# CHAPTER 7: MAINTANANCE OF PLUMBING SYSTEMS

**Unit of learning code**: **CON/CU/PL/CR/07/5/A**

**Related unit of competency in occupational standard:** Maintain plumbing systems

## 7.1 Introduction to the unit of learning

This unit specifies the competencies required to maintain plumbing systems. It involves detecting faults in plumbing systems, quantifying requirements for repair, fixing plumbing system faults and testing plumbing system.

## 7.2 Summary of Learning Outcomes

1. Detect plumbing systems faults
2. Quantify requirements for repair
3. Fixing plumbing system faults
4. Test plumbing system



### 7.2.1 Learning outcome 1: Detect plumbing systems faults

#### 7.2.1.1 Introduction to the learning outcome

This learning outcome specifies the content of competencies required to detect plumbing systems faults. It includes definition of terms and concepts, common faults in plumbing works, causes of faults in plumbing works and ways of rectifying faults in plumbing works

#### 7.2.1.2 Performance Standard

1. Faults in plumbing systems are detected based on functionality
2. Possible causes of the plumbing faults are classified based on routine maintenance reports, design purpose, manufacturer's manual and best practice.
3. Solution for the fault is identified based on best practice.

#### 7.2.1.3 Information Sheet

A plumbing system refers to a system of pipework and fittings so connected for the purpose of supplying cold water, hot water, gas and discharge of waste or used water. In

some instances the system may develop faults that will need to be rectified. It will be necessary for one to understand and troubleshoot the fault and fix the fault

## TERMS AND CONCEPTS

- O-ring: This is a small rubber ring that goes on the stem screw. It helps to hold the handle in place.
- Aerator: This is the mesh filter at the end of the spigot.
- Refill tube: is the component that replenishes the water within the tank.
- Flapper: a round rubber seal that stops water from draining from the tank and into the toilet bowl.
- Flapper chains: This chain is the component that pulls open the flush valve and allows fresh water into the tank as used water is flushed out.
- Float valve: This is a small ball that sinks down when the tank empties with a flush, opening up the inlet valve on the fill tube
- Heating Mechanism: Device used to heat the water within the storage tank. Electric tanks use two electrically powered internal heating elements. Gas heaters use a burner beneath the tank and have a flue system that allows exhaust to travel through the center of the tank (heating the water as it passes) before being vented outside.
- Thermostat: Measures and maintains the water temperature by calling for heat, when necessary. Using the thermostat, the temperature can be adjusted by the user.

## COMMON FAULTS IN PLUMBING WORKS

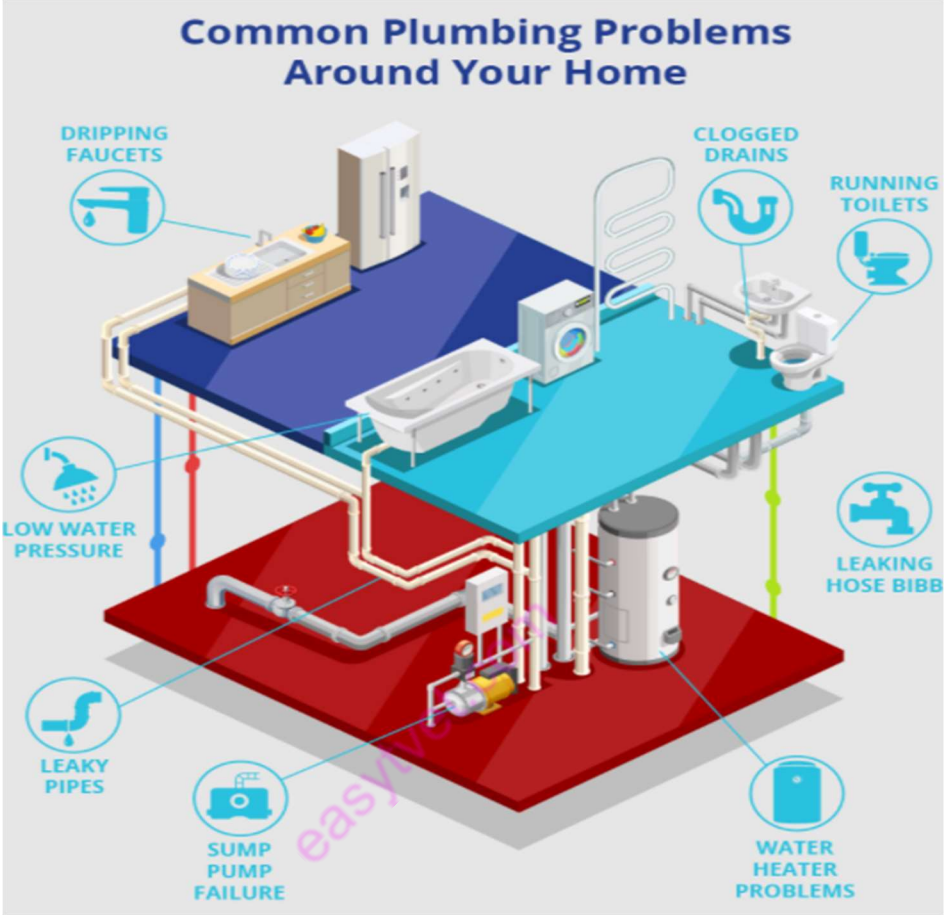



**Figure 194** ***common faults in plumbing***

1. Dripping faucets

Some issues that might affect the performance of faucet include: leaks, squeaks and other problems.

2. Leaky pipes

Leaky pipes can be more than just a nuisance, they can cause damage to floors, walls, and furniture, and the dampness can encourage mold to grow as well as attracts bugs. Leaks almost always happen at the pipe joints.

3. Running toilet

A constantly running toilet is generally an indication that one or more internal components of the toilet tank has malfunctioned.

It includes problems like a slow-filling toilet, a toilet that leaks or is noisy or won't flush.

4. Low water pressure

A low water pressure indicates an issue in distribution. If it’s only occurring at one location, it’s usually an issue in the faucet aerator which is usually an easy fix. But if the water pressure is low in several spots around a home, that’s a sign of a bigger problem

5. Slow or clogged drains

Clogged drains are identified when water backs up when emptying a sink or taking a shower.

The kitchen sink drain may contain things like congealed fat and food remnants which may cause a foul smell as well.

In a bathroom sink, bath or shower, the blockage is more likely to be caused by knotted hair and soap scum. Instead of flushing normally, the water backs up in the toilet bowl and may even overflow.



6. Sump pump failure

Installed inside a covered basin in the basement floor, sump pumps tend not to get much attention until they fail. When the basin overflows with infiltrating groundwater that didn’t get properly pumped out, or a water pipe ruptures.

7. Water heater problems

Water heater failure can cause significant damage to the home.

8. Leaking hose bib

9. Sewer system backup

Sewer system backups are smelly, nasty, inconvenient, and can be expensive to fix. If multiple drains and toilets not working and presence of a bad odor of human waste, this is likely the problem.

## CAUSES OF FAULTS IN PLUMBING WORKS

1. Dripping faucets

   Dripping faucets are annoying, wasteful, and costly. Sometimes, these drips can be caused by:

   - A worn-out washer or O-ring: Over time, an O-ring gets worn out as the handle gets pushed and pulled and at some point, a leak starts at the base of the handle.

   - Improper faucet installation: If a washer was installed and wasn't the correct size, without a perfect seat, friction loosens the washer and lets water through.

   - Old Cartridge: Mineral deposits also clog up the aerator with time and as it clogs, stress is placed on the seals and gaskets.



2. Leaky pipes

   They can be caused by all sorts of problems, including:

   - Stubborn clogs: When a clog goes untreated, pressure can build up behind it. This pressure can be too much for a pipe, causing it to crack or break.

   - Incorrect pipe laying: When it comes to laying pipes, the job should be done by a licensed professional. Pipes and connectors have to be laid correctly. Backflow devices should be used as necessary. If not, leaks may develop.

   - Pipe corrosion: When corrosion occurs, the pipe weakens and begins to break down. This can eventually result in a leak.

- Pipe joint damage: The joints are typically the weakest areas of pipes. They are the curved parts of the pipes that cause the water to change direction. In some cases, the joints can weaken over time, which can then allow a leak to form.

- Cracked seals or cracked pipes: Anywhere pipes connect to faucets or other fixtures, rubber seals should have been placed around them. Over time rubber seals wear out, get damaged and break. When the seals are damaged or broken, this breaks the watertight seal and as a result, water can get out.

- Excessive water pressure: Water going through pipes at high speeds increases the risk of pipes bursting. The sudden changes to the direction of water flow can be too much for pipes to bear, eventually resulting in leaks.

- Temperature changes: Temperature fluctuations can cause your pipes to expand or contract. When these fluctuations occur rapidly, expansion and contraction can damage the pipes. If the damage leads to the formation of a crack, then a leak can develop.



3. Running toilet

The issues that cause running toilets include:

- Refill tube problems: The refill tube of the toilet is the component that replenishes the water within the tank. The top of this tube should always remain above water level. However, if it doesn't, intermittent running may occur.

- Worn out flapper seals or flush valves: This component can age to the point of malfunction, or it can develop mineral deposits and/or wear down. All of these can prevent it from properly sealing.

- Improperly sized flapper chains: If the chain is either too long or too short, then it may interfere with the ability of the flush valve to properly close.
- Problems with the float valve: When the tank is filling, the float ball rises, which closes the valve and stops the filling process. If the float ball is misaligned or

malfunctioning in any way, it might not allow the valve to close completely and the water will continue to run.

4. Low water pressure

Low water pressure is a symptom plumbing problems like:

- Too much demand on water: In some homes, having multiple plumbing fixtures on at once can place too high of a demand on the water supply for proper water pressure to be maintained in every fixture.

- Pipe corrosion: When corrosion ultimately occurs, it leads to a buildup of rust. Eventually, this will cause a deterioration of water pressure, until they become blocked entirely.

- Hidden water leaks in your home: A slow leak can lead to a slow water pressure.

- Clogged pipes: If pipes become clogged, these blockages can disrupt water flow through your pipes. With the flow disrupted, water pressure will also go down.

- Cracked or blocked sewer lines



5. Slow or clogged drains

The most common causes of blocked drains are:

- **Unknown objects**: The problem of blocked drains occurs when foreign materials such as soap, hair, food, and fats build up between the drain-pipe and other pipes that flow at the bottom.

- **Heavy storms and rain**: After heavy rain or storms, drains present outdoors are blocked by the leaves, and dirt, etc. that cause the drains to block.

- **Damaged Pipes**: Another major cause of blocked drains is a broken pipe. For water to flow freely, it needs a perfect pipe, or else it may collapse. The main reasons for this are the poor installation of pipes, and tree roots. Tree roots cause high damage underground and might be difficult to investigate where the blockage is.

- **Water flow problems**: It is obvious that drainage is all about gravity. Inadequate falls will develop a regular build-up of dirt and debris leading to obstruction in your pipes.

6. Sump pump failure

Sump pump failures can be related to a problem with the unit or an external issue. Usually, the causes of sump pump failures include:

- Stuck switches: Sump pumps rely on the switch and the float arm in order to operate effectively, and when one of these fails it compromises the entire system.

- An overwhelming amount of water, like after heavy rain: With an excessive influx of water, flooding or heavy rains, the sump pump might not be able to deal with the high amount of water, especially if it's not powerful enough.

- Clogged discharge pipes: If the discharge line is clogged, water will flow back down the pipe.

- Improper sump pump installation: If the manufacturer's instructions are not followed carefully, water damage could result in the future. Improper installation could include anything from installing your pump on the wrong surface, to failing to install a check valve, to not drilling an air relief hole.

- Power failure: The most common cause for sump pump failure is an electrical power outage.

- Aging, with sump pumps around 10 years old being prone to failure

7. Water heater problems

Usually, water heater problems are caused by issues like:

- Heating element failures
  - Water is cold: Cold water is usually caused by either a lack of power, a faulty thermostat or a faulty heating element.

- Water is warm, but not hot enough: If water isn't getting hot enough, the cause could be an undersized water heater, crossed hot and cold connections, or a faulty heating element or thermostat.
- Water is too hot: When water is running too hot, it usually means the thermostat is set too high.

- Corrosion or sediment buildup in systems: Scale and sediment result from repeatedly heating "hard water." If allowed to accumulate without routine cleaning, it can lead to the destruction of one or both of the heating elements.

- Loose or broken electrical connections
- Improper water heater installation
- The wrong size or type of system to support a home's needs

8. Leaking hose bib

It is mostly caused by change in temperature.

9. Sewer system backup

There are three common causes for a sewer system backup:

- Root intrusion: Trees can grow really long roots that intertwine with sewer lines. Roots can grow into a pipe and cause holes or crush the sewer line by growing around it.

- Clogs: Sewage can back up into your home when either your home's drain pipes or main sewer line becomes clogged. Clogs can consist of hair, grease, or other solid materials that end up in the drains.

- Flooding: Flood waters overwhelming the local sanitary sewage system, if the system merges with stormwater drainage, can reduce the flow rate. Slower drainage can make wastewater back up into your home.
- Pipe misalignment.

RECTIFYING FAULTS IN PLUMBING WORKS

## Dripping faucets

There are four kinds of faucets: cartridge, compression, ceramic disk, and ball type. A compression faucet relies on rubber washers to seal the valve seat, which can wear out and need to be replaced.

If your faucet is dripping:

- Replace washer or O ring
- Replace old cartridge

## Faucet and cartridge

How to fix a leaky cartridge faucet

**Figure 195** ***Leaky faucet***

i. Pry off the decorative cap on the handle, remove the handle screw, tilt the handle back, and pull it off.
ii. If there's a threaded retaining clip holding the cartridge in place, use needle-nose pliers to remove it, then pull the cartridge straight up.
iii. Remove the spout and cut off the old O-rings using a utility knife. Coat the new O-rings with nontoxic, heat-proof plumber's grease.
iv. To replace the entire cartridge, match the length of the old cartridge with the length of the replacement. Also match the stem end where the handle attaches.

## Compression Faucet

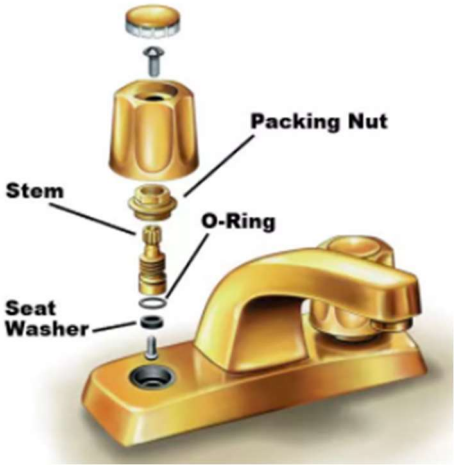



**Figure 196** ***Compression faucet***

How to fix a leaky compression faucet

i. Most leaky compression faucets need new seat washers. Use a small slotted screwdriver or utility knife to pry off the decorative cap on the handle, exposing the attachment screws.
ii. Use a screwdriver to remove the handle screw, then pull off the handle.
iii. Use a crescent wrench to unscrew the packing nut and an adjustable wrench to loosen the stem from the faucet body.
iv. Unscrew the rubber washer from the bottom end of the stem to remove and replace the seat washer.
v. Coat the washers with nontoxic, heat-proof plumber's grease.
vi. Pop the stem out of the packing nut and replace the O-ring, the culprit for leaky handles. O-rings range in size from 3/8 to 5/8 inch, so it's crucial to match the exact size of your faucet. Coat the new O-ring with plumber's grease.
vii. The washer sits in a round, recessed disk called a retainer. If the original retainer is damaged, grind it flush and install a replacement retainer ring. If your faucet continues to leak, the seat may be pitted.
viii. Remove the stem and sand the top end of the seat with emery cloth to smooth it out.
ix. If you can't repair the original seat, replace it with a new one

**Ceramic-disk Faucet**

How to fix a leaky ceramic disk faucet

**Leaky ceramic faucet**

i. Push the handle back to access the set screw. Remove the screw and lift off the handle.
ii. Remove the escutcheon cap, unscrew the disk cylinder mounting screws, and lift out the cylinder.
iii. With a blunt screwdriver, lift out the neoprene seals from the cylinder. If the seals are damaged, replace them.
iv. Use distilled white vinegar and a soft scouring pad to clean the cylinder openings, then rinse them thoroughly.
v. Replace the seals and reassemble the faucet.
vi. Move the handle to the "on" position and turn the water back on slowly—the force of the returning water can fracture the ceramic disk.
vii. If you're replacing the entire cylinder (usually not necessary), set it in place and secure it with the new mounting screws.



**Ball-type faucet**

How to fix a leaky faucet ball-type

This type of faucet contains a lot of parts, which often makes it difficult to find the cause of the leak.

**Ball-type faucet**

i. Use a pocketknife to pry off the small index cover from the side of the faucet and reveal the hex-head screw.
ii. Loosen the screw with a hex-key wrench and pull off the faucet handle.
iii. Use adjustable pliers to remove the cap and collar.
iv. Using the special tool included in the faucet-repair kit, loosen the faucet cam and lift it out, along with the cam washer and the rotating ball.
v. Reach into the faucet body with needle-nose pliers and remove the rubber seats and springs.
vi. Slip a new spring and rubber seat onto the tip of a pencil and lower it down into the faucet.
vii. Repeat to install the second seat and spring.
viii. Reinstall the stainless-steel ball, making sure to align its keyway with the corresponding tab inside the faucet body.
ix. On top of the stainless-steel ball, install a new rubber gasket and cam cap.
x. Align the keyway on the cap with the corresponding slot.
xi. Hand-tighten the top cap assembly back onto the faucet.
xii. Use a spanner wrench to tighten the nut to provide the proper tension against the stainless-steel ball.



**Leaky pipes**

How to seal a leaky pipe

- Tape - If a quick fix is needed, waterproof duct tape will be used. Make sure the pipe is bone-dry and apply the tape. Keep wrapping it tightly around the pipe until it is completely sealed.
- Epoxy paste - Cover the crack with epoxy paste and rubber. Wait for it to set and it should temporarily stop the leak.
- Self-tapping plugs - These are plugs that can be inserted into the hole of a pipe and they will expand to fit them.

Whichever temporary fix used, leave it for at least an hour or two to give the repair time to set.

How to fix a copper pipe leak at the joint

Threaded pipes and copper fittings are prone to leaks. To prevent future problems or repair a current leak, seal them with either Teflon tape i. e. plumber’s tape or a spray sealant for water leaks.

It needs to be wrapped around the pipe in the opposite direction of how the pipe turns into the fitting. The steps below should be followed on how to use plumber's tape correctly:

i. Clean the pipe with a clean rag
ii. Place the end of the pipe leak tape on the second thread from the end of the pipe and hold it in place
iii. Wrap the tape around the pipe in the opposite direction to the way the pipe turns into the fitting
iv. Make sure the pipe leak tape is wrapped tightly and overlap it as you go
v. Wrap it around 4-6 times
vi. Break the tape off and smooth down over your pipe
vii. Leave for an hour or two before turning the water back on

Replacement

Sometimes, a PVC pipe is too damaged for a simple repair. If this is the case, the damaged section will need to be replaced with a new PVC pipe. To replace the pipe, first, water to the pipe should be turned off.

i. Cut the pipe about one inch to the left and to the right of the damaged area using a ratchet cutter or hacksaw.
ii. Allow any excess water to come out of the pipe and dry with a clean cloth.
iii. Once the damaged pipe is cut away, dry-fit the replacement pipe in the hole, ensuring the pipe's fitting is properly secured around the existing PVC.
iv. Apply PVC primer solvent to the inside of the replacement pipe's fittings and to the outside of the existing pipe.
v. Then, apply glue to the existing, exposed PVC pipe and around the inside of the replacement fitting.
vi. Insert the existing pipe into the replacement fittings, using a twisting motion to secure the pipe with glue.
vii. Hold the pipe firmly for 10 seconds to ensure a strong bond.

**Running toilet**

A constantly running toilet, or a toilet that tops up its tank by itself, can stem from a variety of issues, including a faulty flapper, a high-water level, or a water-logged float. If none of these seem to be the problem, it probably has a broken valve.

How to fix a running toilet:

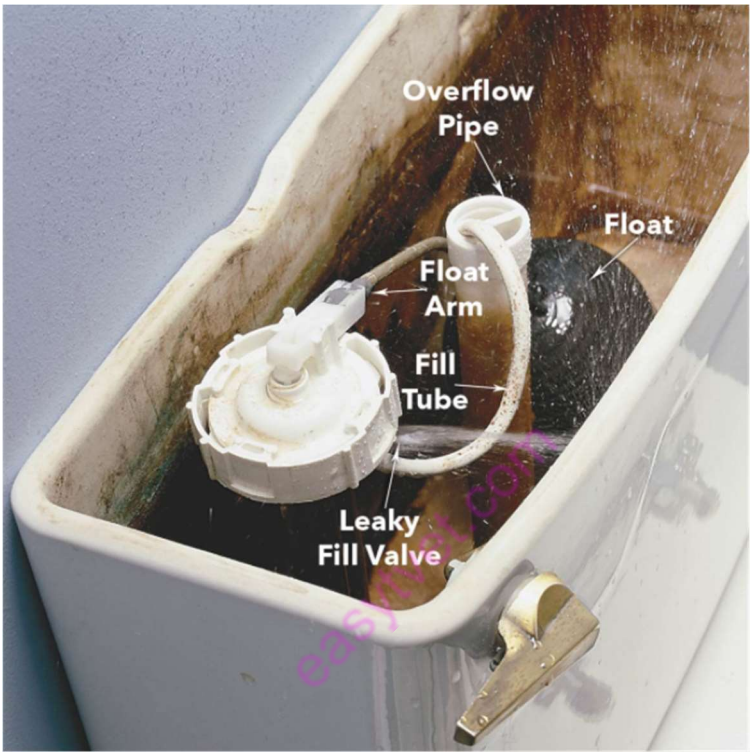
Test the flapper:
A toilet’s flapper is a plastic or rubber cap that keeps water in your tank. Over time, your flapper can become brittle and create a faulty seal.

- Push down on the flapper with a stick when you hear the water running and listen for it to stop.
- If it stops, you know the flapper isn't sealing properly. Replace it.
- Check the fill tube length and cut it back so it's at least 1/2-in. above the water line.
- To replace the flapper, first shut off the water supply valve under the toilet
- Flush the toilet to drain out most of the water, then unhook the old flapper.
- Buy a new flapper of the same type and install it according to the instructions on the package.
- Hook the flapper chain onto the flush lever arm so there’s a little slack when the flapper is closed.


**Test the flapper**

Check the fill valve for a leak

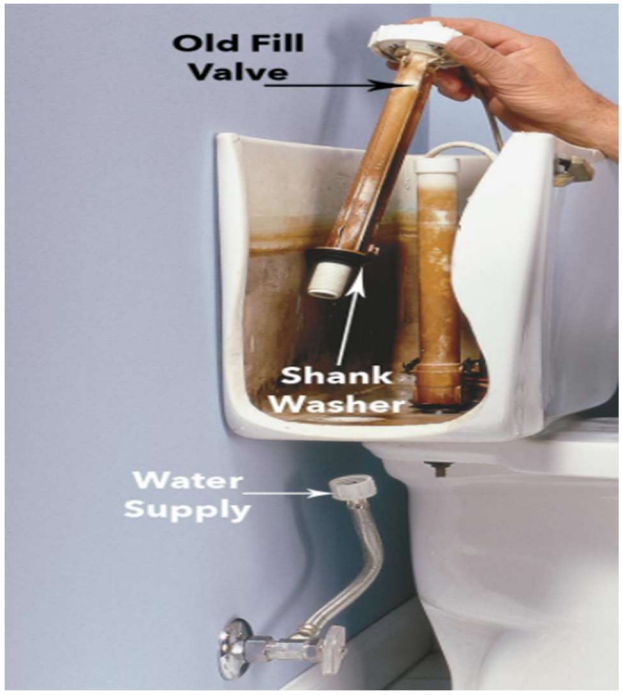
- Flush the toilet and look for a fill valve leak.
- Lift up on the toilet float arm when the tank is filling to see if the water stops.
- Bend or adjust the toilet float arm so the tank stops filling when the water level is 1/2- to one-inch below the top of the overflow pipe.
- If the fill valve still leaks, replace it.




**Check the fill valve**

Remove and replace old toilet fill valve

- Turn off the water supply, flush the toilet and sponge the remaining water from the tank.
- Disconnect the water supply line, unscrew the fill valve locknut and lift out the old fill valve.



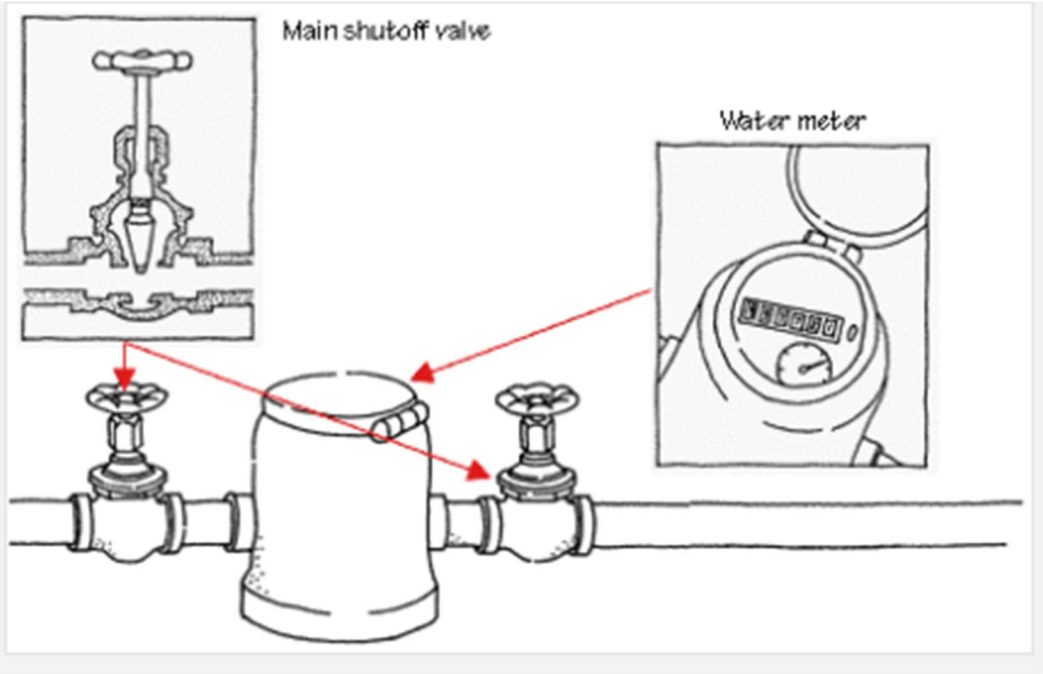

**replacing old toilet fill valve**



- Insert the new fill valve into the tank according to the instruction sheet and tighten the locknut a half turn past hand tight.

**Low water pressure**

- There should be a water shutoff valve next to the meter, in fact, there may be one on each side of the meter as shown below.




**meter**



Be sure the valves are entirely open turned counter clockwise as far as they will go. If you discover that a supply valve is partially closed, opening it should solve the problem.

- If low pressure is still being experienced, pipes need to be cleaned out or replaced to address the issue.

**Slow or clogged drains**

i. Most bathroom drain clogs result when dirt, skin flakes, and especially hair binds to soap scum on the walls of drain pipes. Over time, this gunk accumulates and reduces water flow.

Troubleshooting: Remove and clean the drain stopper. Use the humble drain plunger, keeping in mind to block the over-flow drain in the tub or sink. If that doesn't work, remove the drain elbow joint and clean it out. Clean drain stoppers routinely to prevent clogs and use a hair strainer drain-cover to trap hair before it goes down the drain.

ii. Clogged toilets mainly happen when people try flushing down items that do not dissolve or break apart in water.
Troubleshooting: The plunger is the first. The most effective plungers shoot jets of water to clear the drain pipe. Many have anti-microbial coatings. Next, use an inexpensive hand-powered drain auger. While not a pleasant experience, a hand auger can reach between 2 to 5 feet down the toilet's drain pipe to break-up or retrieve things that are blocking the pipe.

iii. Kitchen sink drains clog when cooking grease or oil cake onto drain pipe walls.
Troubleshooting 1: Start by running very hot water down the drain to soften the clog, followed by a dollop of dish detergent and then more hot water. Wait a few minutes, and then use a plunger and repeat the hot water. If you still have no luck, you might want to move onto a chemical drain opener. Again, use caution.

Troubleshoot 2: Take half a cup of baking soda and pour down the drain, and then pour half a cup of vinegar. After 15 minutes, flush out the drain with hot water

Add equal parts of salt, vinegar and baking soda. After one hour pour hot water into it

Add half a cup of salt and equal amount of baking soda, sprinkle it into the drain and then flush it with hot water.



iv. Drain pipe slope determines how well water carries waste to the sewer line. If there's too much slope, water can run too fast and leave waste material behind. Over time, the buildup forms a blockage. If the pipe slope doesn't have enough slope, then the water and waste pool in the pipe. Some waste will settle out and, again, form a blockage.
Troubleshooting: First, check that nothing is blocking the vent pipe opening on your roof. Sometimes birds or other animals build nests on top of un-enclosed vent pipes for warmth. Also check under sinks for gulp valves. Gulp valves are typically mounted at the end of a drain line and look like a plastic cap from a can of spray paint. The valve prevents sewer gas from escaping the drain line but lets air into the vent pipe when there's enough suction. If you fill the sink with water and then drain it out all at once, you should hear air getting sucked into the gulp valve. If not, the valve might need to be

replaced. Also, if there is a constant odour of raw sewage in your home, contact a professional plumbing service immediately.

**Sump pump failure**

Ensure that: Ooccasional checks are performed on the sump pump.
Proper sump pump installation is done

How to unclog a sump pump

i. Unplug the sump pump.
ii. Pick the sump pump up and turn it over to examine the impeller at the bottom of the pump. If there is nothing visibly lodged in the impeller, try spinning the impeller with a finger. If it moves freely, the impeller is not the problem.
iii. Replace the pump and plug it back in.
iv. Grasp the hose in one hand and activate the pump's switch manually by gently pulling up on the float with the other hand until the pump comes on.
v. Shake the hose vigorously while the pump is running. This should dislodge anything that is clogging the inside of the hose and water should start to run freely again.
vi. If water does not start running, remove the hose and lay it flat on the floor. Shine a flashlight in one end and see if you can see the light coming out the far end of the hose. If not, you can try cleaning the hose out with a broomstick. However, the easiest thing to do is to replace the hose.
vii. If the pump still seems to be clogged, something must be lodged inside the pump's chamber. Seek professional help.

**Water heater problems**

Condensation

A puddle on the floor may be the result of condensation that formed on the outside of the tank. Condensation occurs when most of the water inside the tank is cold. This can happen during periods when hot water usage in the home is especially high. The cold tank, reacting with the warmer air inside the home, causes condensation. The water then drips off the tank and onto the floor, which gives the appearance of a leaking tank.

Try to even out hot water demands in the household so that less than half the tank contains cold water at any given time.

## Pipes

A typical hot water heater connects to two pipes -- a cold water supply line and a hot water line. The pipes often have elbow joints so they can bend toward the water heater. Either of these water lines can leak, particularly at the joints. If water sprays from a fitting or pipe, the problem is clear. A dripping pipe or joint is less noticeable.

Tighten loose fitting joints to stop leaks. If this does not solve the leak, turn off the water supply and power supply, then disconnect the fittings. Allow the temperature on hot water lines to cool down before working on them. Wrap the threaded end of each fitting with plumber's tape, then reconnect the joints.

## Gaskets

Electric hot water heaters rely on one or two heating elements to warm the water. Because the elements project into the tank, they are sealed with gaskets to prevent leakage. Water may collect under the tank if the gaskets wear or become damaged to the point of leaking. Each element is behind a cover plate, but you must turn off electrical power to the water heater before examining the elements.



Move the insulation out of your way, and check all around the element gaskets for the presence of water, which indicates a drip. Drain the tank before removing and replacing elements and element gaskets.

## Pressure Relief Valve

Should pressure rise too high inside the tank, the relief valve opens. Steam escapes and the pressure returns to normal. Once inside the house, the steam quickly condensates and produces a puddle at the bottom of the tank. Too high an operating temperature is usually to blame for excessive tank pressure. Keep the hot water at about 120 degrees Fahrenheit to keep pressure in check and save on energy costs at the same time.

If pressures build often, especially after turning down the water heater's thermostat, a faulty pressure relief valve is the likely cause. Have a professional plumbing professional replace the valve. A faulty pressure relief valve is a potentially dangerous situation and must be addressed immediately.

Tank

Once the tank itself starts to leak water, and you are certain there is no other cause for the leakage, it’s time to replace the water heater. The inside of the tank eventually corrodes from mineral deposits and from the constant strain of heating and cooling. There is no way to repair a leaking tank.

**Leaking hose bibb**

Fixing a leaky hose bib almost always involves one (or both) of two things:

- Replacing the compression washer at the end of the inner valve stem. This will allow the stem to fully close down against the valve seat, keeping the hose bib from constantly dripping.
- Replacing the packing string that is wrapped around the valve stem under the packing nut. This will prevent water from seeping up around the handle each time you use the faucet.

**leaking hose bibb**

It's generally easiest to address both possible causes of leaking when servicing a hose bib the stem washer and the handle packing string.

1. Shut Off the Water

Begin by shutting off the water to the hose bib.

2. Remove the Handle

Use a screwdriver to remove the screw that holds the handle of the hose bib to the valve stem, then pull the handle off a bit of wiggling may be required. Carefully set the handle and screw aside.

3. Unscrew the Packing Nut

Next, use a channel-lock pliers or adjustable wrench to unscrew the packing nut (sometimes called a bonnet nut) that secures the valve stem to the faucet body.

4. Remove the Valve Stem

Remove the valve stem from the faucet body. Usually this involves unscrewing the stem from the threaded body of the faucet

Inspect the rubber or neoprene washer at the end of the valve stem. If it is hardened, cracked, or deformed, this is very likely the cause of your leaky faucet. Unscrew the brass screw holding the washer in place on the stem. Brass is a soft metal, so use care when unscrewing it. If the screw gets damaged, you may need to replace it washer kits often come with replacement screws.

Choose an exact replacement for the old washer and attach it to the end of the valve stem with a screw.

5. Replace the Packing String

Unwrap the old graphite or Teflon packing string from around the valve stem beneath the packing nut, then wrap several loops of new strong around the stem in a clockwise direction .



6. Reassemble the Faucet

Thread the valve stem back into the body of the faucet, then thread the packing nut onto the top of the faucet. Tighten the packing nut slightly with a wrench, then put the faucet handle back onto the stem and check the operation of the faucet. Tightening the packing nut too much may make the handle hard to turn. The handle should turn freely, and you should be able to feel the washer compress down against the valve seat inside the faucet.

7. Test the Faucet

Turn the water back on and check the operation of the faucet, inspecting for leaks. If you experience any leaking around the handle, slightly tighten the packing nut a little further.

**Sewer system backup**

How to rectify a sewage backup

- Install a new plastic pipe or cut tree roots. To prevent tree roots from damaging a sewer line, replace it with a new plastic pipe. If tree roots still grow in the sewer, cut the roots occasionally.
- Install a backwater prevention valve. This fixture allows sewage to leave but prevents it from backing up into your home. Backwater valves are typically installed into a sewer line and sometimes into a drain line in the basement.
- Sewage pump maintenance. Ensure the sump pump is constantly checked.

#### 7.2.1.4 Learning Activities

**Activity:**

**Clogged drain and toilet.**

- A toilet suddenly shows immediate signs of a clog. Instead of flushing normally, the water backs up in the toilet bowl and even overflows.
- You are expected to clear the blockage to restore the drains or toilet back to normal.



#### 7.2.1.5 Self-Assessment

1. **What tools are required to unclog a sink?**
2. What is the home remedies to clear clogged drain?
3. Explain what is the common reason for sump pump failure?
4. Explain how you can fix a leaky PVC water pipe?
5. **What is referred as building drain?**
6. What is meant by air lock?
7. How can one avoid low water pressure?
8. A client has an old brass faucet in their bathroom that they want to keep, but it constantly drips hot water from its spout. They have replaced the washer in the hot water faucet, but the spout still drips. How can the faucet be repaired so as it stops wasting the hot water?
9. Why would the water bill of a client be extremely high?

10. Is it safe to use chemical drain cleaners?

### 7.2.1.6 Tools, Equipment, Supplies and Materials

**Functional Plumbing Workshop with the following:**

**Tools and Equipment**

- Pipe wrench
- Pipe cutter
- Hacksaw
- Pipe Threading Equipment
- Vices
- Taps
- Punch
- Files
- Screwdrivers
- Drill with various sizes of bits
- Portable drill
- Mallet
- Ball pein hammer
- Mason chisel
- PPR machine / Heat Fusion equipment
- Pipe bender
- Trowel
- De-clogging wire / de-clogging machine
- Toilet pump



**Supplies and Materials**

- Screws
- Adhesives
- Cement
- Sand
- Pipes
- Traps
- Electric cables
- Caulking material
- Fitting
-

### 7.2.1.7 References

C.J. Smith., B. Curry., Practical Plumbing (The Motivate series).,1998

F. Hall., Plumbing Technology

Black & Decker., The Complete Guide to Plumbing.,2008

**Model Answers**

1. What tools are required to unclog a sink?
    - Cup Plunger
    - Duct tape or wash cloth
    - Sink Auger
    - Channeled type pliers
    - Bucket

2. What is the home remedies to clear clogged drain?

    - Take half a cup of baking soda and pour down the drain, and then pour half a cup of vinegar. After 15 minutes, flush out the drain with hot water
    - Add equal parts of salt, vinegar and baking soda. After one hour pour hot water into it
    - Add half a cup of salt and equal amount of baking soda, sprinkle it into the drain and then flush it with hot water



3. Explain what is the common reason for sump pump failure?
   Sump pump is usually used in the basement area to remove the accumulated water during flood. Moreover, there are few reason it may stop working all of sudden.

   Switching problem
   Accumulation of excess debris, interfering with the switching
   The pump can move inside the basin, and that may interfere with the switching mechanism

4. Explain how you can fix a leaky PVC water pipe?
    i. Drain the water out and make the leakage pipe dry
    ii. Now take a coupling, similar to the size of the pipe that is leaking
    iii. Now cut the coupling into half
    iv. Make sure that the half you going to use should have stop inside, as you have to slide the leakage pipe into it
    v. Slather the inside of the patch with adhesive, make sure that you have enough of the adhesive on your patch, as that is the portion that going to connect with the leaked pipe.

vi. Place the patch onto the pipe and slide it into place and keep it overnight to get dry

5. What is referred as building drain?

The lowest point in a drainage system where the interior drainage pipe meet and are conveyed into the sewer is referred as Building Drain.

6. What is meant by air lock?

The confining of air between two traps. Air lock may occur both on the drainage and on the hot and cold-water supply system.

7. How can one avoid low water pressure?
    - Install a filtration system to keep minerals out of your pipes to avoid future build-up.
    - Check pipes regularly to find and repair leaks early.

8. A client has an old brass faucet in their bathroom that they want to keep, but it constantly drips hot water from its spout. They have replaced the washer in the hot water faucet, but the spout still drips. How can the faucet be repaired so as it stops wasting the hot water?



A spout leak in a compression faucet is caused either by a defective seat washer or a damaged valve seat. They can replace most valve seats with exact duplicates, using a valve seat wrench. If a worn valve seat can't be removed, use a valve seat dresser to grind it until smooth.

9. Why would the water bill of a client be extremely high?

A ridiculously high-water bill can be as a result of any of the following factors:

- Leaky taps or faucets

This is the most common cause of increase rate in water bills - a dripping faucet wastes water and causes an increase in the utility bill.

- Leaking toilets

Toilets account for 24% of the water used daily. It has been estimated that a leaking toilet can waste up to 200 gallons of water daily.

- Inefficient fixtures

Outdated plumbing works are the causes of leaks and other plumbing problems. If you are experiencing a hike in water bills, it may be time to have the outdated plumbing works replaced.

- Leaky Line

An increase in water bills can be caused when the underground water pipes in your home are leaking or loose. These can be caused by tree roots activity, animal activity, or even earthquakes.

- Water Waste

The water bills may be high because water is used recklessly.

10. Is it safe to use chemical drain cleaners?

Drain cleaners are usually very toxic, not a good thing to keep around the home especially if you have children or pets. These toxic chemicals also have a negative effect on your pipes, causing deterioration from the inside out. When this happens, the drains lines will need to be replaced. There are various products on the market that contain "friendly" bacteria and enzymes. These work great for keeping drain sludge and grease from building up on the pipes. For serious clogs contact a professional plumber.



### 7.2.2 Learning Outcome 2: Quantify requirements for repair.

#### 7.2.2.1 Introduction to the learning outcome

This learning outcome specifies the content of competencies required to Quantify requirements for repair. It includes, definition of terms and concepts, materials and supplies for repair, estimation of quantities, appliance and fittings and reference to manufacturer's manual.

#### 7.2.2.2 Performance Standard

1. Appliances and fittings that need replacement are identified based on the requirements of the job.
2. Materials required for plumbing fault repair are identified based on requirements of the job.
3. Supplies required for plumbing fault repair are identified based on requirements of the job.
4. Materials and supplies required are quantified and costed based on specifications

#### 7.2.2.3 Information Sheet

**Terms and concepts**

Pipe fitting: It is used in the plumbing system to join multiple pipes of same size or different sizes, to regulate the flow or to measure the flow.

## Materials and supplies for repair

### Adhesives

Keeping seals tight and waterproof is essential, from bathroom and plumbing applications to aquariums. Plumbing sealants prevent water damage and help keep fixtures, sinks, and faucets working for a long time.

What are plumbing silicone sealants?
Silicone sealants are a form of liquid adhesive commonly used in building, bonding, and repairing many materials, including finishing joints and filling seams or other gaps. Since they are waterproof and offer durable elasticity and stability in both high and low temperatures, silicone sealants work particularly well as plumbing sealants.

Plumbing silicone sealants are typically available in tubes and cartridges. Because of their many practical uses and easy, tidy application, silicone sealants can be a good alternative to putty for sealing bonds around plumbing fixtures. Other uses include the undersides of sink strainers or pop-up drain fittings for sinks and tubs.



APPLYING A PLUMBING SILICONE SEALANT
Applying plumbing silicone sealant is an easy process, but doing it properly is critical to ensure a durable, waterproof seal.

i. Clean the surface. Make sure that the surface is completely clean and dry. Any dust, dirt, or particles can potentially cause a weaker seal.
ii. Using the sealant cartridge. Load the cartridge into a sealant gun. Use a hobby knife to cut off the cartridge seal and open the applicator nozzle, just enough to allow a narrow line of sealant. Pull the handle to fill the nozzle with sealant.
iii. Apply the sealant. Hold the gun at a 45-degree angle. Squeeze the trigger carefully to create an even, steady flow of sealant, dragging the tube nozzle slowly along the target seam. For an even seal, wet your finger with soapy water and spread the applied sealant evenly along the seam, clearing away any excess or residue as you go.
iv. Curing. Silicone sealants must cure before achieving full bond strength. Curing silicone doesn't require any special steps, just a bit of patience. Curing can take from 24 hours to several days (check your product's instructions).

### Pipes

Pipes must not contaminate water, and must be suitable for the pressure, flow and temperature of the water they are carrying.

Factors to consider
Pipe materials and components must not contaminate potable water. They must also be:

- suitable for the expected temperatures and pressures
- compatible with the water supply, to minimize the potential for electrolytic corrosion
- suitable for the ground conditions (if used underground) to minimize the potential for corrosion of the exterior of the pipe
- suitable for the local climate (if used outdoors) such as freezing conditions or atmospheric salt or Sulphur
- able to withstand UV effects (if used outdoors).

### 1. Copper

Copper has long been used for all types of domestic water services and distribution because it:

- is durable
- has good corrosion resistance
- is malleable and easy to bend
- is self-supporting
- has good flow characteristics
- requires few fittings
- can be recycled.



Copper may be annealed (i.e., heated, then cooled slowly) which improves its properties, for example making it less brittle and stronger.
Although copper in general has good corrosion resistance, this depends on the environment. Acidic conditions, either from the soil (if buried) or from the water, can cause corrosion, so local pH levels should be checked before using copper pipes.

### 2. Polybutylene (PB)

Polybutylene is a plastic material that was introduced in the late 1970s and used extensively for water supply pipes until the mid-1990s. Unfortunately, one brand of polybutylene gained a reputation for failure, resulting in a significant drop in use.

Polybutylene has excellent properties for use as water supply pipework, including:

- low cost

- flexibility
- ease of installation
- ability to be used for both hot and cold-water services
- frost resistance.

In outdoor situations, it must be protected from UV exposure.

### 3. Polyethylene

High density polyethylene (often called alkathene or polythene) has been used since the early 1960s. It is suitable for both potable water and wastewater services but it can only be used for cold water supply.

It is the most commonly used plastic pipe for supplying the mains water to a dwelling.

Polyethylene:

- is durable
- is corrosion resistant
- has good flow characteristics
- is lightweight and flexible
- is easy to install
- has a good bending radius
- is inexpensive
- requires few fittings.



### 4. Polypropylene (PP)

There are three types of polypropylene:

- P-H has good mechanical properties and excellent chemical resistance for use as industrial and sewerage waste pipes systems
- PP-R has good resistance to high internal pressure so it is suitable for domestic pressure water supply systems and both hot and cold-water services
- PP-B is suitable for buried sewerage and wastewater drainage as it has good impact strength, particularly at low temperatures, and excellent chemical resistance.

The use of polypropylene has been increasing since the late 90s as it is:

- chemical and corrosion resistant
- heat resistant
- lightweight

- easy to install
- frost resistant.

In outdoor situations, it must be protected from UV exposure.

### 5. Cross – linked polyethylene (PEX)

PEX tubing is made from a cross-linked, high density polyethylene polymer, which results in a stronger material that polyethylene. Properties include:

- more durability under extremes of temperature and chemical attack
- greater resistance to cold temperatures, cracking and brittleness on impact
- it can be used for hot water supply and hydronic heating systems, as well as potable water supplies
- flexibility
- ease of installation
- it can be used for indoor and buried outdoor situations.

PEX is not recommended for outdoor above ground use – although it can withstand some UV exposure, this should not exceed the manufacturer's instructions.



### 6. Unplasticised Polyvinylchloride (Upvc or PVC-U)

Today in domestic construction it is used chiefly for drains, wastes and vents, and is rare for water supply in new individual houses. The primary jointing method for uPVC is solvent welding, where solvents soften the surfaces of the material, which then chemically fuse together. A rubber ring (elastomeric seal) joint system is also available. This piping:

- is inexpensive
- is easy to handle
- has low resistance to flow.

**Traps**

It is a fitting in a P-, U-, S- or J-shaped type. Traps are fitted near a plumbing fixture. The trap bend is fitted to prevent sewer gases from entering the building. If the gases are inserted back into home, then it could lead to people inhaling foul smell, which could cause illnesses. It could even explode.

**Caulking agents**

It is a sealant but differs from plumbers' putty. A big difference in both is that a silicone caulk cannot be replaced.

It is a sticky material and is an adhesive one.  It is hard enough that you can use it everywhere. It also has a rubbery touch to it that keeps it elastic for quite some time. It can be so tight after applying, you would need a scrapping tool to remove this sealant.

Sealant and glue
Silicone sealants are a form of liquid adhesive commonly used in building, bonding, and repairing many materials, including finishing joints and filling seams or other gaps. Since they are waterproof and offer durable elasticity and stability in both high and low temperatures, silicone sealants work particularly well as plumbing sealants.

Water proofing agents
Concrete is the main building material used in all civil constructions and it is prone to shrinking. Concrete hence requires protection due to porosity, cracks & potential to reaction with atmospheric gases such as CO2. Apart from that, the structures have various joints & connections which need to be considered & given extra protection.

**Plumbing fittings**
Various types of pipe fitting are available in plumbing systems for different purposes and functions. They are made up of different materials like copper, iron, brass, PVC, etc.
Some of the most common types are as follows.



Collar: While joining two pipes in the same length, collar is used. It is fitted at the end of the pipe.

Gasket: They are mechanical seals, generally ring-shaped and fitted for sealing flange joints. A flange joint is a plate or ring to form a rim at the end of a pipe when fastened to the pipe. Gaskets are made as per by construction, materials and features. Important gaskets used are nonmetallic, spiral-wound and ring-joint type.

Offset: When an assembly of fittings on a pipeline makes one section of pipe out of line and parallel to a second section, then it is known as an offset

Elbows: Such pipe fittings are used to change the direction of the flow. They are majorly available in two standard types - 90- and 45-degree angles owing to their high demand in plumbing. The 90-degree elbow is primarily used to connect hoses to water pumps, valves, and deck drains, while the 45 degree elbow is mostly used in water supply facilities, electronic and chemical

industrial pipeline networks, food, air-conditioning pipelines, garden production, agriculture, and solar-energy facility.

**Elbow**

Couplings: A coupling is a pipe fitting used to stop leakages in broken or damaged pipes. The pipes to be connected should be of the same diameter. The two kinds of couplings used in plumbing are regular coupling and slip coupling. The regular coupling is arranged between the two pipes to prevent further leakages with the help of rubber seals or gaskets on the both sides. The slip coupling itself contains two pipes to repair the damaged lengthy pipes.

**Coupling**



Union: This type of pipe fitting is almost similar to coupling in terms of functions, but just with a difference, i.e. a union can be removed easily any time while the coupling cannot. A variety of dielectric unions are used to join pipes made of different materials to avoid any kind of galvanic corrosion between them. These pipe fittings comprise of a nut, female and male ended threads.

**Union**

Adapters: Adapters are connected to pipes to either increase their lengths or if pipes do not have appropriate ends. These pipe fittings make the ends of the pipe either male or female threaded as per the need. This permits unlike pipes to be connected without any need of extensive setup. They are mostly used for PVC and copper pipes.

**Adapter**

Nipple: This is a short butt of a pipe that works as a connection between two other fittings having male threads. A close nipple is a type of pipe fitting having continuous threading on them. They are mostly used in hoses and plumbing.

**Nipple**

Reducer: This pipe setting is used to reduce the flow size of the pipe from the bigger to smaller one. There are two kinds of reducers- concentric reducer and eccentric reducer. Reducer the former one is in the shape of a cone used for gradual reducing of the size of the pipe. The latter one has its one edge facing the mouth of the connecting pipe reducing the chances of air accumulation.

**Reducer**

Tee: This T-shaped pipe fitting used in the plumbing system has one inlet and two outlets arranged at an angle of 90 degrees to the main pipe. This kind of fitting is used to connect the two pipes and make their flow direction as one. If all the three sides of this fitting are same in size, it is called equal tee, otherwise unequal tee.

**Tee**

Cross: This type of pipe fitting contains four openings in all the four major directions. This fitting is adjoined to four pipes meeting at common point. There is either one inlet and three outlets or vice-versa to flow water or any other liquid in four different directions. These kinds of pipe fittings are commonly used in fire sprinkler systems.

**cross**

Flanges: A flange is another pipe fitting used to connect pipes, pumps, valves, and other components to form a full-fledged piping system. They come with a flexibility of easily cleaning or inspecting the whole system from within. They are fixed to the pipes using welding, threading or screwing techniques and then finally sealed with the help of bolts. They are used in residential pump systems and majorly for industrial purposes.

**Flanges**

Caps & Plugs: Both these pipe fittings are used to close the ends of the pipe either temporarily or permanently. The plugs are fitted inside the pipe and threaded to keep the pipe for future use. There are a good number of ways a cap can be applied to the pipe like soldering, glue, or threading depending on the material of the pipe.

**Caps and plugs**

Bushings: These pipe fittings are used to combine pipes of different sizes together by decreasing the size of the larger fitting to the size of the smaller pipe. Bushings are not always threaded inside out and occupy very little space in comparison to a union or coupling used for the same purpose.

**bushings**

Wyes: Such type of pipe fittings are used in drainage systems and have a branch line at 45 degrees to keep the flow of water smooth. When the sanitary tees fail to work in a horizontal connection, such cases needs a wye.

**Wyes**



Valves: Valves are used in the plumbing system to stop the flow of gases or liquids. There are of three types:

- Throttling
- Isolation
- non-return.

The isolation valves are used to disconnect a part of the piping system temporarily for maintenance or repair.

The throttling valves are used to regulate the amount of pressure of a liquid in a pipe; they can also withstand the stress caused by this process.

**Valves**

Barb: A barb is another useful pipe fitting used in the plumbing system that connects flexible tubing to pipes. It has a male-threaded end on one side that connects with the female threads, and the other end has a single or a multi-barbed tube that is inserted in the flexible tubing.

**Barb**

Diverter tee: This kind of a tee-shaped pipe fitting is commonly used in the pressurized hydronic heating systems to redirect a part of the flow from the main line to the side branch connected to a heat exchanger.

**Diverter Tee**

Gaskets and O-rings

Gaskets: A gasket is a flat piece of material that sits between to flat surfaces. The gasket's material whether neoprene, rubber, silicone or another flexible substance prevents liquid or air (or sometimes both) from leaking in or out of an area.

O-Rings: They are circular, ring-shaped pieces that sit in a groove between two (usually cylindrical) parts. The compression of the two parts creates the airtight and liquid-tight seal.

O-rings can be made from many flexible materials, like rubber, neoprene, or polyurethane. While the ring-shape is a staple characteristic of o-rings, the height and thickness of the ring can vary based on your design.

Difference between a Gasket and O-Ring

Both perform the same basic function of stopping liquids or gasses from ingressing or egressing.

2. The shape of the seal is one key criteria where the difference between an O ring and a gasket becomes very clear. In some applications, only a gasket will work because the shape of the joint makes it difficult or impossible to design a good seal using an O ring, which requires a groove to sit in.

2. The other key factors are temperature and pressure. The material used to make the seal is a critical factor with regards to operating temperature. While both O rings and gaskets can perform well in a wide temperature range, gaskets have the edge in extreme temperatures. O rings, however, are the superior choice in applications with extreme pressure. Under pressure, an O ring's performance will improve while a gasket's effectiveness will decrease



**Estimation of quantities**

Illustration of a composite rate build-up for Sanitary Fittings

Composite Rate Build up - Wash Hand Basin

Step 1
Determine the group unit of measurement. When you are measuring e.g., a wash hand basin in elemental or approximate quantities estimating, the group unit of measurement is the number (No)

Step 2
The second step is listing all associated bill items that can be mapped to wash hand basins by number. These are:

- 520x440mm Vitreous china vanity basin and accessories: (No.) Rate – Ksh.6,000.00
- 15mm basin mixer and accessories – (No.) Rate – Ksh.3, 000.00
- 40mm Brass sink P trap – (No.) Rate – Ksh.600.00
- 15mm Star chrome plated bibtap and accessories – (No.) Rate – Ksh.4, 000.00
- 15mm Copper service pipe 350mm girth – (No.) Rate – Ksh.300.00

- 15mm Chromium plated full way ballcock shut-off control valve with screw type control – (No.) Rate – Ksh.500.00

Step 3

Rate build up for items which are linked to the wash basin by number. Since the group unit is the number (No.), you should convert the bill item rates to cost per wash hand basin.

**Rate build up**

| **Sanitary fitting** | **Quantity (No.)** | **Rate cost per wash hand basin Ksh.** |
|---|---|---|
| Vitreous China Vanity basin | 1No. | 6, 000. 00 |
| Basin mixer | 1No. | 3, 000. 00 |
| Sink P trap | 1No. | 600. 00 |
| Bibtap | 1No. | 4,000. 00 |
| Copper service pipe | 1No. | 300.00 |
| Shut-off control valve | 1No. | 500.00 |
| Composite Rate – Sanitary fittings | | 14, 400. 00 |



The composite rate for items which can be mapped to the Wash Basin by number is Ksh.14,400.00 per wash basin.

**Elemental Layout and Grouping**

Items which go into the element INTERNAL PLUMBING and component Sanitary Fittings are stated in the description below:

| | **Unit** | **Quantity** | **Unit rate** | **Cost/ $m^2$** | **Subtotal** | **Cost** |
|---|---|---|---|---|---|---|
| **Internal plumbing** | | | | | | |
| 520x440mm Vitreous china drop-in vanity basin including 15mm basin mixer, 40mm Brass sink P trap, | No | | 14,400.00 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15mm Star chrome plated bibtap, 15mm Copper service pipe 350mm girth, 15mm Chromium plated full way ballcock shut-off control valve and all accessories – chains, waste union, plug, brackets etc. | | | | | | |

### 7.2.2.4 Learning Activities

**Activity**

A client has an issue with a water closet that is consistently having an issue with blockage. Identify, quantify and cost the materials and supplies required for while preparing to remove the old water closet, the precautions to observe while removing the water closet and the preparation in installing a new water closet.



### 7.2.2.5 Self-Assessment

1. What factors will you consider in choosing the right sealant/adhesive?
2. Which of the following is not a factor to consider when choosing water pipes?
    a. suitable for the expected temperatures and pressures
    b. compatible with the water supply
    c. suitable for the local climate
    d. not able to withstand UV effects
3. What are the three types of valves?
4. Which device is fitted to prevent wastage of water from automatic flushing cisterns at times when the cistern is not in use?
5. Of the following which is not true about copper pipes?

a. They are durable
b. They have a poor corrosion resistance
c. Are malleable and easy to bend
d. Has good flow characteristics

6. Why are silicone sealants preferred for plumbing works?

### 7.2.2.6 Tools, Equipment, Supplies and Materials

**Functional Plumbing Workshop with the following:**
**Tools and Equipment**

- Pipe wrench
- Pipe cutter
- Hacksaw
- Pipe Threading Equipment
- Vices
- Taps
- Punch
- Files
- Screwdrivers
- Drill with various sizes of bits
- Portable drill
- Mallet
- Ball pein0 hammer
- Mason chisel
- PPR machine / Heat Fusion equipment
- Pipe bender
- Trowel
- De-clogging wire / de-clogging machine
- Toilet pump

**Supplies and Materials**

- Screws
- Adhesives
- Cement
- Sand
- Pipes

- Traps
- Electric cables
- Caulking material
- Fitting

### 7.2.2.7 References

Joseph J. Galeno and Sheldon T. Greene., RSMeans Plumbing Estimating Methods, 3rd Edition

F. Hall., Plumbing Technology

Black & Decker., The Complete Guide to Plumbing.,2008

### 7.2.2.8 Model Answers

1. What factors will you consider in choosing the right sealant/adhesive?

There are various types of silicone sealants available, and while all offer the same general adhesive properties, some sealants are formulated for specific applications.

- The composition of the sealant determines how elastic it is, what materials it works best with, and how quickly it hardens.
- For use in the bathroom or other wet areas, the best choice is a mold-resistant sealant. This will prevent deterioration and blackening of the joint as it is exposed to moisture over time.
- Acidic components in some adhesives may lead to oxidation on some target surfaces, such as mirrors, stone, and marble tiles, aluminum or copper. If this is a concern, choose an acid-free sealant. Again, check your product information to confirm.
- For most general purposes, look for a universal sealant. It's a powerful waterproof plumbing silicone sealant, perfect for use with metal, glass, rubber, tile, and porcelain. Useful both indoors and outdoors, its flexible and impact- and temperature-resistant formula make it ideal for almost all plumbing applications.

2. Which of the following is not a factor to consider when choosing water pipes?
    a. suitable for the expected temperatures and pressures

b. compatible with the water supply
c. suitable for the local climate
**d. not able to withstand UV effects**

3. What are the three types of valves?
    - Throttling
    - Isolation
    - non-return.

4. Which device is fitted to prevent wastage of water from automatic flushing cisterns at times when the cistern is not in use?
    An Automatic Flow Cut Off Device

5. Of the following which is not true about copper pipes?
    a. They are durable
    **b. They have a poor corrosion resistance**
    c. Are malleable and easy to bend
    d. Has good flow characteristics



6. Why are silicone sealants preferred for plumbing works?
    They are waterproof and offer durable elasticity and stability in both high and low temperatures,

## 7.2.3 Learning Outcome 3: Fix plumbing system faults

### 7.2.3.1.Introduction to the learning outcome

This learning outcome specifies the content of competencies required to Fix plumbing system faults. It includes, terms and concepts, types of maintenance, maintenance reports & schedules, PPEs and their use, plumbing tools and equipment, rectification procedures, safety, care and maintenance of plumbing tools and equipment, plumbing parts repair/replacement, housekeeping and storage of plumbing tools and equipment

### 7.2.3.2.Performance Standard

1. Notice for maintenance operation are issued as per standard operating procedure.
2. Affected areas are closed/isolated based on best practice
3. Tools and equipment are identified and used based on job requirements.
4. Fault is repaired based on standard operating procedures
5. Housekeeping is observed as per best practice
6. Safety and health practices are observed based on OSHA.



### 7.2.3.3.Information Sheet

TYPES OF MAINTENANCE

**Preventive Maintenance**

Preventive maintenance is aimed at catching and fixing problems before they happen. It is most commonly carried out in the form of regular inspections, usually occurring multiple times per year.

When you inspect a system or a piece of technology, carefully check for all signs of wear, tear or imminent breakdown. Replace damaged parts immediately. This will prevent having to go into “crisis mode” if something breaks unexpectedly.

The primary benefit of preventive maintenance is that it can eliminate unplanned shutdown time as you will ideally catch problems before they occur.

**Condition-Based Maintenance**

Condition-based maintenance is sometimes considered to be a more advanced alternative to preventive maintenance. Rather than being inspected according to a schedule, machines and systems are carefully observed for changes that could indicate upcoming failure.

With condition-based maintenance, technicians observe the system running and identify variables that could affect functioning, like temperature, vibration speed, power, the presence or absence of moisture, and more.

Another strategy within condition-based maintenance is predictive maintenance.

**Predictive Maintenance**
Predictive maintenance refers to a specific type of condition-based maintenance in which systems are constantly observed via sensor devices. These devices are attached to components of the system and feed constant, real-time data to software. The software then interprets this data and warns maintenance technicians of approaching danger.

Predictive maintenance is generally considered to be the most advanced and intensive type of maintenance. This is because there is a lot of data to interpret – and the sensor devices themselves need to be regularly maintained and checked.

**Corrective Maintenance**
Corrective maintenance is initiated when a problem is discovered while working on another work order. With corrective maintenance issues are caught ‘just in time'.



For example, during a scheduled maintenance check or while fixing another issue, a maintenance technician notices that a pipe in a HVAC system is not working as it should. Corrective maintenance is then scheduled for a future date where the problem is repaired or replaced.

Because corrective maintenance issues are found ‘just in time’, it reduces emergency repairs and increases employee safety.

**Predetermined Maintenance**
Unlike other styles, predetermined maintenance is carried out using rules and suggestions created by the original manufacturer, rather than the maintenance team. These suggestions are based on experiments and gathered data.

The manufacturer provides statistics and guidelines, usually when the equipment is first purchased and will include data providing the average lifespan of both the entire system and its various parts. The manufacturer will suggest how often parts should be inspected, serviced and replaced.

Relying solely on a predetermined schedule may risk system failures as technicians may not be able to anticipate problems. It can also cause multi-family maintenance teams to replace parts too early, resulting in additional costs. Additionally, predetermined maintenance doesn't guarantee that a system won't break down since the program is based on statistics and not the actual state of the equipment.

## Maintenance reports & schedules

Some benefits of a maintenance report include:

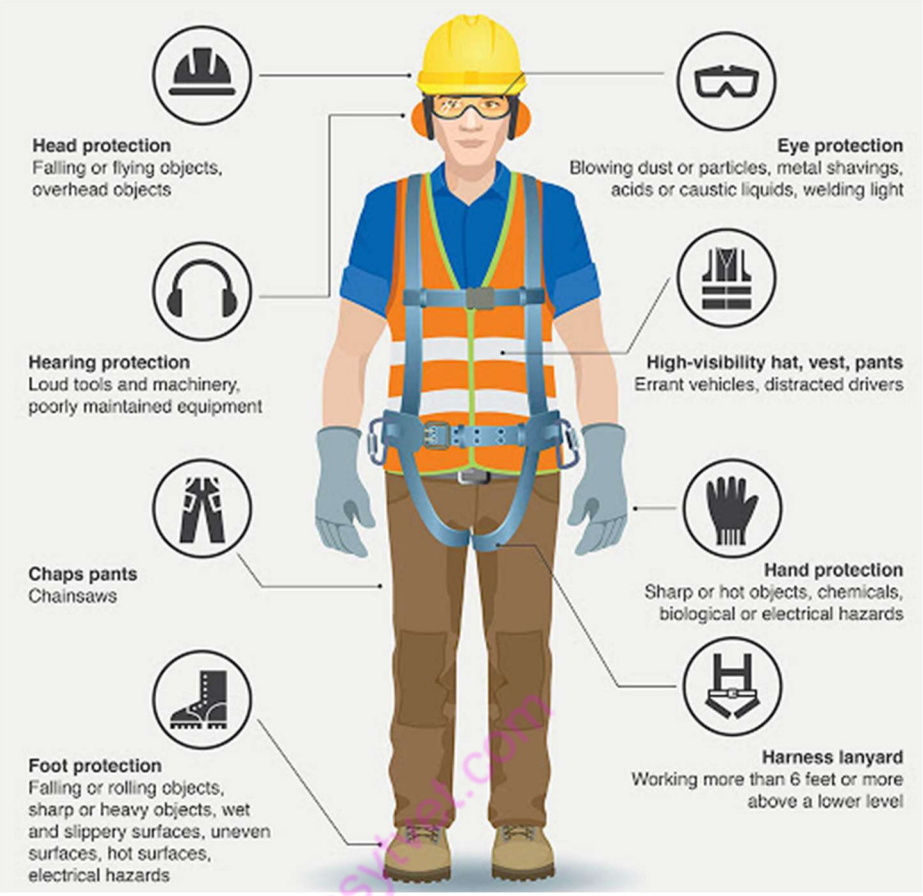
- **It helps maintain reliability**
  This ensures that operating equipment is always made available as needed and in working condition.
- **It helps ensure safety**
  Regular checkups can prevent unexpected risks to the individuals involved in doing repairs.
- **It improves efficiency**
  The early identification of defects and their immediate repairs can save the company both money and time in the long run.
- **It promotes good recordkeeping**
  The regular documentation of equipment repairs and diagnostics helps you identify broader trends while supporting investigations in the future.



**P.P.E.s**

**Plumbing Safety Tools**

PPE can be defined as safety gear that protects plumbers against safety or health risks when handling the job. The main objective of a protective gear for a plumber is to reduce plumber exposure to hazards related to plumbing.
Below are essential PPE for plumbers commonly used on plumbing and their benefits.




**PPE's**

## Helmets

Protective helmets are important in a plumbing site because they prevent injuries from flying or falling objects. Recently, due to advanced technology, some hard hats are equipped with accessories, such as earmuffs and shields. A plumber should consider buying a well-fitted protective helmet to prevent inconveniences. Too small or too large hard hats are inappropriate to use. Falling or flying objects might lead to severe head injuries.

## Masks

Production of toxic substances is common in plumbing sites. Respiratory protection gears, such as respirators, are designed to protect a plumber from fumes, dust, and other dangerous

substances that could lead to respiratory problems. Respiratory protection gears are important in areas where there's air contamination.

1. Safety shoes

Some safety shoes are designed to limit damage to your toes from falling objects. A steel plate is placed in the toe area of such shoes so that your toes are not crushed if an object impacts there. Other safety shoes are designed for use where danger from sparking could cause an explosion. Such danger is minimized by elimination of all metallic nails and eyelets and by the use of soles that do not cause static electricity.

2. Goggles

Proper eye protection is of the utmost importance for all personnel. Eye protection is necessary because of hazards posed by infrared and ultraviolet radiation, or by flying objects such as sparks, globules of molten metal, or chipped concrete and wood. These hazards are ever-present during welding, cutting, soldering, chipping, grinding, and a variety of other operations. It is imperative for you to use eye protection devices, such as helmets, face shields, and goggles, during eye-hazard operations.

Appropriate use of goggles will limit eye hazards. Some goggles have plastic lenses that resist shattering upon impact. Others are designed to limit harmful infrared and ultraviolet radiation from arcs or flames by use of appropriate filter lenses. Remember, eye damage can be excruciatingly painful.



3. Gloves

Use gloves whenever you are required to handle rough, scaly, or splintery objects. Special flameproof gloves are designed for gas and electric-arc welding to limit danger and damage from sparks and other hot flying objects. Personnel in the electrical fields are usually required to wear insulating rubber gloves. Be sure to follow all regulations prescribed for the use of gloves. Gloves must not be worn around rotating machinery unless sharp or rough material is being handled. If such is the case, Extreme Care Should Be Exercised to prevent the gloves from being caught in the machinery.

4. Safety belts and straps

The safety strap and body belt shown are what might be called your extra hands when you work aloft. The body belt, strapped around your waist, contains various pockets for small tools. The safety strap is a leather or neoprene-impregnated nylon belt with a tongue-type buckle at each end. While you are climbing you will have the safety strap hanging by both ends from the left ring.

## PLUMBING REPAIR TOOLS AND EQUIPMENT

Sink Auger

A sink auger (also called a drum auger or canister auger) is the ultimate weapon for breaking up and clearing clogs in sink and tub drains.

A sink auger consists of a flexible stainless steel cable with a corkscrew tip at the end. The cable is coiled within a drum canister and is extended into a drain to reach a clog and clear it. The drum has a handle, and there's a thumbscrew that locks the cable to the canister, and when you insert the cable into the drain and turn the handle, the rotating drum snakes the cable through bends in the drain pipe, allowing the cable tip to penetrate clogs and pull them out.

**sink auger**



Toilet or Closet Auger

The toilet auger (also called a closet auger or water closet auger) is used to clear clogs in toilets.

A toilet auger has a long metal rod with a bend for reaching into the hole at the bottom of the toilet bowl. A rubber sleeve covers the bend to protect the porcelain in the toilet from being scratched. Once the tool is in place, you push and rotate the auger cable to snake it into or through the clog.

Flange Plunger (Toilet Plunger)

The flange plunger, or ball or toilet plunger, is a specially shaped plunger used to clear clogs in toilets. It works like a regular plunger but has a flange—an extended rubber flap below the dome of the plunger head—that helps seal around the hole at the bottom of the toilet bowl. With the bottom opening sealed, the plunger can effectively create the hydraulic pressure necessary to dislodge most clogs from a toilet.

**flange plunger**

Cup Plunger (Sink and Tub Plunger)
The cup plunger may be the most common plumbing tool in the home. It has a rubber cup-like shape and a wooden handle and is used to clear clogs in sinks, tubs, and showers. Do not use this plunger for clearing toilet clogs; that requires a specially shaped plunger called a flange plunger (previous slide). Some flange plungers, though, can be used as standard cup plungers when the flange is tucked up inside.



**cup plunger**

Plumber's Tape
Plumber's tape is an essential material for preventing leaks at threaded plumbing connections. Often called Teflon tape (although it's not made with Teflon-brand material), plumber's tape is a thin white tape that you wrap around threads on pipes and fittings before twisting the parts together. It adds a bit of lubricant to aid threading and also helps to seal

the joint to prevent leaks. Made with PTFE (PolyTetraFluoroEthylene), it is silky in texture and is sold in small rolls.

**plumber's tape**

Channel-Type Pliers

Channel-type pliers are commonly known by the brand name Channel-Locks, and are also known as slip-joint pliers.They're similar to regular adjustable pliers but have extended adjustment sections as well as angled jaws, allowing you to grip pipes or other plumbing parts of almost any size. The long handles provide tremendous leverage for squeezing and twisting. You can use them to grip heavy steel pipe or to gently tighten large plastic nuts on sink drains. If you own only one specialty plumbing tool, this should be the one.

**channel-type pliers**

Adjustable Pipe Wrench

An adjustable pipe wrench is the quintessential metal plumbing tool. It provides tremendous leverage and grip. It is designed to grip round objects (such as pipes) securely by digging its sharp serrated teeth into the pipe with increasing pressure as the wrench is turned.

A pipe wrench leaves teeth marks behind and is not recommended for removal of shiny fixtures or for small or fragile pipes, like copper water pipes. Pipe wrenches are primarily used on galvanized steel and iron pipe and on heavy-duty fixtures with rough finishes, such as outdoor spigots or hydrants.

**Pipe wrench**

Faucet Valve-Seat Wrench

A faucet valve-seat wrench is a simple tool used to remove the valve seats on a compression faucet. Compression faucets, the oldest style of faucet, work by compressing a rubber washer against a valve seat in the faucet body.



When the washer wears out, the valve seat can become damaged and rough, preventing a complete seal. When that happens, you can remove the valve seat and replace it, using a valve seat wrench. If the seat is not removable, you must regrind it to a smooth surface using a reseating tool.

**faucet valve-seat wrench**

Faucet Packing, Washers and O-rings

Faucet packing and rubber washers and O-rings are lifesavers for fixing leaky valves on sinks, radiators, and other old or traditional equipment. Packing is a graphite- or wax-coated string that you wrap around valve stems and pack under packing nuts to create a watertight seal. Rubber washers and O-rings are sold in variety packs containing several different

shapes and sizes. If you're fixing an old faucet and can't find an official replacement part at the store, a variety pack well have the part you need. It's handy to have one around because it might save you a trip to the store.

Tubing Cutter

The tubing cutter is an essential plumbing tool if you're working with copper pipe. Copper requires clean, square cuts, and tubing cutters do just that—with much less effort than a hacksaw. It has a thin cutting wheel that cuts the metal and a flat pressure wheel that applies pressure when you turn the tool's knob. Clamp the tool onto a pipe and rotate it around the pipe, tightening the knob after every two or three rotations. The cutting wheels gradually cut through the material.

After making the cut, remove the burr on the inside of the pipe, using the de-burring tool (a triangular metal piece) that is fitted to the body of the tubing cutter.

**tubing cutter**

Washers

These are simple round, flat, disks with a hole at the center that sits inside the faucets and showerheads.

**washers**

Uses of washers:

- The rubber, plastic, or metallic washers are used to control the intense flow of water through the faucets and showerheads.
- Washers are lifesavers for fixing leaky valves on sinks, radiators, and other old or traditional equipment.

- Pipe wrench

Pipe wrench size should be selected such that its opening exactly pits the pipe and should not be used for bending, raising or lifting pipe.
It is used for:

- screwing and unscrewing small pipes.
- tightening of nut and bolts, fixing of small taps, valves etc in pipelines.


**pipe wrench**

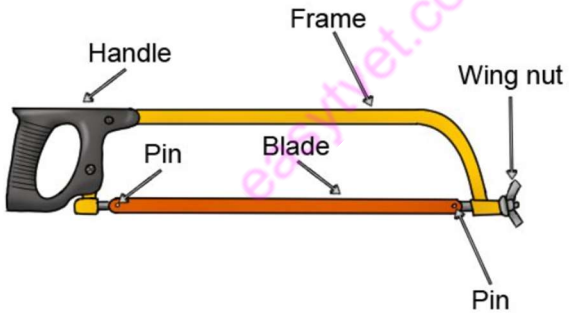
- Pipe cutter

It is used for cutting of pipes. It is placed around pipes and tightens so that it holds the pipe tight. However, over tightening may damage pipe. The cutter is rotated around the pipe one to two times and then the pipe is tightened again. The process is repeated unless the pipe is cut. Pipe cutters are available for cutting of pipes from 25-150 mm.


**pipe cutter**

- Hacksaw

It is used for cutting pipes of smaller diameters (15-25 mm). It consists of frame, handle, prongs, tightening screw and nut. The frame may be fixed type or adjustable type. Blade is fixed in position by means of tightening screw. The direction of the cutting teeth of the blade is to be in the forward direction.




**pipe hacksaw**

- Pipe Threading Equipment

It is used for threading external taper threads of pipe. Pipe is fixed in the pipe vice and threading is done with help of the die set as per pipe size requirement.

**: pipe threading equipment**

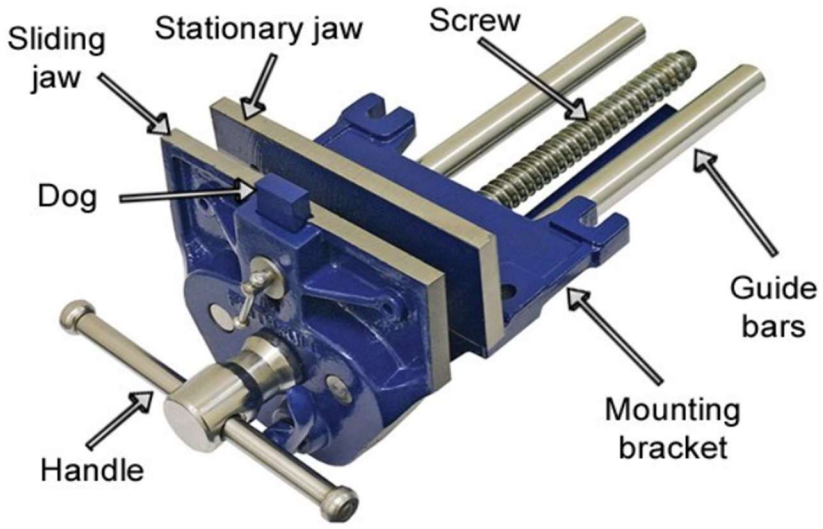
Using instructions:

g. Take required size of pipe threading die.
h. Fix the pipe in the pipe vice tightly.
a. Cut the pipe to required size at right angle.
b. Hold the die in right angle of the pipe and put some oil on pie.
c. Cut the thread on the pie with die rotating in clockwise direction. Rotate the die in anti clockwise direction so that the cut material will come out.
d. Clean the chips or burr.



- Bench vice

It is used for holding pipes in position rigidly for cutting and threading. Pipe vices are available in market in various sizes for holding pipes starting from 37 mm diameter.




**bench vice**

1. The Base

The base of the vise is the part that holds everything together. It is truly the life of the party. The base of the vise is fastened to the bench and it comes in different designs. Some can be clamped in place; the others can be bolted. There are also swivel and vacuum bases available for different purposes.

2. The Jaw

This is where everything stays. The jaw is jaw-like and clamps everything in place. It comes in two different parts. Considering the nature of the job, the jaws can take the form of wood, plastic, or metal.

**The sliding jaw:** this part of the jaw moves when the handle is turned. It also applies pressure on the object being clamped. If you are new to clamping, it's pretty easy to spot out which part of the clamp is the sliding jaw, since it's the part that allows motions and has a handle sticking through.

**The static jaw**: this part is fixed. This is the vise that enforces solidity. The sliding jaw backdrops in this component applying pressure for its immovability. You can identify the static jaw by its size.



3. The Slide

This part moves when the handle is turned, applying pressure to the object. It is attached to the sliding jaw.

4. Main Screw

The force applied to the handle is transformed into the movement of the sliding jaw, which moves towards the static jaw. This jaw is conspicuously attached to the handle and extends through the vise.

The main screw is an essential part. It is so vital that if the main screw is not manufactured based on the type or comes with flaws creating weaknesses, the vise will not hold well at all.

5. Handle

The handle has a lever attached to it.

Applying too much force on the handle can be tempting. But if done out of proportion, it can lead to explosive results. The power applied to move the handle multiplies and gets accompanied by the actions of the main screw. While clamping, if any material observes a bend, it's best to stop and reverse the handle to release the pressure level.

6. The Anvil
This can come in handy form when light-shaping of materials.

7. Serrated Jaws
This is the actual point where the vise meets with whatever it is you are fastening. Take precautions with anything other than metal. The jaws can do a ‘damage job’ when too much pressure is applied.

8. Pipe Jaws
These pipe jaws can be found inside the sliding and static jaw. They allow you to hold pipes and other oddly shaped objects in place, and present you with the prerogative to cut them easily.

- Spanner

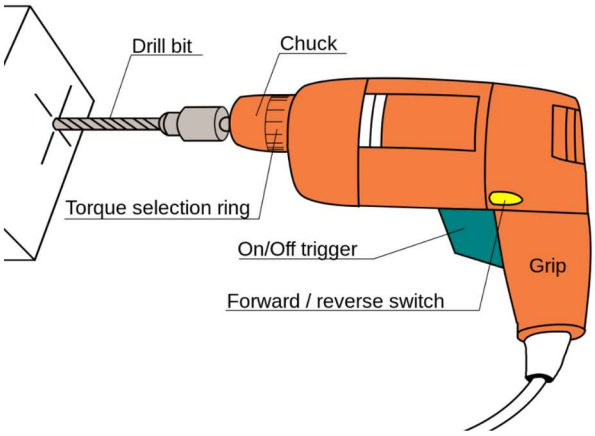
Spanner is used for fixing and opening nuts and bolts. Different types of spanners and size are available as per requirement of pipe size.



**spanner**

- Drill with various sizes of bits

It is a tool primarily used for making round holes or driving fasteners. It is fitted with a bit, either a drill or driver, depending on application, secured by a chuck. Some powered drills also include a hammer function.




**drill and bits**

- PPR machine / Heat Fusion equipment

It is a pipe welding machine set used for welding plastic pipes.

**PPR**

- Pliers

These are used everyday by plumbers. Easily tighten or loosen nuts and bolts that wrenches can’t grab onto.

**Pliers**

- Pipe bender

It is used for bending pipes. Fix wooden stopper to one end of the pipe. Fill the pipe with sand completely. Fix wooden stopper from other side of pipe. Fix the pipe in the machine. Location of the bend should be in center of pulley. Tight the screw. Bend the pipe with help of lever till required bend. Remove stopper and sand from pipe.

**Pipe bender**

SAFETY, CARE AND MAINTENANCE OF PLUMBING TOOLS AND EQUIPMENT

The following rules will make maintenance easier and safer.

i. Keep each tool in its proper storage place.
ii. Keep your tools in good condition. Protect them from rust, nicks, burrs, and breakage.

iii. Use each tool only for the job it was designed to do. Each particular type of tool has a specific purpose. If the wrong tool is used when performing maintenance or repairs, it may cause damage to the equipment being worked on or damage the tool itself. Improper use of tools results in improper maintenance. Improper maintenance results in damage to equipment and possible injury or death.
iv. Safe maintenance practices. Always avoid placing tools on or above machinery or an electrical apparatus. Never leave tools unattended where machinery are running.
v. Never use damaged tools. A battered screwdriver may slip and spoil the screw slot, damage other parts, or cause painful injury. A gauge strained out of shape will result in inaccurate measurements.

The following precautions for the care of tools should be observed:

i. Clean tools after each use. Oily, dirty, and greasy tools are slippery and dangerous to use. Never hammer with a wrench.
ii. Never leave tools scattered about. When they are not in use, stow them neatly on racks or in toolboxes.
iii. Apply a light film of oil after cleaning to prevent rust on tools.
iv. Inventory tools after use to prevent loss.



SAFETY PRECAUTIONS FOR USE WITH PORTABLE ELECTRICAL TOOLS

When portable electric tools are used, you should use the following procedures:

- Before portable electrical tools are used, they must be inspected and approved.
- Prior to the use of any portable electric tools, you should make sure the tools have a current ship's inspection mark. Additionally, visually examine the attached cable with the plug and any extension cords for cracks, breaks, or exposed conductors and damaged plugs. When any defects are noted, the tools should be turned in to the ship's electrical shop for repair before use. Before plugging in any tool, be sure the tool is turned off.
- Personnel using portable electric tools are required to wear safety glasses/goggles.
- Portable electric tools producing hazardous noise levels in excess of the limits set are required to be conspicuously labeled. Personnel using tools designated as producing hazardous noise levels are required to wear proper ear protection, as issued by the medical department.
- Only explosion-proof portable electric tools should be used where flammable vapors, gases, liquids, or exposed explosives are present.

- Hand-held portable electric tools authorized for use on board ship shall be equipped with ON/OFF switches, which must be manually held in the closed ON position to maintain operation.
- Rubber gloves must be worn when you are using portable electric tools under hazardous conditions; for example, wet decks, bilge areas, working over the side, in boats, and so forth.
- Leather glove shells should be worn over rubber gloves when the work being done, such as sheet metal work, could damage the rubber gloves.

HOUSEKEEPING

**Why should we pay attention to housekeeping at work?**

Effective housekeeping can help control or eliminate workplace hazards. Poor housekeeping practices frequently contribute to incidents. If the sight of paper, debris, clutter and spills is accepted as normal, then other more serious hazards may be taken for granted.

Housekeeping is not just cleanliness. It includes keeping work areas neat and orderly, maintaining halls and floors free of slip and trip hazards, and removing of waste materials (e.g., paper, cardboard) and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of incident and fire prevention.

Effective housekeeping is an ongoing operation: it is not a one-time or hit-and-miss cleanup done occasionally. Periodic "panic" cleanups are costly and ineffective in reducing incidents.

**What is the purpose of workplace housekeeping?**

Poor housekeeping can be a cause of incidents, such as:

- tripping over loose objects on floors, stairs and platforms
- being hit by falling objects
- slipping on greasy, wet or dirty surfaces
- striking against projecting, poorly stacked items or misplaced material
- cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, a workplace must "maintain" order throughout a workday.

**What are some benefits of good housekeeping practices?**

Effective housekeeping results in:

- reduced handling to ease the flow of materials
- fewer tripping and slipping incidents in clutter-free and spill-free work areas
- decreased fire hazards
- lower worker exposures to hazardous products (e.g. dusts, vapours)
- better control of tools and materials, including inventory and supplies
- more efficient equipment cleanup and maintenance
- better hygienic conditions leading to improved health
- more effective use of space
- reduced property damage by improving preventive maintenance
- less janitorial work
- improved morale
- improved productivity (tools and materials will be easy to find)

**How do I plan a good housekeeping program?**

A good housekeeping program plans and manages the orderly storage and movement of materials from point of entry to exit. It includes a material flow plan to ensure minimal handling. The plan also makes sure that work areas are not used as storage areas by having workers move materials to and from work areas as needed. Part of the plan could include investing in extra bins and more frequent disposal.

Worker training is an essential part of any good housekeeping program. Workers need to know how to work safely with the products they use. They also need to know how to protect other workers such as by posting signs (e.g., "Wet - Slippery Floor") and reporting any unusual conditions.

Housekeeping order is "maintained" not "achieved." Cleaning and organization must be done regularly, not just at the end of the shift. Integrating housekeeping into jobs can help ensure this is done.

A good housekeeping program identifies and assigns responsibilities for the following:

- clean up during the shift
- day-to-day clean up
- waste disposal
- removal of unused materials
- inspection to ensure clean up is complete

Do not forget out-of-the-way places such as shelves, basements, sheds, and boiler rooms that would otherwise be overlooked.

# Storage of plumbing tools and equipment

Step 1

Figure out how much space is needed for the number of tools available. Get a shelving unit to store smaller tools and equipment.

Step 2

Organize the tools and equipment. Allocate shelves and drawers to store smaller plumbing tools. For larger tools and equipment, organize by type for easy location. Keep the parts for each specific tool close by.

Step 3

Clean out dirt and debris from tools. Oil power tools to lubricate moving parts. Repair loose handles and clean out oil or other fluids used to power the tool. Sharpen blades and replace worn out parts.



Step 4

Set up racks. Mount racks along the wall of the storage area to hang, cords and other equipment. Wind long cords in a loop and hang from rack. Place tools on racks by the handle. Draw the outline of the tool with a permanent marker to identify its place, or use labels to mark the location.

Step 5

Create a library. For tools and equipment that have various functions, designate a library area within the storage space for user manuals and warranty sheets. Store the booklets alphabetically and in a dry area. Type up a sheet listing all of the books to create simple table of contents.

### 7.2.3.4.Learning Activities

**Activity:**

A client has an issue with a water closet that is consistently having an issue with blockage. Describe the procedure to follow while preparing to remove the old water closet, the precautions to observe whle removing the water closet and the preparation in installing a new watercloset.

### 7.2.3.5.Self-Assessment

1. What pre-cautions should a plumber take for health and safety purposes?
2. Mention some health and safety issues that plumbers face?
3. What is the main use of the tool below?

4. What is the importance of good housekeeping?



5. A bench vice is used for holding pipes in position rigidly for cutting and threading. Which three parts can be identified from a bench vice?

6. What is your understanding of the following types of maintenance?
    i. Preventive maintenance
    ii. Predictive maintenance

7. What are the various types of protective equipment used by plumbers?

8. Why are plumbing maintenance reports & schedules important?

### 7.2.3.6.Tools, Equipment, Supplies and Materials

**Functional Plumbing Workshop with the following:**

**Tools and Equipment**

- Pipe wrench
- Pipe cutter
- Hacksaw
- Pipe Threading Equipment
- Vices
- Taps
- Punch
- Files
- Screwdrivers
- Drill with various sizes of bits
- Portable drill
- Mallet
- Ball pein0 hammer
- Mason chisel
- PPR machine / Heat Fusion equipment
- Pipe bender
- Trowel
- De-clogging wire / de-clogging machine
- Toilet pump



**Supplies and Materials**

- Screws
- Adhesives
- Cement
- Sand
- Pipes
- Traps
- Electric cables
- Caulking material
- Fitting

**7.2.3.7.References**

I.C.S. Lewis., Samuel R. & Staff., Plumbing tools and Materials., 1991

C.J. Smith., B. Curry., Practical Plumbing (The Motivate series).,1998

F. Hall., Plumbing Technology

### 7.2.3.8.Model Answers

1. What pre-cautions should a plumber take for health and safety purposes?
   - Avoid awkward body positions, and take break every 30 minutes.
   - Learn safe lifting techniques
   - Wear appropriate footwear and gloves while handling sewage plant or metal pipes
   - Keep tools and equipment's in working condition, to avoid any unexpected accident due to inoperative tools
   - To avoid electric shock use only power tools that can be used in a wet environment and have GFCI (Ground fault circuit interrupter).
   - Keep work area clear

2. What is some of the importance of proper storage of tools and equipment?

   - it is an important factor for safety and health as well as good business
   - Improves appearance of general-shop and construction areas
   - Reduces overall too cost through maintenance.
   - This also ensures that tools are in good repair at hand
   - Teaches workers principles of (too) account ability



3. What are some pointers to follow in storing tools and equipment?
   - Have a designated place or each kind of tools.
   - Label the storage cabinet or place correctly for immediate finding.
   - Store them near the point of use
   - Wash and dry properly before storing
   - Store knives properly when rot in use with sharp edge down
   - Put frequently used item in conveniently accessible location
   - Gather and secure electrical cords to prevent entanglement or snagging.
   - Cutting boards should be stored vertically to avoid moisture collection.
   - Metal equipment can be stacked on one another after drying such as storage dishes and bowls.
   - Make sure the areas where you are stoning the equipment are clean, dry and not overcrowded

4. Mention some health and safety issues that plumbers face?

- Exposure to a hazardous substance like lead, sulfur dioxide, mould, carcinogenic substances
- Exposure to flammable and combustible materials
- Working in awkward positions may lead to musculoskeletal injuries
- Lifting heavy or awkward objects
- Risk of eye injury from flying particles
- Burns from hot equipment's like steam lines, hot water heater, etc.
- Cut and bruises due to a sharp end of pipes
- Risk of electric shock while digging under-ground water pipes

5. What is the main use of the tool below?

To tighten mildly tight against the non-threaded portion of a pipe that has a threaded end.



6. What is the importance of good housekeeping?
    - reduced handling to ease the flow of materials
    - fewer tripping and slipping incidents in clutter-free and spill-free work areas
    - decreased fire hazards
    - lower worker exposures to hazardous products (e.g., dusts, vapors)
    - better control of tools and materials, including inventory and supplies
    - more efficient equipment cleanup and maintenance
    - better hygienic conditions leading to improved health
    - more effective use of space
    - reduced property damage by improving preventive maintenance
    - less janitorial work

7. A bench vice is used for holding pipes in position rigidly for cutting and threading. Which three parts can be identified from a bench vice?
    - Sliding jaw
    - Screw
    - Stationary jaw
    - Dog

- Guide bars
- Handle
- Mounting bracket

**8.** What is your understanding of the following types of maintenance?

i. Preventive Maintenance

Preventive maintenance is aimed at catching and fixing problems before they happen. It is most commonly carried out in the form of regular inspections, usually occurring multiple times per year.

When you inspect a system or a piece of technology, carefully check for all signs of wear, tear or imminent breakdown. Replace damaged parts immediately. This will prevent having to go into "crisis mode" if something breaks unexpectedly.

The primary benefit of preventive maintenance is that it can eliminate unplanned shutdown time as you will ideally catch problems before they occur.



ii. Predictive Maintenance

Predictive maintenance refers to a specific type of condition-based maintenance in which systems are constantly observed via sensor devices. These devices are attached to components of the system and feed constant, real-time data to software. The software then interprets this data and warns maintenance technicians of approaching danger.

Predictive maintenance is generally considered to be the most advanced and intensive type of maintenance. This is because there is a lot of data to interpret – and the sensor devices themselves need to be regularly maintained and checked.

9. What are the various types of protective equipment used by plumbers?
    - Helmets
    - Masks
    - Googles
    - Safety shoes
    - Gloves
    - Safety belts and straps

10. Why plumbing maintenance are reports & schedules important?
    - It helps maintain reliability
    - It helps ensure safety
    - It improves efficiency
    - It promotes good recordkeeping

### 7.2.4 Learning Outcome 4: Test plumbing system

#### 7.2.4.1. Introduction to the learning outcome

This learning outcome specifies the content of competencies required to Test plumbing system. It includes, testing plumbing systems, types of tests and reinstating plumbing systems.

#### 7.2.4.2. Performance Standard

1. Plumbing system is tested based on specifications
2. Make good repaired work area based on best practices
3. Normal supply is reinstated where necessary as per the design



#### 7.2.4.3. Information Sheet

**Objectives of the Testing plumbing Works**

The objectives of the testing plumbing works are:

a. To verify proper functioning of the equipment/system after installation
b. To verify that the performance of the installed equipment/systems meet with the specified design intent through a series of tests and adjustments
c. To capture and record performance data of the whole installation as the baseline for future operation and maintenance.

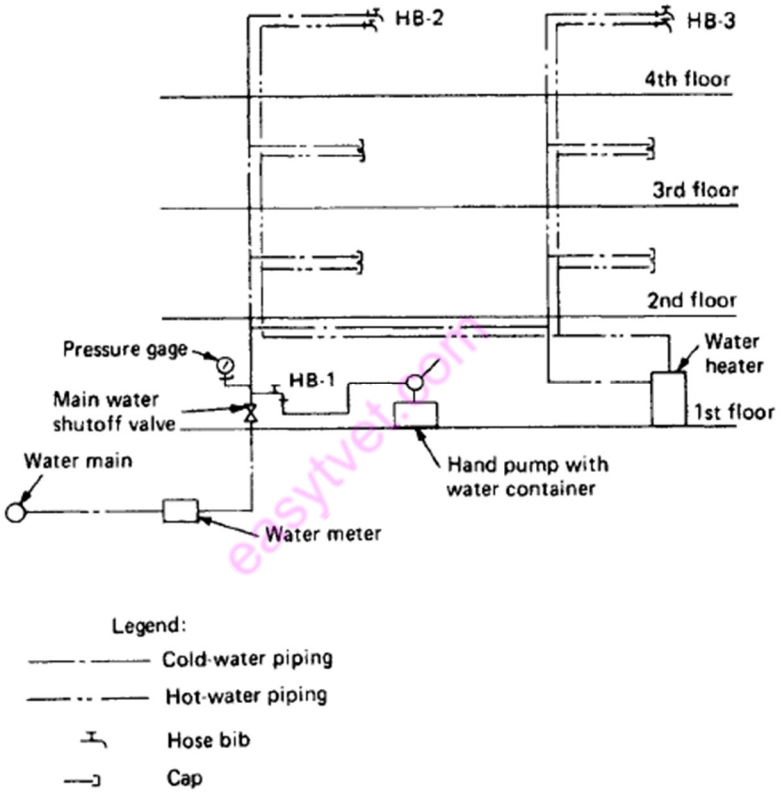
**Testing the Rough Piping Installation**

The following steps should be taken in testing the piping system before the fixtures, faucets, trim, and final connections are made to the equipment:

1. Install hose bibs for filling the piping system with water and to permit the evacuation of air from (i.e., venting) the system.

There should be a hose bib (or similar device) at the bottom of the piping system for filling the system with water and at least one more at the highest point of the system for venting.
Depending on the size and piping layout, several other hose bibs may be required for venting the system.

2. Cap all openings.
   All connections to future fixtures must be capped so they are watertight. Temporary caps will be removed after the pressure test, described below, is completed.




**piping layout**

3. Fill the system with potable water.
   With the bib at the top of the piping system in the open position, fill the system with water through the hose bib located at the bottom position. Air will then be forced out of the piping through the top bibs.
   During the time the piping system is being filled, all hose bibs for venting must be open. When water emerges from all the open hose bibs, all air in the system has been displaced by water. Then all hose bibs must be tightly closed.

4. Attach a pump and a pressure gauge to the piping system.

Depending on the size of the piping system, the pump (used to create pressure in the system) may be a manual pump or a centrifugal pump activated by an electric motor. In general, a manually operated pump is satisfactory for most applications. Water should then be pumped into the system until the pressure gage indicates the pressure desired for the test.

5. Subject the piping system to a hydrostatic test. The magnitude of the test pressure that is required by various codes or jurisdictions is different, but it is usually recommended that test pressure be equal to or higher than the following:
    a. % times the pressure at which the piping system will operate. Water pressure of existing water supplies can be obtained from the local water department.
    b. 125 psi (862 kPa).

6. Sustain the maximum pressure for a period of at least 3 h.
   After the test pressure is attained, close hose bib HB-1. Maximum pressure should be sustained for this period of time without any loss of pressure, as determined from readings of the pressure gage. If pressure is maintained, the system is watertight. If the pressure decreases, there is a leak in the system. The pipes should then be inspected to determine the location of the leaks. The leaks should be repaired and a new pressure test performed. This process must be repeated until it is shown that the maximum pressure is maintained without pressure loss for at least 3 h.

7. If during the testing procedure, the water supply system may be subject to freezing, an air test may be substituted for the hydrostatic test of Step 6.
   The air test is carried out as follows. First replace the water pump with an air compressor.
   Then raise the air pressure to 40 psi (276 kPa). At this pressure, check for leaks by applying liquid soap to the joints and connections. When all leaks appear to have been corrected, raise the air pressure to a value equal to 1% times the water pressure to which the system will be subjected. With the air compressor turned off and the hose bib HB-1 shut off, the pressure must be maintained within the system for a period of at least 2 h. If this is not the case, then previously undetected leaks must be found and repaired and the entire system retested.

**Testing the Complete Plumbing System**

After the rough piping installation has been shown to be watertight and has been accepted, then the following steps should be taken:

1. Install and connect all faucets, fixtures, hose connections, trim, and valves.
2. Connect the water piping system to the water supply.

3. Subject the entire system to the hydrostatic test of Step 5, above. Check for leaks. When all leaks have been detected and repaired, proceed with the operation test of the next step.
4. All bibs, fixtures, flush valves, pumps, tanks, and other appurtenances should be activated to show that the water quantities required for proper operation are adequate and that their operation is satisfactory.

## DISINFECTING THE WATER SUPPLY SYSTEMS IN BUILDINGS

After the above testing has been completed, all aerators, filters, and strainers should be cleaned (after disinfection, they must be replaced), and the entire system should be flushed with portable water to rid it of impurities and debris.

Water should be run through the piping by opening the various faucets and valves until, by visual inspection, the water appears to be running clean, and no impurities such as sand, rust, and similar small particles are observed in the bowls of the plumbing fixtures.

The following procedure, performed by approved applicators or qualified personnel, is recommended:

1. One of the following chemicals, all of which add chlorine to the water, may be used to disinfect water:
    - chlorine gas
    - chlorine liquid
    - sodium
    - hypochlorite
    - calcium hypochlorite
2. Inject a disinfecting agent through the hose bib located at the water service entrance. The injection should take place at a slow and even rate. The flow of this disinfection agent into the main connected to the public water supply is prohibited. Therefore, during disinfection, either the water supply connection should be disconnected or the main water valve should be effectively shut off to prevent any contamination from entering the main water supply.

3. Allow the disinfecting agent to flow into the system by opening hose bibs or faucets in each branch until the chlorine residual concentration is not less than 50 ppm of available chlorine. Then close all valves and accessories. Allow the chlorinated water to stand in the system for a period of not less than 24 hr.

4. After the 24-hr period of retention, the residual chlorine should not be less than 5 ppm. If it is less, the above process must be repeated.

5. If the concentration of residual chlorine is 5 ppm or greater, flush the system thoroughly with portable water before it is put in service.

6. The flushing should continue until;

    iii. the residual chlorine in the system, as measured by orthotolidin tests, is not greater than that in the main water supply
    iv. biological tests show that there is absence of coliform organisms. Such water samples should be taken from faucets located at the highest floor and farthest from the main water supply.

7. If it is impractical to disinfect the water storage tank by the above means, then the entire interior of the tank should be swabbed with a solution containing 200 ppm of available chlorine and allowed to stand for at least 3 hrs before flushing.

8. After final flushing of the system has been completed, at least one water sample should be obtained from the cold-water line and the hot-water line. Water samples must be submitted to a state laboratory which should certify that the water does not contain organisms in excess of standards for potable water.



## TYPES OF TESTS

Plumbing system inspection and tests

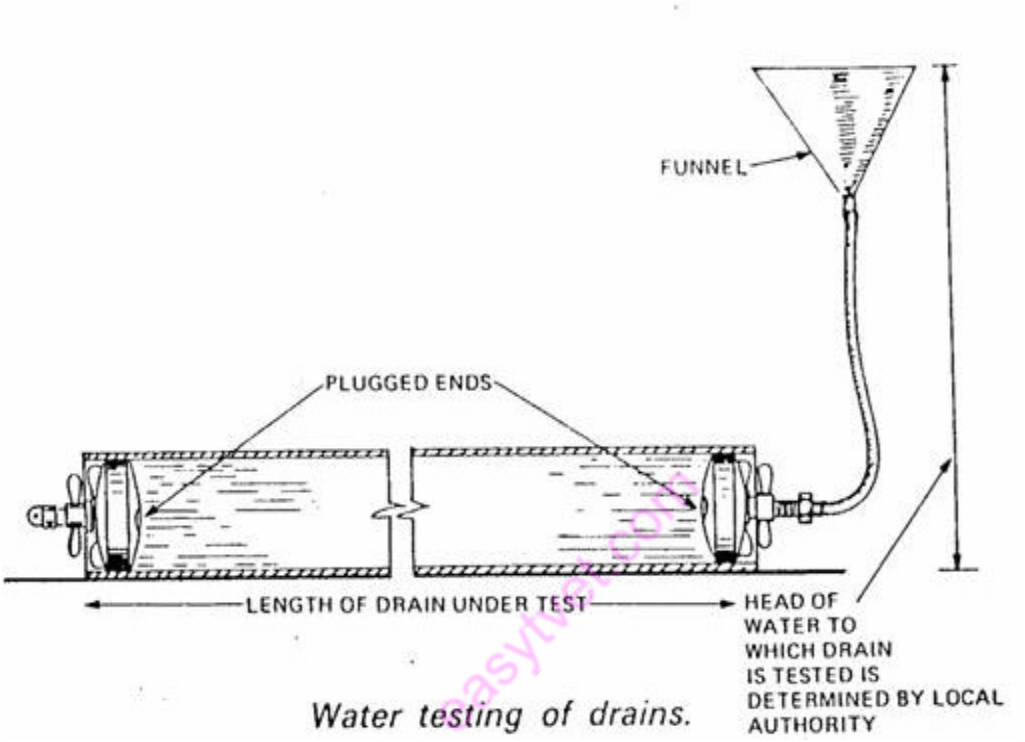
These tests are for the purpose of ensuring correct work, free from defects arising in construction and manufacture. There are three different methods of testing the plumbing system - the water test, air test and peppermint test or smoke test. Of these, the water, peppermint, and smoke tests are most commonly used.

The water and air tests are chiefly used as the first test on new work. When it comes to the final test, either the peppermint or smoke test may be applied.

On old work in residences and other finished and occupied buildings, the water test cannot be applied, owing to the damage that might result. Under these conditions, either the peppermint or smoke test should be used.

- Water test

Most plumbing codes allow air or water to be used for preliminary testing of drainage, vent, and plumbing pipes. After the fixtures are in place, their traps should be filled with water and a final test made of the complete drainage system.



Water testing of drains.

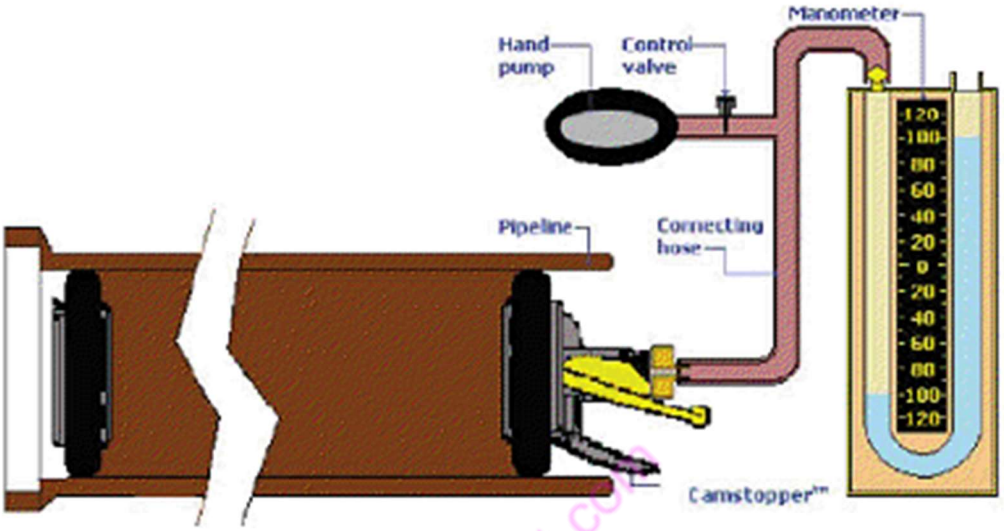
Procedure:
The water test shall be applied to the drainage and vent systems either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to a point of overflow.

If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a ten (10) foot (3m) head of water.

In testing successive sections, at least the upper ten (10) feet (3m) of the next proceeding section shall be tested, so that no joint or pipe in the building (except the uppermost ten (10) foot (3m) of the system) shall have been submitted to a test of less then a ten.(10) foot (3m) head of water. The water shall be kept in the system, or the portion under test, for at least fifteen (15) minutes.

- Air test

An air test is made by sealing all pipe outlets and subjecting the piping to an air pressure throughout the system. The system should be tight enough to permit maintaining this pressure for at least 15 min without the addition of any air.

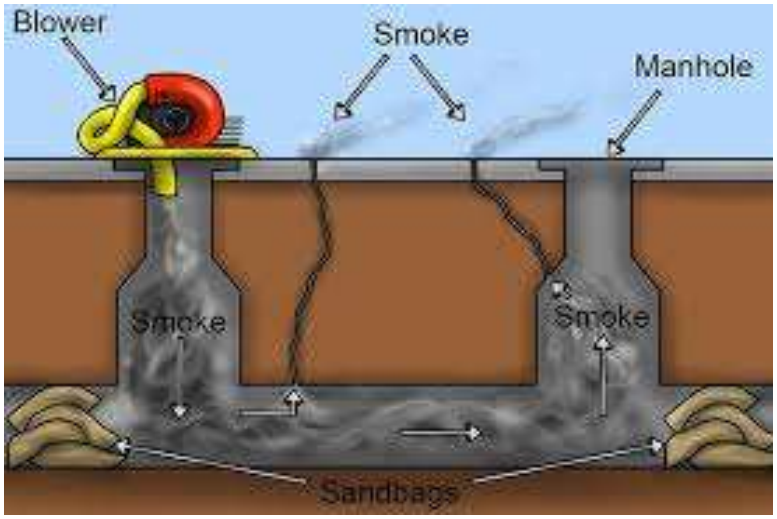





- Smoke test

The smoke test is another test that can be applied to roughed-in new work. It is used most frequently, however, in testing old work, or in testing new work after the fixtures have been set. The manner of applying a smoke test is to close all openings, the same as for the water test, and also the openings at the roof. The testing machine, which is made especially for this purpose, is then connected to the piping system, and the smoke turned into the pipes.

Oily waste or rags are placed in the machine and lighted, thus generating a heavy smoke which will entirely fill the pipes, and escape through any leaks that may exist—which are thereby easily detected. The smoke test is preferred by many, as it is cleaner than the water test, should any leaks develop, and there is no wetting down of the building.




- Peppermint test

The peppermint test is applied by putting about two ounces of oil of peppermint into the system at the roof, after all openings have been closed as with the other tests, and pouring about a gallon of hot water into the piping, immediately closing the opening with a plug kept at hand for the purpose. The fumes of the peppermint are supposed to travel throughout the system of piping, and to penetrate any existing leaks, the presence of which can then be detected from the characteristic smell. There being no pressure applied in this test, there is a possibility of the odour not escaping through very small leaks; and this test, therefore, is not so reliable as the water or smoke tests.

The person who puts the peppermint in the piping should not try to look for leaks, as he will carry the odour around with him through the building, and is apt to imagine that he smells leaks where in reality they do not exist.

- Building sewer test

Building sewers shall be tested by plugging the end of the building sewer at its point of connection with the public sewer or private sewer disposal system and completely filling the building sewer with water from the lowest to the highest point thereof, or by approved equivalent low pressure air test, or by another test as may be prescribed by the Administration Authority. The building sewer shall be watertight at all points.

- Water piping

Upon completion of a section or of the entire hot and cold water supply system, it shall be tested and proved tight under a water pressure not less than the working pressure in which it is to be used.

The water used for tests shall be obtained from a potable source of supply. A fifty (50) pound per square inch (344.5 kPa) air pressure may be substituted for the water test. In either method of test, the piping shall withstand the test without leaking for a period of not less than fifteen (15) minutes.

### 7.2.4.4.Learning Activities

**Activity**

You have purchased a used rubber hose at a market and are considering using the hose pipe as temporary channel for the waste water from you washing machine to the washbasin, but you are concerned about leaks.

Before installing the pipe test the hose for leaks.



### 7.2.4.5.Self-Assessment

1. Testing plumbing systems is the responsibility of the building owner
    a. False
    b. True

2. For some installations, several plumbing systems can be tested and inspected simultaneously, such as the building sewer and water service when they are installed in the same trench
    a. False
    b. True

3. An air test is a plumbing system test in which inlets and outlets to the system are sealed and air is forced into the system until a uniform air pressure of 5 psi is reached and maintained for 15 min without additional air being added to the system
    a. False
    b. True

4. A hand pump or portable air compressor is used to force air into the plumbing system, and is typically used when testing smaller installations, such as a one-family dwelling
    a. False
    b. True

5. Always wear a protective helmet (hard hat) and eye protection when performing air and water tests using test plugs and do not stand directly in front of an outlet where a test plug is installed
    a. False
    b. True

6. Malleable iron plugs and caps have male and female threads, and are removed from a pipe end using a pipe wrench
    a. False
    b. True



7. Water tests are typically performed on PEX systems since it is less time-consuming to perform a water test than an air test
    a. False
    b. True

8. A final air test is a test of the plumbing fixtures and their connections to the sanitary drainage system
    a. False
    b. True

9. Underground sanitary drainage and vent piping is tested and inspected after it is covered with earth and backfilled
    a. False
    b. True

10. Odor and final air test are performed on sanitary drainage and vent piping
    a. False
    b. True

**7.2.4.6. Tools, Equipment, Supplies and Materials**

**Functional Plumbing Workshop with the following:**

**Tools and Equipment**

- Pipe wrench
- Pipe cutter
- Hacksaw
- Pipe Threading Equipment
- Vices
- Taps
- Punch
- Files
- Screwdrivers
- Drill with various sizes of bits
- Portable drill
- Mallet
- Ball pein0 hammer
- Mason chisel
- PPR machine / Heat Fusion equipment
- Pipe bender
- Trowel
- De-clogging wire / de-clogging machine
- Toilet pump

**Supplies and Materials**

- Screws
- Adhesives
- Cement
- Sand

- Pipes
- Traps
- Electric cables
- Caulking material
- Fitting

**7.2.4.7.References**

Fred Hall & Roger Greeno., 2009., Building services handbook incorporating current building & Construction regulations., 5th Edidition

David V. Chadderton., 2007., Building Services Engineering., 5th Edition

**7.2.4.8.Model Answers**

1. Testing plumbing systems is the responsibility of the building owner
    a. **False**
    b. True

2. For some installations, several plumbing systems can be tested and inspected simultaneously, such as the building sewer and water service when they are installed in the same trench
    e. False
    **f. True**



3. An air test is a plumbing system test in which inlets and outlets to the system are sealed and air is forced into the system until a uniform air pressure of 5 psi is reached and maintained for 15 min without additional air being added to the system
    e. False
    **f. True**

4. A hand pump or portable air compressor is used to force air into the plumbing system, and is typically used when testing smaller installations, such as a one-family dwelling
    a. False
    **b. True**

5. Always wear a protective helmet (hard hat) and eye protection when performing air and water tests using test plugs and do not stand directly in front of an outlet where a test plug is installed
    a. False
    **b. True**

6. Malleable iron plugs and caps have male and female threads, and are removed from a pipe end using a pipe wrench
    a. False
    **b. True**

7. Water tests are typically performed on PEX systems since it is less time-consuming to perform a water test than an air test
    **a. False**
    b. True

8. A final air test is a test of the plumbing fixtures and their connections to the sanitary drainage system
    e. False
    **f. True**



9. Underground sanitary drainage and vent piping is tested and inspected after it is covered with earth and backfilled
    **a. False**
    b. True

10. Odor and final air test are performed on sanitary drainage and vent piping
    **a. False**
    b. True