

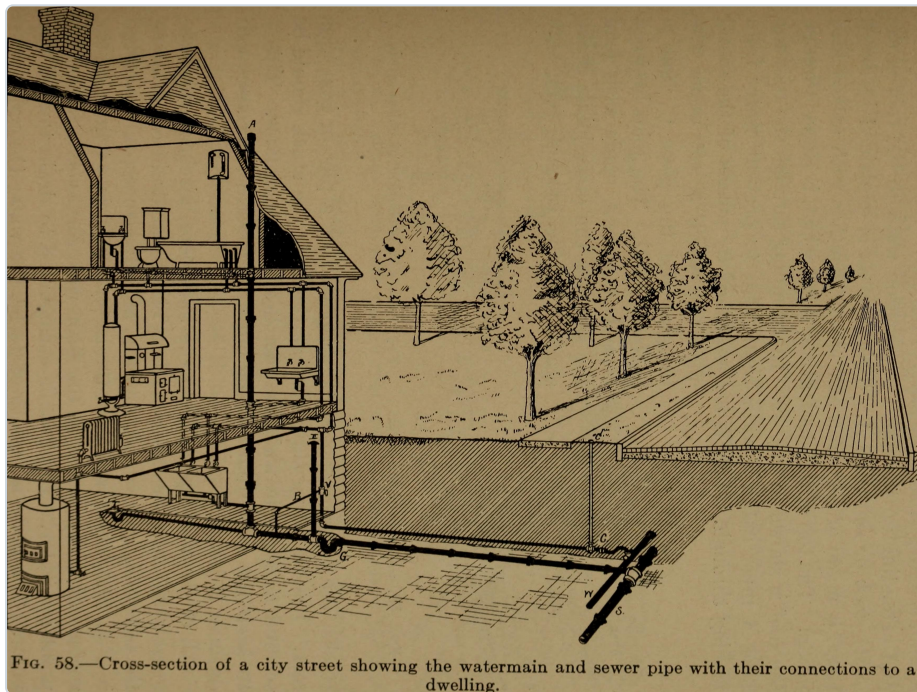
How a house plumbing system works

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.

Think of a house's plumbing as two one-way roads. One road brings clean water in under pressure. The other road lets dirty water roll downhill and out, with air pipes so it can breathe. Everything an apprentice touches belongs to one of those two roads. If you can always say which road a pipe is on, you already understand more than most homeowners ever will.

This module walks both roads from one end to the other. Later modules go deeper on the materials, the fittings, the fixtures, and the code numbers. Here the goal is the big picture.



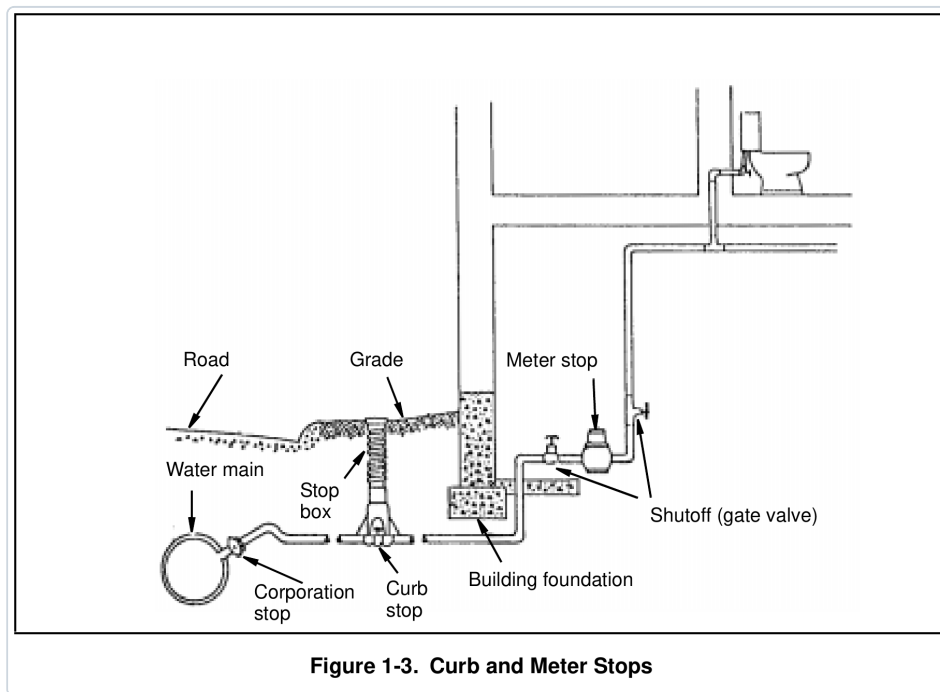
Cutaway of a house and the street in front of it. The water main and the sewer run under the street; the water service comes in low, the soil stack rises past the bathroom and out the roof, and the house drain leaves through the basement wall to the sewer. 1918 textbook plate, so the fixtures look old but the two roads are the same today.

Photo: File:Mechanics of the household; a course of study devoted to domestic machinery and household mechanical appliances (1918) (14799395263).jpg by Keene, E. S. (Edward Spencer), published 1918; scan via Internet Archive Book Images, Public domain (published 1918, US; Flickr Commons 'no known copyright restrictions').

Road 1: The supply side (clean water coming in)

Water comes from the city main at the street or from a well. It is pushed, so it can go up, down, or sideways and does not care about gravity. Because it is pushed, the pipes can be small. The main line through the house is usually 3/4 inch and the branches to each fixture are 1/2 inch.

The supply side is also where most of the money-making repairs happen, because pressurized water finds every weak joint and every worn washer.



Supply side only, from the street to the first fixture: water main, corporation stop, curb stop in its stop box, service line through the foundation, shutoff valve, meter, and meter stop. No PRV or water heater is drawn; the instructor adds those downstream of the meter.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 1-3 Curb and Meter Stops by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

The path, in order

1. **Water meter** at the street. The city measures what the house uses here. It sits in a box with a lid near the curb.
2. **Main shutoff valve** where the pipe enters the house. Every apprentice should find this first on every job, before any other work starts. If something goes wrong, this is where you stop the water.
3. **Pressure reducing valve (PRV)**. A bell-shaped brass part that knocks city pressure down to about 50 to 60 psi so the fixtures inside do not get hurt. Not every house has one. Houses with high street pressure need one.
4. **Water heater**. The cold line splits here. One side stays cold and goes on through the house. The other side goes into the tank, gets heated, and comes out the top as the hot

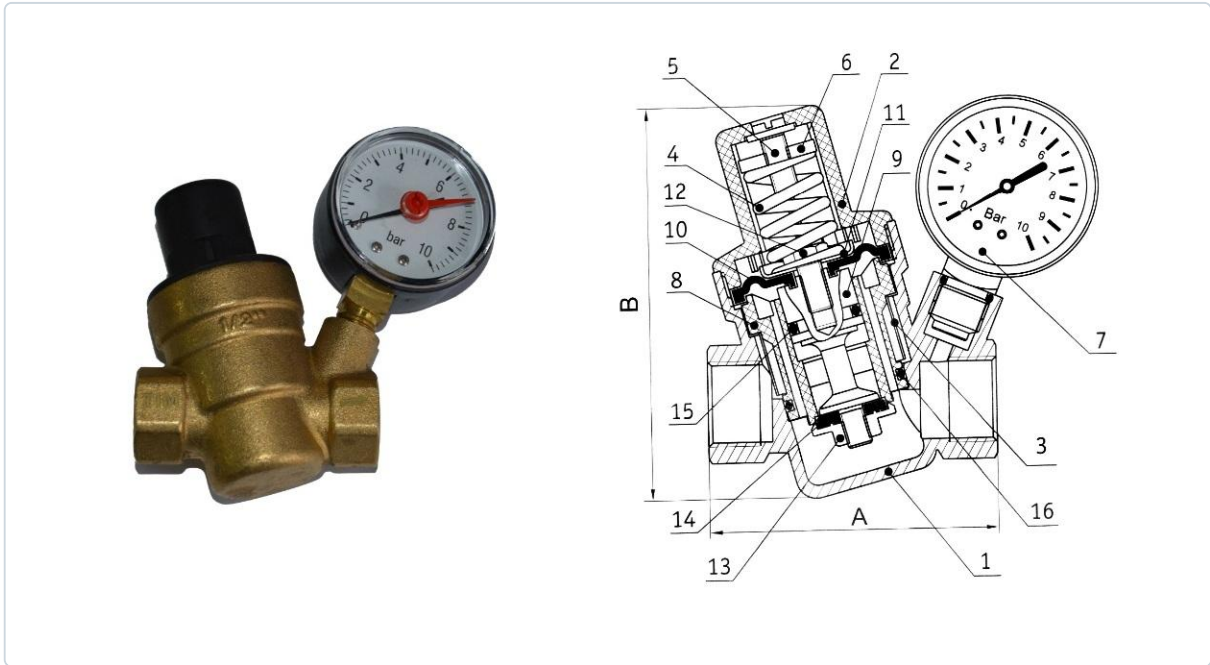
line. On top of the tank is the **T&P valve**, a safety valve that pops open if the tank gets too hot or the pressure climbs too high.

5. **Trunk and branch lines.** Bigger pipes run the length of the house like a tree trunk. Smaller pipes branch off to each sink, toilet, tub, and washer. Hot is always on the left and cold is always on the right when you face the fixture.
6. **Stop valves** under each sink and behind each toilet. Little quarter-turn valves so you can fix one fixture without shutting off the whole house.
7. **Supply tubes.** Short flexible braided lines from the stop valve up to the faucet or toilet tank.
8. **Hose bibs** on the outside walls. The frost-proof kind is called a sillcock.



Residential water meter sitting in its ground box with the register lid flipped open to show the reading. Australian meter, but the brass body, unions on each side, and lidded register look the same as US meters. The main shutoff valve is not in the frame; use A02 to show where the curb stop and house shutoff sit.

Photo: File:Elster water meter.jpg by Bidgee, CC BY-SA 3.0 AU.



Brass pressure reducing valve with a gauge, shown as a photo on the left and a numbered cutaway on the right. The spring under the bell cap pushes on a diaphragm that throttles the seat. Bench photo rather than an installed shot.

Photo: File:Waterreductor.jpg by Луносвет, CC BY-SA 3.0.

Why the heater needs a safety valve and a tank

Water swells when it heats up. In an old open system that extra water just pushed back toward the street. Once a PRV or a check valve is on the line, the system is closed and the swelling has nowhere to go. That is why a small tank called an expansion tank sits near the heater. It has an air bladder inside that gives the hot water room to grow. The T&P valve on the heater is the last line of defense if the tank or the thermostat fails.



Potable water expansion tank hanging from a copper tee on the cold line next to a ball valve. This is where the tank goes on the cold side feeding a water heater.

Photo: File:Watts Potable Water Expansion Tank.jpg by Tony Webster, CC BY 2.0.

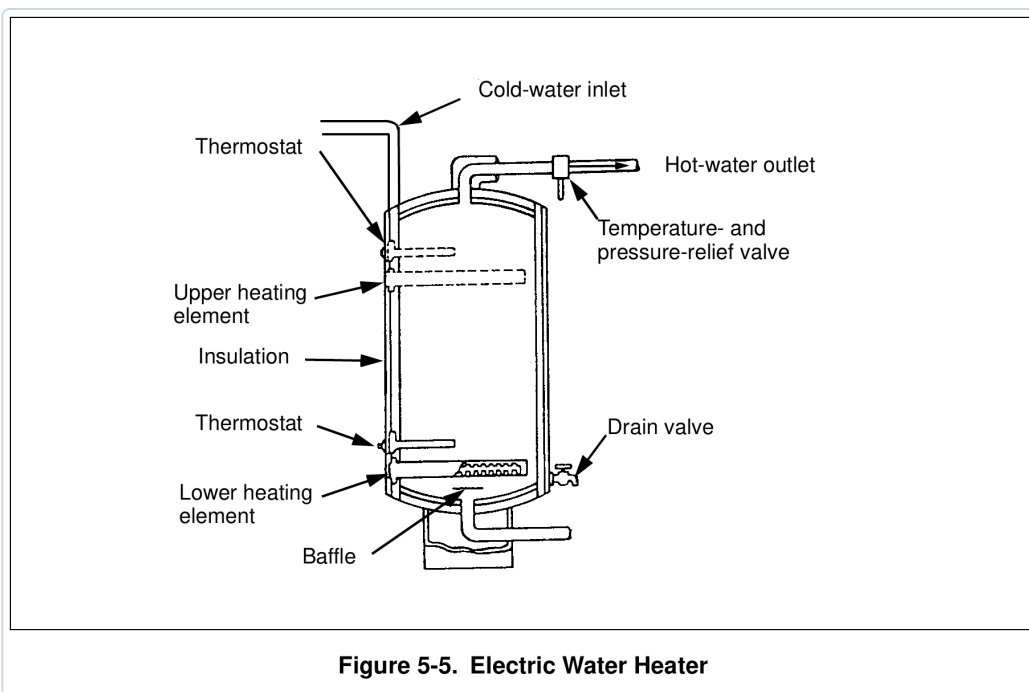
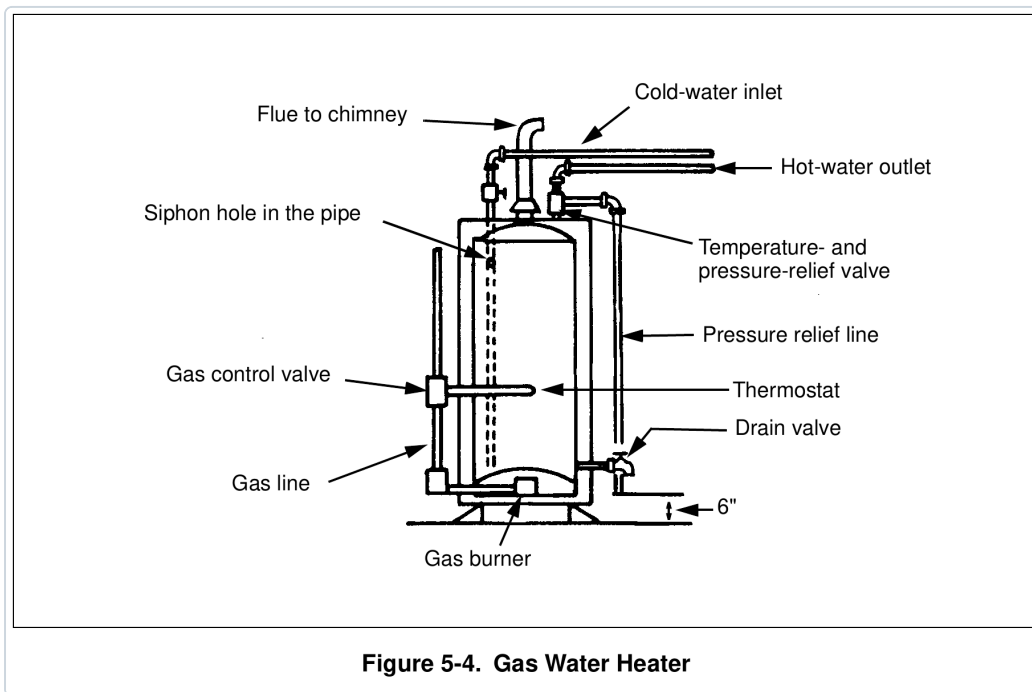


Figure 5-5. Electric Water Heater

Labeled cutaway of an electric tank water heater: cold inlet, hot outlet, T&P relief valve, upper and lower thermostats and elements, insulation, drain valve. The dip tube and anode rod are not labeled; the instructor adds them. The gas version in A11 shows the dip tube.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 5-5 Electric Water Heater by US Army (Headquarters, Department of the Army), Public domain (US federal government work).



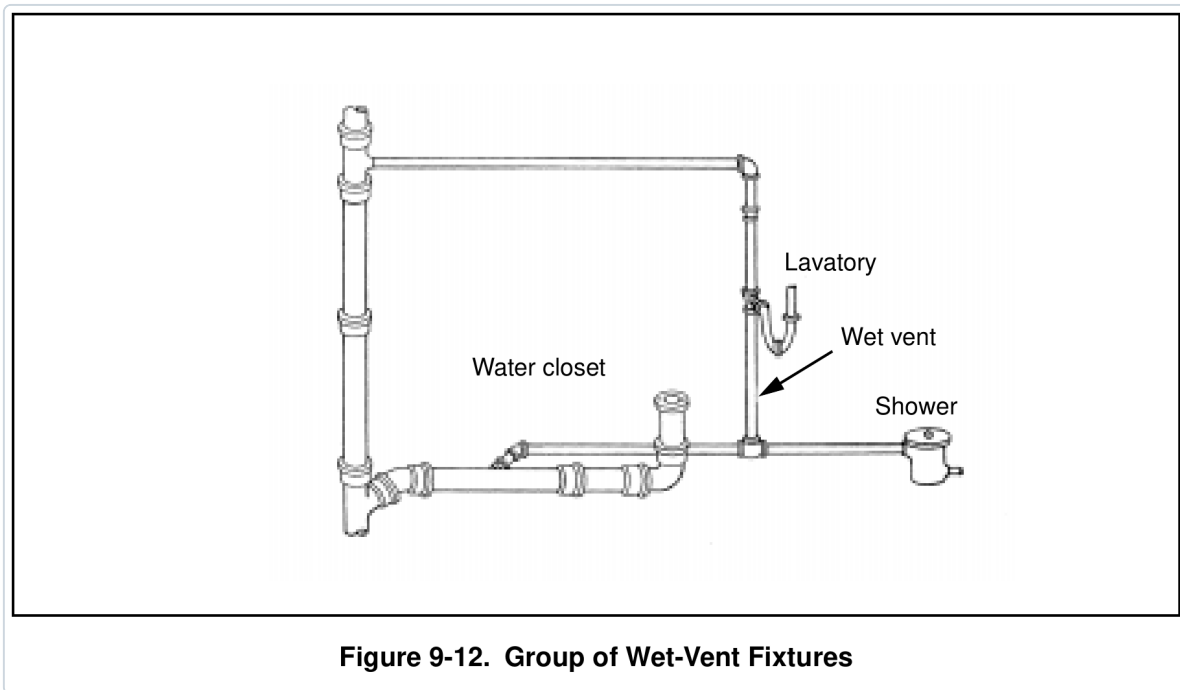
Gas water heater with the T&P relief valve on top and its discharge line run straight down the side of the tank to end 6 inches above the floor. Also labels the dip tube (shown as the siphon hole line), gas valve, burner, flue, and drain valve.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 5-4 Gas Water Heater by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

Road 2: The drain side (DWV: drain, waste, and vent)

Nothing pushes the water on this road. It only rolls downhill. So every drain pipe must slope, usually 1/4 inch of drop for every foot of run. The pipes are big, 1 1/2 to 4 inches, because they only run about half full and need room for air to move along with the water.

Plumbers call this whole system DWV, which stands for drain, waste, and vent. Drain pipes carry water from sinks and tubs. Waste pipes carry toilet discharge. Vent pipes carry air. All three connect into one system.

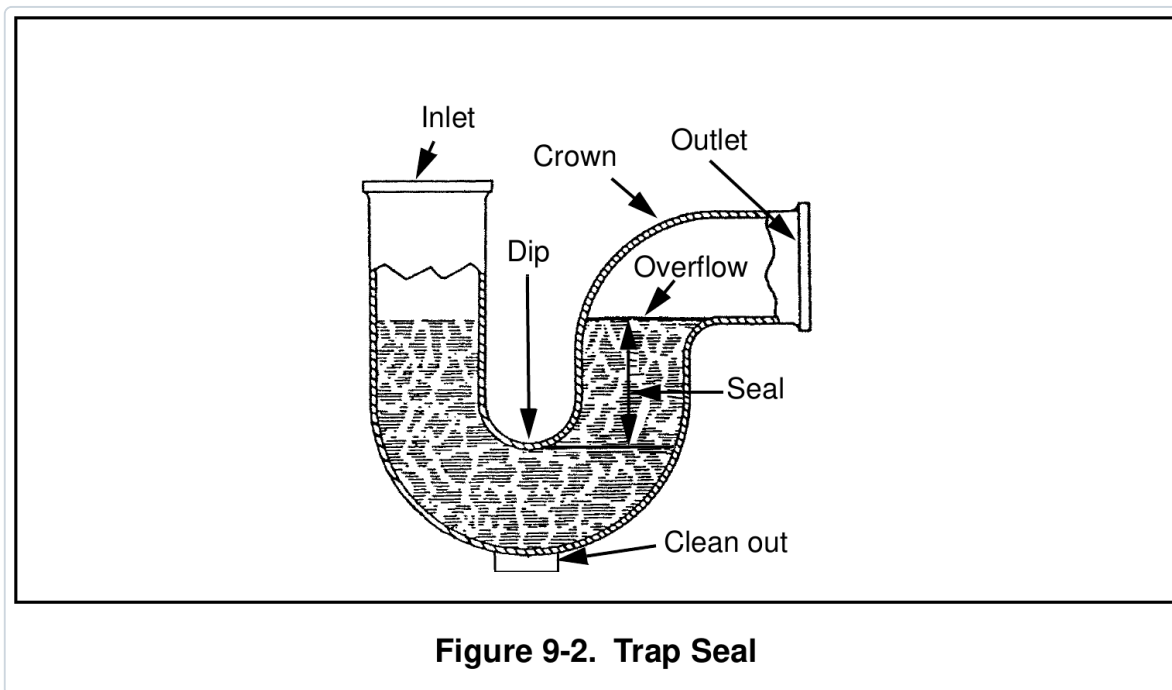


One bathroom group (water closet, lavatory, shower) draining to a stack. The lavatory drain doubles as the wet vent for the shower, and the vent rises and ties back into the stack above the fixtures. Isometric line drawing from the Army plumbing manual.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 9-12 Group of Wet-Vent Fixtures by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

The path, in order

1. **Fixture drain.** The hole in the bottom of the sink or tub.
2. **P-trap.** The U-shaped bend under every sink and tub. It always stays full of water, and that plug of water blocks sewer gas from coming back up into the room. Toilets have the trap built into the bowl, which is why you can see standing water in the bowl.
3. **Trap arm** runs from the trap over to the wall.
4. **Branch drain** inside the wall carries the water to the stack.
5. **Vent.** Every trap needs a pipe that goes up to open air through the roof. Without air coming in behind the water, the drain gurgles and sucks the trap dry, the same way a straw holds liquid when you put your thumb on top. Vents tie together in the attic and poke out of the roof as the **vent stack**.
6. **Soil stack.** The big vertical 3 or 4 inch pipe that toilets drain into. It runs from the roof vent all the way down to the basement or crawlspace.
7. **Building drain.** The horizontal pipe under the slab or in the crawlspace that collects everything from all the stacks.
8. **Cleanouts.** Capped openings, usually with a square-nut plug, where a plumber can run a snake. There is one at the base of each stack and one where the pipe leaves the house.
9. **Building sewer.** The 4 inch line from the house to the city sewer or the septic tank.



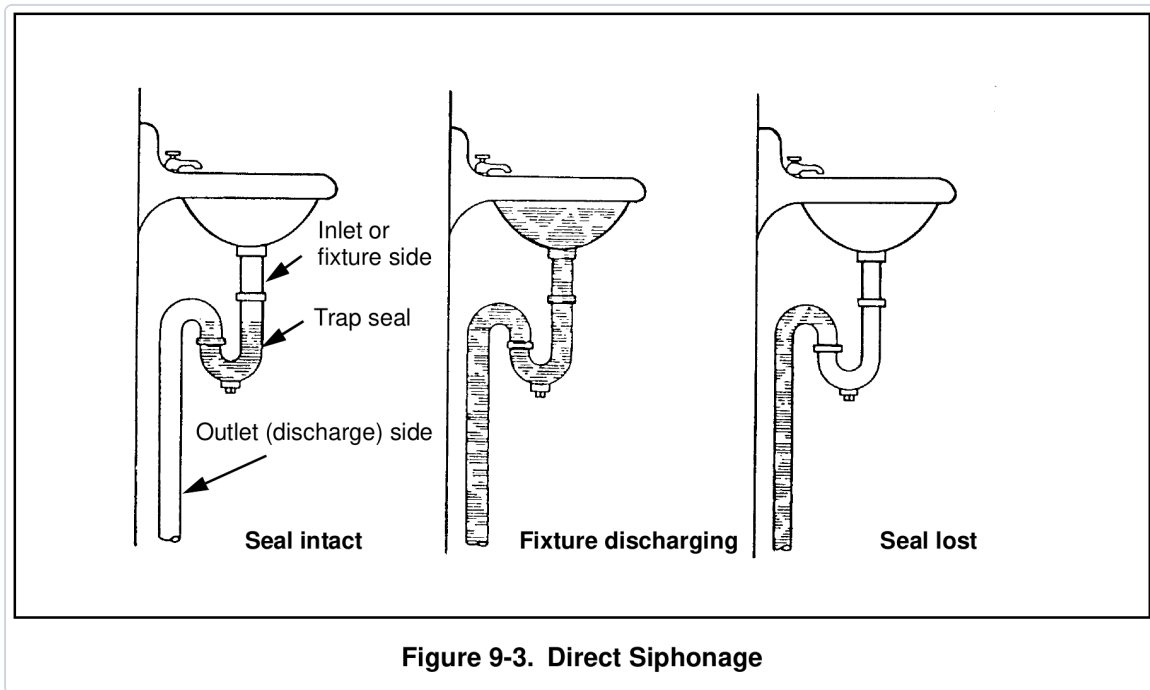
Cross-section of a P-trap with the parts named: inlet, dip, crown, outlet, overflow level, and the water seal between the dip and the overflow that blocks sewer gas.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 9-2 Trap Seal by US Army (Headquarters, Department of the Army), Public domain (US federal government work).

Why the trap works and why it can fail

The water sitting in the bottom of the P-trap is called the trap seal. Sewer gas cannot pass through water, so the seal keeps the smell on the sewer side. Two things break the seal. The first is evaporation, which happens in a floor drain or guest bath that goes unused for months. The second is siphoning, which happens when a slug of water rushes down an unvented drain and pulls the trap water along behind it. A properly placed vent lets air in behind the water so the trap stays full.

An old-style S-trap drops straight down after the U instead of going sideways to a vented wall. It siphons itself nearly every time it drains. Plumbing codes stopped allowing S-traps decades ago, but an apprentice will still find them in old houses.



Trap siphonage with no vent, in three frames: seal intact, fixture discharging and filling the drain, then the seal pulled out of the trap by suction. This is why every trap needs a vent.

Photo: FM 3-34.471 Plumbing, Pipe Fitting, and Sewerage (2001), Figure 9-3 Direct Siphonage by US Army (Headquarters, Department of the Army), Public domain (US federal government work).



Sanitary vent pipe terminating above a flat gravel roof, with the flashing collar at the roof surface and a goose-neck cap on top. Flat-roof version from Austria; it does not show a shingle-roof rubber boot, so point out that the collar does the same job as a boot.

Photo: File:Bregenz-sanitary roof ventilation (pressure equalization)-flat roof-01ASD.jpg by Asumnupal, CC BY-SA 4.0.

Materials an apprentice will meet

Both roads use several different pipe materials depending on the age of the house and what the plumber who built it preferred. Module P02 covers each one in detail. Here is the quick map.

Material	Where it is used	How you join it
PEX (flexible plastic, red/blue/white)	Supply lines in almost all new houses	Crimp rings, cinch clamps, or expansion rings. Push-fit for repairs.
Copper (type L in walls, type M some places, type K underground)	Supply lines in older houses, water heater connections, stub-outs	Solder with a torch, press fittings, or compression.
CPVC (cream-colored plastic)	Supply lines in some tract houses, mostly 1990s to 2010s	Solvent cement, same idea as PVC but a different glue.
PVC (white, schedule 40)	Drains and vents, nearly all new houses	Purple primer, then solvent cement. Push it in and give a quarter turn.
ABS (black plastic)	Drains and vents, mostly western states and older work	One-step black cement, no primer.
Cast iron	Drains in older houses, still used in some commercial for quiet	No-hub couplings with stainless bands, or old lead-and-oakum joints you only cut out.
Galvanized steel	Old supply lines, 1960s and earlier	Threaded. You see it when you tear it out. It rusts shut from the inside.
Brass	Valves, fittings, nipples, stop valves	Threaded with pipe dope or Teflon tape.
Flexible connectors	Water heater, supply tubes, gas appliances	Compression nuts or threaded unions.

How the two roads fit together

Supply is small pipe, pressurized, running any direction, mostly PEX or copper. It gets tested by pumping it to around 100 psi and watching a gauge for 15 minutes. Drain is big pipe, gravity only, always sloped, mostly PVC. It gets tested by plugging the bottom and filling the whole system with water to the top of the roof vent, or by pumping in 5 psi of air.

The two roads meet at every fixture and nowhere else. Clean water comes out of the faucet, falls into the sink, and becomes drain water the moment it hits the bowl. A plumber keeps the two systems apart on purpose. A faucet spout sits above the rim of the sink so dirty water can never be pulled back into the supply. A dishwasher drain hose loops up high under the counter for the same reason. These separations are called air gaps and backflow protection, and the inspector checks for them.

The vent is the part beginners forget. Every single trap has to have a path to the roof, or the fixture will burp and smell. When a drain gurgles after it empties, the first question is always "where is the vent?"

What the apprentice should be able to do after this module

Walk into a house and point to the main shutoff, the PRV if there is one, the water heater and its T&P valve, and the expansion tank. Find the main cleanout. Look under a sink and name the trap, the trap arm, the stop valves, and the supply tubes. Look at any pipe in a crawlspace and say whether it is on the supply road or the drain road, and why.

Check yourself

1. Which road uses pressure and which road uses gravity?
2. Why can supply pipes be small while drain pipes have to be big?
3. What does the water in a P-trap do, and what two things can make it disappear?
4. Why does every drain need a vent?
5. What does a PRV do, and why does a house with a PRV also need an expansion tank?
6. Name the eight things on the supply path from the street to a faucet, in order.
7. Name the nine things on the drain path from a sink to the city sewer, in order.
8. Where would you look first for a cleanout?

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