Plumber (General)

(Job Role)

Qualification Pack: Ref. Id. PSC/Q0104

Sector: Plumbing

Textbook for Class IX

17920

विद्ययाऽमृतमश्नुते

एन सी ई आर टी
NCERT

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Foreword

The National Curriculum Framework–2005 (NCF–2005) recommends bringing work and education into the domain of the curricular, infusing it in all areas of learning while giving it an identity of its own at relevant stages. It explains that work transforms knowledge into experience and generates important personal and social values such as self-reliance, creativity and cooperation. Through work one learns to find one's place in the society. It is an educational activity with an inherent potential for inclusion. Therefore, an experience of involvement in productive work in an educational setting will make one appreciate the worth of social life and what is valued and appreciated in society. Work involves interaction with material or other people (mostly both), thus creating a deeper comprehension and increased practical knowledge of natural substances and social relationships.

Through work and education, school knowledge can be easily linked to learners' life outside the school. This also makes a departure from the legacy of bookish learning and bridges the gap between the school, home, community and the workplace. The NCF–2005 also emphasises on Vocational Education and Training (VET) for all those children who wish to acquire additional skills and/or seek livelihood through vocational education after either discontinuing or completing their school education. VET is expected to provide a 'preferred and dignified' choice rather than a terminal or 'last-resort' option.

As a follow-up of this, NCERT has attempted to infuse work across the subject areas and also contributed in the development of the National Skill Qualification Framework (NSQF) for the country, which was notified on 27 December 2013. It is a quality assurance framework that organises all qualifications according to levels of knowledge, skills and attitude. These levels, graded from one to ten, are defined in terms of learning outcomes, which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. The NSQF sets common principles and guidelines for a nationally recognised qualification system covering Schools, Vocational Education and Training Institutions, Technical Education Institutions, Colleges and Universities.

It is under this backdrop that Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal, a constituent of NCERT has developed learning outcomes based modular curricula for the vocational subjects from Classes IX to XII. This has been developed under the Centrally Sponsored Scheme of Vocationalisation of Secondary and Higher Secondary Education of the Ministry of Human Resource Development.

This textbook has been developed as per the learning outcomes based curriculum, keeping in view the National Occupational Standards (NOS) for the job role and to promote experiential learning related to the vocation. This will enable the students to acquire necessary skills, knowledge and attitude.

I acknowledge the contribution of the development team, reviewers and all the institutions and organisations, which have supported in the development of this textbook.

NCERT would welcome suggestions from students, teachers and parents, which would help us to further improve the quality of the material in subsequent editions.

HRUSHIKESH SENAPATY
Director
National Council of Educational
Research and Training

New Delhi
June 2018

About the Textbook

Plumber (General) is an important job role in the installation and repair of plumbing fittings and fixtures. A Plumber (General) is responsible for installation, minor repair maintenance and servicing of pipes and sanitary fixtures in housing, commercial and institutional set-ups. The person should be able to work independently on the assignment, be comfortable in performing laborious work, be a good listener, good at following instructions, a cooperative team player and result-oriented, with a positive attitude. Plumber (General) is a beginner's level course. On completion of this course, a student can take up an intermediate level course for a job role in the plumbing sector, such as Plumber (General-II), in Classes XI and XII.

The textbook for the job role of Plumber (General) has been developed to impart knowledge and skills through hands-on learning experience, which forms a part of experimental learning. Experimental learning focuses on the learning process for the individual, therefore, the learning activities are student-centred rather than teacher-centred.

The textbook has been developed with the contribution of the subject experts, vocational teachers, industry experts and academicians, for making it a useful and inspiring teaching-learning resource material for the vocational students. Adequate care has been taken to align the contents of the textbook with the National Occupational Standards (NOS) for the job role so that the students acquire the necessary knowledge and skills as per the performance criteria mentioned in the respective NOS of the Qualification Pack (QP).

Unit 1 of the textbook gives an introduction to plumbing and its importance. Unit 2 focuses on the tools used in plumbing. It includes the various types of manual tools required for carrying out plumbing tasks. Unit 3 deals with the plumbing material and pipes used in plumbing. Unit 4 focuses on the measurement and symbols used in plumbing. Unit 5 deals with pipe fittings, joints and valves.

This textbook could not have been completed without the support of the Indian Plumbing Skill Council (IPSC), New Delhi. NCERT would like to acknowledge and thank IPSC for giving us the permission to use the pictures in this textbook.

We extend our gratitude to all the contributors for selflessly sharing their precious knowledge, acclaimed expertise and valuable time, and positively responding to our request for development of the textbook.

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Contents

Do You Know?

According to the 86th Constitutional Amendment Act, 2002, free and compulsory education for all children in 6-14 year age group is now a Fundamental Right under Article 21-A of the Constitution.

EDUCATION IS NEITHER A PRIVILEGE NOR FAVOUR BUT A BASIC HUMAN RIGHT TO WHICH ALL GIRLS AND WOMEN ARE ENTITLED

Give Girls Their Chance !

Unit 1

Introduction to Plumbing

Introduction

The plumbing and sanitary system is an essential part of every house or building. Proper planning and designing of plumbing system is crucial as it takes care of the hygiene requirements of the occupants. It has been reported that about 8 per cent of the construction cost of a building is marked for plumbing and sanitary work.

A plumber's job role consists of installation, repair, maintenance and servicing of plumbing fittings and fixtures. Besides having a thorough understanding of the mechanisms required for performing various tasks, a plumber should be laborious, have effective communication skills and be a result-oriented worker with a positive attitude.

Role of Plumbing

As you may be aware, water is supplied to a house or a building from storage tanks through pipes. Similarly, the waste water from kitchen and washrooms is drained out with the help of pipes. Any building, be it a residential,

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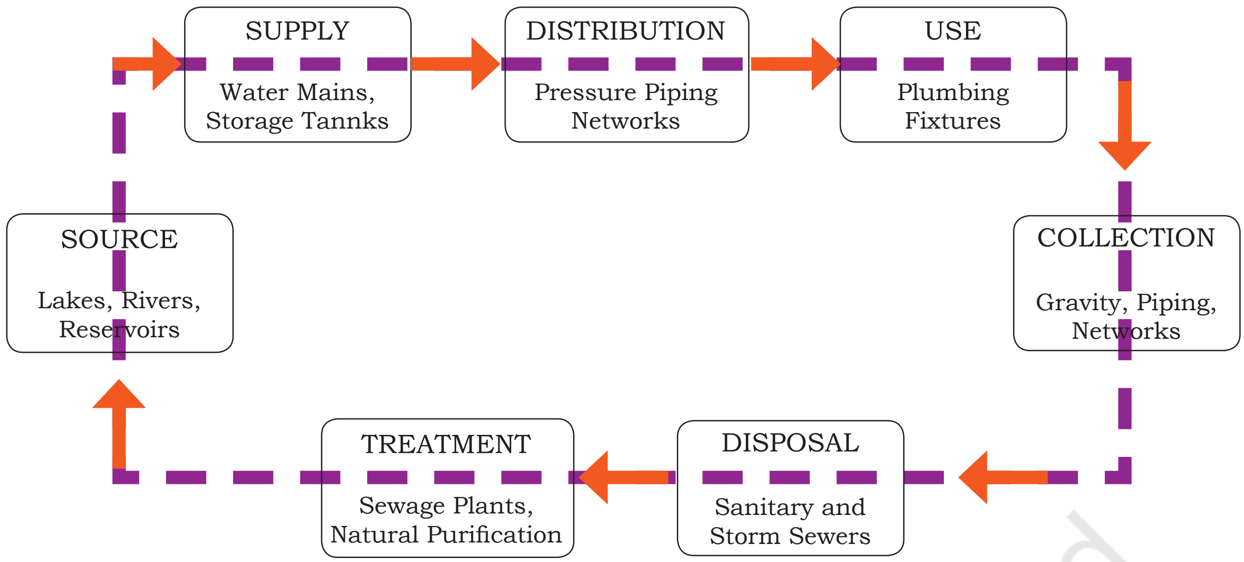

Fig.1.1: Plumbing cycle

commercial or industrial, cannot function properly without having plumbing and sanitary arrangements in place. It is, therefore, important to have regular and adequate water supply and a proper system for the disposal of waste water. Plumbing cycle refers to a mechanism through which water is taken from a source, then supplied to the users, and finally waste water is collected and recycled to the source after proper treatment (Fig. 1.1).

Plumbing and pipe-fittings play a major role in the construction of all types of buildings. An efficient plumbing work keeps the atmosphere free from bad smell and ensures better sanitation.

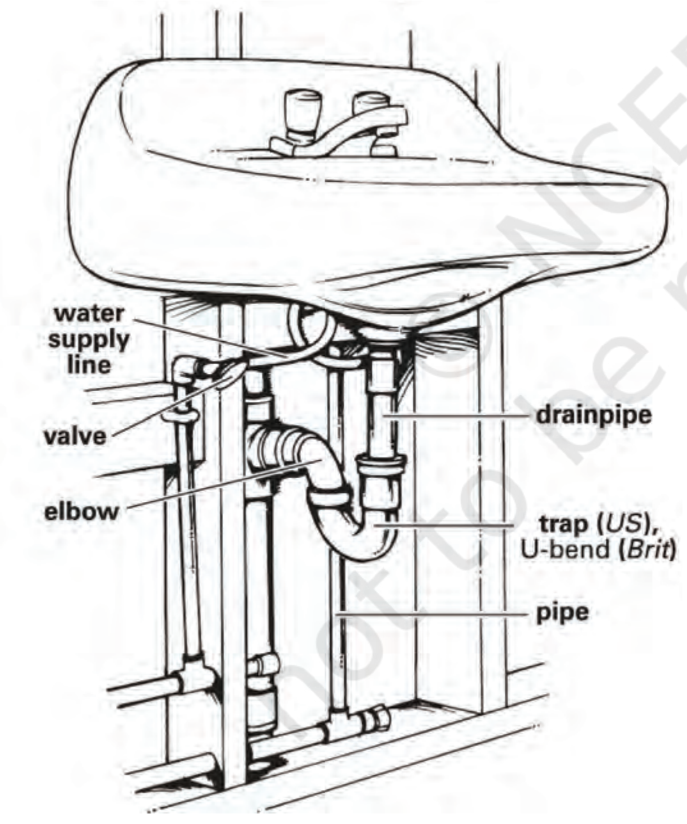

Fig. 1.2: Washbasin and its components

Plumbing

The skill and art that is needed to transport water from the source to the users, then to the treatment plants, and finally supplying the treated water to the users through a distribution system is known as **plumbing**. It is a system of pipes and fittings that carry water.

Sanitary Work

Sanitary work refers to carrying the waste water to the waste disposal system (sewerage system) through plumbing fixtures.

The plumbing installation is governed by the regulations and rules adopted by the concerned municipal corporations or committees of different States and Union Territories. Plumbing and sanitation work thus plays an important role in the construction of a building.

A plumbing system consists of pipe fittings and appliances used for water supply and drainage, as you see the fitting for the washbasin in Fig. 1.2. In this system, different pipes are used for different purposes. The plumbing system includes:

- water supply, galvanized iron (or plastic) pipes and fixtures;
- soil pipes and fixtures;
- sanitary drainage system; and
- rainwater drainage system.

For an efficient plumbing system, it is important that standard plumbing and sanitary material, as per the Bureau of Indian Standards (BIS), are used. It is also important that quality workmanship, practical checks and supervision are ensured during plumbing and sanitary work. It helps in getting the best out of the skilled and unskilled labour.

Before starting the work, the plumber must keep the following points into consideration.

1. Water supply system: sources of clean and potable water
2. Plumbing fixtures and pipes: knowledge about different requirements and specifications
3. Sanitary and drainage system: knowledge about sewerage system
4. Rainwater drainage system
5. Plumbing drawing and their uses: role of plumbing drawing

Notes

NOTES

Practical Exercises

Activity 1

Observation of the plumbing system in your school.

Material Required

1. Pencil or Pen
2. Notebook

Procedure

1. Identify the plumbing items fitted in the school.
2. Make a list of the identified plumbing items.
3. Identify the material used in plumbing fittings and fixtures.

Activity 2

Observation of the plumbing system in your house.

Material Required

1. Pencil or Pen
2. Notebook

Procedure

1. Identify the plumbing items fitted in the house.
2. Make a list of the identified plumbing items.
3. Identify the material used in plumbing fittings and fixtures.

Check Your Progress

A. Answer the following questions

1. Define the plumbing system.
2. Why is plumbing system necessary for all types of building?
3. What are the main components of a plumbing system?

B. Fill in the blanks

1. Every residential building should have regular and adequate ______________supply.
2. Sanctary work refers to carrying the waste water to the waste disposal system through ________.
3. Water is supplied through ____________________and fittings.
4. A plumber is responsible for ________, ________, __________ and __________ of pipes and sanitary fixtures.

C. Mark the correct option

1. The skill and art of transporting water from the source to the treatment plants and then to the end user is known as___________________.
   (a) masonry
   (b) construction
   (c) plumbing
   (d) concreting
2. From the total building construction, the appropriate cost percentage usually marked for plumbing and sanitary work is_____________________.
   (a) 12 per cent
   (b) 10 per cent
   (c) 5 per cent
   (d) 8 per cent
3. Plumbing and pipe fittings play a major role in the construction of buildings like
   (a) Residential
   (b) Commercial
   (c) Industrial
   (d) All of the above
4. Which of the following is the correct order of stages in a plumbing cycle?
   (a) Supply, Distribution, Disposal, Treatment
   (b) Disposal, Distribution, Supply, Treatment
   (c) Supply, Treatment, Disposal, Distribution
   (d) Treatment, Supply, Disposal, Distribution

NOTES

Unit 2

Tools for Plumbing

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Introduction

So far, we have studied the importance of plumbing system, its stages and the role and responsibilities of a plumber. We will now look at the various tools that help a plumber perform the plumbing activities effectively. Like any other sector, a thorough knowledge and working of tools and equipment used in plumbing are essential for a plumber to carry out the tasks.

A plumber requires several tools for the fitting work for plumbing, fixing a tap or to carryout repairs. These tools help the plumber in performing his/her work properly, and therefore it is important that the tools are used systematically and handled carefully to avoid any damage. They should be kept at a designated place after use. The tools can be categorised as per the nature of work like holding tools, fitting tools, cutting tools, pipe threading and bending tools, etc.

The major tools used in plumbing are categorised as:

1. *Holding tools*
   (a) Bench vice
   (b) Pipe vice

2. *Fitting tools*
   (a) Wrenches
   (b) Water-pump pliers
   (c) Spanners
3. *Cutting tools*
   (a) Pipe cutter
   (b) Hacksaw
4. *Pipe bending tools*
   (a) Pipe bending machine
   (b) Threading dies
5. *Other tools*
   (a) Chisel
   (b) Hammer
   (c) Chain wrench
   (d) Rover jumper
   (e) Trowel
   (f) Screw driver
   (g) File
   (h) Plier
   (i) Caulking tools
   (j) Drill machine
   (k) Drill bit
   (l) Hanger
   (m) Measuring tape
   (n) Plumb rule and bob
   (o) Spirit level
   (p) Spade
   (q) Shovel
   (r) Pickaxe
   (s) Mortar pan
   (t) Masons' square
   (u) Water level tube

Holding Tools

Tools which are used for holding the pipes, pipe fittings and fixtures for plumbing operations are called holding tools. Some of the commonly used holding tools are mentioned below.

Bench vice

A **vice** is a tool used for holding an object for various tasks like filing, chipping, sawing, threading, tapping,

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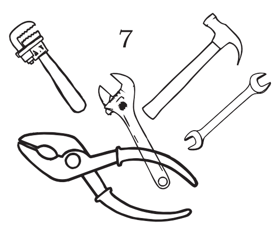

Fig. 2.1: Bench vice

bending, etc. The bench vice has two jaws, one of which is fixed and the other is movable. These jaws are fitted with plates for a better grip on the object during the task. The vice size depends on the width of the jaw. A bench vice is fixed to a table or a bench through a bolt. A vice is opened and closed with the help of a handle attached to a spindle. In this way, the object is held tightly. Bench vices hold the objects and allow use of other tools to complete the tasks (Fig. 2.1).

Fig. 2.2: Pipe vice

Pipe vice

It is a tool used for holding a pipe for carrying out assembly, disassembly, threading, cutting, etc. Pipe vices are of two types:

(i) Open side pipe vice

(ii) Fixed side pipe vice

Standard sizes of vices are 80 mm, 105 mm, 130 mm, 170 mm, etc., as per the opened size of the jaws.

Fitting Tools

While holding tools are used to keep the objects in place, fitting tools are used for carrying out various plumbing operations like cutting, tightening, fixing and other small tasks.

Wrenches

Fig. 2.3: Pipe wrenches

These are hand tools used for tightening and loosening the nuts and bolts. Wrenches hold slippery or small nuts and bolts for loosening or tightening them. Mostly, two types of wrenches are used—adjustable and non-adjustable. These are useful particularly in case of odd-sized nuts and bolts. These tools hold a pipe and pipe fittings for screwing or unscrewing. This is a very common tool, especially for small diameter pipes up to 50 mm.

Adjustable wrench

This type of wrench is used to loosen or tighten the nuts and bolts of any odd and regular sizes. It is used for tightening and loosening valves, cocks, geysers, flexible pipes, etc. It is a good maintenance tool for repair of plumbing items like valves, cocks, pumps, etc.

Fig. 2.4: Different type of wrenches (adjustable)

Fig. 2.5: Adjustable wrench

It has a fixed flat jaw with a handle and a square-toothed screw (Fig. 2.5). The movable flat jaw slides in the body of the fixed jaw with the support of a screw. The gap between the flat jaws is used to hold the object to be twisted for screwing or unscrewing.

Water-pump plier

Fig. 2.6: Water-pump pliers

It is a common plier used by plumbers for holding, tightening and loosening work during fixing process.

Steel is used for manufacturing water-pump pliers. These are available in only one standard size of 250 mm length. The maximum width possible between the two jaws is 40 mm (Fig. 2.6).

Spanners

This tool is used for tightening and loosening nuts and bolts of standard size. The standard spanners used are:

Ring spanners

Fig. 2.7a: Ring spanner

These spanners have full circular closed ring at both ends. It is difficult to slip and cause damage. It is made through forging process, with a burnished finish or a chrome-plating (Fig. 2.7a).

Open-ended spanners

Fig. 2.7b: Open-ended spanner

These types of spanners are open from both sides and are used for tightening and loosening nuts and bolts (Fig. 2.7b).

A spanner having open-ended jaws slides through the nut or bolt with square or hexagonal heads. The bolts or nuts are then turned with the required force to screw or to unscrew. The two jaws have two consecutive sizes like 6 mm and 7 mm or 1/4″ and 5/16″, etc.

Fig. 2.7c: Combination spanner

Fig. 2.8: Bi-hexagonal spanner

Fig. 2.9: Pipe Cutter

Fig. 2.10: Hand-operated hacksaw

Fig. 2.11: Power hacksaw

Combination spanners

These spanners are open at one end and closed at the other (Fig. 2.7c).

Bi-hexagonal ring spanner

It has a bi-hexagonal shape at both the ends to hold a nut or bolt, the head of which is square or hexagonal. The sizes of the two ends are consecutive like 6 mm and 7 mm, 1/4″ and 5/16″, etc. (Fig. 2.8).

Cutting Tools

Tools that are used for cutting the pipes, fixtures and bolts, etc., are known as cutting tools. Some of the commonly used cutting tools are mentioned below.

Pipe cutter

This is a manual tool used to cut a pipe at the work site, especially when it is difficult to use a hacksaw frame. This tool has a sharp, round cutting wheel which is pressed with to and fro rotary motion for cutting a pipe (Fig. 2.9).

Hacksaw

This tool is generally used with both the hands. It cuts material like plastic pipe, steel rod, angle iron, sheets, iron pipes, etc. It can also be used for cutting the bolt heads and nuts when they are jammed. Important parts of a hacksaw are—handle, frame, blade and adjusting wing nut (Fig. 2.10).

A hand-operated hacksaw is used for site work while a power hacksaw is used in a workshop for cutting heavy pipes quickly (Fig. 2.11).

Pipe bending tools

In most of the plumbing operations, pipes are required to be bent at different angles as per requirement, for which pipe bending tools are used. Some of these tools are mentioned below.

Pipe bending machine

This equipment is used to bend or turn pipes. The size and strength of the machine depends upon the diameter of the pipe and the type of the pipe material to be bent. The mechanical or hand-operated pipe bending machines are available for 3/8– 1″ diameter pipes. For higher ranges, i.e., 1/2–2″, 1/2 – 3″, 1/2– 4″ and 2– 6″, hydraulic hand-operated machines are used (Fig.2.12).

Fig. 2.12: Pipe bending machine

Threading dies

Threading is crucial for joining pipes and fixtures effectively. A threading die is used for making threads in a pipe where it is to be joined with another pipe or fixture (Fig. 2.13).

Fig. 2.13: Threading die

Other Tools

Apart from the already mentioned holding, fitting, cutting and bending tools, various other tools are also used in plumbing operations. These are listed below.

Chisel

It is made of hard metal and is mostly used for cutting concrete surface and making grooves in the walls with the help of a hammer. (Fig. 2.14)

Fig. 2.14: Chisel

Hammer

These are general purpose workshop hand tools used for straightening of sections, riveting, striking of nails and inserting the component by striking, inserting keyways and fitting by striking. The hammer consists of a head made of hard and tampered steel, and a wooden handle. The head has a flat striking face and the other side is called pein. The peins are classified as per different shapes such as ball pein, cross pein and straight pein. The hammers made of hardened steel are known as engineer's hammers and are usually used while working with steel components. A one-kilogram hammer is the most commonly used hammer (Fig. 2.15).

Fig. 2.15: Hammers

Chain wrench

The common holding tools do not help much in case of large diameter pipes. For these, chain wrenches are used. A chain wrench consists of a toothed block, a

Fig. 2.16: Chain wrench

handle and a chain. The chain is round, grooved and held on the toothed end of the block. The chain grips the pipe fitting and screws or unscrews. The chain wrench is available in 3″, 4″, 6″, 8″ and 12″,with the length 475 mm, 585 mm, 834 mm, 1100 mm and 1360 mm respectively. These sizes are designated by the maximum diameter of the pipe it can hold (Fig. 2.16).

Screwdriver

Fig. 2.17: Screwdriver

This tool is often used by plumbers to fit the screws. Screwdrivers have a sharp tip which can easily fit into various screws. Different types of screwdriver are used for various types of screw. Various types of heads of the screwdriver are used by plumbers (Fig. 2.17).

Files

Fig. 2.18: File

These hand tools are used for a variety of work, like removing of sharp edges, metal removal, shaping of jobs, smoothening of surfaces, finishing, producing different shapes, etc. The file has five parts: tang, heel, face, edge and point or tip. Various types of files of different shapes like hand round, pillar, square, three square, half round, flat, knife edge and needle file are used as per the work (Fig. 2.18).

Pliers

Fig. 2.19: Plier

They are important tools used for holding small objects and for tightening or loosening various parts. Several types of pliers are used by a plumber during work. Pliers can be used for cutting purpose also. Various shapes and sizes of pliers are available in the market. Pliers of different types are shown in Fig. 2.19.

Caulking tools

Fig. 2.20: Caulking tools

For filling the gaps in the wall, caulking tools are used. This tool helps in filling and removing material in the building (Fig. 2.20).

Drill machine

One of the common but important tools used for making a hole in a metal or wood, or concrete surface. A drill machine (Fig. 2.21) is fitted with a cutting tool like a drill bit. The attachment is tightened with a key.

Safety precautions

Before installing the bit in a drill machine, it should be sharpened.

The key in the chuck, a part of the drill machine used for tightening the drill bit, should be removed after tightening.

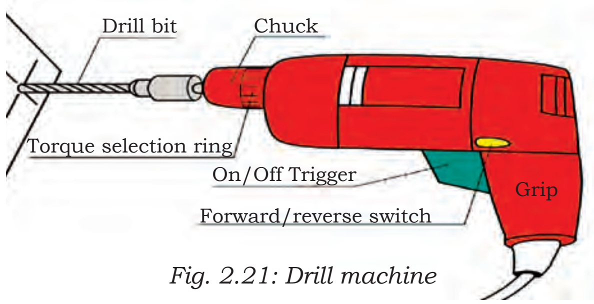

Fig. 2.21: Drill machine

Drill bits

These are the tools used to make cylindrical holes by cutting the material. Bits are fitted in a tool which rotates it and make the hole. For non-cylindrical shaped holes, specialised bits are used (Fig. 2.22).

Fig. 2.22: Drill bits

Hangers

The purpose of a pipe hanger is to hold or support a pipe or a group of pipes from a slab, beam, ceiling or other structural elements (Fig. 2.23).

Fig. 2.23: Pipe hangers

Measuring tape

It is used for measuring the length of an item. The measuring tape is manufactured in various material like steel, cloth and PVC. The length range available is one metre, two metres, three metres, five metres, 10 metres, 15 metres, etc. (Fig. 2.24).

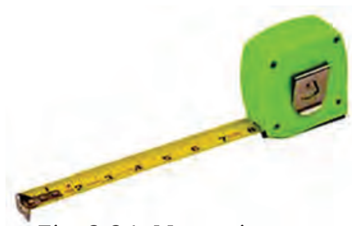

Fig. 2.24: Measuring tape

Plumb rule and bob

This is a useful tool to ensure verticality and uniformity during construction of walls, columns and wooden frames like doors and windows. It also helps in levelling the surface of the floor. It consists of a holding pipe, thread and a plumb bob made of wood and metal. The plumb bob is connected to the holding pipe with the thread (Fig. 2.25).

Fig. 2.25: Plumb bob

Spirit level

It is used to check the horizontality or levelling of the floor, roof, door, window frame, etc. (Fig. 2.26).

Fig. 2.26: Spirit level


Fig. 2.27: Trowel

Trowel

It is used for mixing cement and sand for masonry work. It is used for plastering the surface (Fig. 2.27).


Fig. 2.28: Spade

Spade

A spade is used for digging purpose and for mixing cement, sand and concrete. It consists of a flat form made of steel with an eye hole to hold the wooden handle. The size of a spade is designated by its width and length of the plank (Fig. 2.28).


Fig. 2.29: Shovel

Shovel

It is used for mixing concrete and also for carrying concrete to mortar pans. Shovels are made of steel sheets. The size is designated by its length and width (Fig. 2.29).


Fig. 2.30: Pickaxe

Pickaxe

It is made of steel and is used to excavate hard soil. One end of the pickaxe is flat whereas, the other end is sharp in design (Fig. 2.30).

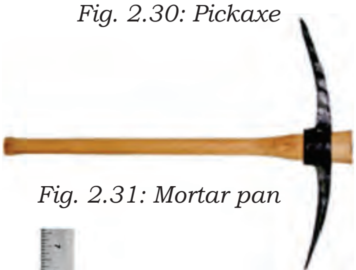
Fig. 2.31: Mortar pan

Mortar pan

This is used to carry the excavated material, cement mortar, concrete, etc. It should never be used for measurement of mixed cement mortar, etc. Mild steel sheet is used for making mortar pan (Fig. 2.31).


Fig. 2.32: Mason's square

Mason's square

It is used to check rectangularity of external and internal corners. It is made of carbon steel sheet. The dimension is also marked on both the sides, either in inch or centimetre (Fig. 2.32).


Fig. 2.33: Water level tube

Water level tube

This tube is used to check and transfer water levels, etc. Water is poured inside the tube at the time of use. Polythene tubes of varying diameter from 10 to 15 mm, and lengths varying as per the requirement are used (Fig. 2.33).

Rover jumper

It is used for making a gap in the wall so that plumbing fixtures can be fixed (Fig. 2.34).

Fig. 2.34: Rover jumper

Safety during work

The following precautionary measures may be taken for the safe use of the plumbing tools.

1. Use the correct methods given in the 'Instruction Manual of tools' while using them.
2. Use the appropriate tools required for the specific work or job. For example, do not use pliers instead of a hammer; use only a hacksaw to cut.
3. Keep the tools in working condition and ensure the required maintenance.
4. Ensure that the necessary protective equipment are available.
5. Follow safety methods while using electrical wires.
6. Use kerosene oil for removing dust from rusty nuts.
7. Do not use tools without a handle as they may not give proper grip.
8. Remove burrs or stuck material from the head of the chisel and the edges of tools.
9. Wear safety glasses while using power tools like a drill machine.
10. Keep metal parts lightly lubricated.
11. Do not apply excessive pressure or force.
12. Inspect the tools regularly.
13. Use or wear safety gear (helmet, gloves, goggles, safety shoes, ear plugs, etc.).

Practical Exercises

Activity 1

Draw figures of plumbing tools.

Material Required

1. Pen
2. Pencil
3. Plumbing tools

Procedure

1. Collect the plumbing tools available in your classroom.
2. Make a list of the plumbing tools available.
3. Draw figures of the plumbing tools and label them.

Activity 2

Draw figures of masonry tools.

Material Required

1. Pen
2. Pencil
3. Masonry tools

Procedure

1. Collect the masonry tools available in your classroom.
2. Make a list of the masonry tools available.
3. Draw figures of the masonry tools and label them.

Check Your Progress

A. Answer the following questions

1. List down the different plumbing tools and their uses.
2. Differentiate between the fitting tools and cutting tools.
3. What are the different parts of a drill machine?
4. What are the methods adopted for safe handling of the pipe cutter, pipe bending and drilling machines?

B. Fill in the blanks

1. The bench vice is a type of ________________tool.
2. The instrument which is used to check rectangularity of external and internal corners is called ______________.
3. For excavating hard soils, ___________ is used.
4. __________________ is a tool used for making a hole in a metal, wood or concrete.
5. A chisel is used for ________ and joining works.

C. Match the following

Column A	Column B
(1) Spanner	(a) Holding tool
(2) Hacksaw	(b) Fitting tool
(3) Threading dies	(c) Cutting tool
(4) Bench vice	(d) Pipe bending tool

Unit 3

Plumbing Material and Pipes

Introduction

Plumbing sector in India has witnessed a lot of development in the recent years. It has improved not only in terms of availability of better quality material, but also better technologies and processes which make the job role of a plumber even more interesting. Various types of new material and fittings have replaced traditional material, for example, plastic material has replaced Galvanized Iron material. The benefits include easy installation, easy-to-use material and cost-effectiveness. In this Unit, we will study about the different types of pipes and pipe material which are widely used by plumbers today.

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Sealing Material (Thread Seal Tape)

Thread Seal Tape or faucet is used for sealing pipe threads. It is manufactured from a poly tetra fluoro ethylene (PTFE) film. This tape is cut to the desired width and placed around the threads of a pipe, prior to fixing it in place (Fig. 3.1).

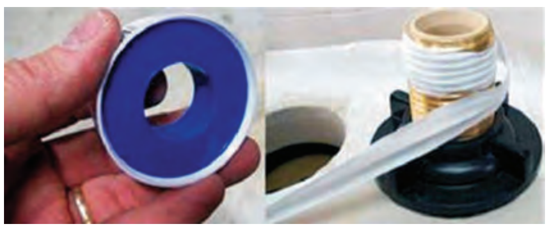


Fig. 3.1: Thread seal tape

Fig. 3.2: Plumber's putty

Plumber's Putty

The putty is used as a sealant during plumbing (Fig. 3.2). It is a simple material needed for watertight seal around taps (also called faucets) and drains. The putty is one of the important components of a plumber's bag.

Sealing Adhesives

Fig. 3.3: Sealing adhesive

These are used while joining plastic parts, fixtures, fittings, etc., and are mostly available in sanitary and hardware shops. These adhesives are made of chemicals. They can be used easily for an effective sealing. It is applied locally with a brush. After application, plumbing fitting should be fixed immediately so as to ensure a good grip (Fig. 3.3).

Plumbing Pipes

As you are aware, pipes are used for different purposes like transporting water for drinking, irrigation purpose, disposing the waste water, etc.

Plumbing pipes are manufactured in various sizes, mostly in a round shape. These pipes are made of various types of material as mentioned below.

Types of plumbing pipes

Commonly used pipes for plumbing system are listed below.

1. Cast Iron (CI) pipes
2. Ductile iron pipes
3. Steel pipes
4. Galvanized Iron (GI) pipes
5. Copper pipes
6. Asbestos Cement (AC) pipes
7. Concrete pipes
8. Stone ware pipes
9. PVC pipes

Cast Iron pipes (CI pipes)

Fig. 3.4: Cast iron pipes

These are mostly used as pressure pipes for transmission of water, gas and sewage and as water drainage pipes (Fig. 3.4). CI pipes have the following advantages—

(a) They are cheaper in cost.

(b) They have more resistance to rust and corrosion.

(c) They are highly durable.

CI pipes are uniform in thickness. Special care needs to be taken during carrying and shifting, and joining of CI pipes, to prevent damage.

Precautions

(i) The socket spigot ends must be dry.

(ii) Always caulk or seal the joint as soon as it solidifies.

Ductile Iron pipes

Fig. 3.5: Ductile iron pipes

These pipes are used for transmission and distribution of potable water.

They are made of ductile iron and are an improved version of Cast Iron pipes (Fig. 3.5).

Steel pipes

Fig. 3.6: Steel pipes

These are popular due to their strength and light weight, as compared to CI pipes. Adequate preventive measures are required so as to save these pipes from adverse atmospheric conditions (Fig. 3.6).

Use of steel pipes in the water supply system is recommended when pipes are to bear more pressure (i.e., above 7 kg/cm^2) and when the diameter needs to be large.

Galvanized Iron (GI) pipes

These pipes are mostly used inside the building for water supply work. A zinc coating is made on wrought steel pipes. These pipes are manufactured in light, medium and heavy grade category, as per the thickness of the metal. For a 15 mm diameter GI pipe, the pipe thickness is kept as 2.0 mm, 2.65 mm and 3.25 mm respectively for the light, medium and heavy category. Mostly, the

Fig. 3.7: Galvanized iron pipes

medium grade type pipes are preferred for internal plumbing work in a building. Screw and socket joints are mostly applied in GI pipes (Fig. 3.7).

Precautions

(i) Ensure that burrs around the pipes are removed before threading.

(ii) Use oil or lubrication during threading.

(iii) Rotate the die stock clockwise and anticlockwise while cutting threads on the pipe, so as to remove clips from the die.

(iv) The threaded portion should not be cut with a pipe cutter; always use a hacksaw for this work.

Fig. 3.8: Copper pipes

Copper pipes

These are mostly used for hot water installation requirements. They have high tensile strength. These are made from thin copper sheet and can be folded easily. Chromium is coated on copper pipes for better appearance (Fig. 3.8).

Asbestos Cement (AC) pipes

For removal of water (from the roofs), soil and waste, and for purifying the air, asbestos cement pipes (Fig. 3.9) are used. Two types of AC pipes are made— one with a beading around the socket (With Beading), and the other without beading around socket (Without Beading). The Without Beading around socket (WOB) type is mostly preferred over the one with beading. These pipes are available in the range of three metres of length. They are heavy and can break easily. The cost of these pipes is less than the PVC pipes. Nowadays, AC pipes are being replaced by PVC pipes.

Fig. 3.9: Asbestos Cement (AC) pipes with beading

Concrete pipes

As the name suggests, concrete pipes are made of plain concrete (mixture of broken stone or gravel, sand, cement and water), which is considered to be one of the strongest and most durable building material. Concrete pipes also come in different categories like unreinforced pipes, reinforced pipes and pre-stressed pipes. While the unreinforced pipes are made of only concrete, reinforced pipes contain iron mesh in addition to concrete, and pre-stressed pipes have iron rings at different intervals without any mesh.

Small diameters of unreinforced pipes, reinforced and pre-stressed pipes of large diameters, are manufactured for various uses as well as for water supply. Small unreinforced concrete pipes are mostly used for removal of water. For water supply works, pipes with bigger diameters are used (Fig. 3.10).

Fig. 3.10: Concrete pipes

Stone Ware (SW) pipes

These are made of clay, and are primarily used in sewerage system for underground drainage, industrial drainage, irrigation, chemical industry for transporting the highly corrosive chemical, etc. Stone Ware (SW) pipes are mostly used to carry night soil and effluent water. These pipes are laid below the surface. The pipes should be laid on regular surfaces as they are rigid in nature (Fig. 3.11).

Fig. 3.11: Stone ware pipes

PVC (Polyvinyl Chloride) pipes

These pipes are mostly used for carrying water in the plumbing system and are light in weight, non-corrosive, cheaper in cost and need not require any threading for joining connections. It makes them easily acceptable in the market (Fig. 3.12).

Fig. 3.12: PVC pipes

Chlorinated PVC (CPVC) pipes

These pipes can be used for higher temperatures up to 120°C, and are therefore suitable for supplying hot water and are mostly used in industrial liquid application.

Precautions

(i) The water supply and waste disposal pipes should not be laid very close to each other.

(ii) Ensure that there is no back flow of water through the pipes towards the source of water supply.

(iii) Avoid any cross connection between the water supply pipes and waste carrying pipes.

(iv) Pipe joints should be properly tightened in the pipeline for getting maximum water pressure.

(v) During installation of pipelines and waste water pipes, proper slope should be given.

(vi) For developing an underground pipeline, good quality of GI pipes, i.e., Class C pipes should be used.

Polypropylene pipes

These are manufactured with polypropylene 'random copolymer'. Polypropylene pipes are primarily used for carrying hot water and cold water supply conduits, industrial pipelines, etc. (Fig. 3.13).

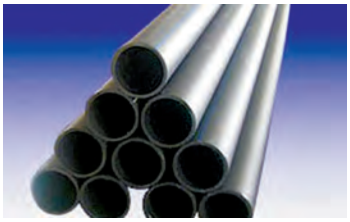


Fig. 3.13: Polypropylene pipes

(a) Unplasticised PVC (UPVC) or rigid pipes are used for cold water.

(b) Plasticised PVC pipes are made with mixing of rubber material. It has low strength and can work in low heat conditions than UPVC pipes.

PEX or XLPE

This type of pipe is made of specialised polyethylene and is used in building services, pipework system, domestic water piping, transportation of sewage, slurries and chemical transportation as well as for natural gas and offshore oil applications.

Fig. 3.14: PEX or XLPE pipe

In water discharge system pipes, the thickness of the soil and waste discharge pipes should be larger than the pipes used for roof drainage. Mostly, hard PVC pipes are always used for supply of water with temperature less than 45°C. At a higher temperature, the strength of the pipes reduces. The strength of PVC pipes reduces due to ultraviolet radiations from the sun as well as changes in atmospheric temperature. PEX or XLPE pipes are costlier than AC pipes and cheaper than GI pipes (Fig. 3.14).

Unplasticised Polyvinyl pipes

Fig. 3.15: Unplasticised Polyvinyl (UPVC) pipes

These are primarily used in ventilation pipework, rainwater applications and waste water discharge system (Fig. 3.15). High Density Polyethylene (HDPE) material is used for making pipes for municipal and industrial water discharge systems. Polyethylene density is classified into three types:

- Low Density Polyethylene raw material (LDPE)
- Medium Density Polyethylene raw materials (MDPE)
- High Density Polyethylene raw materials (HDPE)

The properties of HDPE pipes are—

(a) They are resistant to weather conditions.

(b) They have high resistance to tearing and pressure conditions.

(c) They are non-toxic in nature.

(d) They are suitable for carrying radioactive wastes.

Pipe Laying

It is an important process in plumbing. The steps involved in laying of pipes are:

1. before installation of a new pipeline in the building, a layout plan of water distribution of the pipes from the storage water tank is prepared.
2. line of alignment of the pipes are maintained properly.
3. chalk marking or powdered marking is done with the help of a thread or rope, on the proposed area of wall.
4. pipes are fixed horizontally or vertically as required from the source of main water.
5. threading in the pipelines is carefully done so that joints are well settled and leakage is prevented.
6. jute and white paste are properly applied over the threaded portion to prevent leakage and for having watertight joints.
7. efforts are made to keep the number of joints on the pipeline as minimum as possible.
8. the size of the pipes is selected according to the length of the service pipeline, minimum pressure of water in the distribution main, type of plumbing fixtures, i.e., elbows, bends unions, T-joints used in the building, rate of flow and highest point of delivery above the distribution main.

Notes

Care during work

1. Pipes should be cut to the required length.
2. The cotton thread should be wrapped on threaded portion of the pipe.
3. The packing material should be wrapped around the joint.
4. The pipe should be properly aligned.
5. Zinc oxide should be applied gently.

Practical Exercises

Activity 1

Identify the sealing material in a shop.

Material Required

1. Adhesive
2. Putty
3. Thread seal tape

Procedure

1. Collect the plumbing material from a shop.
2. Read the content written on the packing.
3. Identify the purpose of this material.

Activity 2

Identify the plumbing pipes in a shop.

Material Required

1. Different type of pipes

Procedure

1. Collect the pipes of different sizes available in the shop.
2. Identify the types of material used in the pipes.
3. Draw a figure of the pipes.
4. List the types of pipe and their use.

Check Your Progress

A. Explain the following

1. Differentiate between GI and CI pipes.
2. Why are GI pipes preferred over PVC pipes?

3. List the precautions one should take during laying of pipes.
4. List the uses of the GI, CI, asbestos and PVC pipes.

B. Mark the correct option

1. Use of steel pipes in the water supply system is preferred due to:
   (a) low budget
   (b) non-availability of other pipes
   (c) pipes can be subjected to very high pressure
   (d) low diameter pipes
2. The type of pipes suitable for supplying water of higher temperatures up to 120° C is:
   (a) CPVC
   (b) UPVC
   (c) PVC
   (d) PEX or XLPE
3 Pipes which are used for the removal of rainwater from roofs, soil and waste:
   (a) AC
   (b) PVC
   (c) GI
   (d) CI

C. Mention the full-forms of the following terms

1. GI pipes___________________
2. AC pipes___________________
3. UPVC pipes________________
4. CI pipes___________________

Unit 4

Measurements and Symbols used in Plumbing

17920CH04

Introduction

In the previous Units, we have covered plumbing tools, material and pipes. Besides knowing the benefits and suitability of material in various tasks, a plumber must also be efficient in measurement of plumbing material with the help of measurement tools and be able to manage conversion of units easily. Similarly, a plumber should also be able to understand and read the various symbols used in plumbing drawings.

Plumbing material is needed as per the requirement of the plumbing work to be done and its plan. Plumbing fitting and fixtures are available in the market in different sizes and types. The size of the plumbing items can vary from inch to feet and metre in height. Plumbing items are also available as per volumetric capacity like water tanks, storage and flush tank, etc. Knowledge of various dimensions and sizes of plumbing items is crucial in the proper selection and purchasing of plumbing material in the market.

Fig. 4.1: Measuring scale

Measurement of Length

A plumber uses the metallic tape, cloth tape, scale and foot rule for measuring. Metallic tape should be used for accuracy in the measurement. Metre and its divisions are printed on the measuring tape. The symbol of feet is (′) and the symbol of inch is (″). For example, the meaning of 4′-9″ is four feet nine inches. Both the systems, i.e., metric system and FPS (Foot-Pound-Second) system are used in plumbing measurement.

(a) In metric systems

1 metre = 10 decimetre (dm)

1 metre = 100 centimetre (cm)

1 metre = 1000 millimetre (mm)

10 millimetre = 1 centimetre (cm)

10 centimetre = 1 decimetre (dm)

10 decimetre = 1 metre (m)

(b) In the FPS system

1 feet = 12 inches

3 feet = 1 yard

(c) Inter-relation of Metric and FPS system: Both type of systems can be interrelated, for taking length, in the following manner :

1 inch = 25.4 mm = 2.54 cm

1 metre = 39.37 inches = 1.09 yard

Measurement of Weight

Conversion Tables Weight

1 kilogram	= 10 hectograms
1 kilogram	= 100 decagram
1 kilogram	= 1000 gram
100 kilogram	= 1 quintal
1000 kilogram	= 1 metric ton
1 kilogram	= 2.2046 pounds

Length Conversion

Length conversion is depicted in the following.

1millimetre (mm)	= 0.03937079 in, or about 1/25 in	
10 millimetre	= 1 centimetre (cm)	=0.3937079 in
10 centimetres	= 1 decimetre (dm)	=0.3937079 in
10 decimetres	= 1 metre (m)	= 39.37079 in, 3.2808992 ft, or 1.09361 yd
10 metres	= 1 decametre	= 32.808992 ft
10 decametres	= 1 hectometres	= 19.927817 rods
10 hectometres	= 1 kilometre (km)	= 1093.61 yd, or 0.621377 mile
10 kilometres	= 1 myriametre	= 6.21377 mile
1 inch	= 2.54 cm	1 foot = 0.3048 m 1 yard = 0.9144 m
1 rod	= 0.5029 decametre	1 mile = 1.6093 km

Measurement of Length

Length conversion is depicted in the following.

1 millimetre (mm)	= 0.03937079 in, or about 1/25 in
10 millimetre	= 1 centimetre (cm) = 0.3937079 in
10 centimetres	= 1 decimetre (dm) = 3.937079 in
10 decimetres	= 1 metre (m) = 39.37079 in, 3.2808992 ft, or 1.09361 yd
10 metres	= 1 decametre = 32.808992 ft
10 decametres	= 1 hectometres = 19.927817 rods
10 hectometres	= 1 kilometre = 1093.61 yd, or 0.621377 metre

1 inch	= 2.54cm, 1 foot = 0.3048 m, 1 yard = 0.9144 metre
1 rod	= 0.5029 decametre
1 mile	= 1.6093 kilometre

Measurement of Volume

Conversion Table for Volume

Volume conversion is depicted in the following.

10 litres= 1 decilitre (dl) = 2.6417 gal, or 1.135 pk
10 decilitres = 1 hectolitre (Hl) = 2.8375 bu
10 hectolitres = 1 kilolitre (kl) = 61027.0515 cubic inch or 28.375 bu
1 cubic foot = 28.317
1 gallon (American) = 3.785 l
1 gallon (British) = 4.543 l
1 gallon = 4.546 litre

Measurement of Density

Density conversion is depicted below.

1 lb/ft^3 = 16.018 kg/m^3
1 kg/m^3 = 0.0624 lb. $/ft^3$
1 lb/in^3 = 27.68 g/cm^3

Measurement of Pressure

Pressure conversion is depicted below.

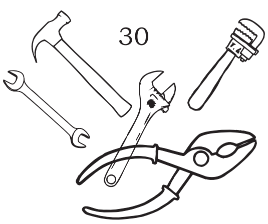
1 lb/ft^2 = 4.8824 kg/m^3 = 1lb/$metre^2$ = 6.895 KgN/m^2
1 $lb/inch^2$ = 0.0703 kg/cm^3

Comprehensive Conversion Table

Millimetres	= 25.400	× inches
Metres	× 3.2809	= feet

Notes

Metres	= 0.3048	× feet
Kilometres	× 0.621377	= miles
Kilometres	= 1.6093	× miles
Square centimetres	× 0.15500	= square inches
Square centimetres	= 6.4515	× square inches
Square metres	× 10.76410	= square feet
Square metres	= 0.09290	× square feet
Square kilometres	× 247.1098	= acres
Square kilometres	= 0.00405	× acres
Hectares	× 2.471	= acres
Hectares	0.4047	× acres
Cubic centimetre	× 0.061025	= cubic inches
Cubic centimetre	= 16.3266	× cubic inches
Cubic metre	× 35.3156	= cubic feet
Cubic metre	= 0.02832	× cubic feet
Cubic metre	× 1.308	= cubic yard
Cubic metre	= 0.765	× cubic yard
Litres	× 61.023	= cubic inches
Litres	= 0.01639	× cubic inches
Litres	× 0.26418	= U.S. gallons
Litres	= 3.7854	× U.S. gallons
Grams	× 15.4324	= grains
Grams	= 0.0648	× grains
Grams	× 0.03527	= Ounces, avoirdupois
Grams	= 28.3495	× Ounces, avoirdupois
Kilograms	× 2.2046	= pounds
Kilograms	= 0.4536	× pounds



Kilogram per square centimetre	× 14.2231	= lb.per sqin
Kilogram per square centimetre	= 0.0703	× lbper sqin
Kilograms per cubic metre	× 0.06243	= lbper cuft
Kilograms per cubic metre	= 16.01890	× lbper cuft
Metric tons (1000 kilograms)	× 1.1023	× tons (2000 lb)
Metric tons (1000 kilograms)	= 0.9072	× tons (2000 lb)
Kilowatts	× 1.3405	= horse power
Kilowatts	= 0.746	× horse power
Calories	× 3.9683	= B.t.u
Calories	= 0.2520	× B.t.u
Francs	× 0.193	= dollars
Francs	= 5.18	× dollars

Tips

(a) To know the circumference of a circle, multiply its diameter by 3.1416.

(b) To calculate the diameter of a circle, multiply the circumference by 0.31831.

(c) To calculate the area of circle, multiply the square of the diameter by 0.7854.

(d) To calculate the circumference, multiply the radius of a circle by 6.283185.

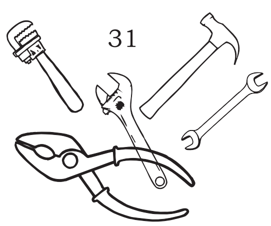
(e) To calculate the area, multiply the square of the circumference of a circle by 0.07958.

(f) To calculate the area, multiply the half the circumference of a circle with half its diameter.

(g) To calculate the radius, multiply the circumference of circle with 0.159155.

(h) To calculate the radius, multiply the square root of the area of circle with 0.56419.

Notes



NOTES

(i) To calculate the diameter, multiply the square root of the area of circle with 1.12838.

(j) To calculate the diameter of a circle equal in area to a given square, multiply a side of the square by 1.12838.

(k) To calculate the side of a square equal in area to a given circle, multiply the diameter by 0.8862.

(l) To calculate the side of a square inside a circle, multiply the diameter by 0.7071.

(m) To calculate the side of a hexagon inside in a circle, multiply the diameter of the circle by 0.500.

(n) To calculate the diameter of a circle inside in a hexagon, multiply the side of the hexagon by 1.7321.

(o) To calculate the side of an equilateral triangle inside in a circle, multiply the diameter of a circle by 0.866.

(p) To calculate the diameter of a circle inside in an equilateral triangle, multiply a side of the triangle by 0.57735.

(q) To calculate the area of the surface of a ball (sphere), multiply the square of the diameter by 3.1416.

(r) To calculate the volume of a ball (sphere), multiply the cube of the diameter by 0.5236.

(s) Doubling the diameter of a pipe increases its capacity four times.

(t) To calculate the pressure in pounds per square inch at the base of a column of water, multiply the height of the column in feet by 0.433.

(u) A gallon of water (U.S. standard) weighs 8.336 pounds and contains 231 cube inches. A cubic foot of water contains 7½ gallons, 1,728 cubic inches and weighs 62.425 pounds at a temperature of about 39°F. These weights change slightly and below this temperature.

Measuring Instruments

Measuring tools

These are important tools in a workshop, which help the plumber to measure size and dimensions of various components of plumbing. Measuring tools are commonly used. A plumber should know the use and handling of these tools. The important measuring tools are steel rule, calliper, screw gauge, pressure gauge, etc.

Steel ruler

It is used to measure lengths and to draw straight lines (Fig. 4.2).

Fig. 4.2: Steel ruler

Calliper

It is a tool used to determine the shorter lengths between two sides of an item. The tips of the calliper are

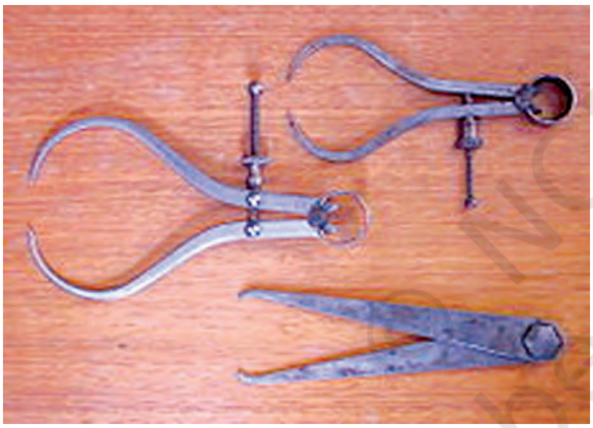


Fig. 4.3: Outside callipers

Fig. 4.4: Inside callipers

kept to the distance to be measured; the calliper is then removed and the distance is measured between the tips with the ruler (Fig. 4.3 and Fig. 4.4).

Screw gauge (Micro metre)

It is a device incorporating a calibrated screw used widely for precise measurement of small lengths. Proper handling of this tool is important in measuring any dimension (Fig. 4.5).

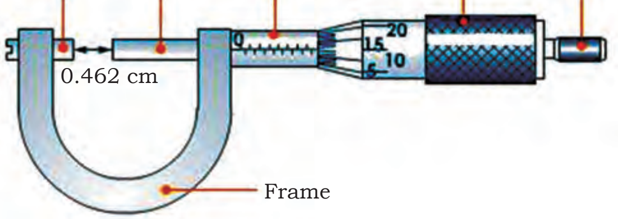


Fig. 4.5: Screw gauge

Fig. 4.6: Measuring tape

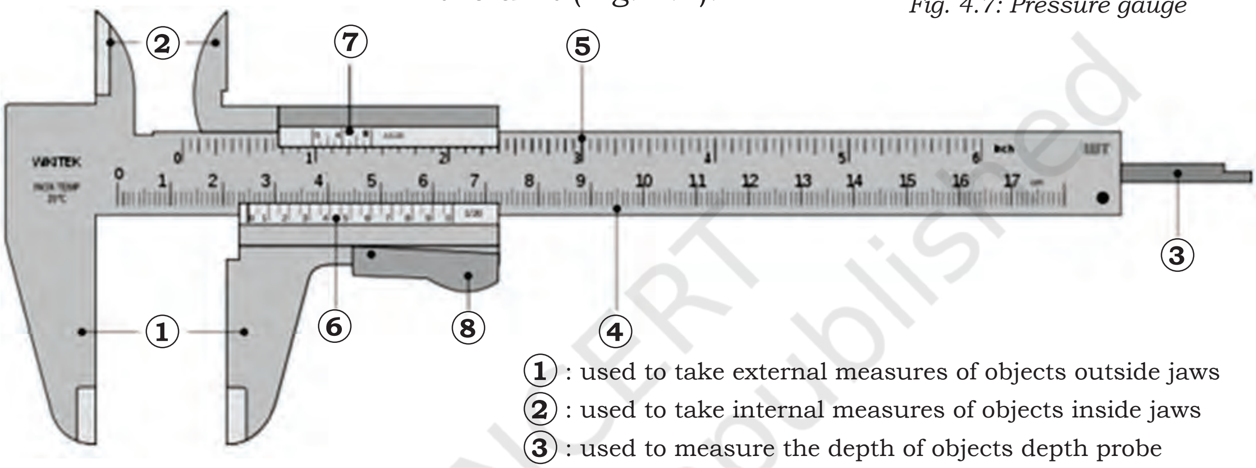
Measuring tape

It is used for measuring the dimension of plumbing items. Tapes are available in various lengths like 10 metres, 20 metres, etc. (Fig. 4.6)

Pressure gauge

It is the instrument used for measuring the pressure in the unit (Fig. 4.7).

Fig. 4.7: Pressure gauge



1 : used to take external measures of objects outside jaws
2 : used to take internal measures of objects inside jaws
3 : used to measure the depth of objects depth probe
4 : (cm) Main scale
5 : (inch) Main scale
6 : (cm) Vernier
7 : (inch) Vernier
8 : used to block movable part retainer

Fig. 4.8: Vernier calliper and its parts

Vernier calliper

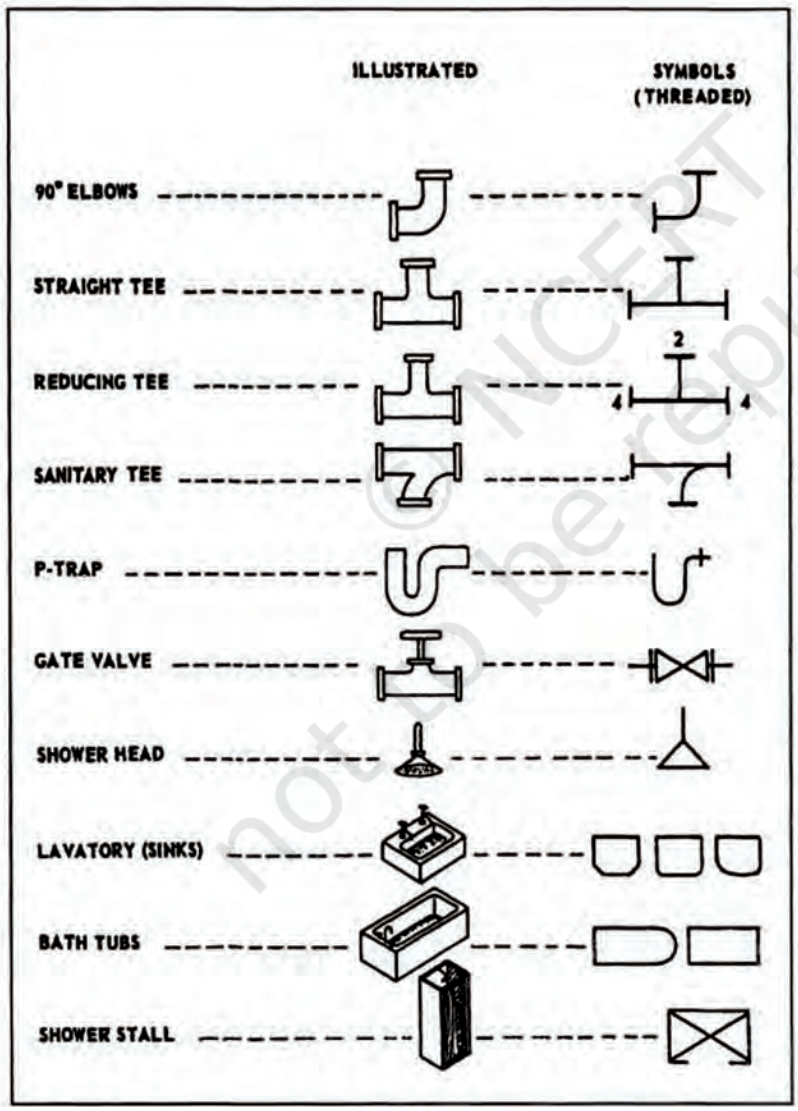
Fig. 4.9: Vernier callipers

The metre scale is used to measure the length to the nearest millimetre only. For measuring smaller lengths precisely, Vernier calliper is used. **Vernier calliper** is a precision instrument used to measure the internal and external lengths. It is usually a manual calliper, as shown in Fig. 4.8 and Fig. 4.9.

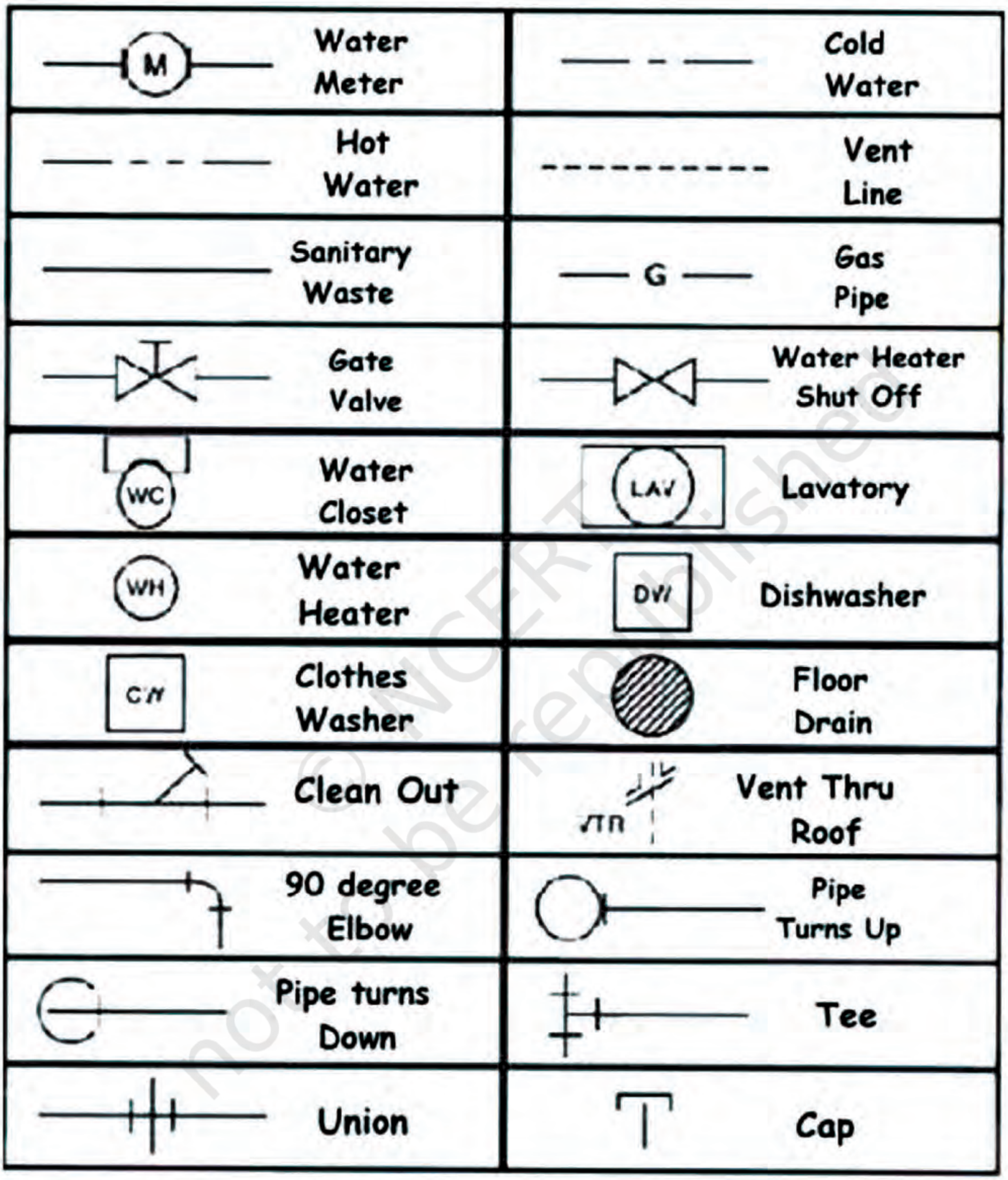
Plumbing Symbols

Importance of plumbing symbols

A well-trained plumber does the installation of the fittings and fixtures as per the drawing given in the assembly sheet of the plumbing fixtures in the manufacturer's catalogue. These drawings consist of symbols, assembly of fixture and installation method. Identification of the symbols given in the drawings of fixtures makes the installation work easy for the plumber. Plumbing symbols are given in this Unit. The students should identify and learn the symbols so that it will be helpful in future.



ITEM	SYMBOL	SAMPLE APPLICATION (S)	ILLUSTRATION
PIPE	SINGLE LINE IN SHAPE OF PIPE-USUALLY WITH NOMINAL SIZE NOTED		
JOINT-FLANGED	DOUBLE LINE		
SCREWED	SINGLE LINE		
BELL AND SPIGOT	CURVED LINE		
OUTLET TURNED UP	CIRCLE AND DOT		
OUTLET TURNED DOWN	SEMICIRCLE		
REDUCING OR ENLARGING FITTING	NORMAL SIZE NOTED AT JOINT		
REDUCER CONCENTRIC	TRIANGLE		
ECCENTRIC	TRIANGLE		
UNION SCREWED	LINE		
FLANGED	LINE		


M
Water Meter
Cold Water
Hot Water
Vent Line
Sanitary Waste
G
Gas Pipe
Gate Valve
Water Heater Shut Off
WC
Water Closet
LAV
Lavatory
WH
Water Heater
DW
Dishwasher
CW
Clothes Washer
Floor Drain
Clean Out
VTR
Vent Thru Roof
90 degree Elbow
Pipe Turns Up
Pipe turns Down
Tee
Union
Cap

Practical Exercises

Activity 1

Measure the length, width and height of a room.

Material Required

1. Measuring tape
2. Copy
3. Pencil

Procedure

1. Collect the measuring tapes and scale.
2. Identify a room in which measurement can be made.
3. With the use of a measuring tape and scale, measure the length, breadth and height of the room.
4. Draw a rough drawing of the room and note down the dimensions.
5. Measure the dimensions in metres and convert into feet.

Activity 2

Measure the weight of a brick and cement bag

Material Required

1. Weighing unit
2. Brick
3. Cement bag
4. Notebook
5. Pencil

Procedure

1. Collect the brick and cement bag.
2. Check and calibrate the weighing unit.
3. Measure the weight of the brick and the cement bag separately.
4. Note down the weight of items in the copy.

Activity 3

Draw the plumbing symbols

Material Required

1. Plumbing symbols
2. Copy
3. Pen

Procedure

1. Draw the plumbing symbols given in this book.
2. Level the figure symbols.

Check Your Progress

A. Answer the following questions

1. Calculate the circumference of a circle of radius of 12cm.
2. A 4,800 litre water tank is ¾ full.
   (a) How much water is there in the tank?
   (b) How much is the empty space?
3. List the different types of material in which plumbing fittings are available.
4. Draw the figures of bends and reducing tee.

B. Fill in the blanks

1. 1 feet = ...inches
2. 1 metre = ...yards
3. 1 kilogram = ...pounds
4. 1 gallon = ...litre
5. 1 lb/in^3 = ...g/cm^3
6. 10 decametres = ...hectometres

C. Mark the correct option

1. The function of a vernier calliper is to________________.
   (a) measure depth of a large container
   (b) measure diameter of a pipe
   (c) measure weight
   (d) measure pressure

2. Which of the following is a unit of length?
   (a) kg
   (b) m
   (c) minute
   (d) mL

3. Which of the following is a unit of area?
   (a) m^2
   (b) cm^2
   (c) Hectare
   (d) All of the above

Unit 5

Pipe Fittings, Joints and Valves

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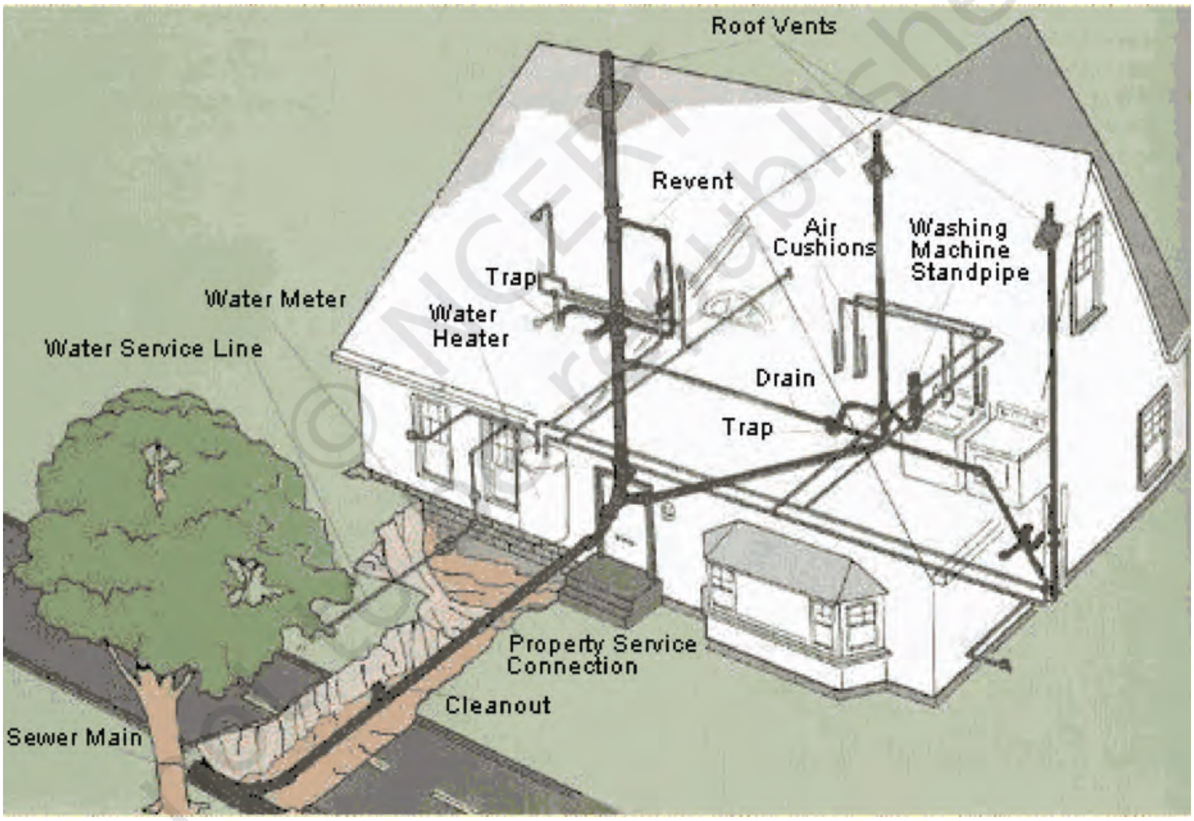


Fig. 5.1: Layout of pipeline (internal) in a building

Introduction

In Unit 4, we studied the importance of measurements in carrying out various plumbing tasks. At the same time, a plumber must also have knowledge of the various pipe fittings like elbow, union, gasket, etc., joints and valves, and where these should be used while carrying out the tasks. Not only does this help in smooth functioning, but also ensures cost-effectiveness. For proper installation of the plumbing system in a building, various types of joints are used, which are shown in Fig. 5.1. As already mentioned, various types of fittings like elbow, gasket, union, etc., are used for making joints. It helps in changing the direction of water supply from main pipes to subsidiary pipes. Proper fitting also helps in checking leakage in the plumbing lines.

Pipe Fittings

Pipe fittings are an important component of the plumbing system. In plumbing, many types of fixtures are joined with the help of various types of material as per the requirement. Fittings are fixed in the plumbing system to join straight pipes or any section of tubes. We can say that the water-supply fittings like elbow, tee, socket, reducer, etc., are fitted to change the direction of flow, distribute the water supply from the main pipe to other pipes of equal size or lower size, etc.

Any part used in connection with water supply, distribution, measurement, controlling, use and disposal of water is known as a pipe fitting (Fig. 5.2).

Fig. 5.2: Pipe fittings

Type of Fittings

1. Collar
2. Elbow
3. Gasket
4. Union
5. Reducer
6. Tee
7. Nipple
8. Trap

Collar

While joining two pipes in the same length, collar is used. Collar is fitted in the end of pipe (Fig. 5.3).

Fig. 5.3: Collars

Elbow

It is installed at the time of joining two pipes. With the help of an elbow, the direction of liquid is changed. Normally a 45° or 90° elbow is used. When the two sides of pipes differ in size, an elbow of reducing size is used. This is called reducing type elbow or reducer type elbow. Elbows are categorised as follows—

Long Radius (LR) Elbows

Here, the radius is 1.5 times the diameter of pipe.

Short Radius (LR) Elbows

In this, the radius is 1.0 times the diameter of pipe.

90° Elbow

This is used when the change in direction required is 90° (Fig. 5.5).

45° Elbow

This is used when the change in direction required is 45° (Fig. 5.4).

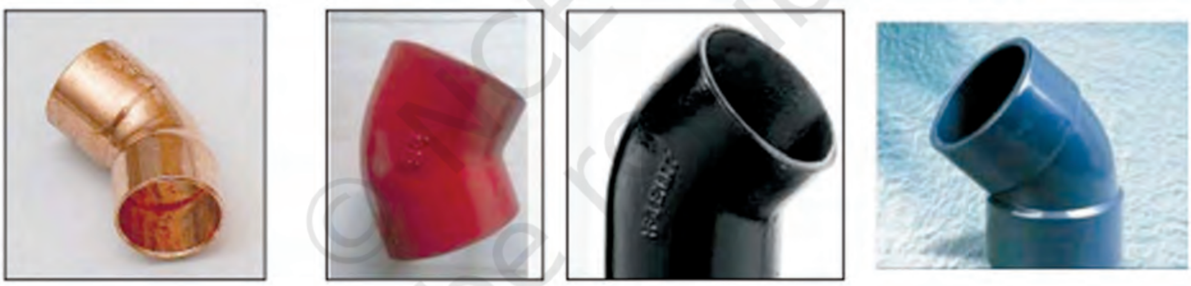


Fig. 5.4: Bend 45°

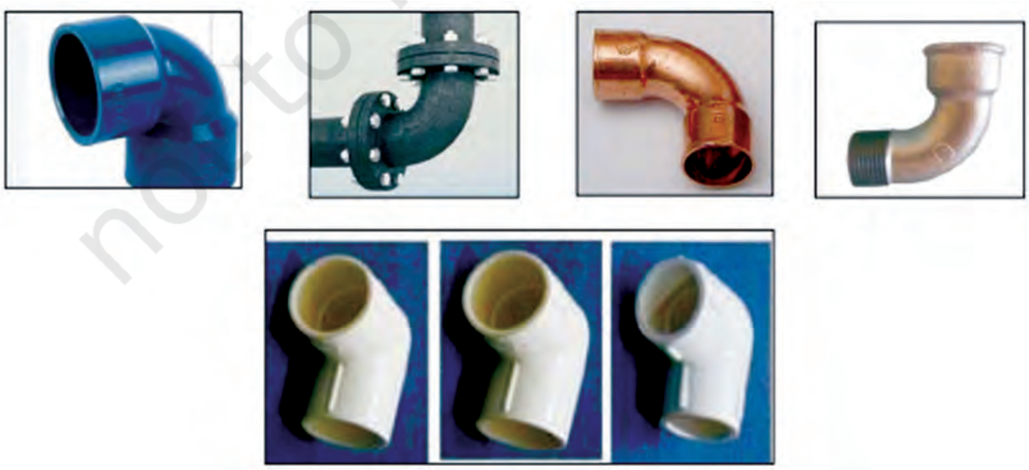


Fig. 5.5: Bend 90°

Fig. 5.6: Y-T Joint

Fig. 5.7: Double Y-T Joint-1

Fig. 5.8: Double Y-T Joint-2

Fig. 5.9: T Trap

Gasket

Fig. 5.10: Gasket

They are mechanical seals, generally ring-shaped type 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 non-metallic, spiral-wound and ring-joint type (Fig. 5.10).

Union

Fig. 5.11: Union

When two ends of pipes are joined, the pipe fitting used is called union. A union is made of three parts namely a nut, a male end and a female end. The male and female ends are assembled with the support of the nuts, and necessary pressure is made to connect the joint. Since the pairing ends of the union are interchangeable, the union can be changed easily in a short time (Fig. 5.11).

Reducer

It is used to connect pipes of different diameters. A reducer may be of various types like reducer tee, reducer elbow and reducer socket (Fig. 5.12).

Fig. 5.12: Reducers

Tee

It is an important fitting with a side outlet at 90^0 to the run of the pipe. Tees connect pipes of various diameters and help in changing the direction of water or material in a pipe. Tees are made in various sizes like equal or unequal. The equal tee is most commonly used (Figs. 5.13–5.15).

Fig. 5.13: Single tee socket

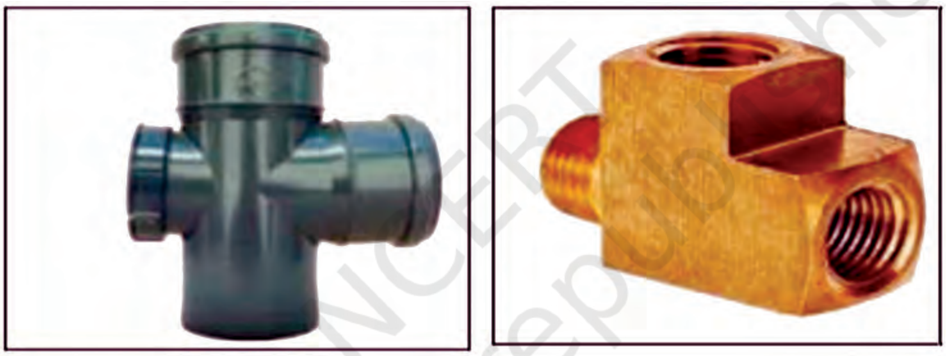


Fig. 5.14: Single tee socket

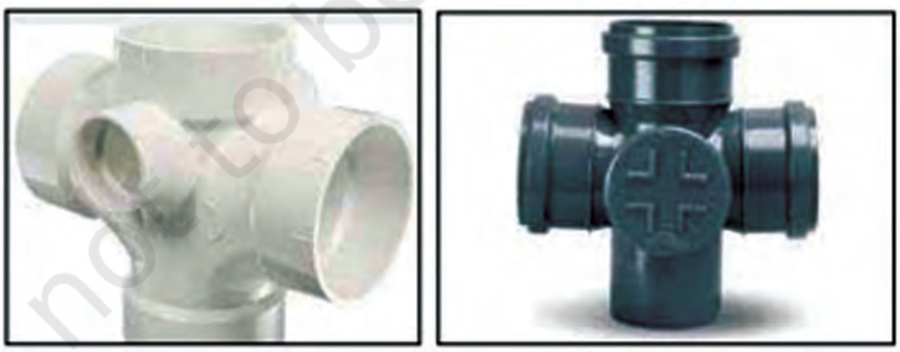


Fig. 5.15: Double tee socket

Nipple

It is a piece of pipe having thread at both sides, and could be used for short extension of plumbing lines. It can also be used for connecting two fittings within small distance (Fig. 5.16).

Fig. 5.16: Nipple

Trap

It is a fitting in a P, U, S or J-shaped type (Fig. 5.17). 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.

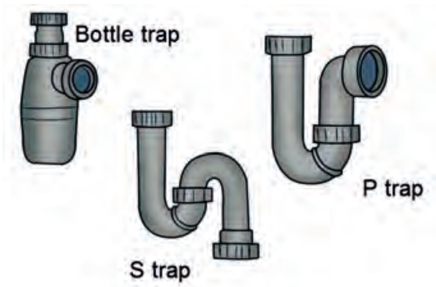


Fig. 5.17: Trap

Cross

When four pipes are joined,a cross is formed. It is also called a cross branch line or a four-way fitting (Fig. 5.18). This fitting has three outlets and one inlet. Cross fittings may deteriorate when temperatures change, because cross fitting is made at the centre of the four connection points.

Fig. 5.18: Cross

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 (Fig. 5.19).

Fig. 5.19: Offset

Laying of GI Pipes in Buildings (Internal Work)

GI (galvanised iron) pipes in the internal work of a building are laid either on the surface or concealed in the wall. For fixing on the surface, the pipes should be kept 1.5 cm apart from the wall and should be laid perfectly vertical or horizontal. The pipes should be held in pipe clamps which are embedded in the wall, roof, etc., with cement mortar 1:3 (1 cement: 3 coarse sand) (Table 5.1).

Table 5.1: Pipe clamp spacing

Diameter of pipe(mm)	Horizontal length (metres)	Vertical length (metres)
15	2.00	2.5
20	2.5	3.0
25	2.5	3.0

32	2.5	3.0
40	3.0	3.5
50	3.0	3.5
65	3.5	5.0
80	3.5	5.0

The following points should be kept into consideration during laying of pipes.

1. GI pipes should not come in contact with lime or lime-mortar. They should be treated with anti-corrosive paints.
2. Whenever a pipe passes through a wall, provision of expansion should be made.
3. Under the floors, the pipes must be placed in the layer of sand to allow expansion.

Pipe Joints

Pipes are connected with the help of joints. A variety of joints are used in an assembly of pipes. Connecting two or more pipes together is called a fitting. Various types of joints could be used in a pipe as per the requirement. Joints are also used for multiple pipe connections, and are an important component of the plumbing system. Generally, the pipe joint fitted can easily sustain the pressure created in the pipe.

Types of pipe joints

Various types of pipe joints are as follows.

1. Threaded joint
2. Welded joint (butt welded, socket welded)
3. Brazed joint
4. Soldered joint
5. Grooved joint
6. Flanged joint
7. Compression joint

Threaded joint

When pipes are joined by screwing in threads which are provided in the pipe, it is called a threaded joint. In this

Notes

joint, one of the pipes has internal threads whereas the other pipe has threads externally. Thethreads are also made in various pipes like PVC, CI pipes, copper pipes and GI pipes, etc. (Fig. 5.20).

Threaded joints are used from 6 mm diameter to 300 mm diameter pipes.

Fig. 5.20: Threaded joint

Welded joints (Butt-welded joints)

It is one of the most common methods of joining pipes used in large infrastructure like commercial, institutional and industrial systems. Cost of material are low, but the labour costs are more due to the non-availability of trained welders and fitters. (Fig. 5.21).

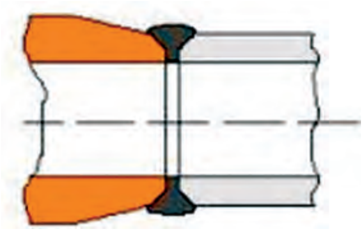


Fig. 5.21: Welded joint

Socket-welded joints

These are used when there is a high chance of leakage in the joints. Pipes are joined as putting one into other and welded around the joint, as shown in Fig. 5.22. Pipes having different diameters are suitable for this type of a joint. Socket-welded joint gives good results as compared to other joints.

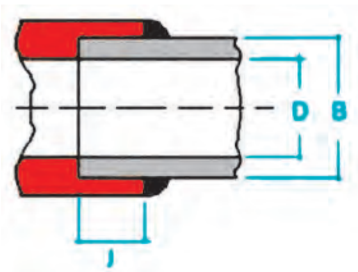


Fig. 5.22: Socket-welded joint

Brazed joints

When pipes are joined with the help of molten filler material at above 840°C, it is called brazing. Brazing is done for connecting copper pipes or copper alloy pipes. It is important to note that the melting point of the parent material (pipe material) should be higher than the filler material. Brazed joints have less mechanical strength, and are preferred in case of moderate temperatures (Fig. 5.23).

Fig. 5.23: Brazing

Soldered joints

Soldering and brazing are similar activities. In soldering, the filler material melts below 840°C. With the help of soldering, copper and copper alloy pipes are joined. During soldering, flux or metal joining material is used to prevent oxidation due to the flame. Soldered joints are suitable for low temperature areas and have low mechanical strength (Fig. 5.24 and Fig. 5.25).

Fig. 5.24: Brazed and soldered joint

Grooved joints

Fig. 5.25: Solder joint

When two pipes are joined together by making grooves (narrow cuts or depression) at the end of pipes with the help of sockets or couplings, such joints are called grooved joints. Due to the ease of assembly of the grooved joints, the labour cost is less. The piping system can be easily uninstalled and reinstalled frequently for maintenance (Fig. 5.26). These are mostly used for fire protection.

Fig. 5.26: Grooved joint

Flanged joints

This joint is commonly used for joining pipes in pumping stations, filter plants, hydraulic laboratories and boiler houses, etc. (Fig. 5.27). These joints are preferred due to easy process of assembly and disassembly, however these connections are costly. These joints can be disassembled and re-assembled when required. A pipe has flanged ends on both sides of the pipe length. Both the ends of pipes are joined at a proper level near one another. A hard rubber washer is placed between flanges and bolted. Flanges are generally fixed to the pipe by welding or threading. In certain cases, a flange-type joint is also called a lap joint. It may also be made by forging the process and machining the pipe end. There is no leakage in flanged joints even after rapid temperature fluctuations.

Fig. 5.27: Flanged joints

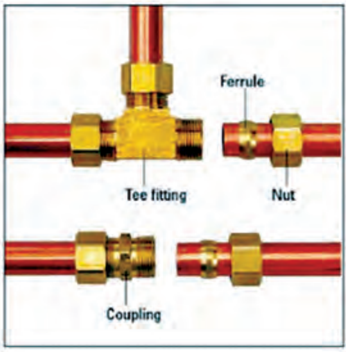


Fig. 5.28: Compression joints

Compression joints

These are applied to join the pipe without any preparations. The cost of installation of these joints is very economical. The pipes having plain ends are joined by fixing fittings at their ends, and such a joint is called a compression joint. The pipe ends are joined with threaded fittings or couplings. Joints are placed properly to check the flow pressure, otherwise, leakage may occur. These fittings are manufactured from different types of material. Selection of fittings is done as per requirement (Fig. 5.28).

VALVES

For proper functioning of the pipeline, valves made of iron or brass are used in the water-supply mains. Valves stop or control the flow of fluid like liquid, gas, condensate, etc. These are classified according to their usage like isolation, throttling and non-return corrector. Various types of valves are manufactured depending upon their use and type of construction.

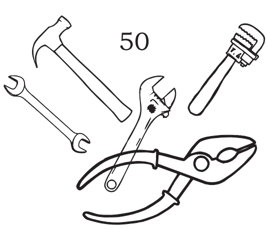
Fig. 5.29: Sluice valve

Sluice valve

It is fitted at an important place like at the entrance of a pipe. It may be the start of a new pipe from a tank, or a number of branches from the tank. This valve isolates the water-supply, as and when required. The sluice valve is specified by the pipe bore (diameter) of the water-way. The standard sizes are 50 mm, 65 mm, 80 mm, 100 mm, 150 mm, 200 mm, 250 mm and 300 mm. The sluice valves are classified as Class 1 and Class 2 (Fig. 5.29 and Table 5.2).

Table 5.2: Test pressure in sluice valve

Class	**Test Pressure kg/cm²**		**Max. working Pressure kg/cm²**
	Body	Seat	
Class 1	20	10	10
Class 2	30	15	15



Scour valve

This valve is provided at the lower level in a pipeline, so that such sections can be supplied and drained for maintenance purpose. The water is distributed into natural drains. It is basically a sluice valve and the very nature of its use has created the difference in the name (Fig. 5.30).

Fig. 5.30: Scour valve

Air valve

It is fitted to release the air automatically when the pipe is filled with water. This valve also permits entry of air when the pipe is drained. This valve is fixed at the end of a communication pipe and controls or stops the supply of water. This valve is specified by the standard bore (diameter) of the socket or pipe outlet, to which it is fitted. The standard sizes are 8 mm, 10 mm, 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm (Fig. 5.31).

Fig. 5.31: Air valve

The body components and washer plate are made of cast brass or leaded tin bronze. The washers are made from fibre, leather, rubber or nylon. This valve is available in two types: internally threaded and externally threaded.

Gate valve

It is used for starting or stopping flow. For a straight-line flow of fluid, minimum flow restriction can also be done with gate valve. In service, these valves are generally either fully open or fully closed. These valves are used for various types of liquids and make a tight seal when closed.

Fig. 5.32: Split taper non-rising gate valve

Types of gate valve

Gate valves have gates of wedge type, solid or split type, or gate of double disc or parallel type. The movement of the gate shall be by the internal or external screw on the spindle. The spindle, which controls the flow of a liquid, can be of the rising or non-rising type. See Fig. 5.32 and Fig. 5.33.

Fig. 5.33: Rising spindle split wedge gate valve

Parallel slide valve

It has two discs without spreading mechanism which slides between the two parallel body seats. The activation of the valve discs is by the internal and the external screw on the spindle and the spindle may be of the rising or non-rising type (Fig. 5.34).

Fig. 5.34: Parallel slide valve

Globe valve

It is a type of valve used for controlling flow in a pipeline. A component of valve includes a movable disc element and a stationary ring seat fitted in a generally spherical body. The globe valve is used for controlling flow control (Fig. 5.35).

Fig. 5.35: Globe valve

Angle valve

It is used to control the movement of a fluid like liquids, gases, fluidised solids, or slurries by opening, closing or partially obstructing various pathways. This type of a valve generally has a round body, in which the body ends are fitted at right angles with each other and the disc moves up and down. The valve is moved to action by the internal or external screw on the spindle. The spindle may be of the rising or non-rising type. See Fig. 5.36 and Fig. 5.37.

Fig. 5.36: Angle valve-1

Fig. 5.37: Angle valve-2

Check valve or non-return valve

It is a valve which permits (fluid) water to move in one direction but checks all the returning flow. It is operated by the pressure above, having no external means of control (Fig. 5.38).

Fig. 5.38: Check valve or non-return valve

Ferrule

It is used for connecting a service pipe to the water main. It is usually made of non-ferrous metal and screwed to the main pipe (Figs. 5.39–5.42).

Fig. 5.39: Ferrule

Foot valve

It is a valve used in the pump. It is also called check valve, as it makes sure that the pump is ready to use. If

Fig. 5.40: Swing check

Fig. 5.41: Horizontal check

Fig. 5.42: Vertical check

the pump is off, then the foot valve keeps enough fluid in the pump to ensure that it can start again. In a well, the foot valve will be between the water surface and the pump. In a water intake system, the foot valve will be at the end of the water intake line. The foot valve has a strainer on the outside which prevents obstructions also (Fig. 5.43).

Fig.5.43: Foot valve

Float valve

It is used for stopping water when the water tank or flush toilet is filled, so that it stops overflowing. When the water level rises, the float also rises; once it rises to a pre-set level, the water level forces the lever to close the valve and stops the water flow. A float valve is a fitting used for filling water tanks as well as flush toilets (Fig. 5.44).

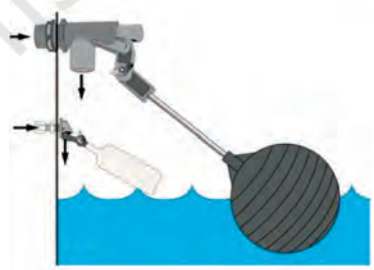


Fig. 5.44: Float valve

Practical Exercises

Activity 1

Prepare a list of fittings available in the market.

Material Required

1. Different types of fitting
2. Notebook
3. Pen

Procedure

1. Survey the local market.
2. Visit the plumbing hardware shop.
3. Identify the fittings available in the shop.
4. Prepare a list of the identified fitting items seen in the market.
5. Note down the cost of the fitting items and their manufacturing company's name.

Activity 2

Draw figures of the various types of bends.

Material Required

1. 45° and 90° bend
2. Notebook
3. Pen

Procedure

1. Inspect the plumbing items fitted in the school.
2. Identify the bends fitted.
3. Draw the figures of bends in your notebook.

Activity 3

Practice joining a pipe.

Material Required

1. Joints
2. Pipe
3. Tools

Procedure

1. Collect the pipe joints, pipes and tools.
2. Identify the components.
3. Collect the joints.
4. Join the pipe with the help of proper pipe joining tools.

Activity 4

Draw the figure of joints.

Material Required

1. Threaded joints, grooved joints and compression joints
2. Pen
3. Pencil

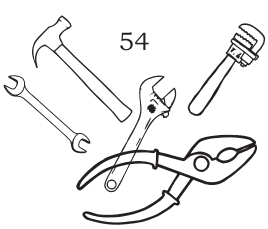
Procedure

1. Collect the figures or joints of threaded joints, grooved and compression joints.
2. Draw the figure of the joints.

Check Your Progress

A. Answer the following questions

1. Why are fittings used in plumbing? Write a short note on any four types of fittings.



2. Why are joints necessary? Discuss in detail, with suitable figures.
3. State the difference between threaded joint and a welded joint.
4. Explain the importance of valves. Write about two types of valves and their uses.
5. What is the role of a float valve? List down its uses and advantages.

B. Mark the correct option

1. Which of the following fittings is used to connect two pipes with each other?

   (a) Tee (b) Connector
   (c) Elbow (d) All of the above

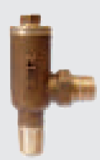
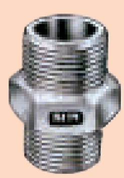
2. Which of the following fittings is used to connect four pipes?

   (a) Offset (b) Union
   (c) Cross (d) Reducer

3. The valve which avoids both overflow and back flow of water is__________________.

   (a) float valve (b) angle valve
   (c) foot valve (d) check valve

C. Match the following

Column A	Column B
1. Nipple	(a) 
2. Ferrule	(b) 
3. Soldered joint	(c) 
4. Foot valve	(d) 

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Answers

Unit	Fill in the blanks	Match the following	Mark the correct option	Full forms
1.	1. Water 2. Plumbing fixtures 3. Pipes 4. Installation, repair, maintenance, servicing		1. (c) 2. (d) 3. (d) 4. (a)	
2.	1. Holding 2. Mason's square 3. Pickaxe 4. Drill machine` 5. Cutting	1. (b) 2. (c) 3. (d) 4. (a)		
3.			1. (c) 2. (a) 3. (b)	1. Galvanized Iron 2. Asbestos Cement 3. Unplasticised Polyvinyl 4. Cast Iron
4.	1. 12 2. 1.09 3. 2.2046 4. 4.546 5. 27.68 6. 1		1. (b) 2. (b) 3. (d)	
5.		1. (d) 2. (c) 3. (b) 4. (a)	1. (d) 2. (c) 3. (a)	

Glossary

Assembly: *Process by which part samples (belonging to the same assembly standard [RFC]) are connected to one another. Assembling two basic parts always results in a new, larger composite part that can be used in future assemblies.*

Bending: *A technique used in various metal forming processes with the aim of increasing the fabrication capabilities of plumbing fixtures. The pipe can be bent at varying angles and in different directions. The simplest curve turns the tube at an angle of 90 degrees forming an elbow. Besides, pipe bending can be done in several other geometries that include 2D and 3D dimensions.*

Chipping: *Removal of wood, spatter, rust or old paints from iron work or plumbing work using hammer and cold chisel.*

Die: *It is used to cut or form the male portion of the mating pair (for example, a bolt).*

Disassembly: *When referring to hardware, disassembly is the process of breaking down a device into separate parts. A device may be disassembled to help determine a problem, to replace a part, or to take the parts and use them in another device or to sell them individually.*

Drilling: *Process of creating a smooth hole in a material with a drill and motor.*

Filing: *Process of removing excess material and deburring the surface. Sandpaper may be used as a filing tool for material, such as wood.*

Sawing: *Process wherein a narrow slit is cut into the workpiece by a tool consisting of a series of narrowly spaced teeth, called a saw blade. Sawing is used to separate work parts into two or more pieces, or to cut off an unwanted section of a part.*

Tap: *It is used to cut or form the female portion of the mating pair (e.g., a nut).*

Taps and **dies:** *Tools used to create screw threads, which is called threading. Many are cutting tools; others are forming tools.*

Tapping: *Process of cutting or forming threads using a tap. It is the action that creates a thread into the side of the hole.*

Threading: *Process of cutting or forming threads using a die.*