/4 in. instead. Everything else in the plan is unchanged.
- Add a second plywood layer to the top later if you want. Screw it on from underneath, and you get a replaceable work surface you can unscrew and flip when it gets chewed up.

This is the project with the most cutting in the pack, and every cut is in framing lumber that is heavier than it looks. Clamp every workpiece before you cut it, support the offcut so it cannot pinch the blade, and take the breaks - most bad cuts happen in the last hour of a long day.

Wooden Toy Car

A safe, kid-friendly build that makes a great gift.

Time	Skill	Cost
2 hours plus finish drying	Beginner	\$10-18

Material list

- One untreated 2x4, 12 in. long, or a hardwood offcut of the same size. Maple, birch or poplar make a better toy than pine because they dent less and splinter less. Never use pressure-treated lumber, decking, or any reclaimed board of unknown history for a toy.
- Four wooden toy wheels, 1 1/2 in. diameter with a 1/4 in. center hole, about 1/2 in. thick. Craft stores and online sellers carry them for a few dollars a set.
- One 1/4 in. hardwood dowel, 12 in. long, for the two axles.
- Wood glue. A standard yellow PVA glue is non-toxic once fully cured, which takes 24 hours.
- A toy-safe finish: pure tung oil, a mineral oil and beeswax paste, or a water-based finish labeled for children's products. Skip solvent-based stains and oil-based polyurethane on this one.

Cut list

Part	Qty	Dimensions (T x W x L)	Notes
Body	1	1 1/2" x 3 1/2" x 6"	Two 5/16" axle holes drilled through the 3 1/2" width, 1" in from each end and 1/2" up from the bottom
Cab	1	1 1/2" x 3 1/2" x 2 1/2"	Front face raked: 2 1/2" long at the base, 1 1/2" at the top
Axles	2	1/4" dia. x 4 3/4"	Cut long and sanded flush after glue-up
Wheels	4	1 1/2" dia. x 1/2"	Purchased, with 1/4" holes

Tools

- Hand saw or circular saw
- Drill with a 5/16 in. bit for the axle holes
- Clamps and a bench hook or scrap block
- Sandpaper in 80, 120 and 220 grit

Step by step

1. Cut the body to 6 in. and the cab to 2 1/2 in. from the 2x4. Keep the offcut - you will use it to back up the drilling.
2. Rake the cab's front face. Stand the cab on the bench, mark 1 in. back from the front along the top face, draw a line from that mark down to the bottom front corner, and saw along it. The cab is now 2

1/2 in. long at the bottom and 1 1/2 in. at the top, which reads as a windshield.

3. Mark the axle holes on one side of the body: 1 in. in from each end and 1/2 in. up from the bottom edge. Use a square to carry both marks straight across to the other side of the body so you have a matching pair of marks on each face.
4. Drill the axle holes with the 5/16 in. bit. Do not try to go all the way through in one pass - drill about 1 3/4 in. in from one side, then flip the body and meet it from the other side. Clamp a scrap block standing square beside the drill as a visual guide to keep the bit level and, if the two halves do not line up perfectly, run the bit through once more to clean up the passage.
5. The holes are deliberately 5/16 in. for a 1/4 in. dowel. That extra 1/16 in. is what lets the axle spin freely inside the body, and it is the difference between a car that rolls and a car that scrapes.
6. Test the fit. Push a length of dowel through each hole; it should turn with a fingertip and not bind anywhere. If it drags, work the bit through again rather than forcing the dowel.
7. Glue the cab onto the body. Set it so the back of the cab sits 1/2 in. forward of the back of the body, with the raked face pointing forward, and clamp it for an hour. There are no fasteners in this toy at all - the joint is glue and the glue is stronger than the wood.
8. Sand everything now, before the wheels go on, because you will never sand around them properly afterwards. Start at 80 to knock every edge and corner into a rounded profile you can run a thumb along, then 120, then 220. On a toy, the sanding is not cosmetic - a rounded, splinter-free edge is the safety feature.
9. Cut the two axles. Measure them as: body width plus twice your wheel thickness plus 1/8 in. For a 3 1/2 in. body and 1/2 in. wheels that comes to 4 5/8 in., so cut at 4 3/4 in. and plan to sand the ends flush. If your wheels are a different thickness, use the formula rather than the number.
10. Slide an axle through one hole, put a drop of glue in one wheel's hole, and press it onto the axle end. Let it set, then center the axle so it protrudes evenly, glue the second wheel on, and check that the wheel faces clear the body by about 1/16 in. on each side. Keep glue off the body itself - if the axle glues into the body, the car will not roll.
11. When the glue is fully cured, sand the axle ends flush with the outer wheel faces so no dowel stands proud, then give the whole car a final pass with 220.
12. Apply the toy-safe finish, wipe off the excess, and let it cure for a full 24 hours before the car is handed over. Then hold a wheel and pull hard - if any wheel comes off in your hand, re-glue it before the toy goes anywhere near a child.

Tips that save the build

- The mistake most people make on this build is gluing the axle to the body instead of to the wheels. The wheels are what get glue; the axle turns inside the body. Put the glue in the wheel hole, not on the dowel, and you cannot get it wrong.
- If you want the car to roll straight, the two axle holes matter more than anything else. Drilling from both sides against a square block is worth the extra minute.
- Sand a small chamfer around the outside edge of each wheel before you fit them. It stops the wheels catching on carpet and it looks like a tire.
- Make two while you are set up. The second one takes half as long, and it is a rare gift that stays interesting to a four-year-old for more than one afternoon.

This is a toy for ages 3 and up. A 1 1/2 in. wheel is a choking hazard for a younger child, so if a toddler is in the house, treat a loose wheel as a reason to take the toy away until it is repaired. Use only untreated wood and a finish that is explicitly labeled safe for children's items - pressure-treated lumber and unknown reclaimed boards have no place in a toy that will end up in a mouth.

Picture Frame

Master tight miter joints with this quick, rewarding project.

Time	Skill	Cost
2-3 hours plus finish drying	Beginner	\$15-25

Material list

- One 1x2 x 6 ft board for the frame face. Poplar or oak is worth the extra few dollars here because the mitered end grain sands cleaner than pine and shows a crisp corner.
- One 8 ft length of 1/4 in. x 3/4 in. screen moulding, for the rabbet strips glued behind the face.
- One piece of 1/8 in. acrylic glazing, 8 1/8 in. x 10 1/8 in. Acrylic rather than glass: it is easier to cut, it will not shatter on a hard floor, and most stores will cut it to size.
- One piece of 1/8 in. hardboard or foam board for the backer, also 8 1/8 in. x 10 1/8 in.
- Wood glue, four small brads or a band clamp, and painter's tape.
- A sawtooth hanger or two D-rings and picture wire.
- Wood filler in a color close to your finish, and sandpaper to 220.

Cut list

Part	Qty	Dimensions (T x W x L)	Notes
Frame sides, long	2	3/4" x 1 1/2" x 12 3/4"	Length is long point to long point. 45 degree miters at both ends, sloping toward each other
Frame sides, short	2	3/4" x 1 1/2" x 10 3/4"	Same miters. Short inner edge measures 7 3/4"
Rabbet strips, long	2	1/4" x 3/4" x 12 3/4"	Screen moulding, mitered to match. Glued to the back, flush with the outer edge
Rabbet strips, short	2	1/4" x 3/4" x 10 3/4"	Same
Acrylic glazing	1	1/8" x 8 1/8" x 10 1/8"	Cut to size at the store
Backer	1	1/8" x 8 1/8" x 10 1/8"	Hardboard or foam board

Tools

- Miter box and backsaw, or a power miter saw
- Band clamp, or painter's tape used as a clamp
- Combination square and a sharp pencil
- Sandpaper, 120 and 220 grit
- Small hammer for the brads and the hanger

Step by step

1. Understand the geometry before you cut anything, because it is the whole project. The photo is 8 x 10 in. The opening is $\frac{1}{4}$ in. smaller in each direction, $7\frac{3}{4} \times 9\frac{3}{4}$ in., so the frame overlaps the photo by $\frac{1}{8}$ in. all around. Each frame piece is cut so its short inner edge equals the opening dimension and its long outer edge equals the opening plus twice the $1\frac{1}{2}$ in. face width - which is where $10\frac{3}{4}$ in. and $12\frac{3}{4}$ in. come from.
2. Clamp the miter box to the bench. It will try to walk across the bench on the first stroke otherwise, and a miter box that moves cuts an angle that is not 45 degrees.
3. Cut one long piece: a 45 degree miter at one end, then measure $12\frac{3}{4}$ in. along the outer edge from the long point and cut the opposing 45 at the other end. Check it against the plan - the outer edge should be $12\frac{3}{4}$ in. and the inner edge should be $9\frac{3}{4}$ in.
4. Cut the second long piece using the first as a template rather than the tape. Lay them outer edge to outer edge and mark. Whether the pieces are exactly $12\frac{3}{4}$ in. matters much less than whether the two of them are identical, because a frame closes only when opposite sides match.
5. Cut the two short pieces the same way: one to $10\frac{3}{4}$ in. on the outer edge, the second traced from the first.
6. Dry fit the four pieces face down on a flat surface. Push the corners together and look at each joint from directly above. Small gaps at the inside of a corner mean the angle is a little over 45; gaps at the outside mean it is a little under. Shave the high side with sandpaper on a flat block rather than recutting.
7. Glue up with the tape trick, which is the easiest clamp a beginner will ever use. Lay all four pieces face down in a line, outer edges touching, in the order they go around the frame - long, short, long, short. Run painter's tape across each of the three joints, flip the whole strip over, put glue on all eight mitered faces, and roll the strip up into a rectangle. Tape the last corner tight. If you have a band clamp, use it over the top of the tape.
8. Check the assembled frame for square while the glue is wet by measuring both diagonals; they should match. Nudge it until they do and leave it flat overnight.
9. Cut and fit the four screen moulding strips with the same miters, to the same outer lengths. Glue them to the back of the frame flush with the outer edge, which leaves a $\frac{3}{4}$ in. wide, $\frac{1}{4}$ in. deep rabbet all the way around the inside. That rabbet is what holds the glazing, and building it up from behind is how you get one without a router.
10. Once dry, drive a small brad through each corner from the outer edge if you want extra insurance, set the head below the surface, and fill the hole. Sand the whole frame to 220, working the corners last so you do not round them over.
11. Finish the frame and let it dry completely. Then load it from the back: acrylic first with the protective film peeled off only at the last second, then the photo face down against it, then the backer.
12. Hold the stack in with four or five small brads tapped part way into the rabbet strips so they pinch the backer, or with turn buttons if you want to change the photo often. Fit the sawtooth hanger centered on the top rail, and hang it.

Tips that save the build

- The mistake most people make on this build is measuring the miters to the inside edge instead of the outside. On a 45 degree miter the outer edge is always longer than the inner edge by twice the width of the stock - 3 in. on a 1 1/2 in. face. Mark from the long point every time and the numbers stop fighting you.
- Cut all four pieces at one miter box setting, in one sitting. Come back tomorrow and the box will have shifted, and four corners that each miss by half a degree add up to a visible gap.
- A tiny gap can be closed. Rub a little glue into it, sand the corner while the glue is wet, and the sanding dust fills the joint with a paste that matches the wood exactly. This is an old trick and it works better than filler.
- To resize the frame for any photo: opening equals the photo size minus 1/4 in. in each direction, and each frame piece's outer length equals its opening dimension plus 3 in. Cut the glazing and backer 1/8 in. larger than the photo.

Leave the protective film on the acrylic until the very last step. It scratches easily, and a scratch put in during assembly is the one flaw you will see every time you walk past the frame.

Step Stool

A useful household build that teaches joinery and stability.

Time	Skill	Cost
3-4 hours plus finish drying	Beginner	\$20-35

Material list

- One 1x10 x 4 ft board, for the top and both legs. Choose a board with no large knots near the middle - the top has to carry an adult's weight over an 11 1/2 in. span, and a knot in the wrong place is where it will break. Poplar is stronger than pine for the same money.
- One 1x4 x 3 ft board, for the two aprons.
- About twenty 1 1/4 in. wood screws and wood glue.
- Sandpaper to 220 and the finish of your choice.
- Four self-adhesive rubber pads for the feet, or a strip of grip tape for the top if the stool will live in a kitchen.

Cut list

Part	Qty	Dimensions (T x W x L)	Notes
Top	1	3/4" x 9 1/4" x 16"	From the 1x10. Overhangs the legs 1 1/2" at each end
Legs	2	3/4" x 9 1/4" x 8 1/4"	From the 1x10. Full-depth panels, not sticks
Aprons	2	3/4" x 3 1/2" x 11 1/2"	From the 1x4. Fit between the legs, front and back, flush with the leg tops
Foot notch	2	1 1/4" deep x 5 1/4" wide	Cut into the bottom edge of each leg, centered, leaving a 2" foot at each side

Tools

- Hand saw or circular saw for the straight cuts
- Coping saw or jigsaw for the two foot notches
- Drill with a 1/8 in. bit and a countersink
- Four clamps
- Combination square

Step by step

1. Cut the 1x10 into one 16 in. top and two 8 1/4 in. leg panels, then cut the two 11 1/2 in. aprons from the 1x4. Six parts total, and the finished stool is 16 in. long, 9 1/4 in. deep and 9 in. tall.
2. Lay out the foot notch on one leg panel. Along the 9 1/4 in. bottom edge, measure 2 in. in from each

side and mark; between those marks, measure 1 1/4 in. up and draw the notch. Cutting this arch or rectangle out is what makes the stool stand on four points instead of two long edges, and it is why a good stool does not rock on an uneven kitchen floor.

3. Cut the notch with a coping saw or a jigsaw. Two straight plunge lines down and one across the bottom is all it takes. If you have a jigsaw, round the two inner corners of the notch slightly - it looks better and it removes the two places most likely to split.
4. Use the first leg as the template for the second: trace the notch, cut it, and stack the two panels together to check they match. Sand them together while they are stacked and both notches end up identical.
5. Dry assemble on the bench, upside down. Stand the two leg panels on their top edges 11 1/2 in. apart, set the aprons between them at the front and back edges so the aprons sit flush with what will be the top of the legs, and hold it with a clamp across the whole assembly.
6. Square it up before any screw goes in. Measure the diagonals across the assembly and adjust until they match, then check that each leg meets the apron at 90 degrees with your square. A stool that dries out of square will rock forever and no amount of sanding fixes it.
7. Drill 1/8 in. pilot holes and countersink them: two through each leg panel into each apron end, so four screws per leg, eight total. The pilot hole is not optional here - you are screwing near the end of a 3/4 in. board and it will split without one.
8. Glue and screw the aprons to the legs. The screws are really clamps that hold the joint while the glue cures, and the glue is what makes the stool last. End grain drinks glue, so put a thin coat on the apron ends, let it soak for a minute, add a second coat, and then assemble.
9. Set the top on the assembled base upside down first to check the overhang - it should stand 1 1/2 in. proud of each leg and sit flush with the front and back apron faces. Mark the leg and apron positions on the underside of the top in pencil so you know where to aim the screws.
10. Glue and screw the top down: three screws into each leg's top edge and three into each apron's top edge, all pilot-drilled and countersunk. Twelve screws sounds like a lot for a small top, but this is the joint that carries a person, and it is the joint you cannot inspect once it is finished.
11. Sand the whole stool to 220, easing every edge and corner with 120 first. Pay particular attention to the top's edges and the ends of the overhang, because those are the parts a bare shin finds in the dark.
12. Finish it, let it cure, and stick the four rubber pads on the feet. Then test it the honest way: set it on a hard floor, stand on it, and shift your weight to each corner in turn. It should not creak, slide or rock.

Tips that save the build

- The mistake most people make on this build is skipping the glue and trusting the screws. Screws driven into end grain lose their grip over time, and a stool that gets stood on every day works those joints hard. Glue every joint, and the screws stop being the thing that holds it together.
- The foot notch is not decoration. Four small contact points always sit flat; two long edges only sit flat on a perfect floor. If you build this without the notches, expect it to rock.
- Check for square twice - once when you dry fit, once again right after the screws go in and before the glue sets. That second check is the one people skip.
- Add grip tape or a few shallow saw kerfs across the top if the stool is going in a kitchen or bathroom.

A painted or oiled top gets slick when wet, and a step stool is a bad place to discover that.

- This is a step stool, not a ladder. Sized and fastened as drawn, it is right for reaching a high shelf; it is not right for standing on the top edge of, leaning off, or using as a work platform.

Test the finished stool yourself before anyone else stands on it, and check the joints once a year. Retighten any screw that has loosened, and if a leg panel has developed a crack from the notch, take the stool out of service and cut a new leg - it is one part and half an hour.

Keep building

If you built even one of these, you now own the skill that every other woodworking project is made of: cutting to a line, checking for square, and gluing a joint that holds. Everything else is a variation. The birdhouse and the picture frame teach accuracy, the shelf and the stool teach how a thing carries weight, and the workbench gives you the surface you will build the next ten projects on.

Build them in the order that suits the room you are in, and do not wait until you feel ready for the harder ones. The way you get ready is by making the parts, discovering that one of them is 1/8 in. off, and figuring out what to do about it. Every woodworker you admire has a stack of first attempts they do not photograph.

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