

Fittings and valves

YES Electric • a plain-language course for new plumbing apprentices

Draft 1 (October 2026). Code numbers follow the International Residential Code and International Plumbing Code as enforced in Alabama. The local inspector has the last word. Prices and hours are rough Birmingham-area numbers.

Pipe only goes straight. Everything else, every corner, every branch, every change of size, every shutoff, is a fitting or a valve. A plumber spends more time picking the right fitting out of the truck than cutting pipe. This module teaches the names, because the names are how the trade talks. When the plumber on the ladder says "hand me a 2 inch san tee," the apprentice who knows what that is keeps the job moving.

Fittings come in two families that match the two roads from Module P01. Supply fittings are for pressurized water and can turn sharp corners. Drain fittings, called DWV fittings, have gentle curves inside so solids do not catch and so the water keeps its flow.

Supply fittings (pressure fittings)

These are the fittings for PEX, copper, and CPVC. They come in each material and in brass. The shapes are the same across all of them.



Copper sweat fittings. Top row: 45-degree elbow, tee, coupling. Bottom row: cap, 90-degree elbow, reducer, street 45 (one end fits inside a fitting).

Photo: Kupferfittings 4062.jpg by Torsten Bätge, CC BY-SA 3.0.



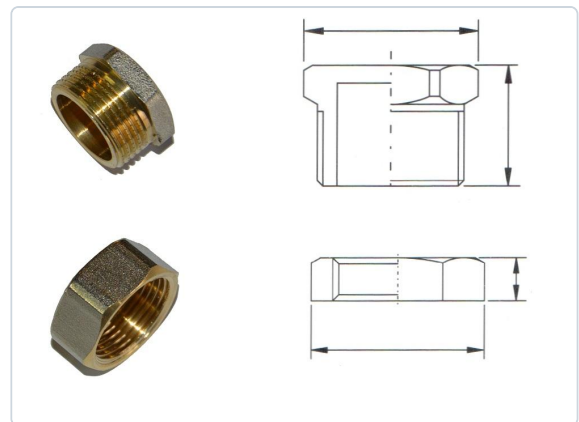
The same tee in six materials, left to right: black malleable iron, galvanized iron, brass threaded, bronze threaded, copper sweat, copper press.

Photo: T-Stuecke 4052.jpg by Torsten Bätge, CC BY-SA 3.0.



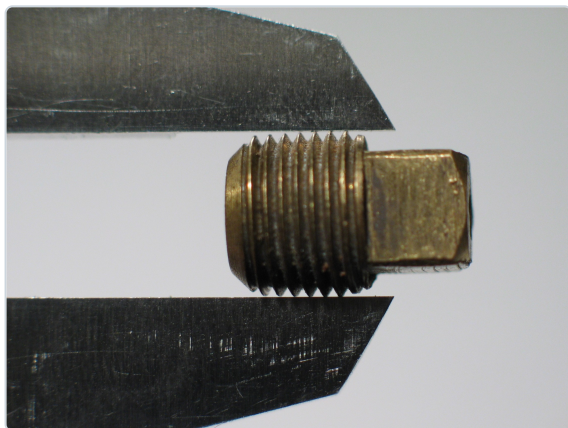
Two male adapters: the smooth end is soldered onto copper tube and the threaded end screws into a female fitting.

Photo: Copper threaded adapters.jpg by Emilian Robert Vicol, CC BY 2.0.



Brass caps. A cap screws over the outside of a male pipe end to close it off; a plug screws into a female fitting.

Photo: Pipe cap.jpg by Луносвет, CC BY-SA 3.0.



Brass square-head pipe plug held in calipers. The tapered pipe thread gets tighter as it screws in, which is what seals it.

Photo: Brass NPT threaded Pipe Plug in a Caliper.jpg by BenFrantzDale, CC BY-SA 3.0.



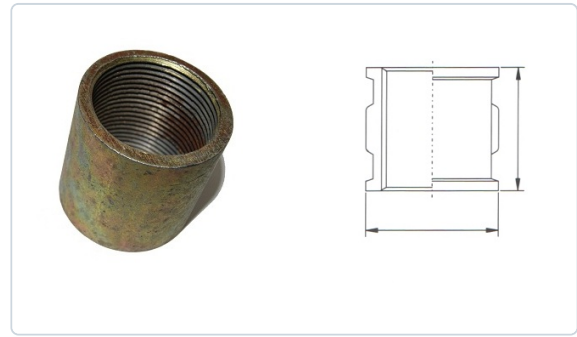
Two unions (male-thread and female-thread). The big nut in the middle lets you take the joint apart later without turning either pipe.

Photo: Американки (металл-полипропилен) - Донор.JPG by Донор, CC BY-SA 4.0.



Hex nipple: a short piece threaded on both ends with a hex in the middle for a wrench. A plain nipple has no hex.

Photo: Doppelnippel stehend.jpg by der greg, CC BY 2.0.



Threaded coupling: female threads on both ends, used to join two male pipe ends in a straight line.

Photo: Coupling pipe.jpg by Луносвет, CC BY-SA 3.0.



Male and female adapters on press-type ends. The male adapter has outside threads; the female adapter has inside threads.

Photo: Pressfittings 4.jpg by Sarang, Public domain (PD-self).

Fitting	What it does
Coupling	Joins two pipes straight.
Elbow (90 and 45)	Turns a corner. A 90 is a square corner. A 45 is half of one. Also called an ell.
Street elbow	One end is the size of the pipe so it fits directly into another fitting without a piece of pipe between.
Tee	Splits one line into two. Named by the run size then the branch size, so a 3/4 x 3/4 x 1/2 tee runs 3/4 straight through and branches 1/2.
Reducer or bushing	Steps from a bigger pipe to a smaller one. A reducer coupling takes pipe on both ends. A bushing sits inside a fitting.
Adapter	Changes from one material or joint type to another. A male adapter has threads on the outside. A female adapter has threads on the inside.
Union	Lets you take a joint apart later without cutting. Three pieces, two ends and a big nut.

Fitting	What it does
Nipple	A short piece of threaded pipe. A close nipple is all thread with nothing in between.
Cap and plug	Close off an end. A cap goes over the pipe. A plug goes into a female fitting.
Drop-ear elbow	A 90 with two screw holes so you can mount it to a stud. Used for shower arms, tub spouts, and hose bibs where the pipe has to stay put when someone turns a handle.
Stub-out	The piece that pokes through the drywall for a stop valve. In copper it is a short pipe with a bend. In PEX it is a bracket that holds the pipe or a copper stub with a PEX end.
Dielectric union	A union with a plastic washer inside that keeps copper and steel from touching. Where two different metals touch in water, the steel corrodes fast. Used at water heaters.



Item 1 (top left) is a drop-ear elbow: a 90 with two screw ears so it can be fastened to a block in the wall for a shower arm or hose bib. The other parts are common PEX fittings.

Photo: PexMall-Brass-Crimp-Fittings-For-PEX.jpg by Plumberapple, CC BY 3.0.

Reading a fitting

Fittings are sized by the pipe they fit, not by their own outside measurement. A 1/2 inch copper 90 is a little bigger than 1/2 inch on the outside because the pipe slides into it. Threaded fittings are sized by pipe thread, and the thread sizes do not match what a ruler says either. A 1/2 inch pipe thread measures about 13/16 inch across. Apprentices learn to read sizes by comparing to a known pipe, not by measuring.

Male means threads on the outside, female means threads on the inside. MIP and FIP mean male and female iron pipe thread, which is the standard pipe thread. Hose thread is different and does not seal to pipe thread. Compression fittings use a third set of sizes based on the outside of the tube.

DWV fittings (drain fittings)

Drain fittings look like supply fittings but every turn is gentler and every branch comes in at an angle that keeps the water moving downhill. The inside of each fitting has a slight slope built in so a horizontal pipe glued into it automatically gets a little fall.

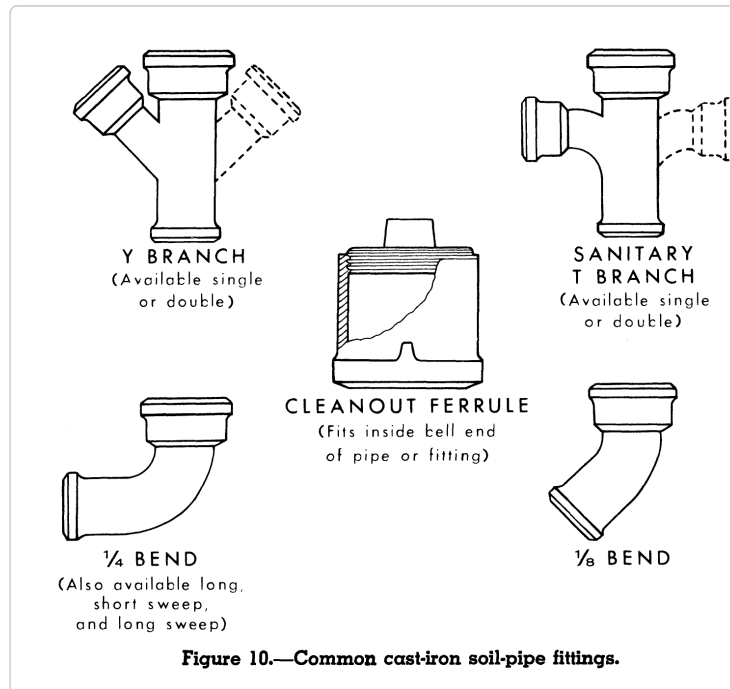


Figure 10.—Common cast-iron soil-pipe fittings.

Common cast-iron drain fittings from a USDA plumbing bulletin: Y branch, sanitary T branch, 1/4 bend, 1/8 bend, and others, each with its name.

Photo: Plumbing for the home and farmstead (IA CAT87204864).pdf by H. L. Garver and J. W. Rockey, U.S. Department of Agriculture (Farmers' Bulletin), Public domain (US Government, USDA).

Fitting	What it does
Sanitary tee (san tee)	A tee with a curve in the branch. Used where a horizontal drain drops into a vertical pipe, like a sink arm into a stack. The curve aims the water downward.
Wye	A branch that comes in at 45 degrees. Used for joining two flows in a horizontal run, and for cleanouts.
Combo (wye plus 1/8 bend)	A wye and a 45 molded as one piece so the branch ends up at 90 degrees but the water still enters at a gentle angle. The go-to fitting for tying a branch into a horizontal run.
Long sweep 90	A 90 with a big radius. Used wherever a vertical pipe turns horizontal, like the base of a stack.
1/4 bend	A regular 90.
1/8 bend	A 45.
1/16 bend	A 22 1/2.
Closet flange	The ring that bolts the toilet to the floor. It glues onto a 3 or 4 inch pipe and screws to the subfloor.

Fitting	What it does
Closet bend	The elbow right under the toilet, sized for the flange.
Trap adapter	Connects the chrome or plastic tailpiece under a sink to the PVC in the wall. It has a slip nut and a rubber washer.
Cleanout tee or cleanout adapter	A fitting with a threaded plug so a snake can go in.
Fernco (flexible rubber coupling)	Joins different pipe materials or sizes with band clamps.
P-trap	The U-shaped water seal under every fixture. Sold as a fitting in PVC and ABS, and in chrome for exposed locations.



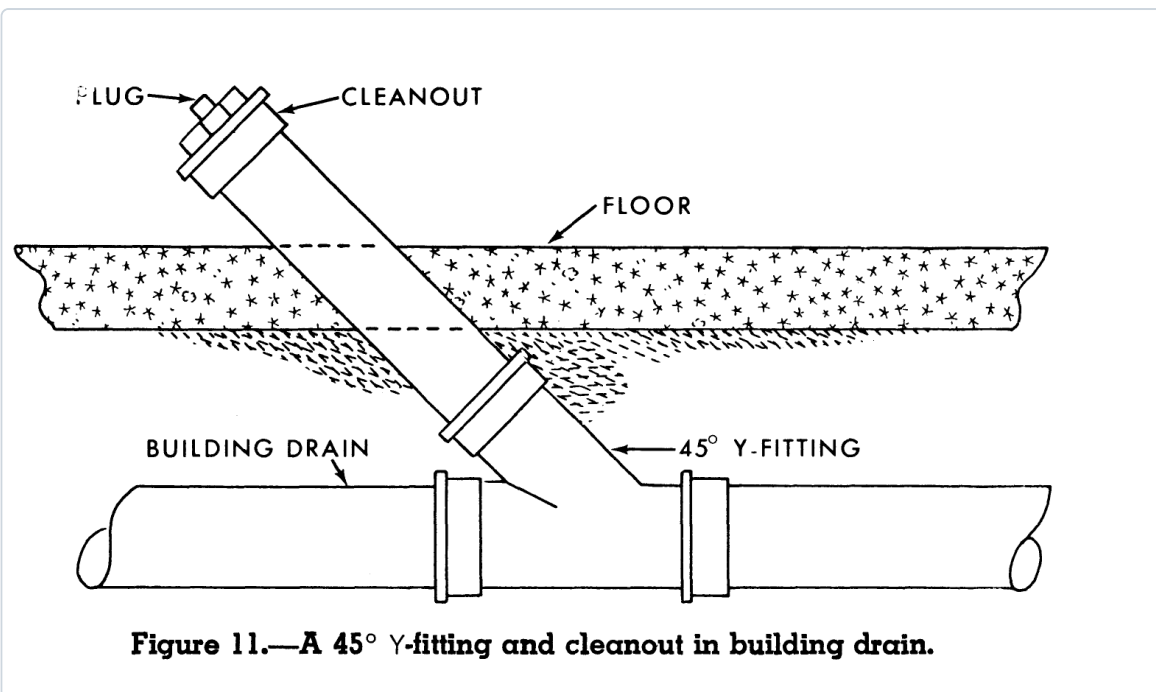
Closet flange set on a concrete floor over the drain pipe. The slots take the closet bolts that hold the toilet down; the wax ring sits on this flange.

Photo: Toilet flange.jpg by Achim Hering, Public domain (PD-self).



PVC P-trap under a bathroom sink. The ribbed slip-joint nuts at the top and at the trap bend hold a washer against the pipe; this one is leaking at the bottom of the trap.

Photo: Leaking PVC Pipe Under Sink - P Trap (52842956605).jpg by Tony Webster, CC BY 2.0.

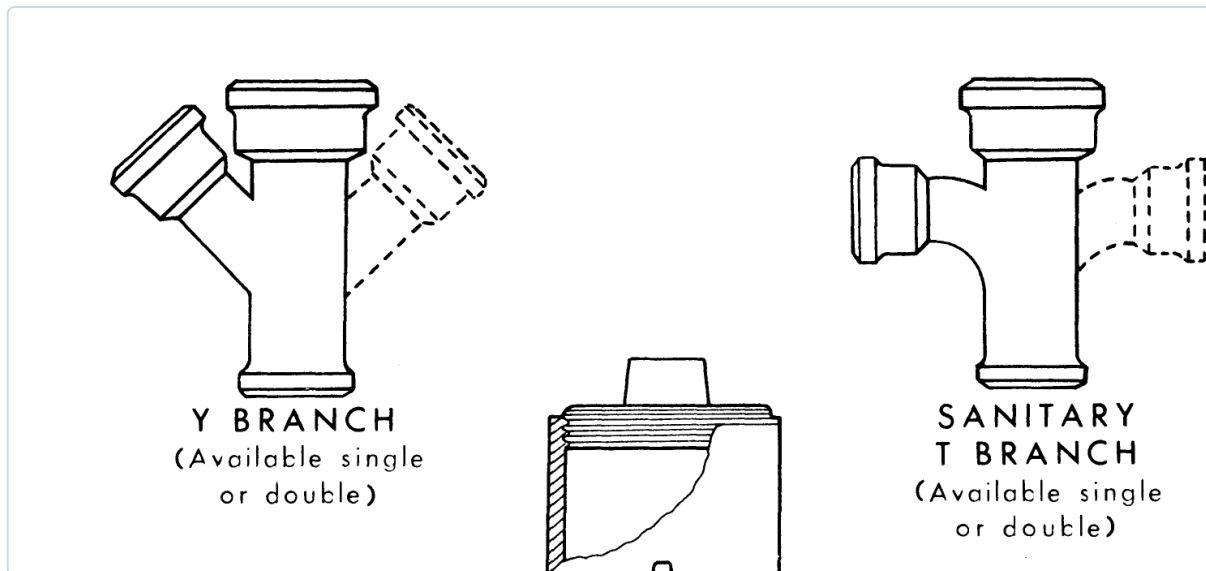


A 45-degree Y fitting in the building drain with a cleanout riser brought up through the floor and closed with a plug.

Photo: Plumbing for the home and farmstead (IA CAT87204864).pdf by H. L. Garver and J. W. Rockey, U.S. Department of Agriculture (Farmers' Bulletin), Public domain (US Government, USDA).

Which fitting goes where

The direction the water is traveling decides the fitting. This is the rule the inspector checks and the rule beginners get wrong.



Y branch (wee) next to a sanitary T branch. The wee lets the branch flow enter at 45 degrees; the sanitary tee turns it 90 degrees with a short sweep, so a tee is only used where the branch is horizontal and the run is vertical.

Photo: Plumbing for the home and farmstead (IA CAT87204864).pdf by H. L. Garver and J. W. Rockey, U.S. Department of Agriculture (Farmers' Bulletin), Public domain (US Government, USDA).

Water is going	Use this	Never this
Horizontal pipe dropping into a vertical pipe	Sanitary tee	A wee pointing up would catch debris
Vertical pipe turning to horizontal	Long sweep 90, or a wee with a 1/8 bend	A short 90 slams the water and splashes
Horizontal pipe joining a horizontal pipe	Wee plus 1/8 bend, or a combo	A san tee on its back. The branch enters too steeply and the water backs up
Horizontal pipe changing direction	1/8 bends or a long sweep	A regular 90 is allowed in some places but a sweep is better
Vent pipe	Any fitting, including a san tee on its back, because only air moves	

A sanitary tee lying on its back, meaning the branch points straight up, is the single most common failed inspection on a DWV rough-in. It is fine for a vent. It is not allowed for drainage because water coming down the branch hits the bottom of the fitting and splashes back.

Drain fittings also come in the same angles as supply fittings, but plumbers name them by the fraction of a circle. A 90 is a 1/4 bend because it turns a quarter of a circle. A 45 is a 1/8 bend. Over 45 degrees from horizontal counts as vertical in the code.

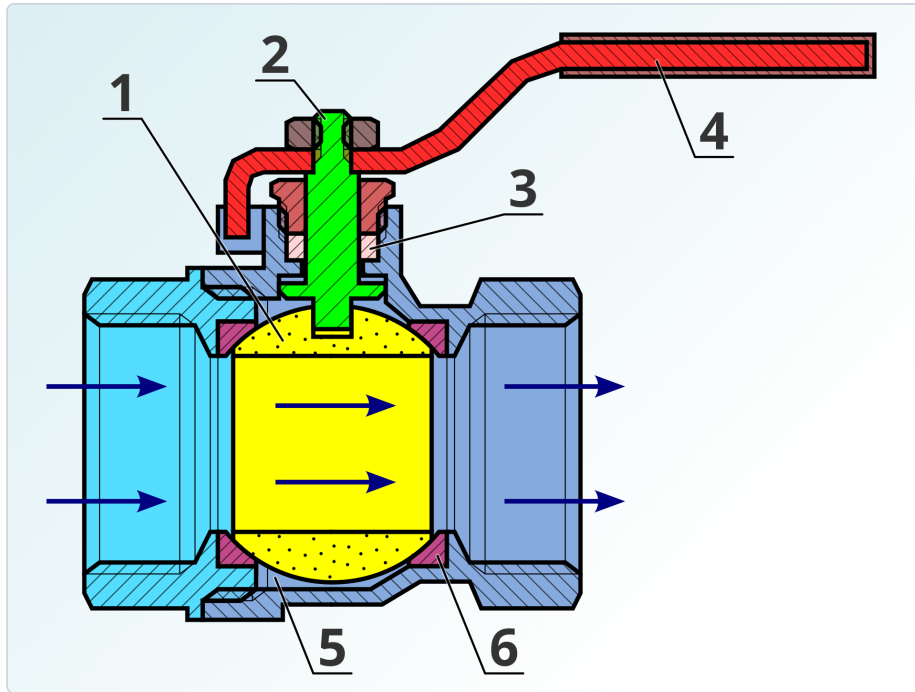
Valves

A valve is a fitting with a moving part inside that stops or controls flow. A plumber has to know which valve does what, because the wrong valve in the wrong spot either will not shut off when it is needed or will wear out in a year.

Valve	What it looks like	What it does
Ball valve	Lever handle, quarter turn	Full open or full shut. A ball with a hole through it turns inside. Fastest and most reliable. The new standard for every shutoff.
Gate valve	Round wheel handle, many turns	A flat gate lowers across the flow. Older main shutoffs. Gets stuck and breaks internally.
Globe valve	Round wheel, but the body bulges	Throttles flow by pressing a disk onto a seat. Rare in houses now.
Stop valve (angle or straight)	Small oval handle under sinks	Shuts off one fixture. Angle stops turn the water 90 degrees out of the wall. Straight stops are for pipe coming up out of the floor.
Check valve	No handle	Lets water go one way only. A flap or a spring-loaded disk closes if the flow reverses. On well pumps, sump pumps, and recirculating lines.
PRV	Bell shaped with a screw on top	Lowers house pressure. A spring and a diaphragm inside. Turning the screw changes the setting.
T&P relief valve	Lever on a brass body, on the water heater	Safety pop-off. Opens at 150 psi or 210 degrees.
Expansion tank	Small blue or white tank near heater	Not a valve, but it goes with the PRV. Gives hot water room to swell.
Mixing valve	Inside the shower wall	Blends hot and cold to one safe temperature. Pressure-balance valves keep the mix steady when a toilet flushes. Thermostatic valves hold a set temperature.
Hose bib / sillcock	Outdoor spigot	Outside water. Frost-free ones have a long stem so the shutoff point is inside the warm wall.
Washing machine box	Recessed box with two valves and a drain	Where the washer hooks up.
Gas valve	Yellow handle or ball valve on black iron	Not water, but plumbers do it. Natural gas or propane shutoff at each appliance.

Ball valve

Inside a ball valve is a steel or brass ball with a hole bored through it. Turn the lever a quarter turn and the hole lines up with the pipe and water flows. Turn it back and the solid side of the ball blocks the pipe. Plastic seats on either side of the ball seal it. A full-port ball valve has a hole the same size as the pipe. A standard-port ball valve has a smaller hole and slows the water a little. The handle tells you the state at a glance. Handle in line with the pipe means open. Handle across the pipe means closed.

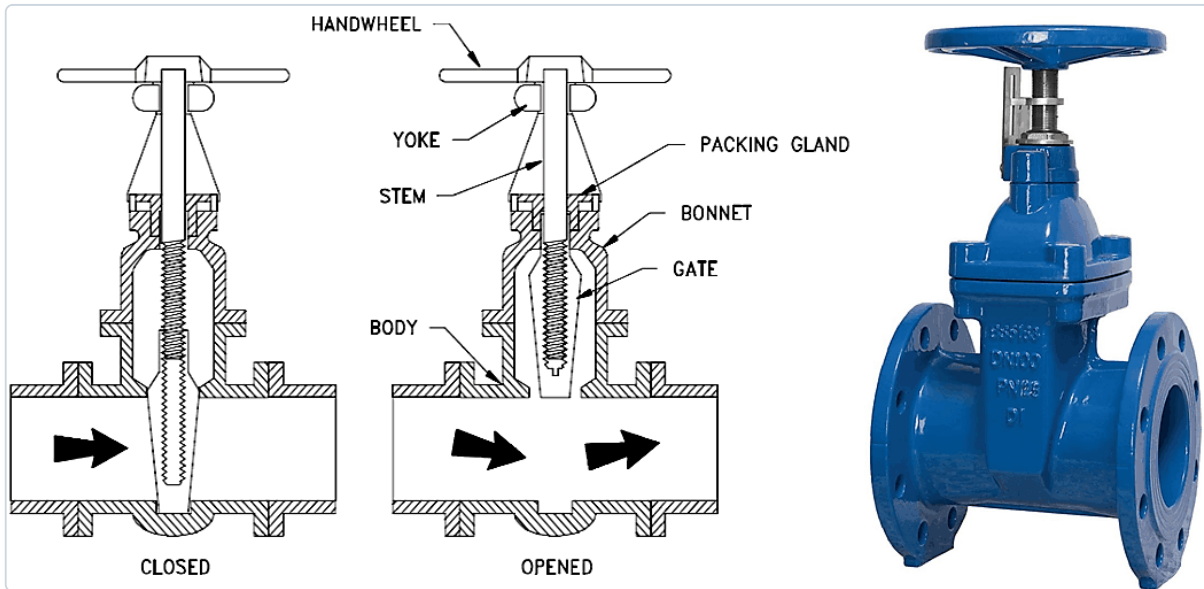


Cutaway of a ball valve. The ball (1) has a hole through it; a quarter turn of the lever (4) on the stem (2) lines the hole up with the pipe for full flow or turns it sideways to shut off. The ball seals against the seats (6); 3 is the stem packing and 5 is the dead space around the ball.

Photo: File:Esquema valvula de bola 1-6.svg by Sthidraulica (original drawing); Sunspeanzler (SVG derivative), CC BY-SA 4.0.

Gate valve

A gate valve has a wedge-shaped gate that screws down across the flow when you turn the wheel. It takes several turns. Gate valves were the standard main shutoff for decades, and they fail in two ways. The gate corrodes and sticks partway, so the valve will not fully close. Or the stem breaks off the gate, so the wheel spins and nothing happens. A gate valve that has sat untouched for twenty years should be replaced with a ball valve, not trusted.

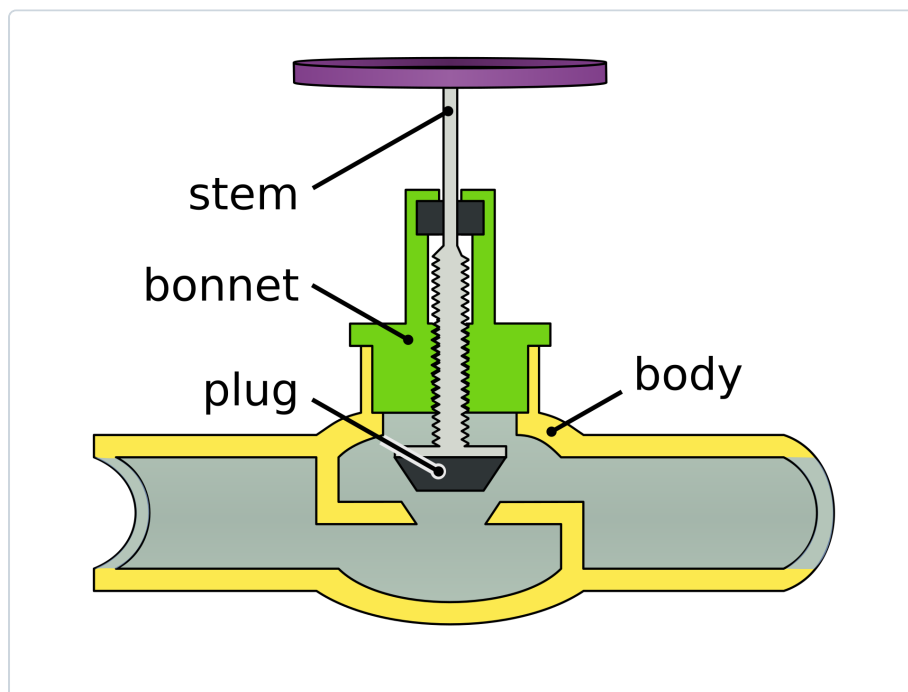


Gate valve shown closed and open, with the parts named: handwheel, stem, yoke, packing gland, bonnet, gate and body. Turning the wheel many times raises or lowers the wedge-shaped gate straight across the flow. The photo at right is a flanged cast-iron gate valve.

Photo: File:Gate valve.png by HardHat Engineer, CC BY-SA 4.0.

Globe valve

A globe valve has a round body and a disk that presses down onto a seat. It is built to control flow, not just stop it, so it can be set half open without wearing out. Houses rarely use them anymore. They show up on old boilers and some outdoor spigots.



Cutaway of a globe valve. Water enters one side, turns up through the seat opening, and leaves the other side. Turning the handwheel screws the stem down so the plug closes on the seat; the bonnet holds the stem and packing on top of the body.

Photo: File:Globe valve diagram.svg by Petteri Aimonen, Public domain.

Stop valves

The stop valve under every sink and behind every toilet is the valve an apprentice touches most. Old multi-turn stops have rubber packing and a stem that unscrews like a tiny faucet. They weep at the stem and seize up. New quarter-turn stops have a small ball valve inside. They come in three inlet types: compression for copper and CPVC, PEX crimp, and threaded for a brass nipple. The outlet is 3/8 compression for the supply tube. Dual-outlet stops feed two things, like a faucet and a dishwasher, from one pipe.

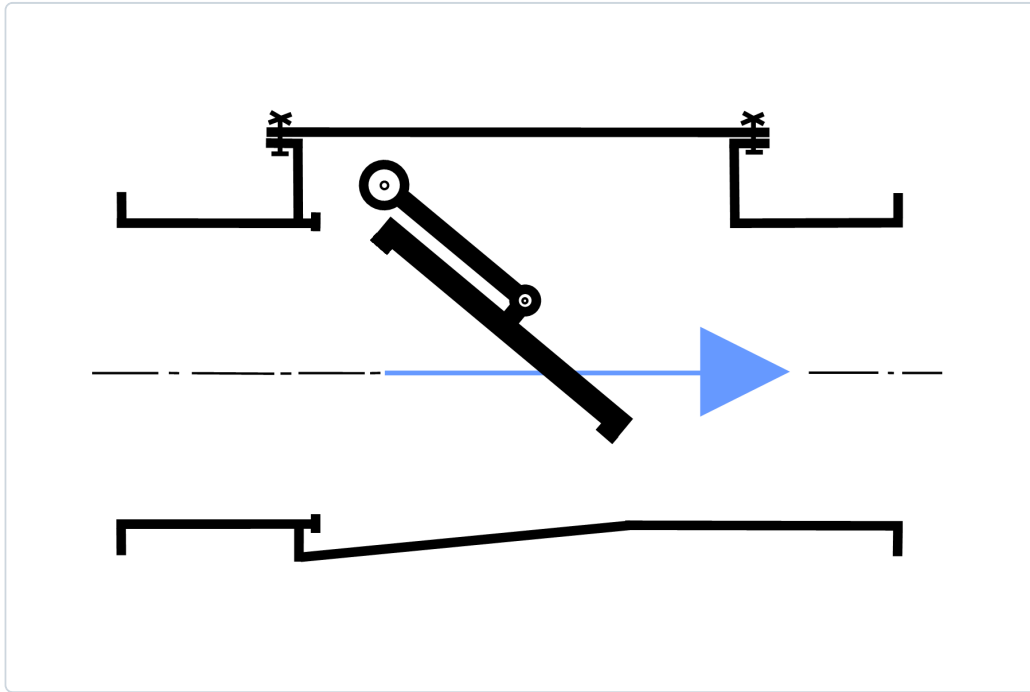


An angle stop valve coming out of the wall at a toilet, with a chrome escutcheon behind it and a braided stainless supply tube running up to the tank. The same valve is used under sinks for the faucet supplies. Turn the oval handle clockwise to shut the water off to the one fixture.

Photo: File:Toilet water shutoff valve.JPG by BrokenSphere, CC BY-SA 3.0.

Check valve

A check valve lets water move one way and stops it coming back. A swing check has a flap that opens with the flow and falls shut when it stops. A spring check has a disk held on a seat by a spring. Sump pump discharge lines have one so the water in the pipe does not run back into the pit. Water heater recirculating loops have one so hot water does not flow backward into the cold line. There is no handle, so the direction arrow stamped on the body is the only clue to which way it goes.



Principle of a swing check valve. The hinged flap swings open when water flows in the arrow direction and swings shut against the seat if flow tries to reverse. It has no handle; it works by itself.

Photo: File:Check valve swing.png by User:KaHe, Public domain.

Frost-free sillcock

A regular hose bib has its shutoff seat right at the handle, outside in the cold. When water freezes in it, the body splits. A frost-free sillcock has a stem 8 to 12 inches long that reaches through the wall and seats on the inside end, in the warm part of the house. The outside part drains empty when the valve is shut. Frost-free sillcocks must be pitched slightly downhill toward the outside so they drain. Leaving a hose connected defeats the whole thing, because the water cannot drain and the stem splits.



Two stems pulled out of frost-free sillcocks (outdoor faucets). The stem is long so the washer and seat at the end sit inside the heated wall, not out in the cold. The top stem is crusted with calcium scale; the bottom one is new.

Photo: File:A frost-free sillcock faucet with calcium buildup .jpg by Tim36272, CC BY-SA 3.0.

Shower mixing valve

The valve in the shower wall mixes hot and cold. Code requires it to be a pressure-balance or thermostatic valve. A pressure-balance valve has a spool or diaphragm inside that moves when the pressure on one side drops, so a toilet flushing does not send scalding water to the shower. The valve body gets set in the wall at rough-in, about 48 inches off the floor for a tub and shower, held to a wood block or a bracket. The trim, handle, and spout come later. Each brand's trim fits only its own valve body, so plumbers pick the brand at rough-in.



A brass shower valve body roughed in inside the wall opening, with hot and cold PEX supply lines coming down to it and the pipe up to the shower head. The tile and trim go on after the wall is closed.

Photo: File:Shower project new diverter valve plus PEX pipes attached.jpg by Tomwsulcer, CC0.

Washer box and other recessed boxes

A washing machine box is a plastic box that sits between studs with two valves, hot and cold, and a 2 inch drain hole for the standpipe. The valves are often a single lever that shuts both at once. Ice maker boxes and some dishwasher boxes are the same idea with one valve. They give the homeowner a shutoff and give the plumber a finished-looking place to bring pipe out of the wall.



A washing machine hookup on a wall: a supply tap with the fill hose attached, and a gray standpipe that the drain hose hooks into. This is a European surface-mounted hookup; US houses usually put the hot and cold valves and the 2-inch standpipe inside a recessed washer box.

Photo: File:Aansluitingen wasmachine Nederland 21e eeuw.jpg by JopkeB, CC BY-SA 4.0.

Gas valves

Plumbers run gas pipe as well as water in most of the country. Every gas appliance gets a shutoff within 6 feet, a ball valve with a yellow handle or a brass gas cock with a flat key. Below the valve on a water heater or furnace is a drip leg, a short dead-end nipple pointing down that catches dirt and moisture before it gets into the appliance. The valve and drip leg are threaded black iron, joined with yellow gas-rated Teflon tape or pipe dope rated for gas.



A main gas shutoff valve (a brass gas cock) on black iron gas pipe in a basement, tagged so anyone can find it. The pipe drops from the valve through an elbow and runs along the wall with a union. A quarter turn of the flat handle across the pipe closes it.

Photo: File:Marked gas shutoff.JPG by CraigKelley62, CC BY-SA 4.0.

Sealing threaded joints

Threaded fittings do not seal on the threads alone. They need either Teflon tape wrapped around the male threads, three or four wraps in the direction the fitting tightens, or pipe dope brushed on. White tape is for water. Yellow tape is thicker and rated for gas. Many plumbers use both tape and dope on gas. Compression fittings get a thin coat of dope on the ferrule, never on the threads. Flare fittings get nothing.

Check yourself

1. What is the difference between a male adapter and a female adapter?
2. Name the fitting for each case: horizontal into vertical, vertical turning horizontal, horizontal joining horizontal.
3. Why is a sanitary tee on its back wrong for drainage but fine for a vent?
4. What is a combo made of?
5. How can you tell if a ball valve is open without turning it?
6. Why should an old gate valve on a main be replaced rather than trusted?
7. How does a frost-free sillcock keep from freezing, and what defeats it?
8. What does a pressure-balance shower valve protect against?
9. Which Teflon tape goes on gas threads?

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