

# Textbook of Plumbing and Solar Water Heating System-II Matric Tech Grade-IX



National Vocational & Technical Training Commission (NAVTTTC)

**Textbook of**  
**Plumbing and Solar Water Heating System-II**  
**Matric Tech Grade-IX**



**GOVERNMENT OF PAKISTAN**  
**Ministry of Federal Education and Professional Training**  
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## PREFACE

This book has been written to meet the requirements to train the students of Matric Tech in plumbing. Matric Tech in plumbing has been introduced for the first time in the history of Pakistan. This textbook is the first national effort to describe the topics related to plumbing and solar water heating system using plastic pipes in one book.

Any building however costly, without a proper plumbing system, is only a skeleton. Proper plumbing alone adds life to the building and the inhabitants. Hence proper plumbing system as per the code of practices with the correct specifications of materials like pipes and fixtures should be used to make buildings sustainable.

A key attempt has been made to make the book interesting and useful. All the chapters cover the basic details understandable to the students of secondary school level. All chapters include relevant plumbing activities and also assessments in form of MCQs, short questions, and long questions.

The book covers 40% theoretical and 60% practical content. These contents are equally helpful for the students of various plumbing systems.

Suggestions from the teachers/ instructors as well as students from the different institutions for the improvement of this book would be appreciated and welcomed with thanks.

Pakistan is a developing country with the 5th largest population in the world. Overall, 64% of our population is below 30 years of age which makes it the second youngest country in South Asia. This “youth bulge” provides unique challenges as well as opportunities for the country’s social and economic development. The only remedy is to develop the youth of Pakistan through vocational and technical training. To control the increasing unemployment, promote entrepreneurship (self-employment), alleviate poverty, and provide skilled manpower for industrial/economic growth, The Govt. of Pakistan has decided to introduce Matric Tech Stream at Secondary School Certificate (SSC) Level. To meet this purpose Plumbing and Solar Water Heating System-II is included as an elective subject in the existing scheme of studies at the SSC level.

The curriculum of Plumbing and Solar Water Heating System is designed to produce a middle-level skilled workforce equipped with knowledge, skills, and attitudes related to the field of construction technology, especially in the plumbing field. This will meet the demand of the required skilled workforce at local/ regional as well as in the country and also at international level to contribute in the economy of Pakistan.

A plumber is a trade person specializing in water supply systems, sanitary systems, disposal of foul gases, disposal of domestic storm sewage of buildings. Plumbers may be employed in the installation of new plumbing fixtures, appliances, and in the maintenance and repair of existing plumbing infrastructure. Plumbers may also specialize in gas installations, oil, and air conditioning systems. Plumbers work in a variety of settings, including homes, industries, schools, hotels, workshops, and hospitals i. e. any type of facility that needs piping work to function.

This text book is designed to enhance the knowledge, positive attitude and work values of plumbers in accordance with international standards. It also covers the competencies in preparing tools, plumbing materials and equipments for performing job focused on national and international parameters.

**Executive Director**  
**National Vocational & Technical Training Commission**  
**(NAVTTTC)**

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# CHAPTER 1

## INTRODUCTION TO PLASTIC PIPES FOR PLUMBING



### Students' Learning Outcome

After Studying this chapter students will be able to:

- identify pvc pipes applicable to a specific plumbing project.
- receive and inspect pipes.
- observe basic principles for pvc pipes.
- monitor the uses of pvc pipes.
- observe the purpose of pvc pipes in water supply scheme.
- check the difference between pvc pipes
- identify pprc, pex, abs, hdpe pipes applicable to a specific plumbing project.
- check for safety hazards.
- receive and inspect pipes.
- observe basic principles for pprc, pex, abs, hdpe pipes.
- monitor the uses of pprc, pex, abs, hdpe pipes
- observe the purpose and classification of pprc, pex, abs, hdpe pipes
- check the difference between ppr and pvc pipes
- observe the advantages and disadvantages of pprc, pex, abs, hdpe pipes.

## Introduction

There are two families of materials available for water pipework systems: metallic and non-metallic materials. Of these the most commonly used materials for drinking-water supply piping are galvanized iron (GI), or steel, copper, polybutylene (PB), unplasticized polyvinylchloride (UPVC), polypropylene Random Co-polymer (PPRC) and polyethylene (PE). Metal alloys, which far exceed the performance specifications of their respective parent materials, are also widely used.

### 1.1 Different types of PVC pipes.

Polyvinyl chloride, also known as PVC, is found in homes built after the 1950s. Its lightweight, low-cost and low maintenance make it attractive for plumbing. This type of pipe is white in colour and looks like hard pipes. However, it must be carefully installed and bedded to ensure cracking does not occur. It also has a tendency to warp at high temperatures of 140-plus degrees.

They are moderately easy to install and demand nothing more than mitre box and a hacksaw to cut through. There are four types of PVC pipes:

- i. Unplasticized PVC (PVC-U)
- ii. Chlorinated PVC (C-PVC)
- iii. Molecular oriented PVC (PVC-O)
- iv. High Impact PVC (PVC-Hi)

#### 1.1.1 Application of PVC pipes

PVC piping is a good, low-cost choice for many plumbing projects. It is easy to install, with a range of different methods for joining, such as clamps, mechanical couplings, or solvent welding. PVC outdoor lines can be buried, though they might need extra care to prevent collapse.

The main drawback of using PVC piping is that it can't withstand high temperatures. This means you can't use it for hot water lines and it's not rated for drinking water, due to possible heat degradation of the plastic. These pipes are mostly used as vent pipe and underground sewer pipe in homes. They are known as vent or drain line pipes.

#### *i- Unplasticized Polyvinyl Chloride (PVC-U)*

Unplasticized Polyvinyl Chloride (PVC-U) is a pipe created without a plasticizer. Plasticizer increases plasticity, decreases viscosity, or decreases friction. A PVC-U pipe is also commonly known as rigid PVC.

Unplasticized PVC is usually used for:

- Drinking water and waste water.
- Sewage
- Industrial drainage
- Industrial applications



*PVC-U pipe*

There are many benefits to using fittings and pipes made from unplasticized PVC. First and foremost, they are lightweight, affordable, and easy to handle.

This makes them a perfect choice for drinking water transportation. They have a high mechanical performance, high chemical resistance, and resistance to ultra violet (UV) exposure. This pipe is fully recyclable. Because of this, they are considered the most environmentally-friendly pipes for sewage.

### *ii- Chlorinated Polyvinyl Chloride (C-PVC)*

Chlorinated PVC, or C-PVC pipes, are pipes with higher chlorine content.

They are made by chlorination of PVC resin.

Manufacturers introduced them to the water distribution systems in the 1960s, but their manufacturing process did change a bit.

There are many additives in chlorinated PVC, such as pigments, lubricants, stabilizers, and impact modifiers.

C-PVC pipes have many advantages to unplasticized PVC pipes. Due to this, they are a popular choice for:

- Pipes and fittings
- Drinking water transportation
- Carrying water with a wider range of temperatures
- Handling of industrial liquids

Just like unplasticized PVC pipes, chlorinated PVC pipes are highly resistant to corrosion and safe to use for drinking water. Also, both are durable due to their great impact resistance.

The biggest difference is that chlorinated PVC pipes are resistant to a wide range of temperatures. This makes them a great choice for sewer systems in both residential areas and commercial construction.

### *iii- Molecularly Oriented Polyvinyl Chloride (PVC-O)*

One of the many different types of PVC pipes is PVC-O or molecularly oriented PVC.

Manufactures produce molecularly oriented PVC by turning the amorphous PVC-U structure into a much more layered form. This makes it an enhanced version of unplasticized PVC.

People usually use molecularly oriented PVC pipes for:

- Pipes and fittings where strong pressure is expected
- Sewer systems in unstable grounds
- Irrigation pipes
- Sewer pumping mains



*C-PVC Pipe*



*PVC-O Pipe*

Compared to U-PVC, molecularly oriented PVC pipes have a higher resistance to corrosion, recyclability, water quality preservation, and cost-efficiency.

If you happen to reside in an area where pipes are commonly exposed to pressure, you might want to consider using them.

They provide an excellent balance between stiffness, flexibility, and strength.

Molecularly Oriented PVC pipes have a great hydraulic capacity, resistance to cracks, and ductility. This makes them very long-lasting and resistant to fatigue and impact.

Simultaneously, they are 100% recyclable, which is very important to numerous homeowners and professionals.

#### *iv- High Impact Polyvinyl Chloride (PVC-Hi)*

High impact PVC, or PVC-Hi, is the newest type of PVC pipes. Manufacturers make them by inserting various chemicals into PVC-U, increasing their resistance to impact.

While standard PVC has many advantages, it had limited usages as it wasn't stable enough. To solve this problem, professionals alloyed PVC with polycarbonate.

This formed an alloy composition with high dimensional stability, especially when exposed to heat or pressure.



*PVC-Hi pipe*

In the end, this created a strong thermoplastic resin composition with high-impact strength and thermal distortion resistance.

This composition usually includes polycarbonate and an alloy of a vinyl chloride resin. Other material combination consists of ethylene-vinyl acetate and butadiene-modified acrylic. Both variations proved to be very rigid.

PVC-Hi is used on occasions when standard PVC wouldn't handle the pressure or the extreme temperatures.

#### **Categories of PVC Pipes:**

- i- Standard 40 PVC Pipes
- ii- Standard 80 PVC Pipe
- iii- PVC clear Pipe
- iv- PVC flexible Pipe
- v- PVC furniture Pipe

These pipes are available in white, black, blue, purple, red, yellow, green and orange colours and more)

				
<i>Standard 40 PVC Pipes</i>	<i>Standard 80 PVC Pipe</i>	<i>PVC clear Pipe</i>	<i>PVC flexible Pipe</i>	<i>PVC furniture Pipe</i>

### 1.1.2 Receive and Inspect Pipes.

- To perform plumbing work, you receive pipe along with other fittings etc. Pipes from store are received through requisition slip. You should mention type of pipe, category of pipe, internal diameter of pipe, thickness of wall of pipe etc. You will be issued required length of pipe for performing job.
- The next step is to inspect the pipe as per specifications given in the requisition. You should have measuring tools to measure the internal diameter of pipe, thickness of wall of pipe, length of pipe. Other inspection may include the visual inspection, e.g., smoothness of internal surface, cracking, flexibility etc. You should ensure you have pipes fit for the job you are going to perform.
- The first thing plumbers must know is the temperature of the substance that will flow through the pipe. PVC pipe can only be used in pipe lines that carry cold or warm water. Galvanized iron, PB, CPVC, and copper pipe can carry both hot and cold water.
- The second thing a plumber needs to know is the volume of the water or waste that will run through the pipe. Hot and cold water supply mains are usually 3/4" and their branches are 1/2". The vent system has a main vent stack of pipe 3 or 4 inches in diameter. The main vent stack connects to 1 1/2 - 2 inch branch vent pipes.
- The last thing that is important to know is where the pipe will be installed. The types of pipes used in the drain and waste system are also used in the vent system. These types of pipes have the letters, DWV (drain, waste and vent), on the outside of the pipe. Today, the most common DWV pipes are made of cast iron, copper tubing and plastic (ABS, PVC, and PE).

### 1.1.3 Basic principles for PVC pipes.

- PVC is a synthetic plastic that has excellent stability and stress tolerance.

- The sanitary pipes should be preferably laid into the ground by the side of the building rather than in walls or underground.
- Vertical pipes in buildings should be kept outside and accommodated in shafts, to avoid their bad appearance
- Horizontal pipes should be laid straight and at grade (1:48) between inspection chambers.
- The joints of the pipes should be made watertight.
- No pipe should be kept open outside the building in the street without covering.
- Suitable size of pipe should be used according discharge quantity.

**Activity 1.1: UPVC, PVC, CPVC pipes are identified to a specific plumbing project.**

The teacher / instructor is required to provide UPVC, PVC & CPVC pipes to the students. Students are required to identify above pipes and note down in their note book the identification properties of each.

**Activity: 1.2: Basic principles of PVC pipes are observed.**

The students are required to discuss in the forms of groups the basic principles of PVC pipes. Also, to note the same on their note books.

**1.2 Purpose of PVC Pipes.**

The basic purpose of PVC pipes is to convey liquids and gases as per requirements. In general, plastic pipe does not rust or corrode, is light in weight, easy to cut and easy to join – no welding required.

**1.2.1 Uses of PVC pipes.**

Polybutylene is a form of plastic resin that was used extensively in plumbing pipes from 1978 until 1995. However, this type of piping began to fail and caused a lot of damage to people’s homes. Failure was later attributed to the interaction between the pipes and chlorine in public water systems, which caused them to weaken.

The type of plumbing pipe and materials, used in your home, play a big role in determining whether or not a system is proper.

CPVC pipe has all the benefits of PVC pipe, plus the added chlorine gives it a higher heat resistance. It is also rated for drinking water, and is flexible, fire resistant, and well insulated to prevent energy loss for either hot or cold water.

PVC pipes are used in a number of settings for everything from general plumbing and piping to landscaping work and swimming pool related applications.

Unplasticized PVC is usually used for:

- Drinking water and waste water.
- Sewage
- Industrial drainage
- Industrial applications

C-PVC pipes have many advantages to unplasticized PVC pipes. Due to this, they are a popular choice for:

- Drinking water transportation
- Carrying water with a wider range of temperatures
- Handling of industrial liquids

People usually use Molecularly oriented PVC pipes for:

- Pipes and fittings where strong pressure is expected
- Sewer systems in unstable grounds
- Irrigation pipes
- Sewer pumping mains

Compared to U-PVC, molecularly oriented PVC pipes have a higher resistance to corrosion, recyclability, water quality preservation, and cost-efficiency.

### **1.2.2 Purpose of PVC Pipes**

CPVC and UPVC pipes are best for water supply schemes. Normal PVC is not recommended for use in water supply schemes. For an area with a lot of traffic, it is recommended to use a schedule 80 PVC-Hi pipe. On the other hand, in an area without a lot of pressure, such thick pipes aren't necessary. PVC-Hi is used on occasions when standard PVC wouldn't handle the pressure or the extreme temperatures. It is recommended for industry.

### **1.2.3 Difference between PVC pipes.**

- I. Both PVC and uPVC pipes are designed to be durable. However, UPVC pipes are more durable in comparison to PVC pipes.
- II. Both PVC and UPVC pipes are handled in the same fashion during the installation process. Both pipes can be cut using hacksaw blades and eliminate the need for using power tools. However, the joining solvent of the two types of PVC pipes may vary.
- III. As PVC pipes are not rigid, they can easily cut into desired lengths and can be fastened with glue. U-PVC pipes, apart from plumbing application, is also used in heavy duty water transport and in the construction industry. UPVC pipes have a high tensile strength and are resistant to chemical and corrosion.
- IV. UPVC pipes are rigid and are not flexible in comparison to PVC pipes.

- V. 1/2-inch diameter schedule 40 pipe has a thinner wall than a 1-inch diameter schedule 80 pipe. The thicker schedule 80 pipe is more resistant to crushing and puncture than schedule 40 pipe. Also, schedule 80 PVC resists greater pressure than schedule 40 PVC.

**Activity 1.3: Basic uses of UPVC pipes are monitored.**

The students are required to discuss the uses of UPVC pipes. Also, to note the same on their note books

**Activity: 1.4: Differences between PVC and UPVC Pipes are observed.**

The students are required to discuss basic identification differences between PVC and UPVC pipes. Also, to note the same on their note books.

**1.3 Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene HDPE pipes.**

PPRC stands for Polypropylene Random Co-polymer, PEX stands for Crosslinked polyethylene, ABS stands for Acrylonitrile Butadiene Styrene, and HDPE stands for High Density Polyethylene. These are different types of plastic pipes along with PVC pipes.

**1.3.1 Identify Plastic Pipes**

***i- Polypropylene Random Co-polymer (PPRC) Pipes***

PPRC stands for Polypropylene Random Copolymer. The thermal conductivity of PPR is very low, meaning temperature cannot easily be conducted from the outside environment to the liquid in the pipe, and vice versa. Presently PPRC pipes are most reliable in plumbing and water supply plants, due to their chemical features and fusion welding, which ensures the plumbing to have a perfect seal tight system. It can be used both as a cold-water pipe or a hot water pipe.

- I. With 20°C and 25 Absolute atmospheric pressure, 50-year lifetime.
- II. It is suitable among. 20° C and +95° C (freezing point of fluid in insulation must be considered).
- III. It is durable due to these reasons.
  - High resistance to chemical substances.
  - Brilliant and smooth inner surface.
  - The colour, odour and taste of water do not change.
  - Provides heat and sound insulation.
- IV. There is no diameter twist on fittings. This provides maximum performance.
- V. Up to 70% savings on installation and installation is environment friendly.



*PPRC Pipe*

### *ii- Cross-linked Polyethylene (PEX) Pipe*

Cross-linked Polyethylene (PEX) pipe is one of the newest and most popular pipes to be used in the domestic and commercial projects. PEX is used only to supply water. PEX is a pipe that is rigid enough to withstand the pressures of water supply but flexible enough to weave throughout walls, ceilings, basements, and crawlspaces. PEX has truly delivered water-supply plumbing into the hands of do-it-yourself and professional plumbers. These pipes typically come in red and blue colours. A highly rigid pipe capable of withstanding high pressures of water supply but are flexible enough to weave through ceilings, crawlspaces, and walls etc.



*PEX Pipes*

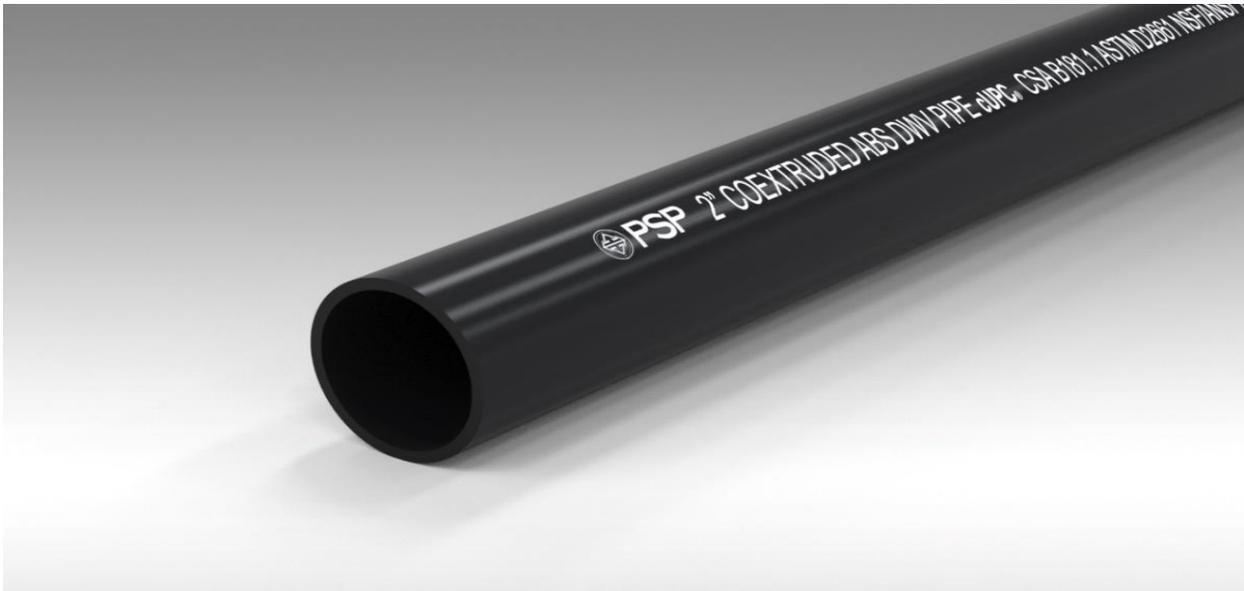
Check your local codes before installing this type of pipe. It must be well supported, and the fittings must be installed properly and tested, especially when installed behind walls.

Many builders use PEX tubing for household plumbing. The entire distribution system, from the service line in the street to the faucet in your bathroom, is constructed with PEX pipe.

PEX is manufactured without an oxygen barrier and may be used in radiant heat applications where there are no ferrous (metal/iron) components.

### *iii- Acrylonitrile Butadiene Styrene (ABS) Pipe*

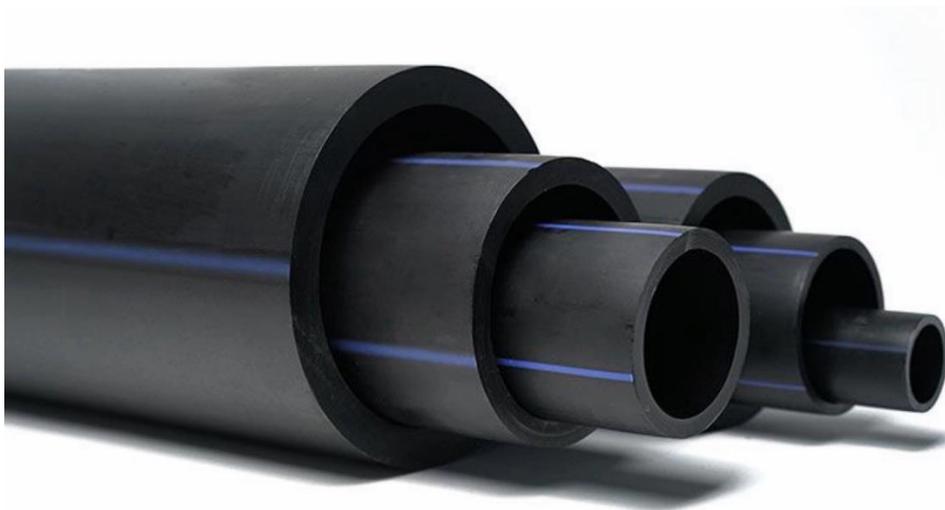
ABS (acrylonitrile butadiene styrene) pipe is mainly used as a vent and drain line. ABS is a dark-coloured pipe, usually black, and it is durable and lightweight. It is mainly used in residential plumbing applications. This piping can be used both above and below ground and is resistant to most salts, acids, and alkalis. ABS Pipe Fitting Applications ABS is Created by polymerizing styrene and acrylonitrile in the presence of polybutadiene. ABS is robust, flexible, glossy, highly processable, and impact resistant. ABS pipe looks very much like PVC pipe, except that it is black and slightly softer. Be sure to consult your local codes to determine where you can use this product.



*ABS Pipe*

*iv- High Density Polyethylene (HDPE) Pipe*

High-density polyethylene pipe is strong, durable, flexible and lightweight. When fused together, HDPE offers a zero-leak rate due to the seamless nature of the pipe system. HDPE pipe offers a more environmentally sustainable footprint because it is non-toxic, corrosion and chemical resistant, has a long lifespan, and is suitable for trenchless installation methods.



*HDPE Pipe*

**1.3.2 Check for safety hazards.**

Plastic piping is a fire hazard. When burned, plastic emits toxic, carcinogenic smoke that can cause severe health consequences when inhaled not only by fire victims, but also by firefighters and

other first responders. Research has shown that in the event of a fire, plastic piping will release hydrochloric acid and other toxins that are harmful.

Plastic pipes are synthetic materials comprising many complex chemicals. chemicals interact with the water moving through the pipes. Plastic piping also presents a risk to safety through its susceptibility to permeation. Permeation occurs when external substances – such as fertilizers, pesticides and other chemicals present in soil and in ground water – can penetrate through this comparatively porous material and pass into the water supply.

### **1.3.3 Receive and inspect pipes.**

- To perform plumbing work, you receive pipe along with other fittings etc. Pipes from store are received through requisition slip. You should mention the specifications of pipe. Type of pipe, category of pipe, internal diameter of pipe, thickness of wall of pipe etc. You will be issued required length of pipe for performing job.
- The next step is to inspect the pipe as per specifications given in the requisition. You should have measuring tools to measure the internal diameter of pipe, thickness of wall of pipe, length of pipe. Other inspection may include the visual inspection, e.g., smoothness of internal surface, cracking, flexibility etc. You should ensure you have pipes fit for the job you are going to perform.
- Plumbing pipes come in different sizes and materials. Plumbers need to know three things before they decide which pipe is best. The first thing they must know is the temperature of the substance that will flow through the pipe.
- The second thing a plumber needs to know is the volume of the water or waste that will run through the pipe. Volume means how much of the contents will pass through the pipe at one time. Hot and cold-water supply mains are usually 3/4 " and their branches are 1/2". The vent system has a main vent stack of pipe 3 or 4 inches in diameter. The main vent stack connects to 1½ - 2 inch branch vent pipes.
- The last thing that is important to know is where the pipe will be installed. The types of pipe used in the drain and waste system are also used in the vent system. These types of pipes have the letters, DWV, on the outside of the pipe. Today, the most common DWV pipes are made of cast iron, copper tubing and plastic (ABS, PVC, and PE).

### **1.3.4 Basic Principles for Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes.**

- The sanitary pipes should preferably be laid into the ground by the side of the building rather than in walls or underground.
- Vertical pipes in buildings should be kept outside and accommodated in shafts, to avoid their bad appearance
- Horizontal pipes should be laid straight and at grade (1:48) between inspection chambers.
- The joints of the pipes should be made watertight.
- No pipe should be kept open outside the building in the street with out covering.
- Suitable size of pipe should be used according discharge quantity.

### **Activity 1.5: Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes are identified to a specific plumbing project.**

The teacher / instructor is required to provide PPRC, PEX, ABS & HDPE pipes to the students. Students are required to identify above pipes and note down in their note book the identification properties of each.

### **Activity: 1.6: Basic principles of Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes are observed.**

The students are required to discuss in the forms of groups the basic principles of PPRC, PEX, ABS & HDPE pipes. Also, to note the same on their note books.

## **1.4 Purpose of Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes**

### **1.4.1 Uses of Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes**

#### ***i- Uses of Polypropylene Random Co-polymer (PPRC) Pipe***

Polypropylene Random Co-polymer (PPRC) pipes are recommended to be used for:

- Hydraulic works in residential, industrial and public projects
- Compressed air systems (air-conditioning)
- Drinking water and food liquids
- Agriculture (watering systems for green houses and gardens)

- Polypropylene Pipe, similar in application to CPVC but a chemically inert material containing no harmful substances and reduced dangerous emissions when consumed by fire. It is primarily utilized in radiant floor systems but is gaining popularity as a leach-free domestic potable water pipe, primarily in commercial applications. The thermal conductivity of PPRC is very low, meaning temperature cannot easily be conducted from the outside environment to the liquid in the pipe, and vice versa.

#### *ii- Uses of Cross-linked Polyethylene (PEX) Pipe*

- PEX is often the best option for smaller projects and quick repairs.
- It is best for small areas like under a sink as the piping can be easily bent.
- PEX pipes are used to run hot and cold water.
- PEX pipes are used for long lines also.
- Being that the lines are long, there aren't as many connectors involved, which also reduces the chance of leaks that could potentially result from connectors that are faulty or over time as they wear.
- Smaller areas that keep PEX confined to an easy to reach spot allow leaks to be detected from any connectors that are used, as well as allow for easy repair.

#### *iii- Uses of Acrylonitrile Butadiene Styrene (ABS) Pipe*

- ABS pipes can be used for higher impact loading condition especially at low temperature.
- ABS pipes are used to convey fluids having acids, alkalis and salts.
- ABS is used in drain-waste-vent pipe systems and sewer systems.
- ABS piping is for drain piping only and is not used for potable drinking water.

#### *iv- Use of High Density Polyethylene (HDPE) Pipe:*

HDPE: High-density polyethylene is so tough and durable that it can be used for virtually all plumbing needs. It can also reduce water pressure since it has a low coefficient of friction, allowing water to flow easily inside.

### **1.4.2: Purpose and Classification of Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes**

**PPRC pipes** are recommended to be used for:

- Hydraulic works in residential, industrial and public projects.
- Compressed air systems (air-conditioning).
- Drinking water and food liquids.
- Agriculture (watering systems for green houses and gardens).

***i- Polypropylene Random Co-polymer (PPRC) Pipe Classifications:***

The raw material of PPRC is separated into 3 groups according to heat, pressure and durability for chemicals. These are Type-1 (polypropylene homo polymer), Type-2 (polypropylene block copolymer) and Type-3 (Polypropylene Random copolymer).

***ii- Cross-linked Polyethylene (PEX) Pipe Classifications:***

Classes of PEX pipes are:

Peroxide crosslinking (PE-Xa),

Silane crosslinking (PE-Xb)

Electron beam crosslinking (PE-Xc)

Azo crosslinking (PE-Xd)

***iii- Acrylonitrile Butadiene Styrene (ABS) Pipe Classifications:***

ABS Piping Systems are available in a range of sizes from designation number (DN) 15 to DN 750. Standard pressure ratings at 20°C are 900 kPa (kilo pascal), 1200kPa and 1500kPa (Class C, Class D and Class E). Class C is 9 bar operational; Class D is 12 bar (but not many sizes are manufactured in this class) and Class E is 15 bar operating pressure.

ABS thermoplastics are recognized as a suitable material to be used in many industry applications.

***iv- High Density Polyethylene (HDPE) Pipe Classifications:***

Typically, the standard specification identify class of a HDPE pipe is by the nominal pressure class - PN - up to PN 20 or 20 bar. HDPE pipe can also be classified by the material used - PE 100, PE 80, PE63, PE 40 or PE 32. (Pressure Nominal – PN)

**1.4.3 Difference between Polypropylene Random Co-polymer (PPRC) and PVC pipes**

- The diameters of PPRC and PVC pipes are the same, the biggest difference is the thickness of the pipe wall, the thickness of the PPRC pipe. The PPR pipe and the PVC pipe have words on them. It is clear at a glance, and the toughness of the PPR pipe is good. Under the same pipe diameter, the PPR pipe wall is usually thicker.
- The PPR tube is produced from a copolymerized polypropylene material, while the PVC tube is produced from a polyvinyl chloride material. The production materials are different, resulting in different properties.
- Second, the colour of PPR pipes and PVC pipe products are different due to different materials.

- Fourth, production costs are different. Due to the material and wall thickness, the production cost and price of PPR pipe is relatively high.
- Fifth, the use is different. Due to material reasons, PVC pipes are not as hygienic and safe as PPR pipes. PPR pipes are generally used as water supply pipes in home installations. They can be used for hot and cold-water pipes. PVC pipes are often used for drain pipes. Only cold-water pipes can be used.

#### **1.4.4 Advantages and disadvantages of Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes**

##### ***i- Polypropylene Random Co-polymer (PPRC) Pipes***

PPRC has some advantages over other plastic pipe used in residential and commercial plumbing (e.g., PVC and CVPC).

##### **Advantages of PPRC Pipes**

- The diameters of PPR and PVC pipes are the same, the biggest difference is the thickness of the pipe wall, the thickness of the PPR pipe.
- The toughness of the PPR pipe is good. Under the same pipe diameter, the PPR pipe wall is usually thicker.
- These pipes are stable.
- These pipes are durable, life is up to 50 years.
- These pipes are leak resistance.
- These pipes need a smaller number of supports, low cost of supports.

##### **Dis-advantages of PPRC Pipe**

- These pipes need special types of fitting and appurtenances which are very costly.
- These pipes need special types of heaters to join with fittings.
- These pipes need special technique to join with fittings.

##### ***ii- Cross-linked Polyethylene (PEX) Pipe***

##### **Advantages of PEX Pipe**

- Color-coded red for hot water and blue for cold water
- Highly flexible, with 90-degree curves possible
- Attaches with push-fit plumbing fittings, among other types
- Inexpensive

- Able to join with copper pipe
- Cuts easily

#### **Dis-advantages of PEX Pipe**

- Long-term capabilities untested
- May leak with push-fit plumbing fittings
- Cannot be recycled

#### ***iii- ABS Pipe***

##### **Advantages of ABS Pipe**

- Stronger than PVC pipes
- Good for underground exterior use
- Works well in cold temperatures

##### **Dis-advantages of ABS Pipe**

- Often not permitted by building code
- Warps and deforms at certain temperatures

#### ***iv- High Density Polyethylene (HDPE) Pipe***

##### **Advantages HDPE Pipe**

- HDPE pipe is much easier to handle and install compared to other pipe materials.
- HDPE pipe require fewer fittings and can be welded into seamless leak-free pipe runs, allowing for significant savings in labour and equipment.
- HDPE pipe can be heat fused together to form a joint that is as strong as or stronger than the pipe itself while being virtually leak free.
- Corrosion and chemical resistance.
- Due to smoother surface, no resistance to flow.

##### **Dis-advantages of HDPE Pipe**

- Poor weathering resistance
- Flammable
- Sensitive to stress cracking
- Difficult to bond

**Activity 1.7: Basic Uses of Polypropylene Random Co-polymer (PPRC), Cross-linked Polyethylene (PEX), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE) pipes**

Students are required to go through the chapter and give a detailed note on usage of above pipes and note down in their not book.

**Activity: 1.8: Differences between Polypropylene Random Co-polymer (PPRC) and PVC are observed**

The students are required to discuss basic identification differences between PPRC and UPVC pipes. Also, to note the same on their note books.

## Key Points

1. The different types of plastic pipes used in plumbing system are PVC, CPVC, UPVC, PPRC, PE, PEX, ABS & HDPE etc.
2. There are four types of PVC pipes:
  - i. Unplasticized PVC (PVC-U)
  - ii. Chlorinated PVC (C-PVC)
  - iii. Molecular oriented PVC (PVC-O)
  - iv. High Impact PVC (PVC-Hi)
3. UPVC pipe have a high mechanical performance, high chemical resistance, and resistance to UV exposure.
4. UPVC pipes and CPVC pipes are highly resistant to corrosion and safe to use for drinking water.
5. Molecularly Oriented PVC (PVC-O) pipes have a great hydraulic capacity, resistance to cracks, and ductility.
6. PVC-Hi is used on occasions when standard PVC wouldn't handle the pressure or the extreme temperatures.
7. The sanitary pipes should be preferably laid into the ground by the side of the building rather than in walls or underground.
8. Horizontal pipes should be laid straight and at grade (1:48) between inspection chambers.
9. No pipe should be kept open outside the building in the street with out covering.
10. A 1/2-inch diameter schedule 40 pipe has a thinner wall than a 1-inch diameter schedule 40 pipe. The thicker schedule 80 pipe is more resistant to crushing and puncture than schedule 40 pipe. Also, schedule 80 PVC resists greater pressure than schedule 40 PVC.
11. PPRC stands for Polypropylene Random Copolymer. The thermal conductivity of PPR is very low, most reliable in plumbing and water supply plants, due to their chemical features and fusion welding, which ensures the plumbing to have a perfect seal tight system.
12. PEX, or cross-linked polyethylene is a highly rigid pipe capable of withstanding high pressures of water supply but are flexible enough to weave through ceilings, crawlspaces, and walls etc.

13. ABS (acrylonitrile butadiene styrene) pipe is mainly used as a vent and drain line. ABS is a dark-colored pipe, usually black, and it is durable and lightweight. It is mainly used in residential plumbing applications
14. High-density polyethylene (HDPE) pipe is strong, durable, flexible and lightweight. When fused together, HDPE offers a zero-leak rate due to the seamless nature of the pipe system.
15. There are three classes of PPRC pipe- Type-1, Type-2 & Type-3.
16. Classes of PEX pipes are peroxide crosslinking (PE-Xa), silane crosslinking (PE-Xb), electron beam crosslinking (PE-Xc) and azo crosslinking (PE-Xd).

## EXERCISE

### Multiple Choice Questions

**Q-1. Tick ( ✓ ) the correct option for the following MCQs.**

1. This plastic pipe is low-cost choice.

- (A) PVC Pipe                      (B) HDPE Pipe  
(C) PVC-U pipe                      (D) C-PVC Pipe

2. This pipe can be used for drinking water supply line:

- (A) C-PVC Pipe                      (B) HDPE Pipe  
(C) PVC-U pipe                      (D) All of these

3. Horizontal pipes should be laid for sewage flow at gradient of:

- (A) 1:24                                  (B) 1:48  
(C) 1:72                                  (D) 1:96

4. This pipe can resist more pressure:

- (A) PVC                                      (B) UPVC  
(C) PVC-Hi                                      (D) None of these

5. The most commonly used plastic pipe for fresh water:

- (A) PVC                                      (B) PPRC  
(C) PVC-Hi                                      (D) All of these

6. PVC-U pipe can be used for conveyance of:

- (A) sewage                                      (B) fresh water  
(C) industrial drainage                      (D) All of these

7. This plastic pipe was firstly manufacture in:

- (A) 1950s                                      (B) 1960s  
(C) 1970s                                      (D) 1980s

8. The pressure resistance of standard 80 is \_\_\_\_\_ than standard 40 pipe:

- (A) less than                                      (B) greater than

- (C) equal to (D) All of these
9. The DWV stands for in plumbing:  
(A) Door window ventilator (B) Dog wolf visitor  
(C) Drain, Waste, vent (D) All of these
10. How many classes are for PPRC pipes:  
(A) 2 (B) 3  
(C) 4 (D) 5

### Short Questions

**Short answer of the following questions.**

1. Enlist types of plastic pipes
2. Give the advantages of PVC pipes.
3. Write down disadvantages of CPVC pipe.
4. What is the use of ABS pipe?
5. What hazards can be suspected from plastic pipes.
6. What is difference between UPVC and normal PVC pipe.
7. Why are iron fittings and fixture coated or galvanized?
8. Why PPRC pipes are used now a days instead of G.I. pipes?
9. Why ABS thermoplastic pipes are considered suitable for the industrial use.
10. Enlist uses of HDPE pipes.

### Long Questions

**Answer of the following question in detail**

- Q-1. Discuss the differences between type of PVC pipes?
- Q-2. Discuss the safety hazards in connection with plastic hazards.
- Q-3. Write down the basic principles for laying of PPRC, PEX, ABS, HDPE pipes.
- Q-4. Explain the different classifications of PPRC, PEX, ABS, HDPE pipes.
- Q-5. Write down the advantages and disadvantages of PPRC, PEX, ABS, HDPE pipes.

## CHAPTER 2

### WORKS PLACE SAFETY



#### Students' Learning Outcome

after studying this chapter students will be able to:

- learn the concept of industrial safety
- industrial pollution effect on environment and humans.
- state use of power tools.
- not remove covering of machines
- not to repair a machine during working. loose clothing and carelessness factors.
- learn about safety symbols and there uses in industry
- know safety regarding construction sites such as high-rise building, deep execution and moving machines.
- introduction of first aid
- importance of first aid.
- first aid in case of accident.
- first aid in case of electric socks.

## **2.1 Introduction to Industrial safety.**

Industrial safety refers to the management of all operations and events within an industry in order to protect its employees and assets by minimizing hazards, risks, accidents, and near misses. Industrial safety is overseen by federal, state, and local laws and regulations. The Occupational Safety and Health Association (OSHA) is the primary regulatory body in the United States dedicated to ensuring industrial safety. Pakistan has no still specific health and safety regulatory body. Although Pakistan Safety Council (PSC) a non-Government organization is there.

Industrial safety covers a number of issues and topics affecting safety of personnel and the integrity of equipment in a particular industry.

The following topics are generally discussed:

- i.** General Safety – General aspects of safety which are common to all industries
- ii.** Occupational Safety and Health – Particularly associated with the occupation
- iii.** Process and Production Safety
- iv.** Material Safety
- v.** Workplace Safety – Safety issues directly related to the workplace setting
- vi.** Fire Safety
- vii.** Electrical Safety – Arising from the equipment used
- viii.** Building and Structural Safety – Including installations as per existing building code
- ix.** Environmental Safety – Concerns the direct and indirect environmental impact of the industry.

### **2.1.1 Concept of Industrial Safety**

In order to understand the accident causation, it is necessary to consider what is meant by "safety". Depending on one's perspective, the concept of safety may have different connotations, such as:

- Zero accidents (or serious incidents);
- The freedom from danger or risks, i.e. Those factors which cause or are likely to cause harm;
- The attitude towards unsafe acts and conditions by employees (reflecting a "safe" corporate culture);
- The degree to which the inherent risks in industry are "acceptable";
- The process of hazard identification and risk management; and
- The control of accidental loss (of persons and property, and damage to the environment).

Safety is the state in which the risk of harm by accident to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.

### **2.1.2 Effects of Industrial pollution on environment and humans.**

Industries and factories give off various pollutants into the environment including the land, air, and waters. It is estimated that about 50% of all pollution is as a result of industrial and manufacturing activities. Illnesses, loss of life, and destruction of the ecosystem are some of the pollution outcomes that take years to manifest. Below are some of the prime effects of industrial pollution.

#### **Effects on Environment**

Followings are the effects of industrial pollution on environment.

##### **A. Global Warming**

Global warming is among the most serious outcome of industrial pollution, witnessed on the account of the steady rise of industrial activities. Industries release into the atmosphere a variety of greenhouse gases including carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). These gases absorb thermal radiation from the sun thereby increasing the general temperature of the earth, leading to global warming.

Global warming has several severe effects on human health and the environment. Rise in water levels, melting of glaciers, extinction of polar species, tsunamis, flooding, and hurricanes are some of the dire effects of global warming.

##### **B. Water Pollution**



Industries demand lots of water for efficient production such as cooling, cleaning, and treatment and as such, the water drawn from the water sources is never the same after use. Inappropriate contamination of used water and the discharge of different industrial waste water into water sources often result in water pollution. The dumping of the wastewater directly into waterways or oceans negatively impacts on marine life, humans, and the environment on various aspects.

### C. Air Pollution

Based on the increased counts of factories and manufacturing processes, both large and small scale, gaseous emissions have continued to compound. This makes industrial pollution one of the main causes of air pollution. Formation of acid rains, the presence of smog, and heightened incidences of respiratory disorders among humans are some of the implications of air pollution.



### D. Soil Pollution

Soil pollution occurs when the soil loses its fertility and structure owing to diverse natural and artificial phenomenon. Disposal of industrial wastes into landfills is among the artificial aspects contributing towards soil pollution. Industrial wastes have in them varied amounts of toxic materials and chemicals, thereby depreciating the fertility and biological activity of the soil due to soil poisoning. Crop productivity is reduced. Also, poisons become part of crops. These crops cause health problems to those who consume such crops.



#### Effect of Industrial Pollution on Human Health

- Smog is cause of industrial pollution. It is seriously harming the human beings as well as other creatures of the universe.

- Water is contaminated by industrial wastes. When this polluted water is used for irrigation purpose, the crops grown give the product which is harmful. When these crops are eaten by the human beings, they suffer from various disorder in their bodies.
- Industrial toxic and chemical wastes that are disposed into water bodies or landfills are also responsible for cancers and human cell poisoning. For instance, exposure to inorganic arsenic causes tumours to form. Above all, industrial pollutants are responsible for thousands of illnesses and premature deaths across the globe.
- The world Health Organization (WHO) revealed that outdoor air pollution accounts for about 2% of all lung and heart diseases. WHO also underscores, around 5% of all lung cancers and 1% of all chest infections are implications of outdoor air pollution.
- In brief, these statistics indicate just how industrial air pollution depreciates human health.

### **Wildlife Extinction**

Industrial wastes, chemicals, emissions, or accidental leaks, fires, oil spills and so on have been prime contributors to wildlife extinction. Wild life generations are being destroyed by the harmful water and polluted air by the industries.

### **Other Common Implications**

Other common implications of industrial pollution encompass damage to structures and buildings and increased risks of different occupational hazards like exposure to asbestos, chemical dust, among other mineral or metallic particles.

#### **Activity 2.1: Visit of nearby industries.**

Students visit to nearby industry should be arranged. They should collect data of how uncontrolled industry is affecting the environment and humans. They have to submit the report of their visit.

#### **Activity 2.2: Demonstrate industrial pollution and its effects.**

Based on the report of the visit, students should practice to demonstrate the industrial pollution and its effects.

## **2.2 Safety regarding Power Tools**

All power tools can be dangerous if both general and tool specific safety instructions are not followed carefully. General safety instructions apply to all electric (corded and cordless), pneumatic & hydraulic power tools.

### **2.2.1 State use of Power Tools.**

1. Assess the risks before using tools i.e., S.T.A.R (Smile, Take a deep breath And Relax) Cards.

2. Ensure you are properly trained and authorised to safely use the power tool. Always read and understand the tool's operator's manual, tool markings and the instructions packaged with the accessory before starting any work.
3. Ensure you have the correct PPE for the task, some tools require different PPE to others.
4. If the power tool has guarding or other safety devices they shall be fitted as per the manufacturer's specifications.
5. Inspect the power tool for damage and or wear before use.
6. Horseplay with any tool is strictly prohibited.
7. Do not operate power tools in explosive atmospheres, near flammable liquids, gases, or dust.
8. Wait for the tool to stop spinning before placing it on the ground or bench.
9. Always switch off the tool and remove the plug before making adjustments.
10. Remove adjusting keys and spanners before operating.
11. Never modify or alter a power tool from its original manufacturers design.
12. Never attempt to repair a faulty power tool unless authorised to do so.
13. Never use a tool that is prohibited from site (check the prohibited items register).
14. Take all damage power tools out of service by attaching a warning tag.
15. If in doubt stop the task and seek further advice before recommencing.
16. Explosive Power Tools are prohibited.
17. Not remove covering of machines
18. Not to repair a machine during working.
19. Loose clothing and carelessness factors.

Do you know?

PPE is your last line of defense against from harm. Hazards to the users include projectiles, contact, noise, vibration and entanglement.

Always wear appropriate PPE to protect you from the specific hazards presented by power tools, such as dust exposure and projectiles. PPE such as goggles, dust mask, gloves, hard hat, and safety boots should be worn where appropriate.

Depending on the noise levels involved, it may be necessary to wear hearing protection during your use of the tool.

### Activity 2.3: Demonstration of machines working/visit of machine shop.

The teacher/ instructor is required to demonstrate to the students how to work safely with machines, tools, accessories, plugs, cables, and batteries in machine shop. Students have to take notes, observe the same and write on their practical note book.

### Activity 2.4: Demonstration of machines safe guard.

The teacher/ instructor is required to demonstrate to the students. how to protect themselves while operating machines, tools, batteries & electrical safety in machine shop Students have to take notes, observe the same and write on their practical note book.

### Activity 2.5: Demonstration of loose clothing and carelessness in machine shop

The teacher/ instructor is required to demonstrate to the students which PPE to wear for self-safety and for safety of others in machine shop. Students have to take notes, observe the same and write on their practical note book.

## 2.3 Industrial safety symbols.

Industrial safety signs take a variety of forms and functions, but they can be best classified by their primary use. When most people think of industrial safety signs, they think of the standard “caution” and “warning” signs that indicate a risk. These types of signs represent one of three hazard levels:

- i. **Danger Signs** – Indicate immediate hazards that will result in injury or death if not avoided.  
For example:



- ii. **Warning Signs** – Indicate a hazard level that falls somewhere between caution and danger, indicating a risk that could result in serious injury or death if not avoided. For example:



- iii. **Caution Signs** – Represent the lowest hazard level, indicating potentially hazardous situations that may result in minor to moderate injury if not avoided. For example:



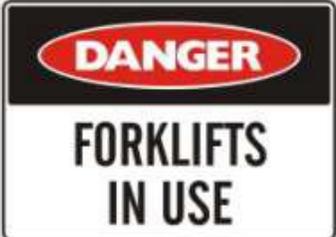
### 2.3.1 Safety Symbols and Their Uses in Industry

Other industrial safety sign types include:

- i. **Biological Hazard Signs** – Used to indicate either the actual or potential presence of a biohazard at work place.
- ii. **Notice Signs** – Used to communicate general information relevant to equipment, a building, area, or machine.
- iii. **General Safety Signs** – Used to communicate important safety instructions and procedures.
- iv. **Fire Safety Signs** – Industrial safety signs are often used to label the location of emergency equipment, such as fire extinguishers
- v. **Admittance Signs** – Indicate who is permitted to enter designated areas or locations.
- vi. **Safety Symbols** – While safety symbols can stand alone on a sign (provided they're sufficient to convey the message), they're often used in conjunction with other sign types to provide a pictorial depiction to accompany written text and notifications.
- vii. **Surround Shapes** – Surround shapes include hazard alerting, mandatory actions, prohibition, and information etc.

Here under are the common industrial safety signs:

	<p><b>Prohibition signs</b> – these are signs that indicate something that you must not do. They are made up of a red circle border with a line through it, a white background and black symbol.</p>
	<p><b>Mandatory signs</b> – these signs tell you that you must wear some special safety equipment. They are made up of a blue solid circle and white symbol.</p>

	<p><b>Restriction signs</b> – these signs tell of a limitation placed on an activity or use in the area concerned. They are made up of a red circular border, no crossbar, and a white background.</p>
	<p><b>Hazard warning signs</b> – these signs warn you of a danger or risk to your health. They are made up of a yellow triangle with a black border and a black symbol.</p>
	<p><b>Emergency information signs</b> – these signs show where emergency safety equipment is kept. They are made up of a green solid rectangle with a white symbol or text.</p>
	<p><b>Fire signs</b> – these signs tell you the location of fire alarms and firefighting facilities. They are made up of a red solid rectangle with white text.</p>
	<p><b>Danger hazard signs</b> – these signs warn of a particular hazard or hazardous condition that could be life-threatening. They have the word DANGER in white on a red background, a black border and black text.</p>
	<p><b>Dangerous goods signs</b> (also known as Hazardous chemicals signs) are defined in the Australian dangerous goods code. They are used to indicate what is in a tank or package and how it needs to be stored and transported.</p>



If you are hurt, this is where you should go.



Do not smoke here



Do not go in here



Gas can catch fire



This gas could catch on fire



Don't use this machine without a safety guard.



You must wear gloves.



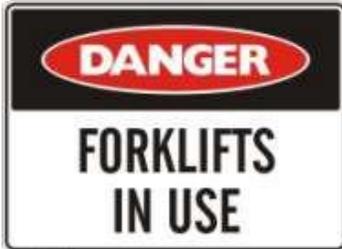
You must wear eye protection.



You must wear a hard hat in this area.



You should go here if there is an emergency.



Watch out for forklifts in this area.



If there is an emergency, leave the building here.



Don't use your mobile here.



Don't use the lift if there is a fire.



Don't put your hands here.



The scaffolding isn't ready to be used.

 <p>Be careful. The floor is slippery.</p>	 <p>There are dangerous amounts of electricity here.</p>
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**Activity 2.6: Learning and demonstration of safety symbols, preparing play cards of safety symbols.**

There are four sub-activities in this activity:

**Activity a: matching safety signs**

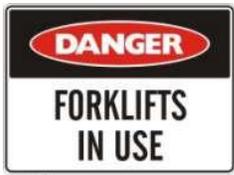
Match same category signs

**Activity b: types of signs**

Write down type of each sign provided to you.

**Activity c: signs in the workplace** one example is given. Put other signs and also give the answers of questions given in header row.

Perform your activity by following example.

Sign	Why did you choose this sign?	Where might this sign be placed?	Why is this sign needed?
e.g. 	e.g. Often forklifts are used in a warehouse to move goods around.	e.g. In areas where forklifts are operating and people might walk.	e.g. People can get hurt if hit by a forklift.
1.			

**Activity d: signs at school**

Name and prepare album of safety signs used at school.

**2.4 Safety Regarding Construction Site.**

Safety at construction sites may include as high-rise building, deep execution and moving machines.

### 2.4.1 Safety at Construction Site in high-rise building

During the high-rise construction process, safety precautions include vigilance, understanding the risks of the working practices and employing professional physical safeguards like barricades, braces, railing, and guy lines. Also, the following protection systems should be standard in high-rise construction projects:

- standpipes
- sidewalk sheds
- jersey barriers
- vertical netting
- horizontal netting

The most frequent problems/accidents related to safety in high-rise construction often include:

- Ladders are weak.
- Falling Debris
- Falling From Heights
- Electrical shock & Machinery
- Trips and Slips
- Crane and hoist operation

Making responsible decisions in the planning and design stages can ensure safety during a high-rise construction project. Safety also relies heavily on educating the workers and ensuring optimal cooperation and communication between owners, inspectors and project managers during the construction phase.

### 2.4.2 Safety at Construction Site in Deep Excavation

Key issues during deep excavation are:

- i. Collapse of excavations
- ii. Falling or dislodging material
- iii. Falling into excavations
- iv. Undermining nearby structures
- v. Inflow of ground and surface water

#### **Collapse of excavations**

**a- Temporary support** - Before digging any trench pit, tunnel, or other excavations, decide what temporary support will be required and plan the precautions to be taken.

Make sure the equipment and precautions needed (trench sheets, props, baulks etc) are available on site **before** work starts.

**b- Battering the excavation sides** - Battering the excavation sides to a safe angle of repose may also make the excavation safer.

In granular soils, the angle of slope should be less than the natural angle of repose of the material being excavated. In wet ground a considerably flatter slope will be required.

### **Falling or dislodging material**

**a- Loose materials** - may fall from spoil heaps into the excavation. Edge protection should include toe boards or other means, such as projecting trench sheets or box sides to protect against falling materials. Head protection should be worn.

**b- Effect of plant and vehicles** - Do not park plant and vehicles close to the sides of excavations. The extra loadings can make the sides of excavations more likely to collapse.

### **Falling into excavations**

Edges of excavations should be protected with substantial barriers where people are liable to fall into them.

To achieve this, use:

- Guard rails and toe boards inserted into the ground immediately next to the supported excavation side; or fabricated guard rail assemblies that connect to the sides of the trench box
- the support system itself, eg using trench box extensions or trench sheets longer than the trench depth.

### **Undermining nearby structures**

- Make sure excavations do not undermine the scaffold footings, buried services or the foundations of nearby buildings or walls.
- Many garden or boundary walls have very shallow foundations which are easily undermined by even small trenches, causing the wall to collapse onto those working in the trench.
- Before digging starts, decide if extra support for the structure is needed.

### **Inflow of ground and surface water**

Regular dewatering should be done in case of inflow of water. The area should be surrounded by danger signs. The location for source of water either surface or ground should be identified. Necessary measures should be taken to prevent inflow of ground or surface water.

### 2.4.3 Safety at construction site for moving machines

A construction site is an extremely busy work environment. For example, whilst excavator operators are usually safe when on a excavator, those on foot are at risk. Pedestrians need to keep a safe distance. Employers can designate safe areas outside of traffic patterns and eliminate distraction – no ear buds or loud music.

Similarly, when working with trucks and dogs, workers ought to stay away from the trailer when material is being loaded or unloaded. If workers are required to assist, have a safe communication plan with the operators and drivers and a safe area to stand. All workers need reflective clothing.

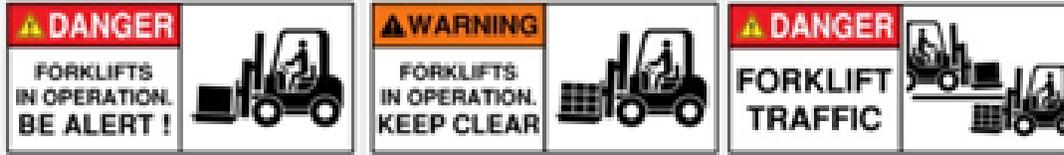
To prevent colliding with moving objects, the following safety features can be adopted:

- Traffic management tools such as signage, marking, safety cone, flag, barricade or bunting
- Reversing cameras, sensor devices or alarms
- Speed control bumps
- Elevated walkway or crossing gates
- Safety cages or guarding for tyre rim assembly/fitting
- Stanchions or chokes to secure log stacking
- Bollards

To prevent being trapped by moving machinery or equipment, it can be extremely helpful to implement:

- Machine guarding, including fixed, interlocked, photoelectric or a combination of those
- Emergency stop switches
- Electronic guarding and sensing devices, including trip bars or electronic curtains
- Rollover protective structures (ROPS) for tractors
- Power take-off (PTO) guards





*Safety symbol for moving machinery*

### **Activity 2.7: Visit of a nearby construction Sites.**

Visit to nearby industry and submission of report regarding health and safety at construction site for deep excavation, safety adopted near moving machinery.

### **Activity 2.8: Practice in fixing of safety belts.**

Fixing of safety belt for the student for working at heights and other measures adopted during working at heights..

## **2.5: First Aid**

First aid is the immediate care given to a person who is injured or ill.

### **2.5.1 Introduction of First Aid**

First aid includes identifying a life-threatening condition, taking action to prevent further injury or death, reducing pain, and counteracting the effects of shock. Because life-threatening situations do occur, everyone should know how to provide emergency care until a victim can be treated or transported to a medical facility. First aid is not intended to replace care by a physician or surgeon. Its intent is to protect the victim until medical assistance can be obtained.

The primary purpose of first aid is to:

- Care for life-threatening situations.
- Protect the victim from further injury and complications.
- Arrange transportation for the victim to a medical facility.
- Make the victim as comfortable as possible to conserve strength.
- Provide reassurance to the victim.

### 2.5.2 Importance of first aid.

First aid is important because it is the essential primary care given to an injured person hence the name, "first aid". If a person were simply thrown in the back of the ambulance on route to a hospital, then it would be possible that he or she could bleed out where as if proper first aid was given, they might have lived. First aid is important because it is an immediate care. The 5 main aims of first aid are:

- i. Preserve life. This is the number one aim of preserving life. First aid ensures that an injury or illness does not escalate to become life-threatening.
- ii. Preventing the situation from worsening.
- iii. Pain relief.
- iv. Promote Recovery.
- v. Protect the unconscious.

### 2.5.3 First aid in case of accident.

**1. Check yourself first:** If you have been injured in the accident, first check yourself for any injuries. Try to assess how well you can move your limbs, and if you experience symptoms such as dizziness etc. Remember you need to be fit enough to help the others.

**2. Check the other person(s) for injuries:** If other people are injured, first assess the extent of his/ her injuries. For e.g. is he bleeding from the head, neck, arms legs, abdomen back etc. Treat the quietest person first, they are usually more seriously injured or cannot breathe. People who can talk or scream, on the other hand, can breathe therefore can be treated a little later. Ask for the patient's name, if he responds, it means he is able to understand the situation and has most likely not suffered a severe head injury.

**3. Look for signs of breathing:** Next, check if the person is breathing and if he has a pulse.

**4. Call for help 1122:** Immediately call for an ambulance or rush the person to a hospital. Once you know more about the patient's condition you will be in a better position to tell the doctors about his/her condition.

**5. Check for obstructions in the person's mouth and throat:** If you do not hear any breath sounds, check his/her mouth for any obstructions. If there is something obstructing the airway, use your index and middle finger to clear the airway.

**6. Perform life saving techniques:** If there is no pulse, start CPR (Cardio pulmonary resuscitation) or EAR (External Air Resuscitation). Keep the person's neck straight to start EAR or CPR. There are 3 types of EAR; Mouth-to-mouth, Mouth-to-Nose, Mouth-to-Mask.

**7. Ways to help him/her in grave situations:** If there is bleeding from the mouth or the patient is vomiting, turn the person to his/her side. This will avoid any chances of the person choking. Place the person's arm that is under him straight out and the arm closest to you across his chest.

**8. Deal with open wounds:** If there are extensive wounds, try to control the bleeding using pressure to the area using a cloth. Press down with your palms rather than your finger tips. You can also read about first aid measures for fractures.

**9. Always suspect spinal injuries:** If the person's neck is in an awkward position (not normally placed) or the person is unconscious, do not move the patient. Get help immediately. This could mean that the person's neck is broken, and moving him/her in such a situation can cause more harm than good.

**10. Keep the person warm:** Usually accident victims feel excessively cold due to shock. Therefore keeping them warm is essential to survival. You can use whatever you have to do this, such as a T-shirt, jacket, etc.

**11. Avoid feeding the person:** Do not give the person any water, food or other fluids through the mouth, it could lead to the patient choking.

#### **2.5.4 First aid in case of electric shocks.**

Electrical shocks always need emergency medical attention -- even if the person seems to be fine afterward.

The **1122** emergency personnel may instruct you on the following:

##### **1. Separate the Person from Current's Source**

To turn off power:

- Unplug an appliance if plug is undamaged or shut off power via circuit breaker, fuse box, or outside switch.

If you can't turn off power:

- Stand on something dry and non-conductive, such as dry newspapers, telephone book, or wooden board.
- Try to separate the person from current using non-conductive object such as wooden or plastic broom handle, chair, or rubber doormat.

If high voltage lines are involved:

- The local power company must shut them off.
- Do not try to separate the person from current if you feel a tingling sensation in your legs and lower body. Hop on one foot to a safe place where you can wait for lines to be disconnected.
- If a power line falls on a car, instruct the passengers to stay inside unless explosion or fire threatens.

## **2. Do CPR (cardiopulmonary resuscitation), if Necessary**

When you can safely touch the person, do CPR if the person is not breathing or does not have a pulse.

- For a child, start CPR for children
- For an adult, start adult CPR.

## **3. Check for Other Injuries**

- If the person is bleeding, apply pressure and elevate the wound if it's in an arm or leg.
- There may be a fracture if the shock caused the person to fall.
- For burns, do Burn Treatment.

## **4. Wait for 1122 to Arrive**

## **5. Follow Up**

- A doctor will check the person for burns, fractures, dislocations, and other injuries.
- An ECG, blood tests, urine test, CT scan, or MRI may be necessary.
- The person may be admitted to the hospital or a burn center.

### **Activity 2.9: Demonstration First aid in case of accident.**

Mock Practice for first aid for an accidental person.

### **Activity 2.10: Demonstration in case of electric shocks.**

Mock Practice for first aid for an accidental person.

## Key Points

1. Industrial safety refers to the management of all operations and events within an industry in order to protect its employees and assets by minimizing hazards, risks, accidents, and near misses.
2. Pakistan Safety Council (PSC) a non-Government organization is there.
3. Safety is the state in which the risk of harm by accident to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management.
4. It is estimated that about 50% of all pollution is as a result of industrial and manufacturing activities.
5. Rise in water levels, melting of glaciers, extinction of polar species, tsunamis, flooding, and hurricanes are some of the dire effects of global warming.
6. The pollutions may be global warming, air pollution, soil pollution.
7. Ensure you are properly trained and authorised to safely use the power tool. Always read and understand the tool's operator's manual, tool markings and the instructions packaged with the accessory before starting any work.
8. Never modify or alter a power tool from its original manufacturers design.
9. Not to repair a machine during working.
10. The safety symbols are of three categories- danger signs, warning signs, caution signs.
11. During the high-rise construction process, safety precautions include vigilance, understanding the risks of the working practices and employing professional physical safeguards like barricades, braces, railing, and guy lines
12. First aid is the immediate care given to a person who is injured or ill.
13. First aid is important because it is the essential primary care given to an injured person hence the name, "first aid".

## EXERCISE

### Multiple Choice Questions

**Q-1. Tick ( ✓ ) the correct option for the following MCQs.**

- 1- This is a step of first aid in case of electric shock.  
(A) separate from source      (B) Do Artificial respiration  
(C) Call 1122                      (D) All of these
- 2- What is the percentage of industrial pollution?  
(A) 30%                              (B) 40%  
(C) 50%                              (D) 60%
- 3- According to WHO what %age of lungs cancer is due to air pollution:  
(A) 3%                                (B) 4%  
(C) 5%                                (D) 6%
- 4- This is a breathing technique:  
(A) STAR                              (B) Drain  
(C) Balloon                          (D) All of these
- 5- This is a category of industrial sign:  
(A) Warning sing                  (B) Danger Sign  
(C) Caution sign                  (D) All of these
- 6- Industrial safety is to protect its employees and assets by minimizing this:  
(A) hazard                            (B) risk  
(C) accidents                        (D) All of these
- 7- This is an effect of industrial pollution on environment:  
(A) lungs cancer                    (B) heart disease  
(C) water pollution                (D) All of these
- 8- This is an effect of industrial pollution on human health:  
(A) air pollution                    (B) lungs cancer  
(C) water pollution                (D) All of these
- 9- This is an issue during deep excavation at construction site:  
(A) falling into excavation      (B) falling debris  
(C) trips and slips                 (D) All of these

- 10- This is the most frequent problem during working in high rise building at construction site:  
(A) falling into excavation      (B) undermining of nearby structure  
(C) trips and slips                      (D) All of these

### Short Questions

**Short answer to the following questions.**

- 1- Enlist key issues during deep excavation.
- 2- State the three categories of safety symbols.
- 3- Write down 3 considerations for working near moving machines.
- 4- Define first aid.
- 5- Enlist steps of first aid in case of accident.
- 6- Enlist steps of first aid in case of electric shock.
- 7- How to provide first aid to an injured person?
- 8- Enlist life saving techniques.
- 9- Define industrial pollution.
- 10- Define danger signs.

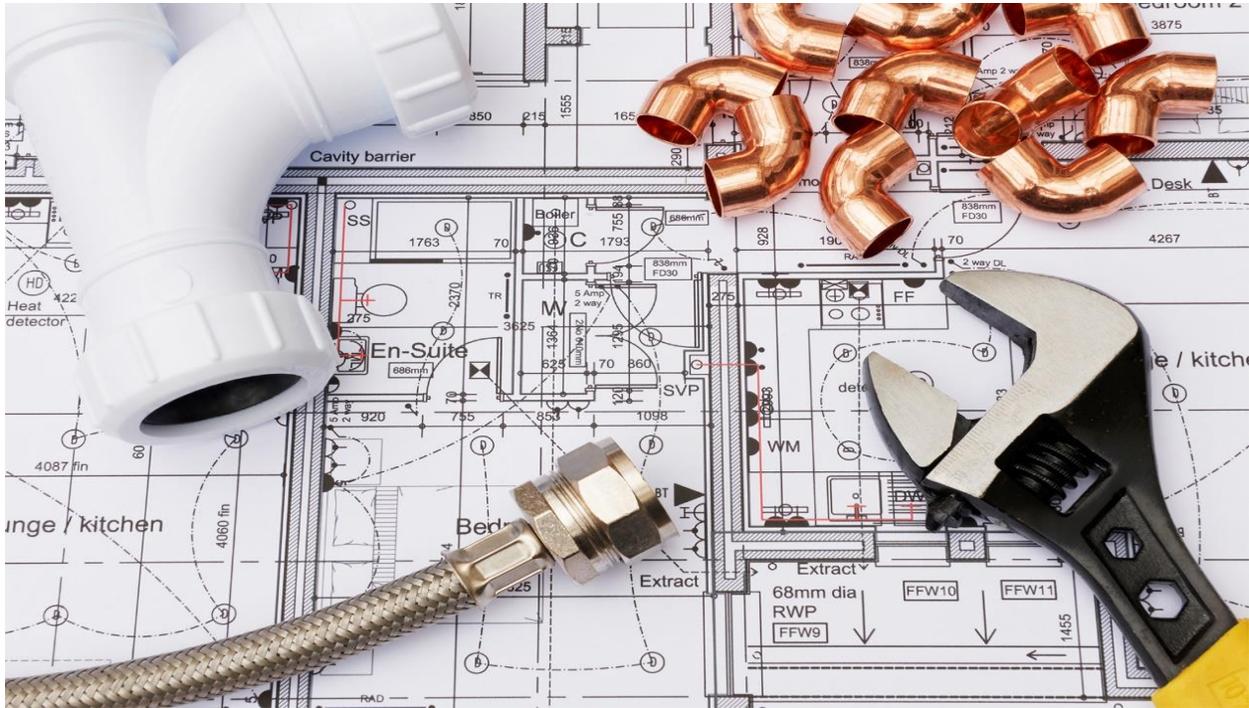
### Long Questions

Answer of the following question in detail

1. Describe the safe use of power tools?
2. Describe in details the pollution produced by industries?
3. Enlist 5 warning and describe their purpose and location in the industry.
4. Explain safety measure adopted in high rise building.
5. Explain procedure of first aid in case of electric shock.

# CHAPTER 3

## PLUMBING LAYOUT DRAWING



### Students' Learning Outcome

**After Studying this chapter students will be able to:**

1. state types of drawings.
2. state key features to be recorded
3. identify and follow work health and safety (whs) requirements on site.
4. state tools and equipment required for inspection and measurement and for producing the drawings.
5. state pps for safety and serviceability.
6. inspect area and record required measurements.
7. create suitable views and simple sketches and drawings using standard drawing conventions.
8. create standard sectional drawings of structural elements.
9. observed sustainability principles and concepts in undertaking work process.
10. record information on the drawing with symbols and abbreviations.
11. label according to organizational administration and quality procedures.

## Introduction

Drawing is the language of engineering related persons. There are many ways of expressing ideas, and information. Preparing drawing for plumbing systems is a short but complete way of conveying the planning for this system. Drawing expresses components by means of lines, and symbols of components and materials.

### 3.1. Sketches and drawings.

Ideas can be expressed in the form of sketches/ drawings along with other means. Graphical representation of ideas is a drawing. When we prepare a drawing without the help of scale it is generally termed as sketch. The scaled graphics are known as drawings. Drawings of various structures are prepared. Here in plumbing we will consider building drawings. The facilities provided in the building are also represented in drawings. Plumbing systems are facilities for the incumbents of the building.

#### 3.1.1 Types of drawings.

There are basically 6 types of drawings related to building:

*v- Architectural drawing.*

This type of drawing provides complete view of building. It demonstrates the location of building and all parts where they will be placed. There are different types of architectural drawings named as are plan, elevation, section, etc.

*vi- Structural Drawing.*

This type of drawing provides detail about structures, i.e., strength of different structural elements, structural material, grade, size and placement of reinforcements etc.

*vii- Electrical drawing.*

This type of drawing provides details and location of electrical wiring, fixtures, sub-station etc. Electrical load calculation is also given in the drawing.

*viii- Plumbing and sanitation drawing.*

These drawings give the location of piping both for water supply & Sanitation systems, fixtures, and the process to connect every fixture etc.

*ix- Finishing Drawing*

This type of drawing contains the detail of finishing and appearance of the building such as marbles, tiles, etc.

*x- Gas and Air conditioning drawing.*

These drawings give the location of piping both for gas & HVACR systems, fixtures, and the process to connect every fixture etc.

The sub-types of above drawings are different types of plans to represent location of elements of building. The top view of building/ structure is called plan. These are site plan, line plan, location plan, roof drainage plan, electrification, sanitary installations plan, water supply installation plan, reinforcement plan, foundation plan, and landscape plan.

Others types of drawings are long section, cross section, sections of different types of structural members, all sides elevations, structural drawings of all components of building,

### **3.1.2 Key Features Recorded in Drawings**

To represent the features we use symbols, perspectives, dimensioning, lettering & printing, units of measurement, notation systems, visual styles elements. By the use of these elements, features in different types of drawings are drawn. These drawings include plans, elevations, sections, perspective views etc. The key features relevant to plumbing are given below:

- Location and arrangement of various rooms.
- Arrangement and location of furniture and fixtures.
- Location of piping network for water supply system.
- Location of piping network for drainage and sanitation system.
- Location of fixtures of water supply system.
- Location of fixtures of sanitation system.
- Location and arrangement of sanitary structures, e.g., intercepting chambers, manholes, septic tanks etc.
- Drawings showing structural details of intercepting chambers, manholes, septic tanks etc.

### **3.1.3 Work health and safety (WHS) requirements.**

The following main safety measures are observed during preparation of drawings:

1. Drawing materials can be: Toxic, can cause physical injury by inhalation, ingestion or by skin contact. They can be irritating, causing inflammation of the skin, eyes, mucous membranes or pain.
2. Familiarize yourself with substances that are dangerous.
3. Hands should be kept clean at all times during work.
4. Keep the work area clean and try to keep it in order.
5. All drawing instruments should be kept clean with a cloth or towel.
6. Identify the location of the extinguishers and the first aid box.

7. When using liquid drawing media such as ink try using those that are alcohol-based as they are less toxic.
8. Never paint your body with markers or drawing inks. Body painting should be done with cosmetic colours.
9. Never use markers in close range to prevent from dangerous vapours coming out.
10. When using the pencil sharpener, make sure your hands are clean and free from any trace of graphite.
11. Never carry your work items into your mouth.
12. Hand contact with the drawing sheet should be avoided.
13. Never leave glasses near the project being carried out.

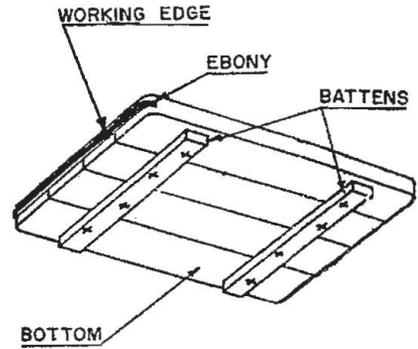
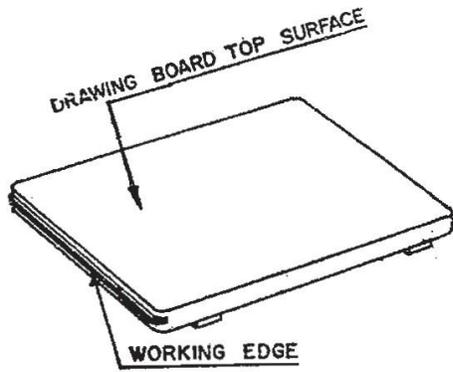
#### **3.1.4 Tools and equipments for inspection & measurement and producing the drawings.**

- i. Tools for inspection and measurement: Steel measuring tape, plum bob, spirit level, marker.
- ii. Drawing Board, drawing paper, Pencil, Eraser and drawing pins or tape and clips, duster, sand paper.
- iii. Tools for Drawing Straight Lines: T-square and set square, Mini drafter, scales.
- iv. Tools for Curved Lines: Compass, French curves and Templates,
- v. Tools for Measuring Distance and angles: Dividers, scales and Protractor.

Some main drawing instruments are described as under:

##### ***xi- Drawing Board***

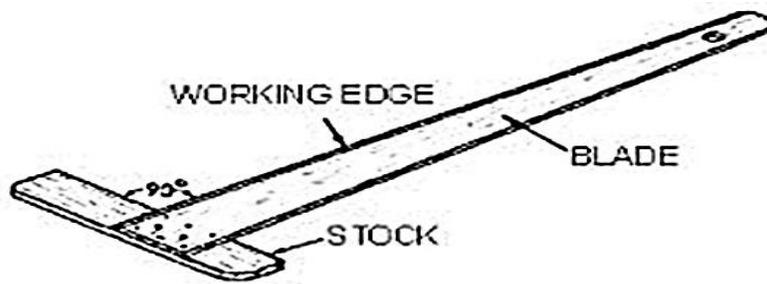
The drawing board is traditionally made of well-seasoned and soft wood of yellow pine free from knots and other defects. Narrow strips of wood are glued edge to edge to make a board which is fixed by screws to two battens. A straight ebony edge is fitted on the left side of the board against which the head of tee- square moves. The top surface of the board is perfectly smooth and level. Fig below shows a view of the drawing board.



*xii- Tee Square*

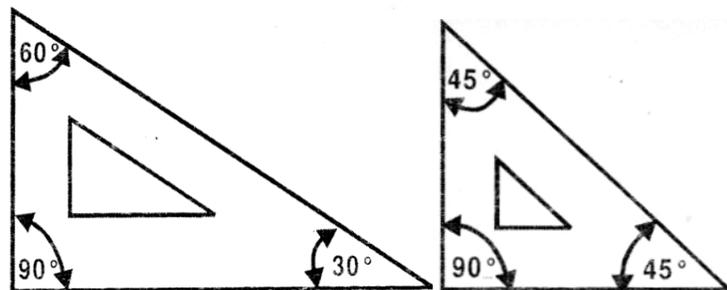
It is composed of a long strip called blade which is screwed rigidly at right angles to a shorter piece called head or stock. It is made of pear wood, a harder wood than the board wood. The blade is fitted with a straight ebony or plastic piece called working edge. The head also has an ebony edge which slides against

Working edge of the board.



*xiii- Set Square*

Set squares are prepared from celluloid, having a French curve or simply a gap cut in the body. They are as important instruments as the tee square for drawing work. A good combination of set squares is 30° x 60° set square and 45° set square



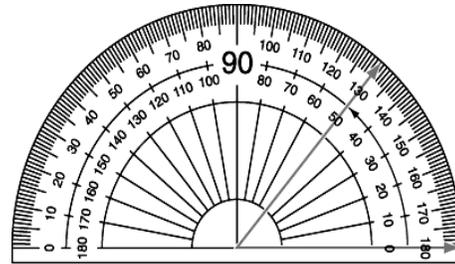
*xiv- Compasses*

Compasses are used to draw circles and arcs. They can be converted into divider by fixing needle in place of the pencil leg. For large radius circles and arcs, a lengthening bar is inserted in place of the pencil leg.



#### *xv- Protractor*

A protractor is a measuring instrument, typically made of transparent plastic or metal, for measuring angles. Some protractors are simple half-discs. More advanced protractors, such as the bevel protractor, have one or two swinging arms, which can be used to help measure the angle



**Protractor**

#### *xvi- Drawing Pencils*

Drawing pencils are ordinarily made of wood with a compress lead. Lead is made of clay and graphite. A pencil may be round or hexagonal in section, but hexagonal is proffered as it can be held in figures easily and does not role on the drawing board. Printing figures arrow head and free hand small curves are drawn with HB pencils. The H, 2 H, 3 H pencils are used for all the line work.

### **3.1.5 Personal Protective Equipments (PPEs) for safety and serviceability.**

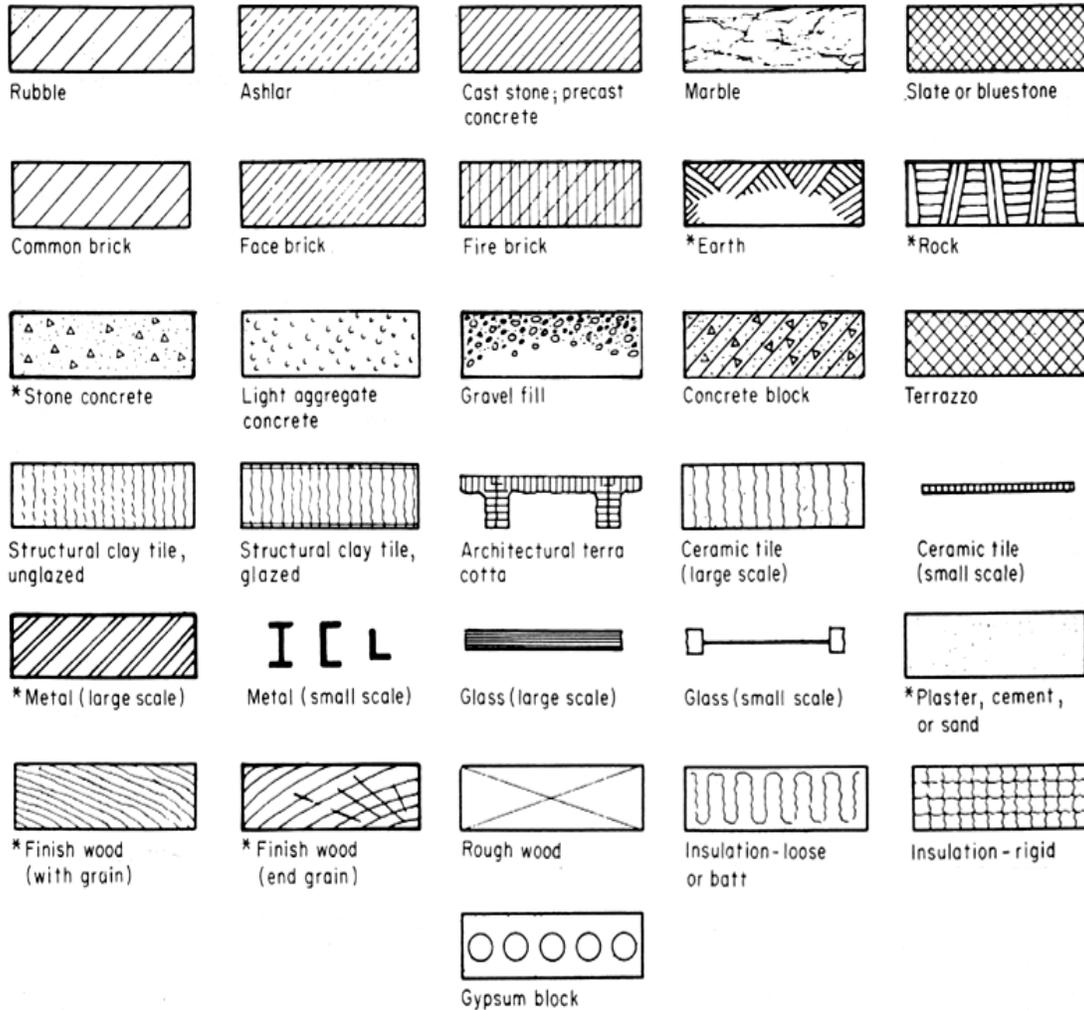
The personal protective equipments for safety and serviceability during preparing drawing include the followings:

- i- Gloves,
- ii- Handkerchief,
- iii- Duster,
- iv- Towel,
- v- Face Mask,
- vi- Glasses.
- vii- Face shields

The identification and types are not explained here as the same has been given in book one of plumbing and solar water heating system-I.

### Activity-3.1: Draw symbols of Building elements

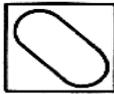
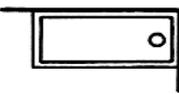
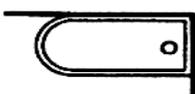
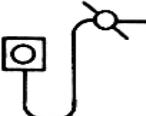
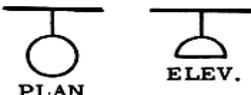
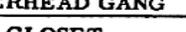
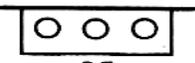
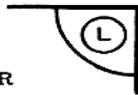
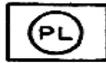
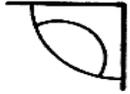
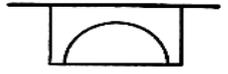
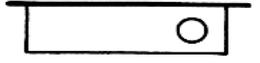
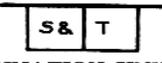
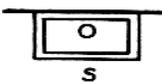
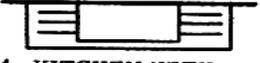
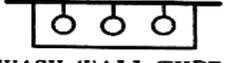
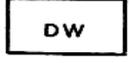
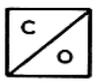
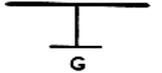
Students are required to draw the symbols of following building elements with the help of drawing instruments under the supervision of teacher/ instructor.



### Activity-3.2: Draw symbols of Plumbing Fittings/ Fixtures

Students are required to draw the symbols of following plumbing fittings/ fixtures with the help of drawing instruments under the supervision of teacher/ instructor.

## GRAPHICAL SYMBOLS FOR PLUMBING FIXTURES

<p><b>BATH TUB</b></p> <p>1. ANGLE </p> <p>3. RECESSED </p> <p>4. ROLL RIM </p> <p>5. FOOT </p> <p>6. SITZ </p> <p><b>DRAIN</b></p> <p>7. DRAIN </p> <p>8. FLOOR WITH BACKWATER VALVE </p> <p>9. HOT WATER TANK </p> <p>10. WATER HEATER </p>	<p><b>SHOWER</b></p> <p>11. HEAD </p> <p>12. MULTI-STALL </p> <p>13. STALL </p> <p>PLAN  ELEV. </p> <p>14. OVERHEAD GANG </p> <p><b>WATER CLOSET</b></p> <p>15. HIGH TANK </p> <p>16. LOW TANK </p> <p>17. NO DRAIN </p> <p><b>DRINKING FOUNTAIN</b></p> <p>18. DRINKING FOUNTAIN </p> <p>19. PEDESTAL TYPE </p> <p>20. TROUGH TYPE </p>	<p><b>LAVATORY</b></p> <p>21. CORNER </p> <p>22. DENTAL </p> <p>23. MANICURE OR MEDICAL </p> <p>24. PEDESTAL </p> <p>25. WALL </p> <p><b>URINAL</b></p> <p>26. CORNER TYPE </p> <p>27. PEDESTAL TYPE </p> <p>28. STALL TYPE </p> <p>29. TROUGH TYPE </p> <p>30. WALL TYPE </p>	<p><b>SINK</b></p> <p>31. COMBINATION SINK AND DISHWASHER </p> <p>32. COMBINATION SINK AND LAUNDRY TRAY </p> <p>33. KITCHEN </p> <p>34. KITCHEN WITH DRAINBORADS </p> <p>35. WASH-WALL TYPE </p> <p>36. DISHWASHER </p> <p>37. METER </p> <p>38. GREASE SEPARATOR </p> <p>39. CLEANOUT </p> <p>40. GAS OUTLET </p>
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**Activity-3.3: Draw symbols of water supply & Gas Fittings/ Fixtures**

Students are required to draw the symbols of following plumbing fittings/ fixtures with the help of drawing instruments under the supervision of teacher/ instructor.

90° ELBOW 

PIPE TURNED UP 

45 DEGREE ELBOW 

GATE VALVE 

TEE JOINT 

ANGLE GATE VALVE 

TEE JOINT TURNED UP 

GLOBE VALVE 

TEE JOINT TURNED DOWN 

SHUT OFF VALVE 

ELBOW TURNED DOWN 

ANGLE GLOBE VALVE 

—SAN—  
SANITARY SEWER  
PIPE

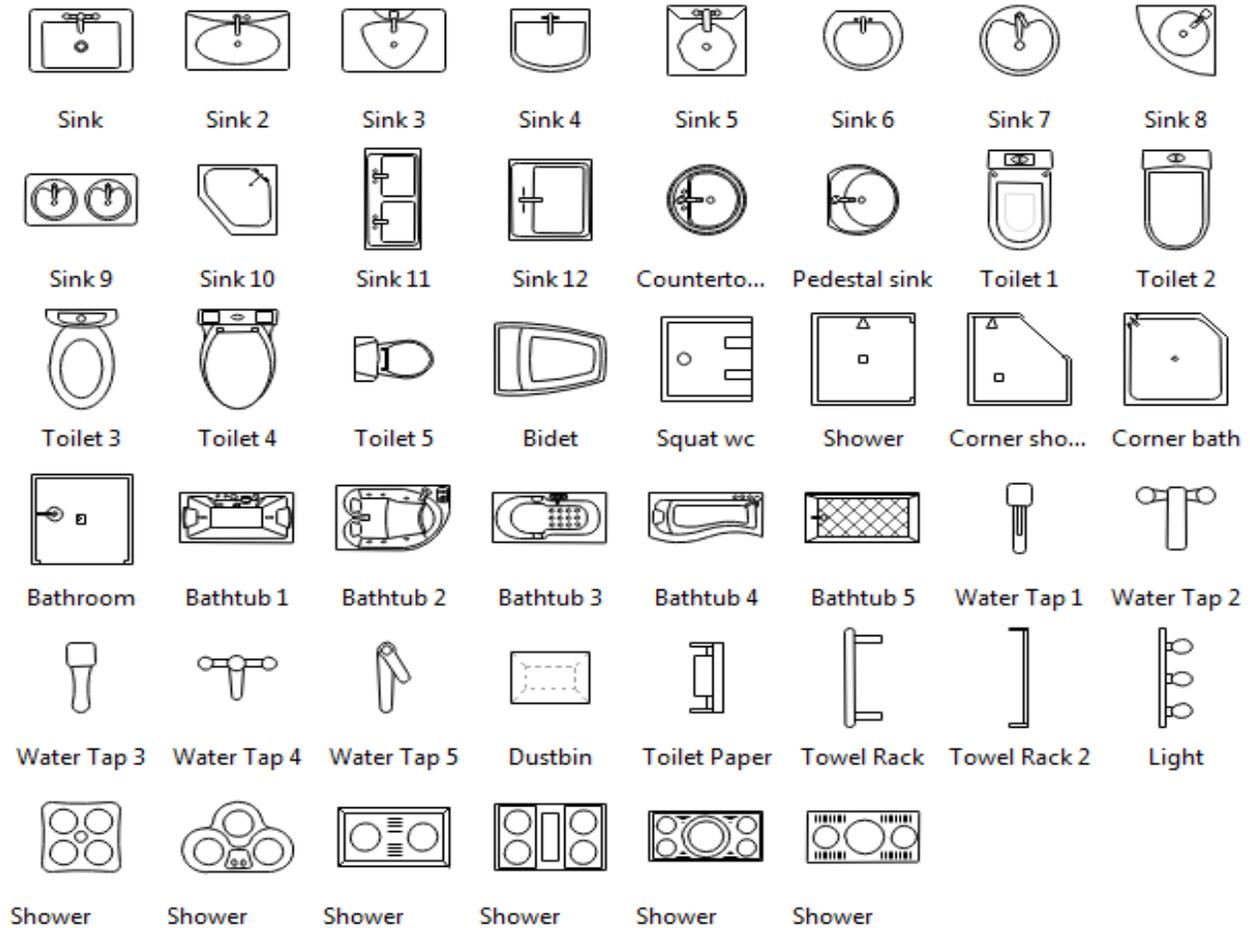
—CW—  
COLD WATER  
PIPE

—STM—  
STORM SEWER  
PIPE

—HW—  
HOT WATER  
PIPE

### Activity-3.4: Draw Symbols of Sanitary fixtures

Students are required to draw the symbols of following plumbing fittings/ fixtures with the help of drawing instruments under the supervision of teacher/ instructor.



## 3.2. Create simple sketches and drawings.

Any type of sketch or drawing can be prepared by use of drawing instruments. To prepare the drawings for plumbing systems you are required to draw lines and relevant symbols.

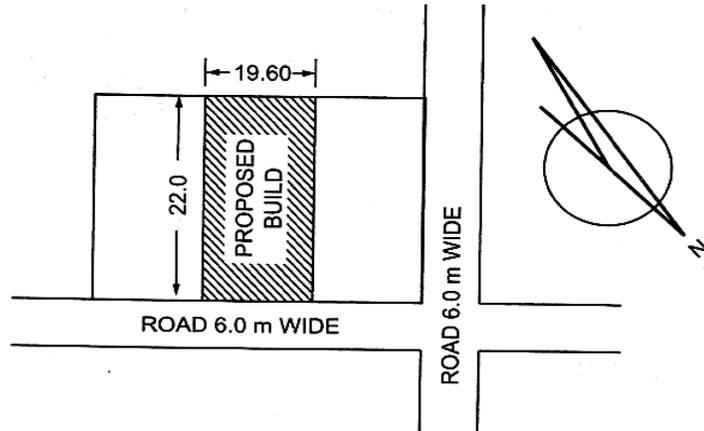
### 3.2.1 Inspect area and record required measurements.

Different types of building drawings are prepared for the idea to be expressed or information to be given by graphical mode. Here you are guided to create suitable views and simple sketches and drawings using standard drawing conventions.

**3.2.2: Create Suitable views and simple sketches and drawings using standard drawing conventions.**

*xvii- Site Plan*

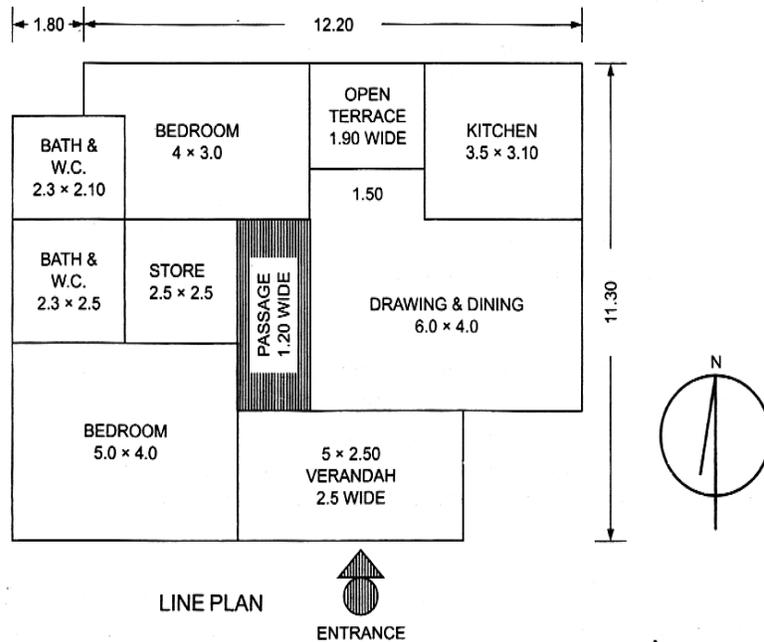
A plan in which the outer shape of object is shown in relation to the direction or boundaries.



*Site Plan*

*xviii- Line Plan*

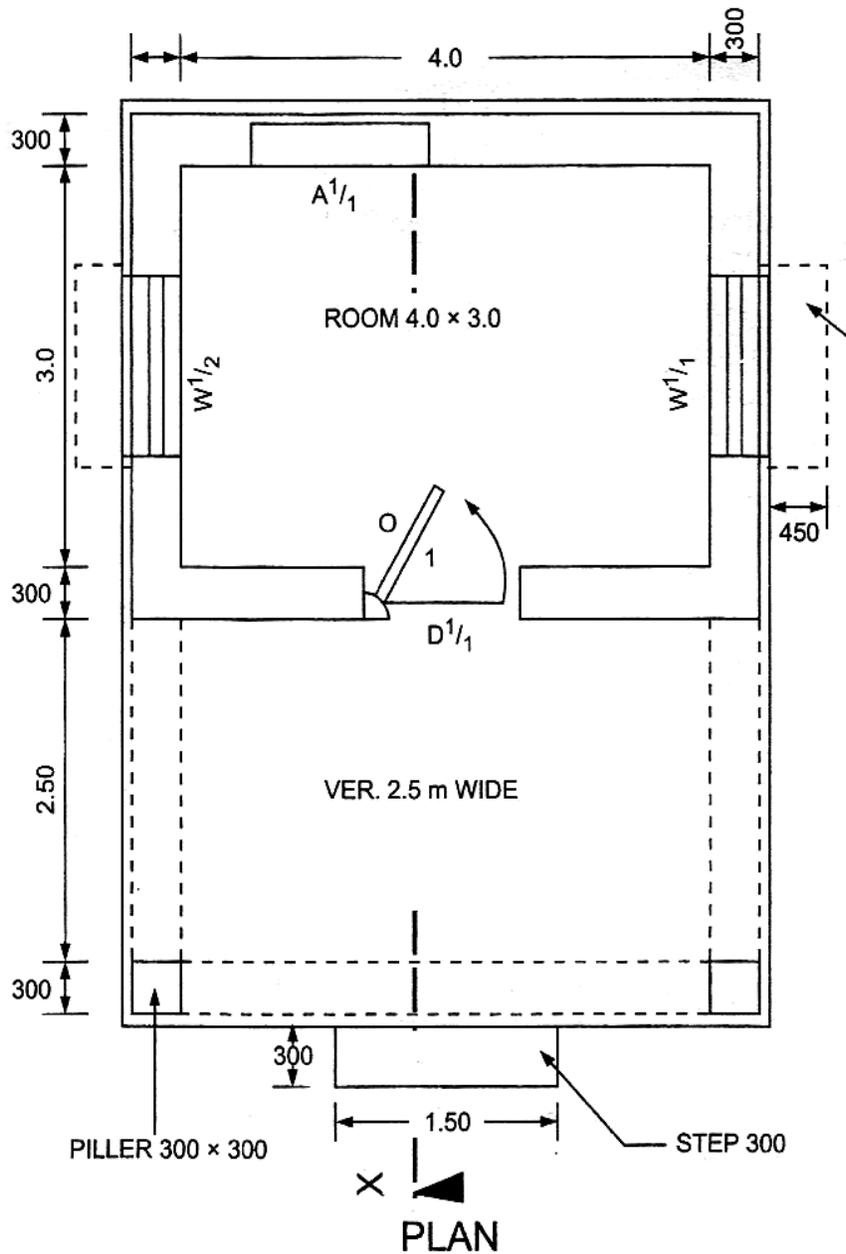
A plan drawn in a single line is called line plan. Wall thick ness is shown by single line.



*Line Plan*

*xix- Detailed Plan.*

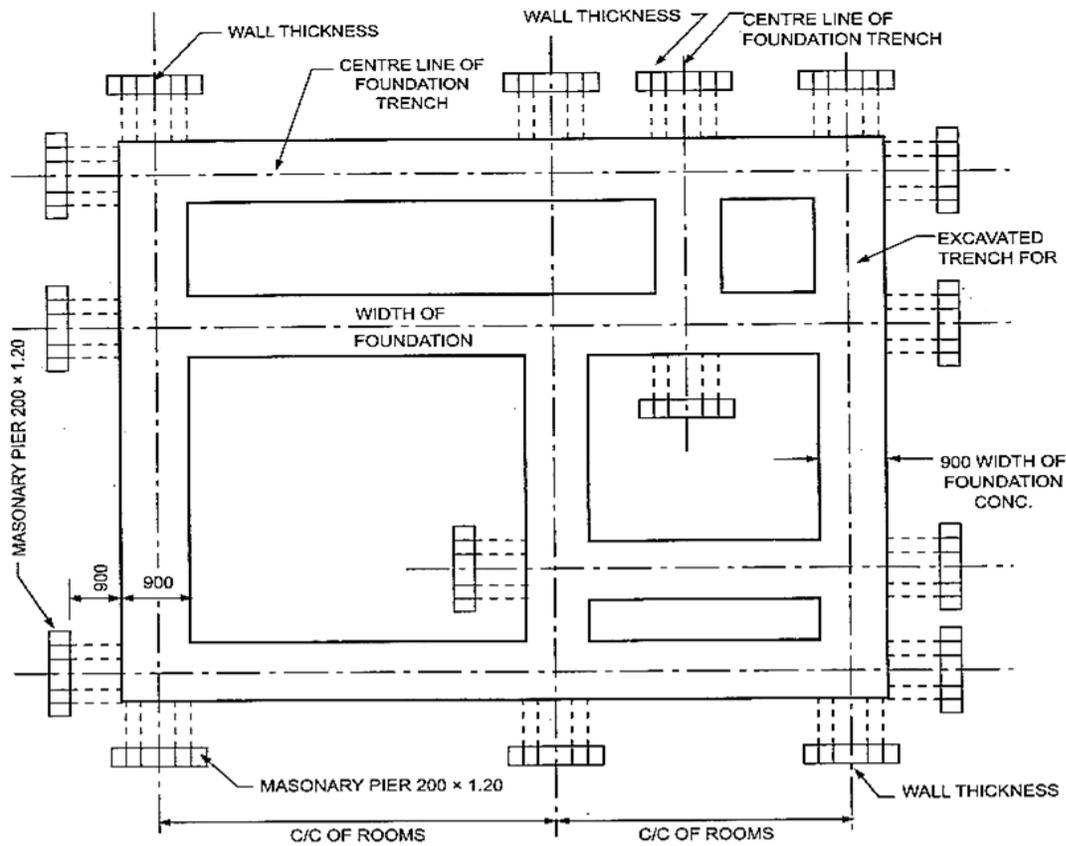
The top view represented by double lines for thickness of walls is called detailed plan. Plan is drawn by assuming the structure to be cut at a height of 4ft (1.5m) from ground level. Thickness of walls, width of doors, windows, sun shades, steps and porches etc. are shown in the plan. The parts of structure above the cutting plane are shown by dotted lines. Plinth protection can also shown in the plan.



*Detailed Plan*

*xx- Foundation Plan.*

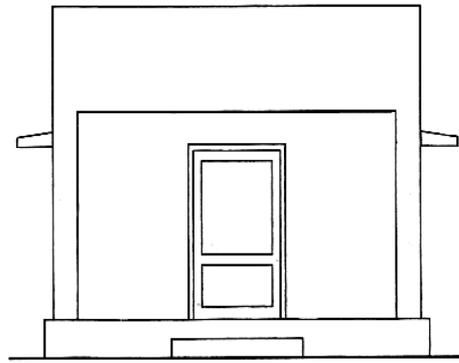
A horizontal plan taken below the plinth level and drawn on horizontal plane. It is the earth removed plan of foundation.



*Foundation Layout Plan*

*xxi- Elevation.*

It shows the width and height of a structure. Front, back, right side and left side views are drawn to give frontal look or elevation, backside elevation, right side elevation and left side elevation of building. Back elevation is also termed as rear elevation. The shape of windows, doors, verandah openings, sun shade, Louvers, railings and parapets are shown in their true look.



ELEVATION

REFERENCE

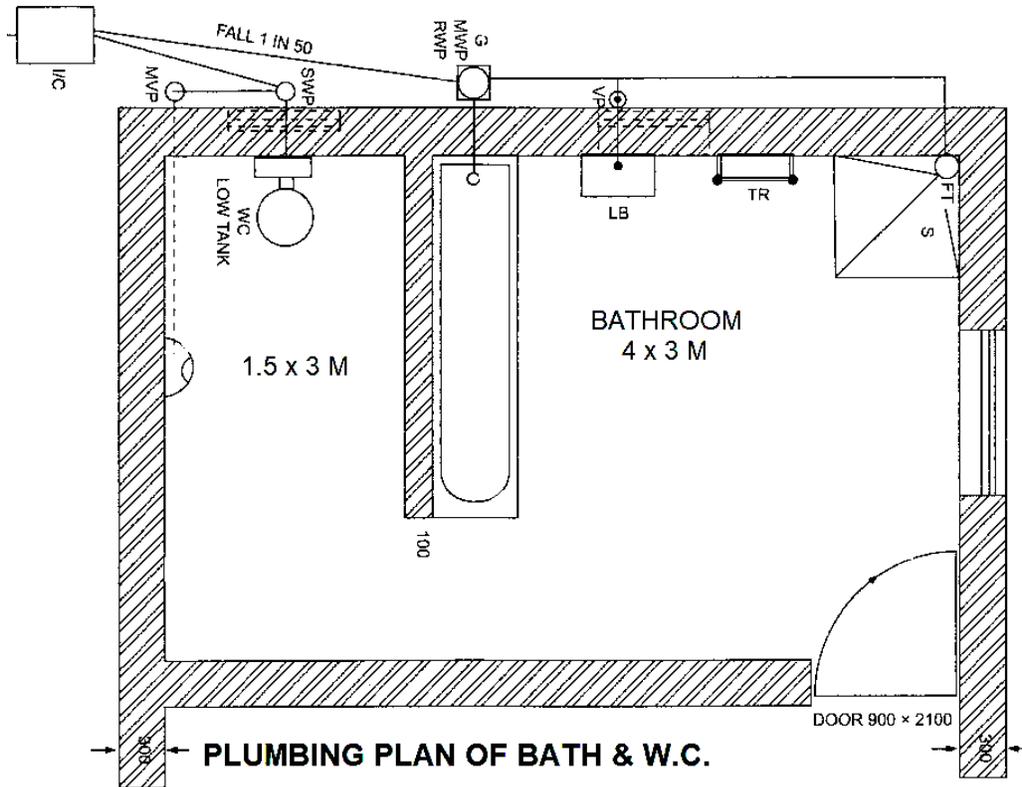
S.NO.	SIZE	DESIGNATION	NUMBERING
1.	1.10 × 2.10	11 DS 21	D <sup>1/1</sup>
2.	1.50 × 1.20	15 WT 12	W <sup>1/1</sup> W <sup>1/4</sup>
3.	1.5 × 1.5	15 AT 15	A <sup>1/1</sup>

### *xxii- Plumbing Plans.*

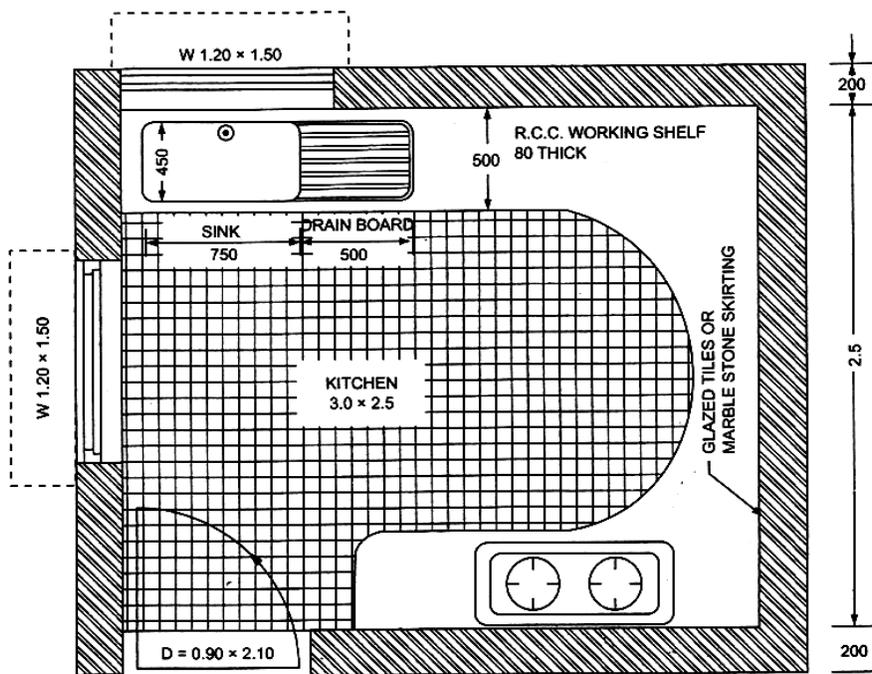
Plumbing plans consists of water supply plan, sanitary plan, gas installation plans. The plumbing components which are connected to our potable supply of water are fixtures, appurtenances and appliances. The components of water supply which are used to connect two or more pipes, change the direction of flow, etc. are called fittings, e.g., socket, elbow, bend, union, cross, etc.

The different devices required for controlling the flow of water, for preventing leakage and for other purposes in the water supply system are called appurtenances. For example, valves, cocks, fire hydrants. Valves are the mechanical devices that control the flow of water, regulate pressure, to release or admit air, prevent flow of water in opposite direction. Some appliances which perform specific functions are showers, dishwasher, water meter, hot water heater, etc.

Drain pipes feed used water right into outward bound pipelines that transport the waste water into sewer or septic tanks. Urban and rural have drain systems to manage the drainage, as well as country residences have septic systems for cleanliness. Some example examples for sanitary system aor fixtures are wash hand basin, water closet, bathtubs, traps, and vents.



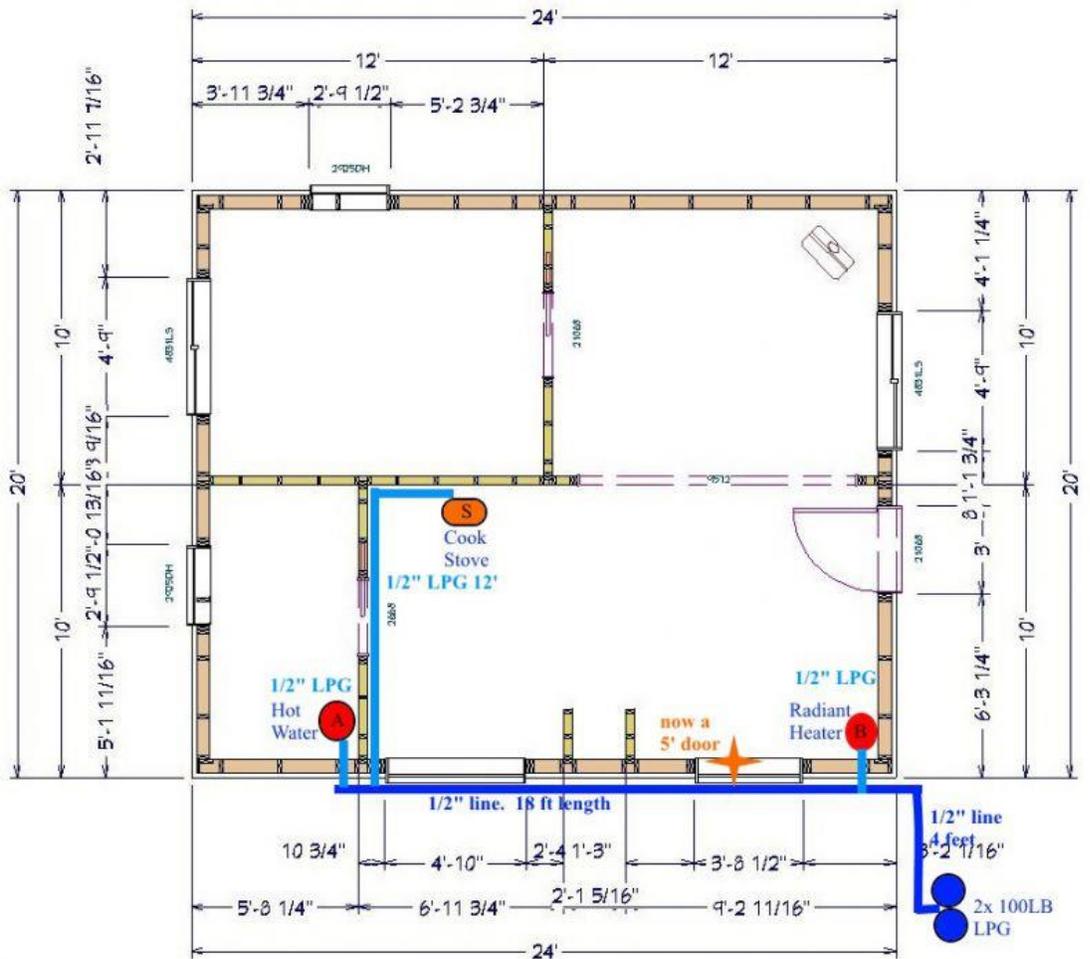
Plan showing Bathroom with W.C. fixtures



Plan showing kitchen fixtures

### xxiii-Gas Installation plan

A Gas plan consists of pipe work of gas. Pipe work is jointed with fittings as in case of water supply. But gas fittings and valves are of special quality. Gas supplied may be sui gas from main service line or from domestic gas cylinders of liquid petroleum gas (LPG). Gas plan shows the pipe network jointed with fittings, fixtures and appliances: e.g., gas valves, gas meter, gas geyser (gas water heater), gas burner (stove), gas lamp, gas heater, etc.



Plan showing gas fixtures

### 3.2.3 Create standard Sectional drawings of structural elements.

The structure is supposed to be cut by a vertical plane, and the view of cut-section is drawn, which is termed as a section. It shows height of rooms and depth of foundations, type of roofs, floors, thickness of walls and plinth height etc. Section also shows type of materials used for construction. Different conventional symbols are used to show different materials. Height of doors, windows and Almirah's including thickness of lintels are also shown in the structure.



### Activity-3.5: Draw layout plan of water supply and Sanitary

Students are required to draw the plumbing plan of Bathroom & W.C. with the help of drawing instruments under the supervision of teacher/ instructor.

Students are required to draw the plumbing plan of Kitchen with the help of drawing instruments under the supervision of teacher/ instructor.

### Activity-3.6: Draw layout plan of Gas for residence.

Students are required to draw the to draw the gas plan showing fixtures and appliances, appliances etc., in a kitchen with the help of drawing instruments under the supervision of teacher/ instructor.

## 3.3. Notate Drawings.

### 3.3.1 Record information on the drawing

When the line work of a drawing has finished, the respective symbols are incorporated for the structural components. For the purpose, **symbols** of different components, fittings and fixtures are given in practical exercise. For example, symbol of concrete, brick work, earthwork in sections. Symbols of structural components i.e., symbols of doors, windows, ventilators, almirah etc. Symbols of installations i.e., wash hand basin, sink, bath tub, shower rose, fountain, valves, mixers, taps etc.

Symbols of different types of pipes according to use, i.e., fresh water pipeline, hot water line, soil pipe, vent pipe etc.

Symbols of appliances like gas geyser, gas meter, water pump, gas burner, water cooler, solar water heater, etc.

Defined **abbreviations** are written with above components, like, MH for manhole, GT for gully trap, FT for floor trap, WC for water closet etc.

### 3.3.2 Label the Drawing

It is important to ensure each drawing on a drawing sheet is labelled. Beneath each drawing, you should include a title bar that contains the following information:

- title of the drawing
- drawing number
- scale of drawing
- paper size
- drawing sheet number of referenced drawing (where applicable, i.e., sections, elevations.)

All the above labeling should be done according to organizational administration and quality procedures.

Labelling also include reference markers on the drawing, i.e., section marker, elevation marker, and detailed marker.

Drawing is also dimensioned. Various types of dimensions are incorporated as per requirement and other lettering is performed for names of components.

Notate means to annotate the drawing i.e., labeling complete in all respects. Dimensioning, lettering etc.

**Activity-3.7: Notate plan of water supply for residence**

Students are required to notate the water supply layout plan as per directions of teacher/ instructor.

**Activity-3.8: Notate layout plan of Sanitary for residence**

Students are required to notate the sanitary layout plan as per directions of teacher/ instructor.

**Activity-3.9: Notate layout plan of Gas for residence.**

Students are required to notate the gas layout plan as per directions of teacher/ instructor.

### **Key Points**

17. Plumbing plans give the location of piping both for water supply & Sanitation systems, fixtures, and the process to connect every fixture etc.
18. Types of drawings are: architectural, structural, electrical, plumbing, finishing and Gas & HVACR drawings.
19. A protractor is a measuring instrument, typically made of transparent plastic or metal, for measuring angles.
20. Tee Square is composed of a long strip called blade which is screwed rigidly at right angles to a shorter piece called head or stock.
21. A horizontal plan taken below the plinth level and drawn on horizontal plane. It is the earth removed plan of foundation
22. A plan drawn in a single line is called line plan.
23. When building is cut horizontally, 4 feet above the floor level, the top view represented by double lines for thickness of walls is called detailed plan.
24. Printing figures arrow head and free hand small curves are drawn with HB pencils.
25. Drawing pencils are ordinarily made of wood with a compress lead. Lead is made of clay and graphite.
26. The PPEs for safety and serviceability during preparing drawing include: Gloves, Handkerchief, Duster, Towel, Face Mask, Glasses.
27. Compasses are used to draw circles and arcs.

## EXERCISE

### Multiple Choice Questions

#### Q-1. Tick ( ✓ ) the correct option for the following MCQs.

- 1- A plumbing plan shows this in the drawing.  
(A) location of fixture                      (B) arrangement of fixtures  
(C) pipe work                                  (D) All of these
- 2- Drawing materials can cause:  
(A) irritation                                  (B) inflammation  
(C) pain    (D) All of these
- 3- Which liquid medium is less toxic?  
(A) oil based                                  (B) water based  
(C) alcohol based                              (D) All of these
- 4- The instrument used to draw angle at 30o 45o are called:  
(A) set square                                  (B) divider  
(C) ruler    (D) scale
- 5- This instrument is used to mark angle at any degree:  
(A) set square                                  (B) divider  
(C) protractor                                  (D) scale
- 6- This instrument is used to draw horizontal line:  
(A) set square                                  (B) T-square  
(C) protractor                                  (D) scale
- 7- LPG stands for:  
(A) Liquid petroleum gas                      (B) Line parallel to grid  
(C) Local paid grocery                          (D) None of these
- 8- This tool is used to mark angle at any degree:  
(A) set square                                  (B) divider  
(C) protractor                                  (D) scale
- 9- In a plumbing plan the symbol of following is drawn:  
(A) safety    (B) hazards  
(C) fixtures    (D) none of these

- 10- This is the pillar of sustainability:  
(A) economy (B) society  
(C) environment (D) all of these

### Short Questions

**Short answer to the following short questions.**

- 1- Enlist types of drawings.
- 2- Enlist 5 points about safety requirements during drawing work.
- 3- Write the usage of Tee square.
- 4- Why symbols are drawn.
- 5- Draw symbol of water closet and Basin.
- 6- Draw symbol of concrete and brick work.
- 7- What is environmental sustainability?
- 8- What is meant by notate?
- 9- What is the importance of economical sustainability?
- 10- Enlist pillars of sustainability.

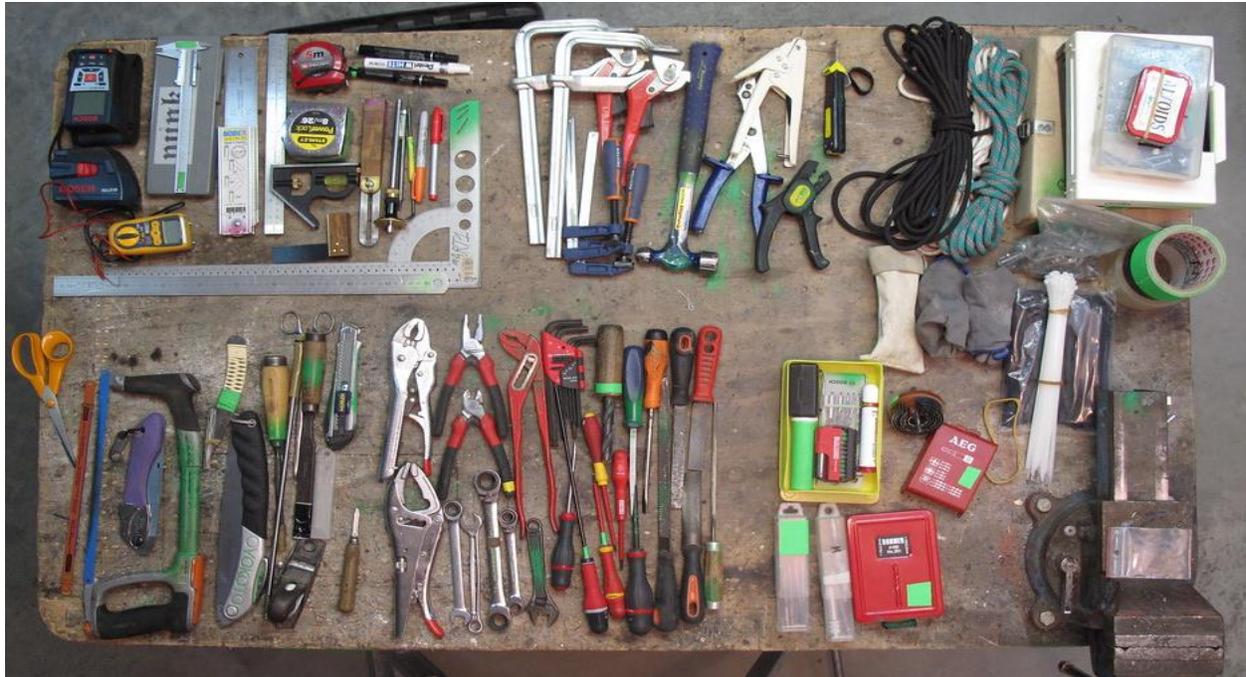
### Long Questions

**Answer the following question in detail**

1. Explain hazards during drawing work.
2. Give the usage of drawing board, set squares and Tee Square.
3. Write down the key features recorded in plumbing plans.
4. Explain types of drawings.
5. Draw a sanitary plan for 8' x 6' bath with standard fixtures.

## CHAPTER 4

### MEASURING, MARKING AND CUTTING PLASTIC PIPES



#### Students' Learning Outcome

After studying this chapter students will be able to:

- select appropriate measuring tool for plumbing work
- ascertain the functionality & correctness of the instrument.
- state the support interval for different dia. ppr & pvc pipes
- measure internal and external diameters.
- select appropriate pipe, fitting and fixture.
- measure length of selected pipe.
- mark the pipe for cutting as per drawing.
- mark the position of fixture on site for its installation.
- select appropriate tool for cutting of pipes.
- observe whs requirements in cutting the pipes.
- cut the pipes and deburr it.

## Introduction:

Plumber has to measure the lengths of pipes, internal and external diameters of pipes and fittings & fixtures. He has to measure the distances on site for layout. For the purpose he marks cutting positions for pipes, drilling position for holes. Ultimately he cuts the pipe for jointing. This chapter describes the measuring, marking and cutting techniques for plastic pipes.

### 4.1 Measure plumbing pipes, fittings and fixture

Length is measured for pipes, pieces to be cut according to layout in horizontal & vertical directions. Internal & external diameters of pipes, fittings and fixtures are measured. Angle according to layout of pipe line are measured. For these measurements various types of tools are used.

#### 4.1.1 Select appropriate measuring tool for plumbing work

- For linear measurements most commonly used tool is steel measuring tape. To measure the internal diameter, internal caliper with steel rule is used. For the measurement of external diameter external caliper with steel rule is used. A single tool is also available to measure internal and external diameter. This tool is Vernier caliper. Now a days digital calipers are also available.
- Protractor is used to measure or mark required angles during piping fabrication angle is usually degrees. Angle may also be in grads or radians. Some are also coupled with steel rule.
- Tri-square is used to align two parts at right angle before welding, draw lines or align at 90 degrees, etc.
- A plumb bob is used as a vertical reference line, or plumb-line. It is essentially the vertical equivalent of a "water level".
- Spirit levels can be used as a measuring device for the vertical and horizontal alignment of spaces, surfaces or objects.

#### 4.1.2 Functionality & Correctness of the Instrument.

Prior to use, the concerned responsible person should give the certificate of typical instrument. The scheduled maintenance of the instrument should be performed. Any out of order machine should be sent to the concerned mechanic for its maintenance and repair. The calibration of sensitive instruments should be done after regular intervals. One must make sure prior to use the serviceability of machines and tools.

### 4.1.3 State the support interval for different dia. P.V.C & PPR.C pipes

#### xxvii- P.V.C

Maximum distance between PVC - Polyvinyl Chloride - pipes supports depends on operating temperature:

#### a. PVC Pipe - Schedule 40

Maximum Support Spacing (feet)			
NPS (inches)	Operating Temperature ( $^{\circ}F$ )		
	60	100	140
1/2	4.5	4	2.5
3/4	5	4	2.5
1	5.5	4.5	2.5
1 1/4	5.5	5	3
1 1/2	6	5	3
2	6	5	3
3	7	6	3.5
4	7.5	6.5	4
6	8.5	7.5	4.5
8	9	8	4.5

#### b. PVC Pipe - Schedule 80

Maximum Support Spacing (feet)			
NPS (inches)	Operating Temperature ( $^{\circ}F$ )		
	60	100	140
1/2	5	4.5	2.5
3/4	5.5	4.5	2.5
1	6	5	3

Maximum Support Spacing (feet)			
NPS (inches)	Operating Temperature (°F)		
	60	100	140
1 1/2	6.5	5.5	3.5
2	7	6	3.5
3	8	7	4
4	9	7.5	4.5
6	10	9	5
8	11	9.5	5.5

- $1 \text{ ft (foot)} = 0.3048 \text{ m}$
- $T(^{\circ}\text{C}) = 5/9[T(^{\circ}\text{F}) - 32]$

#### xxviii- PPR.C Pipes

- PPR.C pipes with liquids with a density of  $1 \text{ g/cm}^3$

Dia (mm)	Pipe bracket intervals L for SDR 11 pipes in mm at pipe wall temperature:						
	≤20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
16	500	475	450	425	425	400	375
20	525	500	500	475	450	425	425
25	600	575	575	550	525	500	500
32	725	700	675	650	650	600	575
40	825	800	800	750	725	700	650
50	950	925	900	875	825	775	750
63	1100	1075	1050	1025	975	925	900
75	1150	1150	1100	1050	1000	975	950
90	1250	1200	1150	1150	1100	1050	1000
110	1400	1350	1300	1300	1200	1125	1050
125	1500	1450	1450	1350	1300	1200	1150
140	1600	1550	1500	1450	1350	1275	1200
160	1700	1650	1600	1500	1450	1350	1300

180	1750	1750	1650	1600	1500	1425	1350
200	1900	1800	1750	1650	1600	1500	1450
225	2000	1900	1850	1750	1700	1600	1500
250	2100	2050	1950	1900	1800	1700	1600
315	2350	2300	2200	2150	2050	1950	1850
355	2500	2425	2350	2250	2125	2050	1950
400	2650	2575	2500	2400	2275	2175	2050
450	2850	2775	2700	2575	2475	2325	2200
500	3075	3000	2875	2775	2625	2500	2350

For other SDR multiply the values given in the table with the following factor:

- SDR17 and SDR17.6 with 0.91
- The pipe bracket spacing given in the table may be increased by 30 % in the case of vertical pipe runs, i.e., multiply the values given by 1.3.

b. PP-R pipes with fluids of a density other than 1 g/cm<sup>3</sup>

If the liquid to be transported has a density not equal 1 g/cm<sup>3</sup>, then the bracket spacing in the table above should be multiplied by the factor given in the following table.

Density of the fluid in g/cm <sup>3</sup>	Type of fluid	Factor for pipe bracket spacing
1.00	Water	1.00
1.25	Other	0.96
1.50		0.92
1.75		0.88
2.00		0.84
≤ 0.01	Gaseous	1.30 for SDR11, 1.47 for SDR17.6 and SDR17

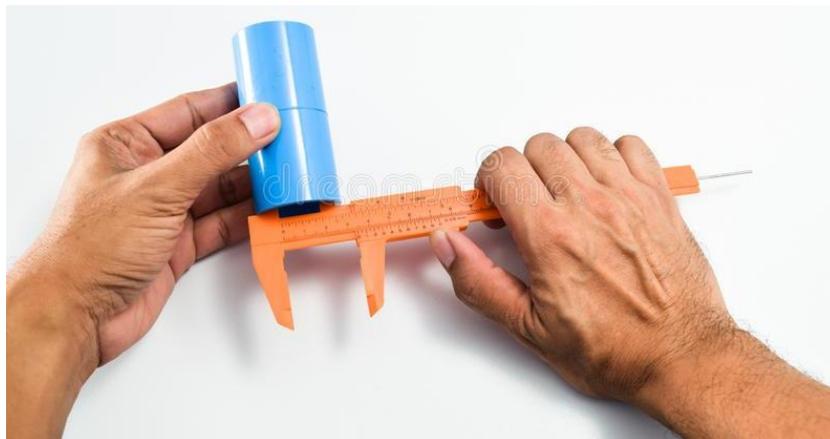
#### 4.1.4 Measure Internal and External Diameters.

To measure the internal diameter of pipe, open the jaws of vernier caliper. Insert the top jaws in the pipe or fitting for which internal diameter is required to be measured. Note the main and vernier scales readings. Sum up the both to have the internal diameter dimension.

Similarly, to measure the external diameter of pipe or fitting open the jaws of vernier caliper. Put the pipe or fitting between the bottom jaws of vernier caliper. Note the main and vernier scales readings. Sum up the both to have the internal diameter dimension.



*Measurement of external diameter*



*Measurement of internal diameter*

#### **4.1.5 Select appropriate pipe, fitting and fixture.**

To select the appropriate pipe, fitting and fixture as per site requirements you must have measuring tools. An experienced plumber can visually judge the diameters of pipes, fittings, and fixtures. However, a learner must use measuring tools to select the appropriate pipe, fitting and fixture. You will measure the internal diameter of fitting for selection.

Measure the length and diameters of pipe, fitting and fixtures.

To measure the angle of inclination, perform the following steps

**Tool required**= protractor, marker

**Materials**= angular wye tee

- Observe safety precautions.
- Open the protractor.
- Note down the angle.
- Also mark different angle on the ground.

Measure the internal and external dia. of given fittings, PPR and PVC pipes Measure the angles of bends, elbow etc.

**Tool required**= vernier calliper, protractor

**Materials**= pipes of different lengths and diameters.

- Measure the internal diameter of pipe, open the jaws of vernier calliper. Insert the top jaws in the pipe or fitting for which internal diameter is required to be measured. Note the main and vernier scales readings. Sum up the both to have the internal diameter dimension.
- Similarly, measure the external diameter of pipe or fitting open the jaws of vernier calliper. Put the pipe or fitting between the bottom jaws of vernier caliper. Note the main and vernier scales readings. Sum up the both to have the internal diameter dimension.
- Open the protractor. Note down the angle. Also mark different angle on the ground.

#### **4.1.6 Measure length of selected pipe.**

Open the steel measuring tape. Steel measuring tape usually have both inches and centimeters. There are 12 inches in a foot and 100 centimeters equals one meter. Note down the lengths in both the measuring units.

**Tool required**= steel measuring tape

**Materials**= pipes of different lengths and diameters.

- Observe safety precautions.
- Open the steel tape.
- Align with pipe.
- Note down the lengths in both the measuring units.



#### **Activity-4.1: Measure the length of pipes.**

The teacher/ instructor is required to assign the students to measure and mark lengths of pipes according to drawing.

#### **Activity-4.2: Measure the angles on ground and fittings-bends etc.**

The teacher/ instructor is required to assign the students to measure angles of fittings and mark on ground location of pipes at various angles.

#### **Activity-4.3: Measure Angles, Internal and external dia.**

The teacher/ instructor is required to assign the students to measure the internal and external dia. of given fittings of PPRC and PVC pipes. They will have also to measure the angles of bends, elbow etc.

## **4.2 Marking of Pipes and fixtures**

Different marking tools are used for marking length of pipe, location of fixtures on site. These are permanent markers, chalk crayons, Pipe wraps, nylon string, centre punch, Compass or divider, counter marker chalk lines, nails.

### **4.2.1 Mark the pipe for cutting as per drawing.**

- Use following tools to mark the position of cutting pipes. Permanent markers are used for pipe marking.
- Pipe wraps are used to mark pipe for cutting at specified angle.
- Contour Marker is used to mark circular marking on pipe periphery at various angles for cutting purpose.

## **Tools & Materials**

Hook tape, measuring tape, marker, pipe wraps.

### **Procedure:**

- Measure the plastic pipes with hook tape and mark with help of marker and pipe wraps cutting locations.
- Measure the PPRC pipes with measuring tape and mark with help of marker are pipe wraps cutting locations.
- Measure and mark the location of service connection on main line with measuring tape and mark with help of marker are centre punch the drilling location.

### **4.2.2 Mark the position of fixture on site for its installation.**

- Use following tools to mark the position of fixtures on site of installation. Use the permanent markers to mark the position of fixtures on site of installation.
- Contour Marker is used to mark circular marking on pipe periphery at various angles for cutting purpose.
- Chalk Crayons are good for the surfaces which aren't ideal for markers, like cement, and that quick game of tic tac toe during break.
- Nylon String can be used to do various long markings on pipes and any other markings.
- Chalk line is used to mark long straight lines on pipes or metal plates.

## **Tools & Materials**

Marker, steel tape, Steel scale, Plumb bob, chalk line.

### **Procedure:**

- Measure with steel tape and mark with help of marker locations of basin, its brackets or rowel bolts etc.
- Measure with steel tape and mark with help of marker locations of shower, its stop cock or mixer on wall.
- Measure with steel tape and mark with help of marker locations of sink, sink mixer and its brackets.

#### **Activity-4.4: Mark the specified length on pipes.**

The students are required to mark work pieces like pipes etc., according to job requirements as per directions of teacher/ instructor.

#### **Activity-4.5: Mark the position of Basin and Shower as per given drawing.**

The students are required to mark the dimensions as per drawing for location of basin and shower as per directions of teacher/ instructor.

### **4.3 Cutting of pipes**

Pipes are required to be cut for preparing network of pipes. Different tools are used to cut plastic pipes. These are:

Tubing cutter, ratchet plastic pipe cutter, reciprocating saw, hacksaw, hole saw kit, internal PVC pipe cutter etc.

#### **4.3.1 Select appropriate tool for cutting of pipes.**

##### ***xxix- Tubing Cutter***

A tool used by plumbers to cut through plastic tubing, with each one having its own cutting range.



*Tubing cutter*

##### ***xxx- Ratchet Plastic pipe Cutter***

As plastic pipes are softer in nature, therefore scissor type cutter is used to cut these pipes. It is shown in the picture. It is generally known as PPRC pipe cutter.



*Ratchet plastic pipe cutter*

##### ***xxxi- Electric Pipe cutter (Jig Saw)***

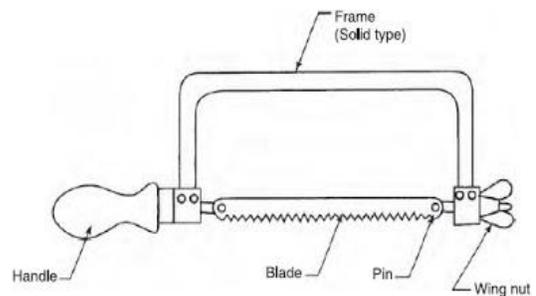
Electric pipe cutter has one electric motor and one cutting wheel. Cutting wheel will be driven via electric motor and it will be adjustable too for compensating the various diameters of pipes.



*Electric pipe Cutter (Jig Saw)*

**xxxii- Hacksaw**

Hacksaw is basically used for cutting pipes, fasteners, metal bar and rods. Workpiece will be fixed in vice and hacksaw will be used for cutting the workpiece at desired position. It comprises of frame, a blade, wing nuts and handle



*hacksaw*

**Hole saw kit**

A hole saw is used to cut perfectly round holes in plastic sheets, wooden planks etc. it is fixed with drill machine.



*Hole cut saw*

**xxxiii- Reciprocating saw**

A reciprocating saw is a multi-purpose saw used to cut pipes, sheets and other object just like an ordinary saw but motorized drive.



*Reciprocating saw*

#### *xxxiv- Internal PVC pipe cutter*

This works with any electric drill to help you cut pipes. It works in places where there is no space to operate a pipe cutter, hacksaw etc. This accessory cuts the pipe from inside.



*Internal PVC Pipe Cutter*

### **4.3.2 Work Health & Safety (WHS) requirements in cutting the pipes**

#### *xxxv- The Safety Precautions while using knives:*

- Keep hands behind the cutting edge at all times.
- Never cut towards yourself, always cut away from your body.
- Where possible, use a cutting board underneath the material being cut.
- Always pass knives to others handle first.
- Never run with knives or push/shove people around using knives.
- Ensure knives are kept sharp – blunt knives can be dangerous.
- To clean, wipe the blade with a cloth keeping the knife's sharp edge turned away from the hand
- Do not substitute knives for can openers, screwdrivers, or ice picks.
- Replace or sharpen any cutting tool that has lost its correctly angled cutting edge.
- Dispose of all broken or blunt blades in a sharp's container.
- Hand shears used for cutting plastic sheet should be selected for the type of cut based on the side the waste material lies.

#### *xxxvi- The Safety Precautions while using saws:*

- The work piece should be securely held in a vice or other firm support.
- When crosscutting, start the cut with two long slow pulls upwards.
- When ripping, start the cut with the finer teeth at the end of the blade.
- During the cutting process, apply downward force only on the forward cut not when drawing back.
- As the cut approaches completion, reduce the force applied to the saw to avoid breaking through the material and injuring hand.

### 4.3.3 Cut the pipes and deburr it.

#### *xxxvii- Cut the Pipe*

There are some basic tools that you can use to cut the pipe. Some of these tools are present in the market and lab. On the other hand, some specialty tools are made strictly for PVC pipe cutting.

Some of the basic tools are:

- Miter Saw
- Miter Box
- Handsaw
- Sharp utility knife
- Hacksaw

On the other hand, there are specialty cutters, such as:

- PVC Cutters
- Scissor-style pipe cutters
- Ratchet-style pipe cutters
- Tubing cutters

**Tools required:** Milter Saw, Hacksaw, PVC Cutter, pipe vice, Sharp utility knife, sand paper.

**Material:** PPRC pipes, lubricating oil

#### **Procedure:**

- Measure the diameter and length of pipe.
- Mark the location of cutting with help of pipe wrap and marker.
- Fix the pipe in pipe vise.
- Select the appropriate cutting tool and cut the pipe.
- Repeat the above steps for other pipes with varying cutting tools.
- To deburr, run the knife over the uneven edges until they are smooth.
- Make sure to clog the pipe with some cloth first. This is done to prevent plastic bits from falling inside the tube.
- Also use sandpaper to smoothen the edges out.

Repeat the above steps for other pipes with varying cutting tools.

#### *xxxviii- Deburring*

One of the ways to deburr a cut PVC pipe is to use a utility knife. The process itself is simple – just run the knife over the uneven edges until they are smooth.

Make sure to clog the pipe with some cloth first. This is done to prevent plastic bits from falling inside the tube.

You can also use sandpaper to smoothen the edges out. If you did an awful job making a straight cut, you could mix these two methods. This is the recommended way, as you will be able to deburr everything quickly and precisely.

**Activity-4.6 Cut the PPRC pipes of given size.**

The teacher/ instructor is required to direct the students for cutting of PPRC pipes of different sizes and lengths.

**Activity-2 Cut the PVC pipes as per drawing.**

The teacher/ instructor is required to direct the students for cutting of PVC pipes of different sizes and lengths as per drawing.

**Activity-3 Cut the ABS pipes as per drawing.**

The teacher/ instructor is required to direct the students for cutting of ABS pipes of different sizes and lengths as per drawing.

**Activity-4 Cut the HDPE pipes as per drawing.**

The teacher/ instructor is required to direct the students for cutting of HDPE pipes of different sizes and lengths as per drawing.

## Key Points

1. For linear measurements most commonly used tool is steel measuring tape
2. Protractor is used to measure or mark required angles during piping fabrication angle is usually degrees.
3. A plumb bob is used as a vertical reference line, or plumb-line. It is essentially the vertical equivalent of a "water level".
4. Spirit levels can be used as a measuring device for the vertical and horizontal alignment of spaces, surfaces or objects.
5. Prior to use, the concerned inspector/ supervisor should give the certificate of typical instrument.
6. The centre to centre distance of support increase as the diameter of plastic pipe increases.
7. Greater the operating temperature, lesser will be the centre to centre distance of supports for plastic pipes.
8. Vernier calliper is used to measure the internal and external diameter of pipes.
9. You can also use sandpaper to smoothen the edges out. If you did an awful job making a straight cut, you could mix these two methods.
10. The marking tools used are permanent markers, chalk crayons, Pipe wraps, nylon string, centre punch, Compass or divider, counter marker chalk lines, nails.
11. Flexible pipes cannot be cut by tubing cutter,
12. Observe the safety precautions while use different types of saws,
13. Knives and ratchet cutters must be operative by observing the safety precautions.

## EXERCISE

### Multiple Choice Questions

**Q-1. Tick ( ✓ ) the correct option for the following MCQs.**

- 1- The deburring for PVC pipe can done with.  
(A) Sand paper (B) handkerchief  
(C) Towel (D) None of these
- 2- A specific tool for cutting plastic pipe is:  
(A) Miter saw (B) miter box  
(C) hand saw (D) All of these
- 3- For this purpose, Vice is used:  
(A) Grasp the pipe (B) during cutting of pipe  
(C) During deburring pipe (D) all of these
- 4- This tool is used for cutting UPVC pipe:  
(A) chisel (B) knife  
(C) internal saw (D) None of these
- 5- To measure the angles, this tool is used:  
(A) Steel square (B) protractor  
(C) calliper (D) None of these
- 6- This tool is used to mark the pipe to cut at some angle:  
(A) centre punch (B) protractor  
(C) chalk lime (D) None of these
- 7- This tool is used to cut the pipe:  
(A) ratchet cutter (B) marker  
(C) calliper (D) None of these
- 8- To cut the pipes at any angle, this is the appropriate cutter:  
(A) Pipe Cutter (B) Tubing cutter  
(C) jig saw (D) None of these
- 9- This tool is used to measure the internal and external diameter:

- (A) internal calliper      (B) screw gauge  
(C) vernier calliper      (D) None of these
- 10- To cut the harder plastic pipes, this is the appropriate cutter:  
(A) jig saw      (B) Tubing cutter  
(C) Pipe Cutter      (D) None of these

### Short Questions

**Short answer to the following questions.**

- 1- How appropriate fitting is selected for a PPRC pipe.
- 2- How cut point of plastic pipe is marked.
- 3- How verticality of pipe is checked.
- 4- Enlist PPEs used during cutting of pipes.
- 5- Enlist main marking tools for plastic pipes.
- 6- Write down cutting tools for plastic pipes.
- 7- Write down three safety measures for cutting with saws.
- 8- What is a reciprocating saw?
- 9- What is the use of pipe wraps?
- 10- How ratchet cutter is used to cut plastic pipes.

### Long Questions

**Answer the following question in detail**

1. State WHS requirement in cutting plastic pipes.
2. Explain the cutting and deburring procedure.
3. State the safety precautions while using saws.
4. State the use of callipers and protractor.
5. State briefly the use of measuring tools for plumbing.

## CHAPTER 5

# JOINTING WATER SUPPLY FITTINGS & FIXTURES WITH PLASTIC PIPES



### **Students' Learning Outcome**

**After studying this chapter students will be able to:**

- Select appropriate heater for supplied pipes and fitting.
- Fix and remove required diameter heating sockets with heater.
- State the system of supply of water- dead end (tree), radial, grid iron and circular system
- Heat the pipe and fitting observing WHS requirements.
- Join pipes and cool the joint.
- Jointing of plastic Pipes.
- Mark the location of fixtures as per plan.
- Select appropriate installation mechanism.
- Install the fixtures observing WHS requirements

## Introduction:

Plastic pipes are basically jointed by two methods: by solvent solution and by fusion method. In solvent the solution is applied on outer side of pipe and inner side of fitting. The solution melts the surfaces on which it is applied. In this state pipe is inserted inside by pressing and ultimately pipe is jointed. Infusion method Fusion heaters or other relevant special equipments and techniques is applied to join the pipe.

### 5.1 Jointing plastic Pipes

Plastic pipe or fittings are joined to each other by heat fusion, by use of jointing material- chemical solution or with the help of mechanical fittings. Plastic pipe may be joined to other pipe materials by means of compression fittings, flanges, or other qualified types of manufactured transition fittings. There are many types and styles of fittings available from which the user may choose. Each offers its particular advantages and limitations for each joining situation the user may encounter.

#### 5.1.1 Select appropriate heater for supplied pipes and fitting.

There are three types of conventional heat fusion joints currently used in the industry; Butt, Saddle, and Socket Fusion. Additionally, electrofusion (EF) joining and Infrared are available with special EF couplings and saddle fittings. The principle of heat fusion is to heat two surfaces to a designated temperature, then fuse them together by application of a sufficient force. This force causes the melted materials to flow and mix, thereby resulting in fusion.

#### *Socket Fusion Heater (For PPRC, HDPE PVC-U)*

This technique consists of simultaneously heating both the external surface of the pipe end and the internal surface of the socket fitting until the material reaches the recommended fusion temperature, inspecting the melt pattern, inserting the pipe end into the socket, and holding it in place until the joint cools. Figure below illustrates a typical socket fusion joint. Mechanical equipment is available to hold both the pipe and the fitting and should be used for sizes larger than 2” CTS to help attain the increased force required and to assist in alignment. Most pipe manufacturers have detailed written procedures to follow.



*Figure Standard Socket Fusion Joint and heater*

Follow these general steps when performing socket fusion:

- Thoroughly clean the end of the pipe and the matching inside surface of the fitting
- Square and prepare the pipe end
- Heat the parts
- Join the parts
- Allow to cool

### **a- Equipment Selection**

Select the proper size tool faces and heat the tools to the fusion temperature recommended for the material to be joined. For many years, socket fusion tools were manufactured without benefit of any industry standardization.

### **b- Square and Prepare Pipe**

Cut the end of the pipe square. Chamfer the pipe end for sizes 1¼”-inch diameter and larger. (Chamfering of smaller pipe sizes is acceptable and sometimes specified in the instructions.) Remove scraps, burrs, shavings, oil, or dirt from the surfaces to be joined. Clamp the cold ring on the pipe at the proper position, using the integral depth gauge pins or a separate (thimble type) depth gauge. The cold ring will assist in re- rounding the pipe and provide a stopping point for proper insertion of the pipe into the heating tool and coupling during the fusion process.

### **c- Heating**

Check the heater temperature. Periodically verify the proper surface temperature using a pyrometer or other surface temperature measuring device.

### **d- Joining**

Simultaneously remove the pipe and fitting from the tool using a quick “snap” action. Inspect the melt pattern for uniformity and immediately insert the pipe squarely and fully into the socket of the fitting until the fitting contacts the cold ring. Do not twist the pipe or fitting during or after the insertion, as is the practice with some joining methods for other pipe materials.

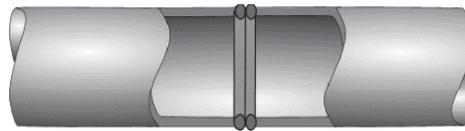
## ***Butt Fusion Heater***

The most widely used method for joining individual lengths of PE pipe and pipe to PE fittings is by heat fusion of the pipe butt ends as illustrated in Figure 1. This technique produces a permanent, economical and flow-efficient connection. Quality butt fusion joints are produced by using trained operators and quality butt fusion machines in good condition.

The butt fusion machine should be capable of:

- Aligning the pipe ends
- Clamping the pipes
- Facing the pipe ends parallel and square to the centreline

- Heating the pipe ends
- Applying the proper fusion force



*Standard Butt Fusion Joint*

The six steps involved in making a butt fused joint are:

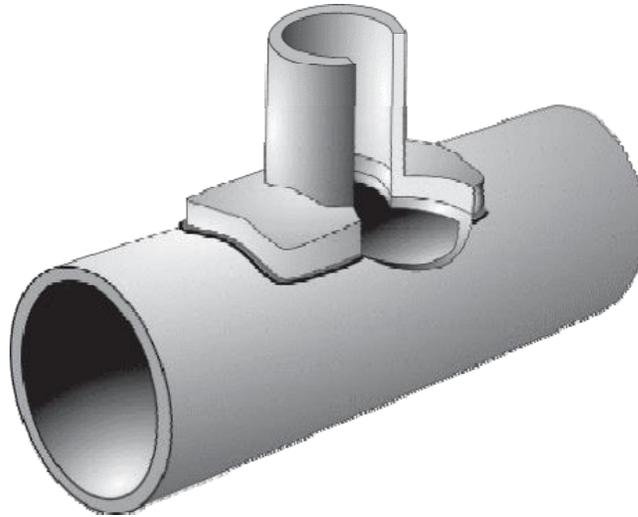
- i. Clean, clamp and align the pipe ends to be joined
- ii. Face the pipe ends to establish clean, parallel surfaces, perpendicular to the center line
- iii. Align the pipe ends
- iv. Melt the pipe interfaces
- v. Join the two pipe ends together by applying the proper fusion force
- vi. Hold under pressure until the joint is cool

### **Butt Fusion of PE Pipe Products with Different Wall Thicknesses**

PE pipes of the same outside diameter but having different specified wall thicknesses, that is, different Dimension Ratio (DR) designations, may be butt fused to each other under special conditions. Since this represents a special situation, it is subject to limitations.

#### *Saddle/Conventional Fusion*

The conventional technique to join a saddle to the side of a pipe, illustrated in figure below, consists of simultaneously heating both the external surface of the pipe and the matching surface of the “saddle” type fitting with concave and convex shaped heating tools until both surfaces reach proper fusion temperature. This may be accomplished by using a saddle fusion machine that has been designed for this purpose.



*Standard Saddle Fusion Joint*

Saddle fusion using a properly designed machine, provides the operator better alignment and force control, which is very important to fusion joint quality. The Plastics Pipe Institute recommends that saddle fusion joints be made only with a mechanical assist tool unless hand fusion is expressly allowed by the pipe and/or fitting manufacturer.

There are eight basic sequential steps that are normally used to create a saddle fusion joint:

- Clean the pipe surface area where the saddle fitting is to be located
- Install the appropriate size heater saddle adapters
- Install the saddle fusion machine on the pipe
- Prepare the surfaces of the pipe and fitting in accordance with the recommended procedures
- Align the parts
- Heat both the pipe and the saddle fitting
- Press and hold the parts together
- Cool the joint and remove the fusion machine

In electrofusion there is no heater to melt pipes.

Other methods are beyond the scope of this book.

### **5.1.2 Water Distribution Systems**

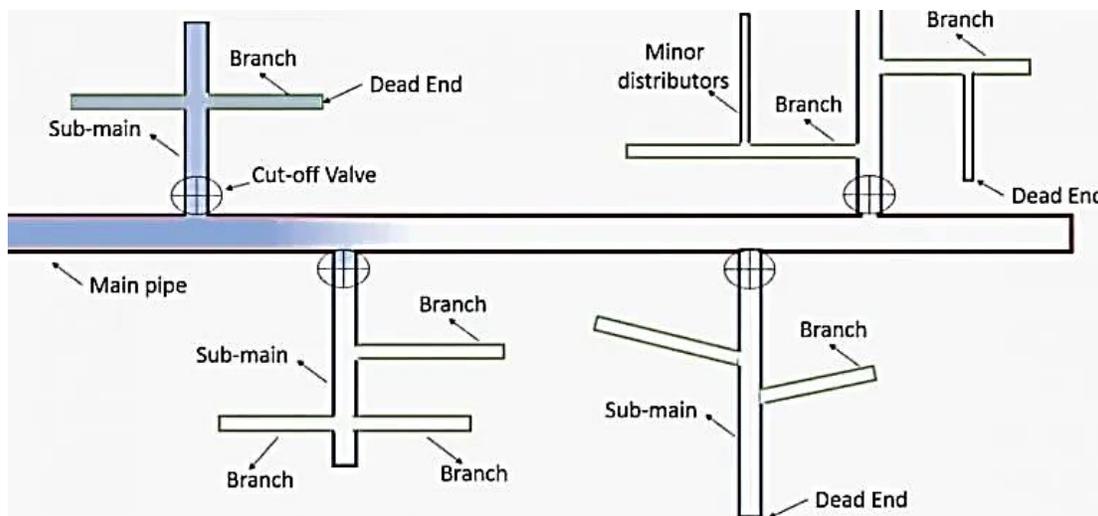
The system of withdrawing water from the treatment plant and making it available at all appliances (fixtures) for use is known as a domestic water supply system. The following are four major types of water distribution system,

1. Dead-end or Tree Distribution system
2. Grid Iron Distribution System
3. Circular or ring Distribution System
4. Radial Distribution System

### *1. Dead-end or Tree Distribution System*

In this type of water distribution system, one main pipeline runs through the centre of the building or town, and the sub-mains branch lines off from both sides.

The sub-main lines are then divided into several branch lines from which service connections are provided for particular houses.



*Dead End Distribution of Water Supply System*

#### **a- Advantages of Dead-end Distribution System**

- The design of pipe laying is simple and easy.
- A smaller number of cut-off valves are required and the operation and maintenance costs are low.
- Pipe laying is simple and no skilled labour is required.

#### **b- Disadvantages of Dead-end Distribution System**

- The system is less successful in maintaining satisfactory pressure in high-rise buildings and is therefore not favoured in modern waterworks practice.
- Only one pipe provides the water to the entire building which is quite risky.

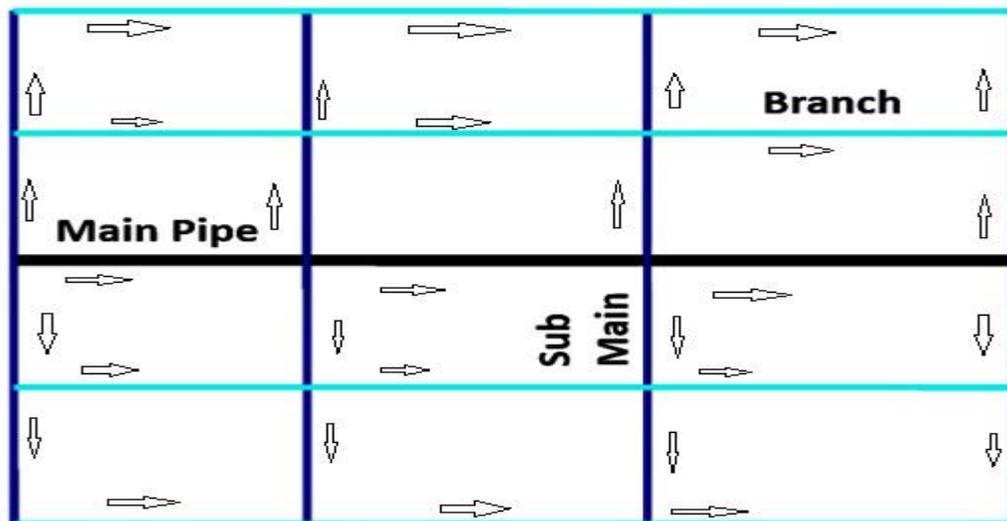
- The head loss is relatively high, requiring a larger pipe diameter and need pumping units.
- The discharge available during firefighting is limited due to high head loss in the piping system.
- The water pressure available is also lower which requires a pumping system.

## 2. Grid Iron Distribution System

In this, the main supply lines run through the center of the building, and sub mains branch off in perpendicular directions. The branch interconnects the sub-mains.

The distinguishing features of this system are that all the type of pipes are interconnected and there are no dead ends.

Water can reach at the given point of withdrawal from many directions, which allows more flexible operation, particularly when repairs are required.



*Grid Iron- Water Distribution System*

### a- Advantages of Grid Iron Distribution System

- This system enables the free circulation of water, without any stagnation or sediment deposit.
- Because of the fewer interconnections water is available at every point with minimum loss of head.
- Adequate water is available with pressure for firefighting requirements from the various branch lines.
- During repair, only a few houses are affected.

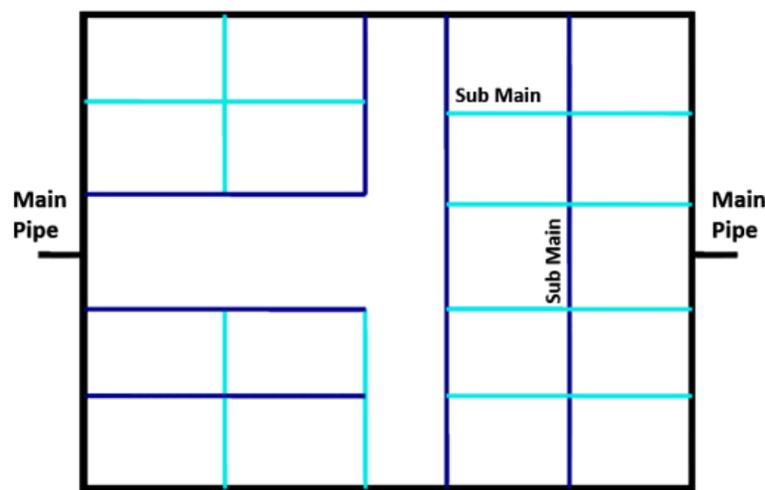
### **b- Disadvantages of Grid Iron Distribution System**

- In this system, more cut-off valves are required.
- This system requires longer pipe lengths with larger diameters.
- The analysis of discharge, pressure, and velocity in the pipes is difficult and cumbersome.
- As more pipes are required, ultimately increases the cost of the distribution system.

### *3. Circular or Ring Distribution System*

In this type of water distribution system, the supply mains form a ring around the area. The branch pipes are connected cross-wise to the mains and also to each other.

This system is most reliable for several buildings located in the same area planned locations.



*Ring Water Distribution System*

### **a- Advantages of Circular or Ring Distribution System**

- The number of interconnections is less with minimum loss of head.
- The discharge is also higher when compared to other methods of distribution.
- Fewer consumers are affected at the time of repairs as separate main lines available for each household.

### **b- Disadvantages of Circular or Ring Distribution System**

- The length of pipe laying is more which ultimately leads to higher cost.
- Several valves are required to control the flow and discharge of water.

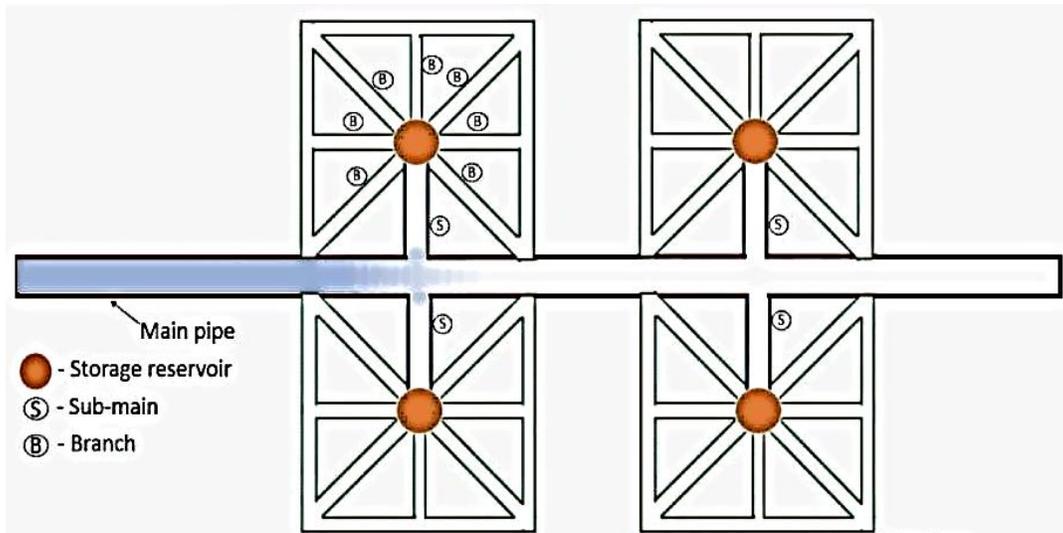
#### 4. Radial Distribution System:

In this type of water distribution system, the whole buildings are divided into several distribution areas.

Each building has a centrally located elevated reservoir from where distribution pipes run radially towards the periphery of the distribution areas.

This system gives swift service, without much loss of head.

The design of the pipe laying system is much simpler.



*Radial Distribution System*

#### a- Advantages of Radial Distribution System:

- Generally, in high-rise buildings, a radial system is used for the water distribution system.
- In this system, water is available with higher discharge and with minimum head loss.
- Fewer numbers of the consumer are affected while repairing.

#### b- Disadvantages of Radial Distribution System:

- The design of the pipe laying system is complicated.
- More length of pipe is required as the connection is more in this system.

#### 5.1.3 Heat the pipe and fitting observing WHS requirements.

- During all plastic pipe heating/ welding operations, the operators and associated workers should wear protective clothing and equipment. One should wear a helmet,

shields, safety goggles, flameproof clothes, and head hats. These protective safety items ensure the protection of the workers performing the welding task.

- Any loose contamination on the surface is removed when the pipe ends are wiped out with a lint-free cloth on both inner and outer surfaces. The heater of the welder also needs to be wiped regularly as anything that will come in contact will burn during the process.
- Only qualified person should perform cutting and fusion of different types of pipes.
- Out of order tool or machine should not be used.

#### **Activity-5.1: Join the PPRC pipes for dead end system.**

The teacher/ instructor is required to prepare annotated drawing of dead end system and direct the students prepare model of the same.

#### **Activity-5.2: Join the ABS pipes for radial system**

The teacher/ instructor is required to prepare annotated drawing of radial system and direct the students prepare model of the same.

#### **Activity-5.3: Join the PVC pipes for grid iron system.**

The teacher/ instructor is required to prepare annotated drawing of grid iron system and direct the students prepare model of the same.

#### **Activity-5.4: Join the PEX pipes for circular system**

The teacher/ instructor is required to prepare annotated drawing of ring system and direct the students prepare model of the same.

### **5.2 Installation of fixtures with plastic pipes.**

For installation of fixtures with plastic pipes, you must know the measuring, marking and cutting techniques. Then you will be able to start installation process.

#### **5.2.1 Mark the location of fixtures as per plan.**

- Read the plan carefully.
- Note the measurement required for marking.
- Use the steel tape for measuring length.
- Use the spirit level for horizontal alignment.
- Use the plumb bob for vertical alignment.
- Use the chalk line for marking horizontal and vertical lines.
- Use the permanent markers to mark the position of fixtures on wall for installation. You can also use center punch for marking location of fixture.

### **5.2.2 Select appropriate installation mechanism.**

To install a fixture with the plastic pipe, you should firstly join a fitting which have threading on terminal side. A fitting with the plastic pipe can be jointed in any of three ways:

1. By heat fusion
2. By use of jointing material- chemical solution
3. With the help of mechanical fittings.

#### **1. By Heat Fusion**

Heat fusion has been described in para 5.1.1-i.

#### **2. By use of jointing material- chemical solution**

For use of chemical solution, you have to firstly clean both the pipe and fitting ends which are required to be jointed. Any burr at end of pipe should be removed and smoothened. Then apply the solution on both i.e., pipe and fitting. The solution when applied melts the surfaces of pipe and fitting. Then you push the pipe into the fitting. You should keep the together for some time. Then water is applied for cooling.

In the fusion heating outside of pipe and in side of fitting are forced against heater sockets until the material reaches the recommended fusion temperature, inspecting the melt pattern, inserting the pipe end into the socket, and holding it in place until the joint cools.

#### **3. Jointing with help of mechanical means**

Now you can fix the fixture with help of adjustable screw wrench or another suitable tightening tool. These can be flanged joints with special hollow cones driven in the pipe after heating to specified temperature. Flanges are brought closer by tightening the nut bolts. A gasket is placed between to flange to make joint leak free.

### **5.2.3 Install the fixtures observing WHS requirements**

The fixtures are usually installed with the help of adjustable screw wrench, or spanner set which are directly fitted with fitting. Some are required to be fixed with wall or on the ground. These are installed by drilling holes in the wall firstly. Then rowel plugs with bolts or screws are used to firmly fix with wall or on the ground. The drilling is performed by drilling with relevant bit for making holes. After drilling of holes, plugs are inserted in holes. The fixture is fixed by tightening bolts or screws.

- Extra care should be observed for self and equipment safety. Always read labels and instructions when using chemicals or machines.
- Follow the recommendations for use at all times.
- Before cutting or drilling into a wall, ceiling, or floor cavity, make sure you know what's behind the surface.

- Use tools and equipment for their intended purpose only. The mis-use of tools can result in injury and/or damage to the tool.
- Personal protective equipment, hazard identification, and emergency preparation are essential safety elements at the installation site.

**i- Installation of bib cocks, T-stop cock, non-return valve, Shower rose, instant Geyser, Mixers with plastic pipes.**

Before you start installation, the following tools are required:

- Measuring tape: To measure the distances between the supply lines and the fixtures.
- Silicone: Will join together all the joints in the faucet.
- Basin wrench: Will help you reach those points behind the faucets that are hard to access and unscrew or tighten anything with ease.
- bib cocks, T-stop cock, non-return valve, shower rose, mixers
- A cutting disc or blade, it is
- Screwdriver, Pipe wrench

**Procedure:**

- i. Stepwise complete the activities.
- ii. Measure, mark and cut pipes
- iii. Measure and mark locations of fixtures.
- iv. Join the pipes with fittings.
- v. Install the fixtures step wise as per drawing.

**ii- Instant Geyser Installation**

Steps for geyser installation are given as under:

**a. Marking location & Drilling as per existing T-stop cocks**

Ensure that there is sufficient space available for geyser unit. The area or the space must be in accordance with the size of electric geyser and for gas instant geyser. Instant geyser is nearly a tankless geyser. Geyser unit must be installed at correct height from the ground. A minimum height of 1.8 meters (6 ft) from ground is recommended for geyser installation. To ensure safety, geyser should be fitted away from wet and damp areas like bathtubs and shower areas.

Mark the drilling position by marker. Make the holes with drill machine on marked positions as per size of bolt.

**b. Fixing the geyser with wall.**

Before geyser installation get your water pipes checked for any blockage. Make sure that the pipes are clean and clog free for smooth water flow. Firstly, a wall plate or frame is fixed on the wall and then geyser is installed on the plate. In case of solid walls hole must be properly drilled and in line to fix wall plate.

Make water connections

Connect the cold and hot water lines with proper identification with help of flexible metallic pipes. Never forget to fix safety wall for high pressure of steam in case of failure of thermostat. Also join gas pipe if it is an instant geyser.



*Geyser installation*

**c. Check for leakage**

Open the valves/ T-stop cocks. Check for leakage if any. Now geyser is ready for use.

**Activity 5.5: Install the bib cocks, T-stop cock, non-return valve, Shower rose, instant Geyser, Mixers with plastic pipes.**

The teacher/ instructor is required to provide detailed layout plan for a bath room comprising of installation of a bib cock, shower mixer & shower rose, instant geyser along with its non-return valve, T-stop Cock. This should be installed on working board or wall as per convenience.

## Key Points

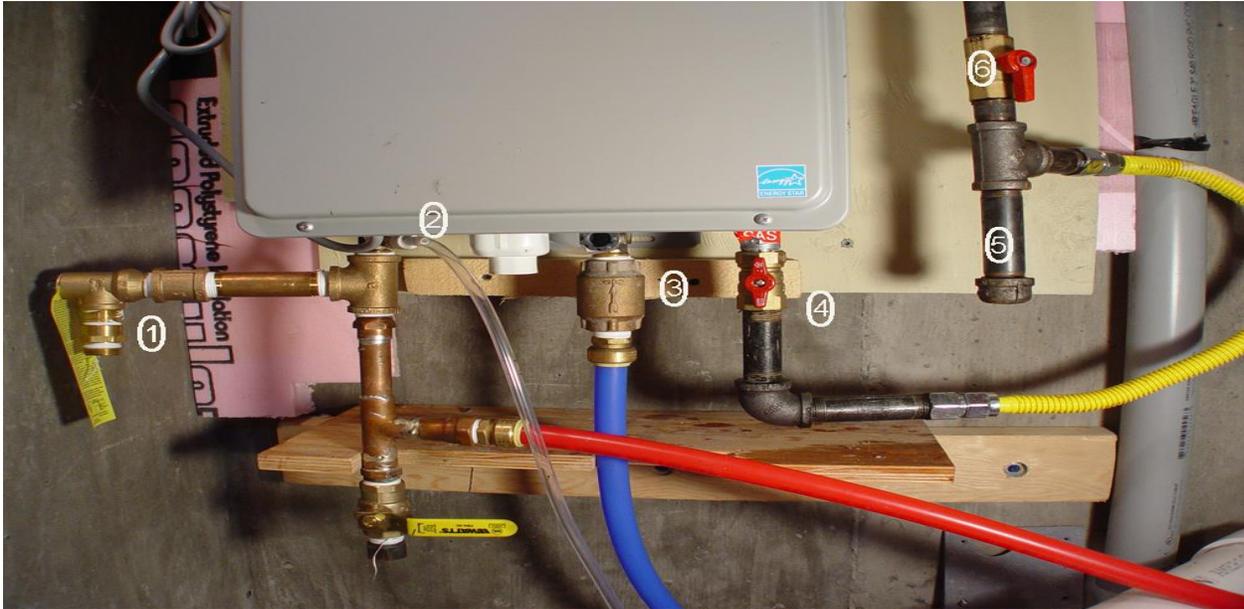
1. There are three ways of jointing plastic pipes namely; by help of chemical solution, by heat fusion and by mechanical means.
2. In case of chemical solution, chemical is applied on outer side of the pipe and inner side of the fitting. This solution melts the surface materials. Then pipe is pushed into the fitting, held for some time and then cooled down.
3. There are three types of conventional heat fusion joints currently used in the industry; Butt, Saddle, and Socket Fusion.
4. The principle of heat fusion is to heat two surfaces to a designated temperature, then fuse them together by application of a sufficient force. This force causes the melted materials to flow and mix, thereby resulting in fusion
5. Socket fusion consists of simultaneously heating both the external surface of the pipe end and the internal surface of the socket fitting until the material reaches the recommended fusion temperature
6. The most widely used method for joining individual lengths of PE pipe and pipe to PE fittings is by heat fusion of the pipe butt ends
7. Saddle fusion consists of simultaneously heating both the external surface of the pipe and the matching surface of the “saddle” type fitting with concave and convex shaped heating tools until both surfaces reach proper fusion temperature.
8. Scope of plumbing is wide from basics to fuel gas supply and air conditioning.
9. Fixtures are classified as fresh water fixtures, appliances, sanitary fixtures, gas fixtures and air conditioning fixtures.
10. The electrofusion joint is heated internally, either by a conductor at the interface of the joint or, as in one design, by a conductive polymer. Heat is created as an electric current is applied to the conductive material in the fitting.
11. In dead end water distribution system, one main pipeline runs through the centre of the building or town, and the sub-mains branch lines off from both sides.
12. Height of geyser should not be less than 18 meters from floor level.
13. Before cutting or drilling into a wall, ceiling, or floor cavity, make sure you know what's behind the surface.
14. Use tools and equipment for their intended purpose only. The misuse of tools can result in injury and/or damage to the tool.
15. Personal protective equipment, hazard identification, and emergency preparation are essential safety elements at the installation site.





## CHAPTER 6

### INSTALLATION OF FIXTURES



### Students' Learning Outcome

**After Studying this chapter students will be able to:**

- access, read and determine water service installation requirements from job specifications, relevant pakistan standards, codes, manufacturers' instructions and jurisdictional requirements.
- obtain, interpret and follow workplace, work health and safety (whs) and environmental requirements.
- create a materials list and collect materials.
- select and check serviceability of appropriate tools and equipment including personal protective equipment (ppe).
- set out and install pipework and connection points according to drawings, relevant specifications, local standards, codes and jurisdictional requirements.
- test installed pipework according to relevant local standards, codes, manufacturers' instructions and jurisdictional requirements.
- install the fixtures observing whs requirements
- clear the work area and dispose of, reuse or recycle materials in accordance with state or territory legislation and workplace requirements.
- clean tools and equipment, check for serviceability and report any damage, and store and secure.

## **Introduction:**

The installation of fixtures, and appliances is the last activity of plumbing work. For installation of fixtures, plumber must know the requirements for working of the fixtures. He has to collect materials and tools required for installation. He must observe the safety precautions during installation work. Installation of fixture at proper location is very important. The system should be leak proof. Proper house keeping and cleaning of the work area is responsibility of a good plumber.

### **6.1 Identify installation requirements.**

Various types of installations are required according to the codes and standards of the local governing body for plumbing works. The plumber must read the standards and codes for compliance of these. On the basis of these codes and standards, he/ she has to decide the numbers and specifications of installations. He has also to follow the manufacturer's instructions for handling and installation of fixtures.

#### **6.1.1: Water Service Installation Requirements.**

Codes and standards govern the minimum plumbing systems, facilities and plumbing fixtures to be provided. The followings are requirements for installation of water services.

- Every dwelling unit shall contain its own bathtub or shower, lavatory, water closet and kitchen sink which shall be maintained in a sanitary, safe working condition. The lavatory shall be placed in the same room as the water closet or located in close proximity to the door leading directly into the room in which such water closet is located. A kitchen sink shall not be used as a substitute for the required lavatory.
- At least one water closet, lavatory and bathtub or shower shall be supplied for each 4 rooming units.
- All plumbing fixtures shall be properly installed and maintained in working order, and shall be kept free from obstructions, leaks and defects and be capable of performing the function for which such plumbing fixtures are designed. All plumbing fixtures shall be maintained in a safe, sanitary and functional condition.
- Plumbing fixtures shall have adequate clearances for usage and cleaning.
- Where it is found that a plumbing system in a structure constitutes a hazard to the occupants or the structure by reason of inadequate service, inadequate venting, cross connection, back-flow, improper installation, deterioration or damage or for similar reasons, the Code official shall require the defects to be corrected to eliminate the hazard.

- Every sink, lavatory, bathtub or shower, drinking fountain, water closet or other plumbing fixture shall be properly connected to either a public water system or to an approved private water system.
- The water supply shall be maintained free from contamination, and all water inlets for plumbing fixtures shall be located above the flood-level rim of the fixture.
- Water heating facilities shall be properly installed, maintained and capable of providing an adequate amount of hot water to be drawn at every required sink, lavatory, bathtub, shower and laundry facility at a temperature of not less than 110°F (43°C). A gas-burning water heater shall not be located in any bathroom, toilet room, bedroom or other occupied room normally kept closed, unless adequate combustion air is provided. An approved combination temperature and pressure-relief valve and relief valve discharge pipe shall be properly installed and maintained on water heaters.
- As per Capital Development Authority (CDA) byelaws, an over head tank and underground water tank must be provided in each building.
- The Provision of Ground Water tank is mandatory. Underground/Overhead Water Tank to be provided in all buildings as per following minimum sizes:

<b>Under Ground Water Tank</b>				
Length	Width	Height	Cubic Feet	Gallon
3-ft (0.91m)	3-ft. (0.91m)	2-ft (0.61m)	18 cft (0.51 cu.M)	--
6'-0"	4'-0"	2'-6"	60 cft	400
10'-0"	5'-0"	2'-6"	124 cft	800
10'-0"	5'-0"	4'-0"	200 cft	1200
30'-0"	10'-0"	8'-0"	2400 cft	15000
30'-0"	20'-0"	8'-0"	4800 cft	30000

#### **Over Head Water Tanks**

Plot	Width	Length	Height	Cubic Feet	Gallon
Upto 7 Marla	3'	4'	2.5'	62 cft	200
7 Marla to 1 Kanal	5'	5'	4'	100 cft	400
Above 1 Kanal	5'	5'	4'	100 cft	600
Multi Storey 4 to 10 storeys	15'	10'	8'	1200 cft	7500
Above 10 storey	20/'	15'	8'	2400 cft	15000

## Materials and tools requirement

### Plumbing Equipment

Measuring tape, plumb bob, spirit level, permanent marker, center punch, chalk line, PPRC Pipe Cutter, Hacksaw, Screw wrench, Socket fusion heater with accessories, drill machine with bits, Sink wrench, A cutting disc, Screwdriver, spade bit, straight edge, Jig saw, Tubing cutter, hammer.

### Personal Protective Equipment Requirements:

All types of PPEs as per job requirements are required for safely installations of fixtures. The main PPEs are helmet, hard hats, work gloves, safety goggles, workwear, safety footwear, ear plugs, filter respirators, safety harnesses.

### 6.1.2: Workplace Health, Safety (WHS) & Environmental Requirements.

Obtain, interpret and follow workplace, work health and safety (WHS) and environmental requirements from local body. Main requirements are as under:

- Extra care should be observed for self and equipment safety. Always read labels and instructions when using chemicals or machines.
- Follow the recommendations for use at all times.
- Before cutting or drilling into a wall, ceiling, or floor cavity, make sure you know what's behind the surface.
- Use tools and equipment for their intended purpose only. The misuse of tools can result in injury and/or damage to the tool.
- Personal protective equipment, hazard identification, and emergency preparation are essential safety elements at the installation site.

### Activity-6.1: Prepare List of Equipment for Installation of Fixtures.

The teacher/ instructor is required to assign the students to prepare lists of equipments for the installation of followings separately and write the same on note books.

Sink

Urinal

Geyser

One fresh water fixture

Electric cooler

Water filtering system

## 6.2 Prepare for work.

For installation of fixtures, plumber must know the requirements for working of the fixture. He has to collect materials and tools required for installation.

### 6.2.1 Materials list for Installation of Sink, Urinal, Geyser

#### Materials list for Installation of Sink

- |                      |                                 |
|----------------------|---------------------------------|
| i) Sink              | v) P-trap (pipe type for sink). |
| ii) Brackets of sink | vi) Sink mixer                  |
| iii) Waste coupling  | vii) Plug with chain for sink.  |
| iv) Waste pipe       |                                 |

#### Materials list for Installation of Urinal

- |                        |                               |
|------------------------|-------------------------------|
| i) Urinal wall type    | v) T-stop cock                |
| ii) Rowel plugs        | vi) Flushing cistern          |
| iii) Rowel bolts       | vii) Flush pipe with coupling |
| iv) Plastic connection | viii) Waste pipe.             |

#### Tools for Urinal Installation

- |                        |                       |
|------------------------|-----------------------|
| ➤ Steel measuring tape | ➤ Adjustable wrench   |
| ➤ Electric drill       | ➤ Flex hose           |
| ➤ Clean rag            | ➤ Stud finder         |
| ➤ PVC cement/ solution | ➤ Washers             |
| ➤ Pencil               | ➤ Lag screw           |
| ➤ Spirit level         | ➤ Wall hanger         |
| ➤ Plywood              | ➤ Slotted screwdriver |
| ➤ Drill bits           | ➤ Drain flange        |
| ➤ Drywall saw          | ➤ Drain flange gasket |
| ➤ Carpenter's level    | ➤ Cap nut             |
| ➤ Non-stick tape       | ➤ Caulk               |
| ➤ 90-degree elbow      |                       |

#### Materials list for Installation of Geyser

- |               |                                       |
|---------------|---------------------------------------|
| ➤ Geyser      | ➤ T-stop cocks                        |
| ➤ Rowel plugs | ➤ Metallic flexible water connections |
| ➤ Rowel bolts | ➤ Plate.                              |

#### Materials list for Installation of Plastic Shelf

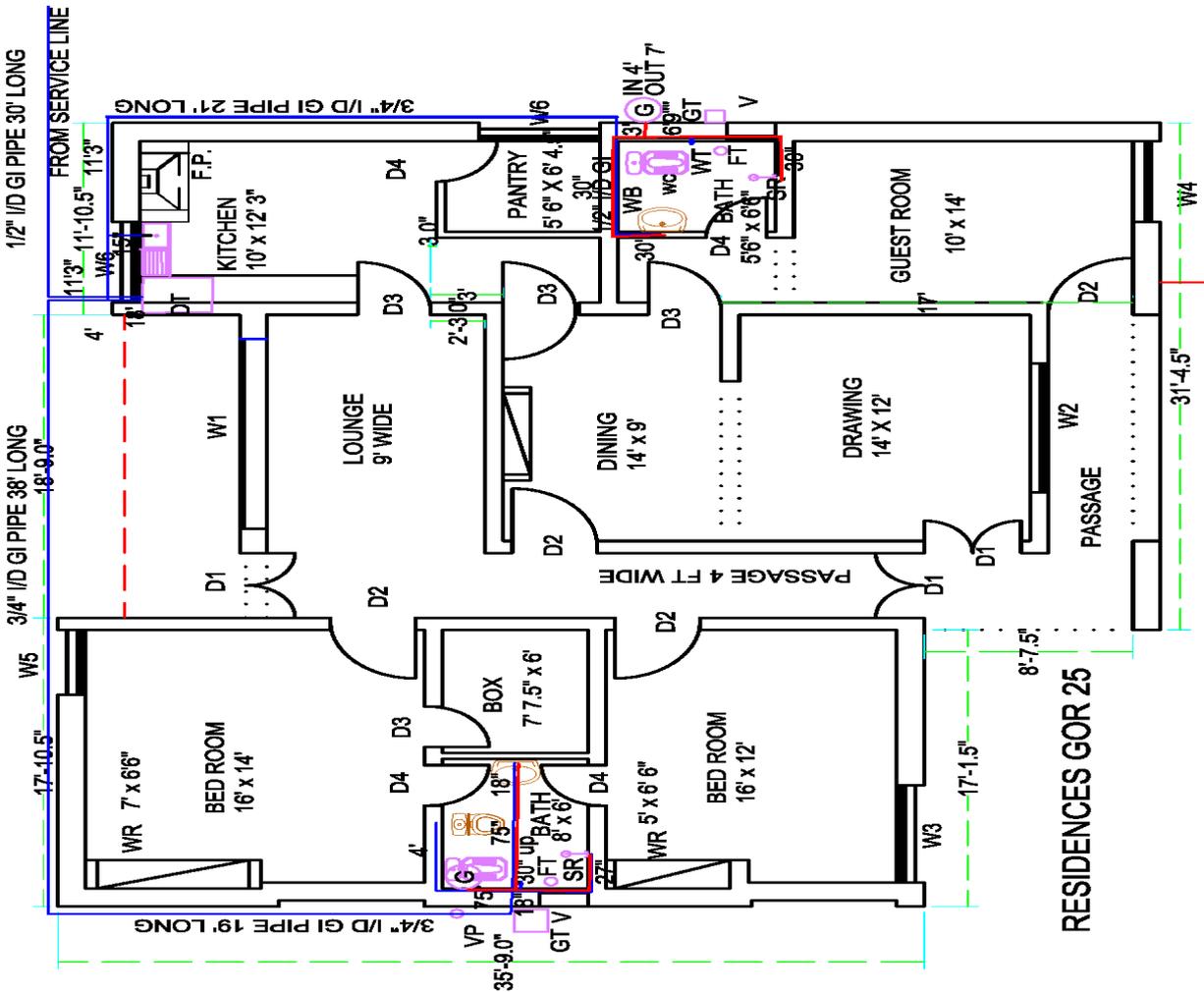
- |                     |              |
|---------------------|--------------|
| ➤ Plastic Shelf     | ➤ rowel plug |
| ➤ hangers for shelf | ➤ screws.    |

## Materials list for Installation of Looking Mirror

- i) Looking mirror
- ii) rowel plug
- iii) screws
- iv) Silicone.

### 6.2.2 Serviceability of tools and PPE

Prior to start the work the plumber must ensure the availability of required tools along with PPEs for specific plumbing work / installation of fixtures. He must ensure that the tools being used are in working order. Also, the requisite personal protective equipments are available and in working condition. The scheduled maintenance of the instrument should be performed. Any out of order machine should be sent to the concerned mechanic for its maintenance and repair. The calibration of sensitive instruments should be done after regular intervals. Plumber must make sure prior to use the serviceability of machines and tools.





#### **Activity-6.4: Prepare materials' list for appliances of given drawing.**

The teacher/ instructor is required to assign the students to prepare lists of materials for all the appliances fixtures after read the drawing of bath and kitchen.

### **6.3 Install sanitary fixtures and test pipe system.**

For installation of sanitary fixtures, there must be network of sanitary pipe for disposal of waste from sanitary fixtures and vent pipes for disposal of foul gases.

#### **6.3.1 Set out and install pipework and connection points**

Read the plan carefully.

Note the measurement required for marking.

- Use the steel tape for measuring length.
- Use the spirit level for horizontal alignment.
- Use the plum bob for vertical alignment.
- Use the chalk line for marking horizontal and vertical lines.
- Use the permanent markers to mark the position of fixtures on wall for installation. You can also use Centre punch for marking location of fixture.

To install plastic pipe network as per drawing, join fittings which have threading on terminal side. Adopt the following two ways for jointing pipes.

4. By use of jointing material- chemical solution
5. By heat fusion

- Any burr at end of pipe should be removed and smoothed. Then apply the solution on both i.e., pipe and fitting. The solution when applied melts the surfaces of pipe and fitting. Then you push the pipe into the fitting. You should keep the together for some time. Then water is applied for cooling.
- In the fusion heating outside of pipe and in side of fitting are forced against heater sockets until the material reaches the recommended fusion temperature, inspecting the melt pattern, inserting the pipe end into the socket, and holding it in place until the joint cools.

Now you can fix the fixture with help of adjustable screw wrench or another suitable tightening tool.

### **6.3.2 Test installed pipework**

For installation the following steps in order should be adopted.

#### **Step 1:**

Cap all the stub-outs connected to the system you're testing. For a Drain Waste Vent (DWV) system, this usually means gluing a cap to each stub-out with plastic pipe cement. If you're testing a water system, you may have to glue or solder the caps, depending on the type of pipes in your system. You'll cut off the caps when the test is complete.

#### **Step 2**

Install or find a fitting that allows you to connect an air compressor hose and pressure gauge to the system. In waste systems, you usually do this by screwing an adapter to a clean-out fitting and installing a tee. For water systems, it usually works to leave one stub-out uncapped and install a tee and adapter for the hose and gauge on that stub-out.

#### **Step 3**

Turn on the compressor and fill the pipes with air until the gauge reaches the test pressure reading. For water systems, this reading is usually around 80 psi. For drain systems, it's much lower -- about 5 psi.

#### **Step 4**

Turn off the compressor and leave the system pressurized for 15 minutes. Any reduction in pressure during that time signifies the presence of a leak.

### **6.3.3 Install the fixtures observing WHS requirements**

- Obtain, interpret and follow workplace, work health and safety (WHS) and environmental requirements.
- Extra care should be observed for self and equipment safety. Always read labels and instructions when using chemicals or machines.
- Follow the recommendations for use at all times.
- Before cutting or drilling into a wall, ceiling, or floor cavity, make sure you know what's behind the surface.
- Use tools and equipment for their intended purpose only. The misuse of tools can result in injury and/or damage to the tool.
- Personal protective equipment, hazard identification, and emergency preparation are essential safety elements at the installation site.

### **6.3.4 Install Fixtures**

For installation of fixture various steps in order are followed.

#### **a- Install sink**

For installation of sink following steps in order should be performed.

1. Measure and mark the kitchen sink's layout.
2. Mark the cut line on to the counter.
3. Cut a sink opening with a jig saw.
4. Install sin faucet.
5. Attach strainer over plumber's putty.
6. Set the sink and connect water supply
7. Connect the waste pipe with waste coupling with the sink.
8. Attach the dish washer drain.

#### **b- Install Urinal wall type**

For installation of urinal following steps in order should be performed.

1. Turn off water supply and if necessary, remove the old urinal.
2. Install or relocate the water supply pipe and drain pipe to the specified rough-in dimension shown on drawing.
3. Install adequate support to mount the urinal.
4. Install the wall hanger per rough-in specification.
5. Apply sealant tape to the drain pipe threads and install the outlet flange to the drain pipe.
6. Install the gasket on the outlet flange.
7. Carefully position the urinal on the wall hanger.
8. Secure the urinal to outlet flange with screws and washers.
9. Install the flush valve per manufacturer's instructions.
10. Install the strainer.
11. Turn-on the water supply and flush urinal several times.
12. Carefully check all connections for leaks.

#### **c- Install Electric Geyser**

For installation of geyser following steps in order should be performed.

- 1: Prepare the new plumbing lines with the help of sandpaper cloths. Rub the sandpaper on the ends until they shine.
- 2: Fix the new geyser tank into a drain pipe.
- 3: Position the T&P discharge to the valve.
- 4: The geyser inlet-outlet connection now comes into consideration. Connect the cold-water supply and hot water supply with the respective inlets. Using flexible hoses for this connection will be a good idea.
- 5: Make use of dielectric connectors to attach the flexible hoses to the trap nipples (cold and hot). You will also need to line the threads with plumber's tape.
- 6: Tie up the flexible hose to one end of the connector body.
- 7: Check the flexible hose for any leaks.
- 8: Install the discharge pipe to the T&P valve.
- 9: Slide the compression nut into the pipe. Then press the pipe into the connector and tighten the compression nut.
- 10: Turn on the hot water tap and check for leaks.
- 11: Fill the water heater tanker and connect all the electrical wirings.
- 12: Then connect the green ground wires to the screws and twist the wires with the connectors.
- 13: Turn on the circuit breaker at the main power.

#### **d- Install Shelf**

For installation of shelf following steps in order should be performed.

1. Mark the spot on the wall where you want the shelf to fix.
2. Mark the horizontal line with the help of spirit level and pencil.
3. Hold the shelf against the wall and mark hole location
4. Drill pilot holes and install the rowel plugs in the holes.
5. Screw the hangers of shelf into place in the holes
6. Fix the shelf on the hangers.

#### **e- Install Looking Mirror:**

For installation of sink following steps in order should be performed.

1. Mark the spot on the wall where you want the mirror to hang.
2. Use a level to make sure the mirror will hang straight.

3. Double check that the wall is flat with straight edge.
4. Locate and mark the studs in the wall.
5. Mark where you plan to install the bottom mirror clips.
6. Drill pilot holes and install the bottom clips on the wall.
7. Mark where you plan to screw in the top clips.
8. Drill the pilot holes and screw the top clip brackets into place.
9. Screw on the rest of the top clips to secure the mirror against the wall.

#### **Activity-1: Install sink**

The teacher/ instructor is required to provide detailed layout plan for a kitchen comprising of installation of layout of sink. This should be installed on working board or wall as per convenience.

#### **Activity-2: Install Urinal wall type**

The teacher/ instructor is required to provide detailed layout plan for a bathroom showing of installation wall type urinal. This should be installed on working board or wall as per convenience.

#### **Activity-3: Install Geysers**

The teacher/ instructor is required to provide detailed layout plan for a bathroom showing of installation of geysers. This should be installed on working board or wall as per convenience.

#### **Activity-4 Install Shelf and looking mirror**

The teacher/ instructor is required to provide detailed layout plan for a bathroom showing of installation of glass shelf and looking mirror. This should be installed on working board or wall as per convenience.

### **6.4 Clean Up.**

At the end of each installation, it is the basic principle to clean up the area from waste materials. The equipments are also cleaned to prevent them from corrosion. Check the serviceability of equipments to ensure their future use and store the same at proper locations.

#### **6.4.1 Cleaning of Work Area:**

- Clear the work area by use of brooms.
- Dispose off the materials those are not reusable or recycle able at proper place.
- Store the materials those are reusable in storage bins.
- Place the materials at recycling station those are recycle able.

#### **6.4.2 Housekeeping of Equipments:**

- Clean tools and equipment
- Check for serviceability of tools and equipment.
- Report any damage tools and equipment
- Store and secure tools and equipment in cabinets.

#### **Activity-6.9: Clean the work area for each activity.**

- ✓ Students are required to perform cleaning of work area and housekeeping of tools and equipment after installation of sink.
- ✓ Students are required to perform cleaning of work area and housekeeping of tools and equipment after installation of urinal.
- ✓ Students are required to perform cleaning of work area and housekeeping of tools and equipment after installation of Geysers.
- ✓ Students are required to perform cleaning of work area and housekeeping of tools and equipment after installation of plastic shelf and looking mirror.

## Key Points

1. Codes and standards govern the minimum plumbing systems, facilities and plumbing fixtures to be provided.
2. Every dwelling unit shall contain its own bathtub or shower, lavatory, water closet and kitchen sink which shall be maintained in a sanitary, safe working condition. The lavatory shall be placed in the same room as the water closet or located in close proximity to the door leading directly into the room in which such water closet is located. A kitchen sink shall not be used as a substitute for the required lavatory.
3. At least 1 water closet, lavatory and bathtub or shower shall be supplied for each 4 rooming units.
4. A gas-burning water heater shall not be located in any bathroom, toilet room, bedroom or other occupied room normally kept closed, unless adequate combustion air is provided.
5. Extra care should be observed for self and equipment safety. Always read labels and instructions when using chemicals or machines.
6. Prior to use of instrument, the concerned inspector/ supervisor should give the certificate of typical instrument.
7. For jointing with chemical solution, any burr at end of pipe should be removed and smoothed. Then apply the solution on both i.e., pipe and fitting.
8. Cap all the stub-outs connected to the system you're testing.
9. For water systems, pressure applied for testing pipe work, gauge reading is usually around 80 psi.
10. Before cutting or drilling into a wall, ceiling, or floor cavity, make sure you know what's behind the surface.
11. Personal protective equipment, hazard identification, and emergency preparation are essential safety elements at the installation site.
12. Dispose off the materials those are not reusable or recycle able at proper place.
13. Check for serviceability of tools and equipment.

## EXERCISE

### Multiple Choice Questions

Q-1. Tick ( ✓ ) the correct option for the following MCQs.

- 1- What is the minimum requirement of water closet for 4 rooming units.  
(A) 1 (B) 2  
(C) 3 (D) 4
  
- 2- How much %age of contamination is permitted in water supply:  
(A) 0.5% (B) 1%  
(C) 1.5% (D) 0%
  
- 3- What should be the temperature of hot water at exit from faucet of sink, shower etc.:  
(A) 43oC (B) 53oC  
(C) 63oC (D) 73oC
  
- 4- This is an accessory for installation of sink:  
(A) Waste coupling (B) bracket  
(C) waste pipe (D) all of these
  
- 5- Spirit level is used to check:  
(A) Verticality (B) level  
(C) Angle (D) all of these
  
- 6- For water systems, pressure applied for testing pipe work is usually:  
(A) 60 psi (B) 70 psi

(C) 80 psi (D) 90 psi

- 7- This is an essential item of safety at construction site:
- (A) PPEs (B) hazard identification  
(C) emergency preparation (D) all of these
- 8- Plumb bob is used to check:
- (A) Verticality (B) level  
(C) Angle (D) all of these
- 9- This governs the minimum plumbing systems, facilities and plumbing fixtures to be provided Spirit level is used to check:
- (A) codes (B) standards  
(C) Angle (D) all of these
- 10- Safety valve is required for installation of:
- (A) sink (B) geyser  
(C) urinal (D) all of these

### Short Questions

**Short answer to the following questions.**

- 1- Enlist accessories required for installation of looking mirror and glass shelf.
- 2- What are the essential safety elements?
- 3- Enlist PPEs required for installation of sink.
- 4- Enlist marking tools required for pipe work and fixture installation.
- 5- Why serviceability of tool is checked before use?
- 6- How PVC pipe is jointed with fitting.
- 7- Enlist PPEs required for installation of geyser.

- 8- Enlist materials required for installation of wall type urinal.
- 9- Why clean-up is performed after every activity?
- 10- How looking mirror is installed.

## **Long Questions**

### **Answer the following question in detail**

- 1. State the plumbing service installation requirements.
- 2. Describe requirements observed for health and safety for installation of urinal.
- 3. How installed pipe work is tested.
- 4. How Geyser is installed.
- 5. Explain the serviceability of tools and PPEs.

# CH. 7

## QUANTITY CALCULATION

### Students' Learning Outcome

After Studying this chapter students will be able to:

- Access, read and determine requirements from plumbing plans and specifications.
- Identify amendments to ensure plans and specifications are the most current version
- Confirm drawing conventions used and their application
- Know and understand the simple formulas for solution of triangles.
- Know and understand the simple formulas for solution of quadrilaterals.
- Know and understand the simple formulas for solution of circle.
- Apply the above formulas to calculate numbers, length and areas of simple plane figures.
- Determine type of materials.
- Calculate dimensions of required materials.
- Calculate the quantities of materials for plumbing system.
- Read the drawing of commercial building.
- Calculate the quantities of materials from the help of given plumbing plan.

### Introduction

Everyone wants to know the before-hand quantities of materials and cost of works. Calculation of quantities gives us quantity estimate, while the before-hand cost is known as cost estimate or simply estimate. For the purpose some data is required. The data comprises of drawings, specifications and rates. In the first instance, with the help of drawing and specifications, quantities are calculated for items of work. Afterwards cost is calculated by multiplying the quantity with its relevant rate. In this chapter you will learn how to calculate the quantities for different items of work. You will recognize symbols of items for plumbing works from plumbing plans. Most of the items are counted. Only unit of measurement of pipes is ft or meter.

### 7.1 Reading Plans

Reading plan means to understand and identify the different components in the plumbing plans. Plumbing plans show the different elements of plumbing systems in the shape of their symbols. These systems are mainly of two types- water supply system and sanitary system. Standards are set for the requirements of different elements of plumbing systems. However, if in the plumbing plans some information is missing then you have to assume that information as per standards.

### **7.1.1 Components of Plumbing Plans.**

Water supply system in a home starts from the source of water passing in the pipeline from the street. If this source is not available, then there will be an individual pump which is source to provide underground water in the system.

To note the components when the source is external water supply system, then you will have to start from the water supply service line. Have the plumbing plans with you, the sequence of components will be as under:

#### ***xxxix- Water Supply Components:***

- Clamp of size as per diameter of the service line having socket welded of as per standards of service providers.
- Ferrule valve is fitted over this clamp after boring a hole in the service line.
- Then with help of socket of elbow supply line for the home is laid up to the storage tank.
- In the way near the gate to inward side a valve, either sluice or ball is fitted which is called Gate Valve. The size of the valve as per size of pipeline.
- If the water supply connection is a metered one then ferrule valve may not be fitted.
- In a house there may be two types of water tanks namely underground storage tank and distribution tank on the roof. The size of tanks depends upon number of users in a house.
- In the distribution a ball valve is fitted to prevent the loss of water due to over storage.
- Valves are also fitted for inlet pipe and distribution pipe of distribution water tank.
- The distribution pipe from storage tank is usually of 1” diameter. This pipe runs down up to the branches which supply water to the individual bath or kitchen etc.
- The size of branch pipe is generally  $\frac{3}{4}$ ” internal diameter (i/d).
- Inside the bath or kitchen usually  $\frac{1}{2}$ ” i/d pipes are laid.
- When there is dual supply of hot and cold water, then water heater is provided. This water heater may be electric/ fuel geyser, or solar water heater.
- In a bath, the water supply fixtures are bib cock or faucet, stop cock, T-stop cock, shower rose, shower mixer, bath tub mixer, basin mixer or pillar cock, Muslim shower, etc. as per requirements.

- In the kitchen, the water supply fixtures are pillar cock or sink mixer. T-Stop cock in the case that the mixer is to be fitted directly with the sink, for wall type mixer there is no need of T-Stop cock.
- The fittings are sockets, tees, elbow, bends, crosses, unions, nipples, bush, and plugs etc.

**The followings can be items of work:**

- Providing and fixing chromium plated pillar-cock, heavy 1.5 cm (1/2")
- Providing and fixing chromium plated stop cock, heavy 1.5 cm (1/2")
- Providing and fixing underground stop cock 13 mm (1/2"), with chromium plated cover.
- Providing and fixing chromium plated bib cock, heavy 1.5 cm (1/2")
- Providing and fixing chromium plated tee stop cock, heavy 1.5 cm (1/2")
- Providing and fixing chromium plated shower rose 1.5x10 cm (1/2"x4")
- Providing and fixing, chromium plated mixing valve, for wash hand basin, sink or shower.
- Providing and fixing gun metal Peet/gate valve (screwed) 30 mm (1 1/4") dia
- Providing and fitting, chromium plated or brass oxidised, swan neck cock 15 mm (1/2") dia., single way.
- Providing and fixing, union brass cock. 13 mm (1/2").
- Providing and fitting chromium plated or oxidised, gas cock 6 mm (1/4") single way.
- Providing and fitting nipple or bush, 6 mm to 10 mm (1/4" to 3/8") i/d.
- Providing and fixing, brass gas cock: 15 mm (1/2").
- Providing and fixing brass stop cock/bib cock: 15 mm (1/2").
- Providing, laying, cutting, jointing, testing and disinfecting G.I. pipeline in trenches, with socket joints, using G.I. pipes of B.S.S. 1387-1967 complete in all respects, with specials and valves

**a) Light Quality** 1/2", 3/4, 1, 1 1/4, 1 1/2, 2, 2 1/2, 3, 4" (15mm-2 to 100mm- 3.65mm) (**Note:** Cost of sockets, tees, elbows, bends, valves, crosses, unions and plugs, etc. is included in the rates.)

**b)- Medium Quality** 1/2", 3/4, 1, 1 1/4, 1 1/2, 2, 2 1/2, 3, 4, 5, 6" (15mm-2.65 to 150mm- 4.85mm)

**Note: i.** Cost of sockets, tees, elbow, bends, valves, crosses, unions and plugs etc. is included in the rates except for internal G.I piping (1"dia, 3/4"dia & 1/2"dia) for Bath rooms/ Lavatory.

**ii.** For internal G.I piping (1"dia, 3/4"dia & 1/2"dia) Bath room(s)/ Lavatory of rate (composite) shall be reduced by 8% and specials mentioned above may be paid at the rates placed on Website as per actual quantity used.

**c)- High Quality** 1/2", 3/4, 1, 1 1/4, 1 1/2, 2, 2 1/2, 3, 4,5, 6" i/d (15mm to 150mm i/d, 3.25mm to 5.4 mm thick wall). Cost of all the specials e.g., is taken separately.

**xl- Sanitary Components:**

Basic sanitary components are:

- Appliances, appurtenances and fixture in individual units.

- In the Bath room there are glazed earthen ware water closet European type, excluding seat and cover
- Double seat and cover only. (Bakelite, plastic).
- Glazed earthen ware water closet, squatter type (Orisa pattern), combined with foot rest. (White, coloured) orisha, Arisa
- Glazed earthen ware wash hand basin 56x40 cm (22"x16") including bracket set, waste pipe and waste coupling, etc. i- white, with pedestal
- Providing and fitting plastic made low down flushing cistern 1363 litre (3 gallons) capacity, including bracket set, copper connection, etc. complete. (White , coloured)
- Providing and fixing, chromium plated soap dish.
- Providing and fixing, chromium plated toilet paper holder
- Providing and fixing, chromium plated towel rail:- i- 60 cm (24") long, and 2 cm (¾") dia
- Providing and fixing looking glass 55x40 cm (22"x16") size, and 5 mm thick, first quality.
- Providing and fixing glass shelf 60x13 cm (24"x5"), with 5mm thick glass:
  - i- with chromium plated brackets and railing
  - ii- glass shelf only, without chromium plated brackets and railing
- Providing and fixing, floor trap of cast iron, including concrete chamber all round, and C.I. grating: 10x7.5 cm (4"x3")
- Providing and fitting "P-trap: -

i- 10 cm (4") of cast iron ii- 10 cm (4") glazed

- Providing and fitting 10 cm (4") gully trap, including cement concrete, cost of PVC grating 15x15 cm (6"x6") and masonry chamber 30x30 cm (12"x12").
- Providing and fitting, cast iron soil pipe with: -

i- lead caulked, yarn joint: - a- 10 cm (4") i/d and b- 5 cm (2") i/d

- Providing and fitting cast iron specials, such as tee bend, collar, cross, etc. plain type: lead caulked joint ii-cement caulked joint: (In case of plug type, the composite rate shall be increased by Rs.2 per kg.)
- Providing and fitting, cast iron vent pipe with: lead caulked, yarn joint: 5 cm (2") i/d

## **For the Kitchen**

- Providing and fixing stainless steel sink with drain board, size 120x60 cm (48"x24") including bracket set, waste pipe and waste coupling.
- Providing and fixing, floor trap of cast iron, including concrete chamber all round, and C.I. grating: 10x5 cm (4"x2") ii- 10x7.5 cm (4"x3")
- Providing and fitting, cast sullage pipe with:- i- lead caulked, yarn joint:- 5 cm (2") i/d
- Providing and fitting cast iron specials, such as tee bend, collar, cross, etc. plain type: lead caulked joint: (In case of plug type, the composite rate shall be increased by Rs.2 per kg.)
- Supply and fitting of cast iron manhole cover with frame, etc. complete. i- 30 cm (12") dia ii- 45 cm (18") dia iii- 60 cm (24") dia
- Providing and fitting R.C.C. pipe 10 cm (4") dia, including laying and jointing in trenches.

## **Replacement**

- Providing and fixing, chromium plated waste coupling:-  
i- 3 cm (1¼") ii- 4 cm (1/2 ")
- Providing and fixing rubber plug with chain:  
i- 3 cm (1¼") ii- 4 cm (1/2 ")
- Providing and fixing, waste pipe of PVC:-  
i- 3 cm (1¼") ii- 4 cm (1/2 ")
- Providing and fixing, flushing bend of PVC.  
i- 3 cm (1¼") ii- 4 cm (1/2 ")
- Providing and fixing chromium plated bottle trap with waste pipe, etc. complete:  
i- 3 cm (1¼") ii- 4 cm (1/2 ")
- Providing and fixing, angle iron brackets for:-  
i- wash hand basin and cistern ii- sink
- Providing and fixing 1.5 cm (½") dia connection, including check nuts, etc.:  
i- plastic rubber connection ii- copper connection
- Providing and fixing brass ball float valve:

i- 1.5 cm (1/2") dia ii- 2 cm (3/4") dia iii- 2.5 cm (1") dia iv- 3 cm (1.25") dia v- 5 cm (2")  
dia

### 7.1.2 Amendments in Existing Plumbing Plans

Identify amendments to ensure plans and specifications are the most current version codes & standards of the water authority. If some are not shown in the drawing the point out, mark and note down the missing necessary component of water supply and sanitary systems. In any case, both the water supply and sanitary system should be complete in all respect.

### 7.1.3 Conventions in the Plumbing Plans

Confirm drawing conventions used are as per standards of local Water Authority. The recognition of the symbols must be assured and their application as per standards & manufacturer's instruction. The requisite symbols of all the fixtures i.e., water closet, wash hand basin, sink, bath tub, urinal, gully trap, intercepting chambers should be given as you have learnt in "Plumbing Layout Drawing". Pipe lines are shown with line name, e.g., gas for gas line, SW for soil waste, etc. Pipe lines are usually shown in colour code as given below:

- The cold-water pipe lines are shown in blue colour,
- Hot water pipe lines in red colour.
- In the sanitary plan pipe lines for disposal of sewage from WCs are shown in grey colour
- The pipelines for disposal of waste water from wash basins, sink and floors are in magenta colour.

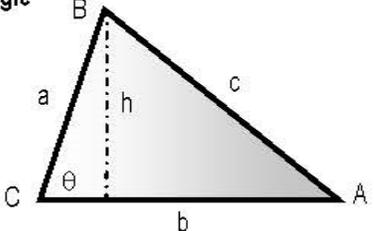
### Activity-7.1: Enlist the quantities of Fitting and Fixtures

The teacher / instructor is required to provide the plumbing plan. Read the given plan of plumbing system of a house and enlist the quantities of each and every fitting and fixtures separately.

## 7.2 Mensuration of plane figures

Branch of mathematics which deals with properties of plane and solid geometrical figures is known as mensuration. These properties are linear dimensions, angles, area and volume. Different plane figures are triangles, quadrilaterals, circle, annulus, ellipse, polygon and irregular plane figures. There are also sub-figures of these figures, e.g., semicircle, sector, segment and zone of circles. The solid figures are prism, cylinder, sphere, cone, pyramid, torus, etc.

### 7.2.1 Formulas for Solution of Triangles.

<p><b>1. Sine Rule:</b></p> $a/\sin A = b/\sin B = c/\sin C$ <p><b>2. Cosine Formula:</b></p> <p>In any triangle ABC,</p> <p>(i) <math>\cos A = (b^2+c^2-a^2)/2bc</math></p> <p>(ii) <math>\cos B = (c^2+a^2-b^2)/2ca</math></p> <p>(iii) <math>\cos C = (a^2+b^2-c^2)/2ab</math></p> <p><b>3. Projection Formula:</b></p> <p>In any triangle ABC,</p> <p>(i) <math>a = b \cos C + c \cos B</math></p> <p>(ii) <math>b = c \cos A + a \cos C</math></p> <p>(iii) <math>c = a \cos B + b \cos A</math></p> <p>In right angled triangle          Let P= Perpendicular, B= Base and H= Hypotenuse then,  <math>\sin \theta = P/H,</math>  <math>\cos \theta = B/H,</math>  <math>\tan \theta = P/B</math></p>	<p><b>Triangle</b></p>  <p><b>Given base b and altitude h</b></p> $A = \frac{1}{2} bh$ <p><b>Given two sides a and b and included angle <math>\theta</math>:</b></p> $A = \frac{1}{2} ab \sin \theta$ <p><b>Given three sides a, b, and c: (Hero's Formula)</b></p> $A = \sqrt{s(s-a)(s-b)(s-c)}$ $s = \frac{a+b+c}{2}$ <p><b>Given three angles A, B, and C and one side a:</b></p> $A = \frac{a^2 \sin B \sin C}{2 \sin A}$ <p><b>Pythagoras theorem</b> <math>\Rightarrow H^2 = P^2 + B^2</math>  <math>H = \sqrt{P^2 + B^2}</math>          For an <b>Equilateral Triangle</b> side = a, then Area = <math>A = 0.433 a^2</math>          For <b>Isosceles Triangle</b> base = a, equal inclined sides = b</p> $\text{Area} = \frac{1}{2} \times a \times \sqrt{\left(b^2 - \frac{a^2}{4}\right)}$
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### 7.2.2 Know and understand the simple formulas for solution of quadrilaterals.

Quadrilateral Type	Quadrilateral Formula
<b>Square</b>	$= a \times a$ where a is side of square. $= d^2 / 2$ where d is diagonal of square.
<b>Rectangle</b>	$= l \times b$ where l and b are sides of rectangle
<b>Rhombus</b>	$= (d_1 \times d_2) / 2$ where $d_1$ and $d_2$ are diagonals. $= a^2 * \sin \theta$ where a is side of rhombus and $\theta$ is angle between them.

<b>Parallelogram</b>	= $b \times h$ where $b$ is base and $h$ height of parallelogram = $b \times h \times \sin \theta$ where $a$ is side of rhombus and $\theta$ is angle between them.
<b>Trapezoid</b>	= $[(a + b)/2] \times h$
<b>Cyclic Quadrilateral</b>	$Area = A = \sqrt{(s - a)(s - b)(s - c)(s - d)}$ Where $S = \frac{a+b+c}{2}$
<b>Kite</b>	$(d_1 \times d_2) / 2$ where $d_1$ and $d_2$ are diagonals.

**Example 1:** The area of a rectangle is  $36 \text{ cm}^2$  and the height is 4 cm. Find the base.

Sol: Given, area =  $36 \text{ cm}^2$ , and  $h = 4 \text{ cm}$

To find: base =  $b$

Formula: area =  $b \times h$

Area of rectangle =  $b \times h$

$$36 = b \times 4$$

$$b = 36 / 4 = \mathbf{9 \text{ cm}} \text{ Ans}$$

### 7.2.3 Simple formulas for solution of circle.

#### Area of a circle

$$= \pi r^2 = \pi d^2/4 = O^2/4\pi$$

**Circumference** (Perimeter) of Circle =

$$O = 2 \pi r$$

**Area of a half circle** (Semi-circle) =  $\pi r^2/2$

**Area of a Quarter circle** =  $\pi r^2/4$

**Area of Sector of a circle:**  $A = (\theta/360) \times \pi r^2$

**Length of an arc of a sector:**  $\text{Arc} = C = (\theta / 360) \times 2\pi r$

**Sector angle of circle** =  $180 \times \pi r$

Area of the sector =  $\theta/2 \times r^2$

**Area of the circular ring (annulus)**

$$= \pi \times (R^2 - r^2)$$

Where,

**r** is the radius of the circle.

**d** is the diameter of the circle.

**C** is the circumference of the circle.

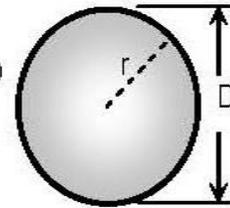
**$\theta$**  is the Angle between two radius

**R** is the Radius of Outer Circle

#### Circle

$$\text{Circumference} = 2\pi r = \pi D$$

$$\text{Area, } A = \pi r^2 = \frac{\pi}{4} D^2$$

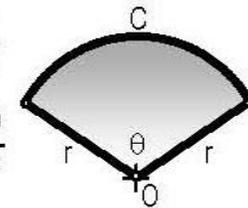


#### Sector of a circle

$$\text{Arc } C = r \times \theta_{\text{radians}} = \frac{\pi r \theta}{180^\circ}$$

$$\text{Area} = \frac{1}{2} r^2 \theta_{\text{radians}} = \frac{\pi r^2 \theta}{360^\circ}$$

$$\text{Area} = \frac{1}{2} C \times r$$



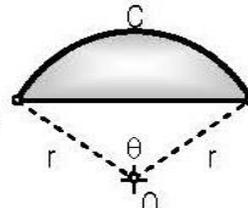
Note: 1 radian is the angle  $\theta$  such that  $C = r$ .

#### Segment of a circle

$$\text{Area} = A_{\text{sector}} - A_{\text{triangle}}$$

$$\text{Area} = \frac{1}{2} r^2 \theta - \frac{1}{2} r^2 \sin \theta$$

$$\text{Area} = \frac{1}{2} r^2 (\theta - \sin \theta)$$

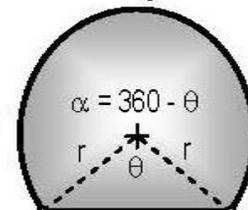


$\theta$  = angle in radians

$$\text{Area} = A_{\text{sector}} + A_{\text{triangle}}$$

$$\text{Area} = \frac{1}{2} r^2 \alpha + \frac{1}{2} r^2 \sin \theta$$

$$\text{Area} = \frac{1}{2} r^2 (\alpha + \sin \theta)$$



### 7.2.4 Application of formulas of quadrilaterals, triangles and circle:

**Example 2:** For a quadrilateral ABCD, the side BD = 15 cm and the heights of the triangles ABD and BCD are 5 cm and 7 cm respectively. Find the area of the quadrilateral ABCD.

**Solution:**

Diagonal = BD = 15 cm

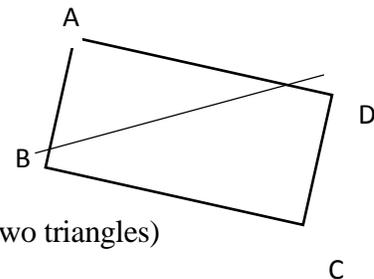
Heights,  $h_1 = 5$  cm &  $h_2 = 7$  cm

Sum of the heights of the triangles =  $h_1 + h_2 = 5 + 7 = 12$  cm

Thus, area of quadrilateral ABCD =  $\frac{1}{2}$  (diagonal x sum of heights of two triangles)

$$= \frac{1}{2} (12 \times \text{diagonal}) \quad \{12 = \text{Sum of height of two triangles}\}$$

$$= (15 \times 12) / 2 = \mathbf{90 \text{ cm}^2}$$



**Example 3:** Find the perimeter of the quadrilateral with sides 2 cm, 7 cm, 9 cm and 10 cm.

**Solution:**

The formula to find the perimeter of the quadrilateral = sum of the length of all the four sides.

The lengths of all the four sides of a quadrilateral are 2 cm, 7 cm, 9 cm, and 10 cm.

Perimeter of quadrilateral = 2 cm + 7 cm + 9 cm + 10 cm = **28 cm**

**Example 4:** Calculate the area of circle whose circumference is 3.1415 ft.

**Solution:**

Circumference =  $O = \pi \times d$

$\rightarrow d = O / \pi$

$= 3.1415 / \pi = 1 \text{ ft}$

Area of circle =  $A = \pi \times d^2 / 4$

$= 3.1415 \times 1^2 / 4 = 3.1415/4$

**= 0.785 ft Ans**

**Activity-7.2: Perform calculations for working out number, area and length of triangles, quadrilaterals and circle.**

Calculate the area of circle whose circumference is 6.283 ft.  
Find the area of isosceles triangle whose base = 5" and sloping sides are 8".  
Find the area of rhombus whose diagonals are 6" & 9".  
Find area of triangle whose sides are AB=5", BC=3" and CA=4". Also show that Angle C is of 90 degrees.

### **7.3 Calculate quantities for domestic plumbing system**

In a domestic plumbing system, there are bath rooms and kitchen. In the bath rooms generally, there are wash hand basin, water closet, shower rose, towel rail, looking mirror, glass shelf, soap dish, toilet paper holder, traps, bidet shower, T-stop cock, etc.

In the kitchen there is generally sink, sink mixer, tap, trap etc.

#### **7.3.1 Determine type of materials.**

Here in the following pages two plumbing plans are shown. The first plan shows the layout of sanitary installations in a residence. In the plan the following main fixtures can be seen.

- One European type water closet
- Two Indian type water closets
- Two wash hand basins
- One sink
- Vent pipes
- Traps
- Four intercepting chambers
- Pipe lines of different lengths
- Other allied components are shown.

In the second plumbing water supply pipework and its fixture are shown. These include the shower rose, tap combined with bidet shower, sink mixer, tap etc.

### **7.3.2 Calculate dimensions of required materials.**

The dimension of the pipe work i.e., diameter of pipes and length are shown in the plans.

- Standard size fixtures will be considered in the materials list.
- Generally, sink is of stainless steel 4' x 2',
- Wash hand basins are earthen ware glazed.
- Water closets are earthen ware glazed.
- The cold-water pipe lines are shown in blue colour,
- Hot water pipe lines in red colour.
- In the sanitary plan pipe lines for disposal of sewage from WCs are shown in grey colour
- While the pipelines for disposal of waste water from wash basins, sink and floors are in magenta colour.

### **7.3.3 Calculation of Quantities of Materials**

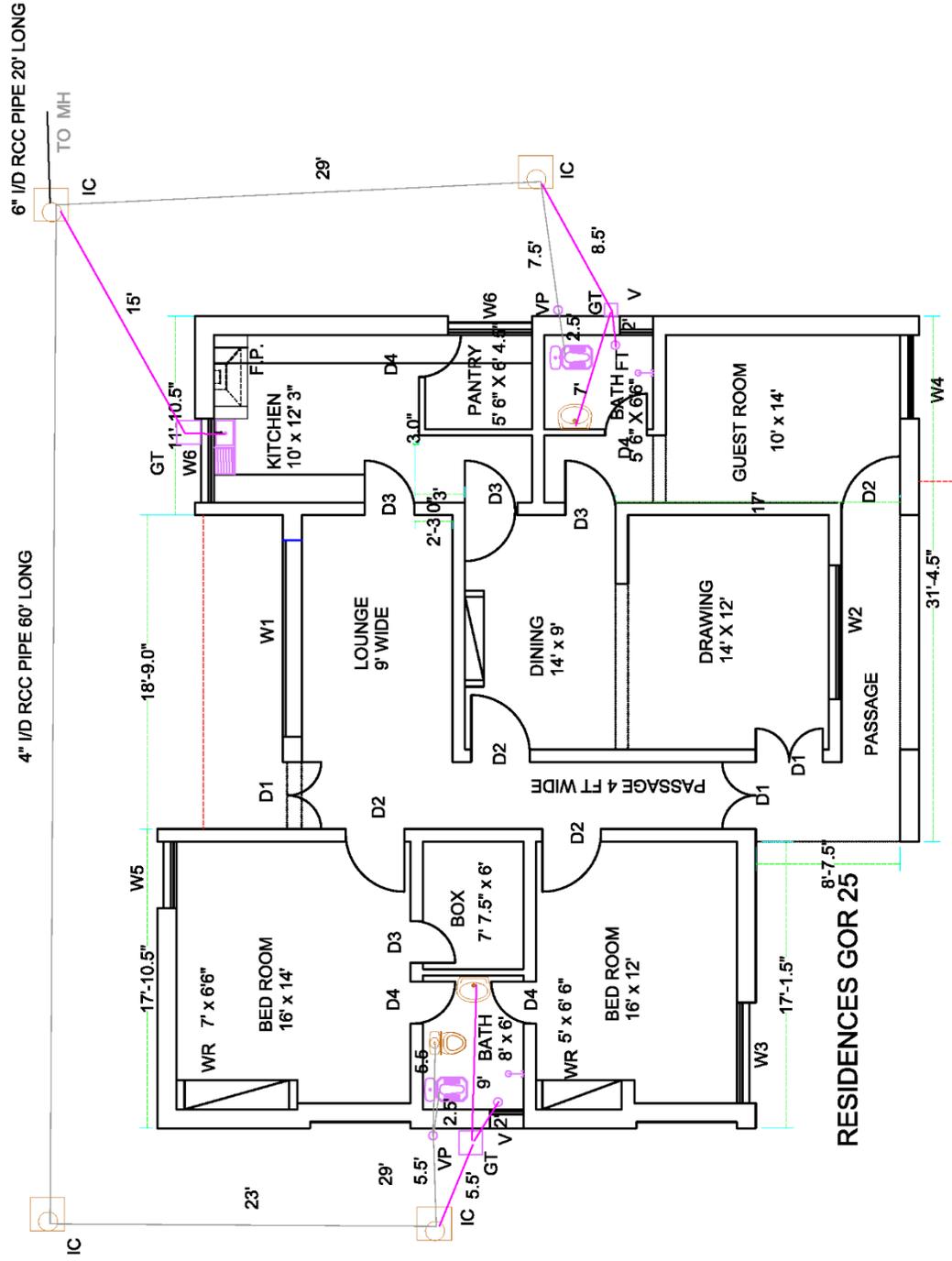
Length in feet or meters is calculated for all types of pipes mentioning the material of pipe, method of jointing, internal diameter of pipe, wall thickness and quality of pipe.

- For Light quality GI pipes, rates of specials/ fittings are included in the rate of pipes. For billing purpose, the quantities of fittings are not calculated. But for purchasing purpose the quantities of all the fittings are calculated.
- For medium quality GI pipes, fitting are included in the rates except for internal G.I piping (1"dia, 3/4"dia & 1/2"dia) for Bath rooms/ Lavatory.
- For internal G.I piping (1"dia, 3/4"dia & 1/2"dia) Bath room(s)/ Lavatory of rate (composite) shall be reduced by 8% and specials mentioned above may be paid at the rates placed on Website as per actual quantity used.
- For high quality GI pipes, pipes and fittings are paid separately.
- Quantity of fittings of Cast Iron pipes are calculated in kilogram.
- Quantity of fittings of pipes other than Cast Iron are calculated in numbers mentioning the material, internal diameter and quality.
- Quantities of all other fittings, fixtures, appliances, appurtenances are calculated in numbers mentioning the material, specifications, diameter etc.



S#	Description of item/ material	Quantity	Unit
1	GI clamp for 4" i/d diameter of the service line having 1/2" i/d socket welded	1	Nos.
2	Ferrule valve of 1/2" x 1/2" of brass	1	Nos.
3	GI pipe 1/2" i/d length in feet service line to distribution tank= 30+4+18=52 ft right side bath= 2(2.5+5.75+6.75+2.5)+4+7+3=48 ft Kitchen= 1.25+5 =6.25 ft Left bath= 2(2.25+6.25+6.25+1.5)+4+2+2.5= 41 ft	147.25	Rft
4	GI pipe 3/4" i/d length in feet For right side bath= 3+21+11.25=35.25 ft Left bath= 4+38+19+1.5=62.5 ft	97.75	Rft
5	Gate Valve for 1/2" i/d pipe	1	No.
6	Distribution tank of 250-gallon capacity along with coupling for pipes	1	No.
7	Ball Valve for 1" dia pipe	1	No.
8	Ball Valve for 3.4 " dia pipe	3	Nos.
9	Ball Valve for 1/2 " dia pipe	1	No.
10	CP Shower rose 1/2" x 3"	2	Nos.
11	CP Shower mixer 1/2"	2	Nos.
12	Bidet shower with taps composite 1/2"	3	Nos.
13	Tee- Stop cock 1/2" (6+5=11)	11	Nos.
14	GI elbows for 1/2" i/d pipe (14+4+12=30)	30	Nos.
15	GI socket for 1/2" i/d pipe (8+3+2+7)	20	Nos.
16	GI union for 1/2" i/d pipe (5+2+5)	12	Nos.
17	PVC Dead plugs	24	Nos.
18	GI elbows for 3/4" i/d pipe (3+2)	5	Nos.
19	GI socket for 3/4" i/d pipe (2+1)	3	Nos.
20	GI union for 1/2" i/d pipe (2+2+1)	5	Nos.
21	Basin Mixer complete Set	2	Nos.
22	Shower Mixer Complete set	2	Nos.
23	Electric Geyser 20 litre capacity	1	No.

# Sanitary Plumbing System



Sanitary layout plan

<b>S#</b>	<b>Description of item/ material</b>	<b>Quantity</b>	<b>Unit</b>
1	Glazed earthen ware water closet European type, excluding seat and cover.	1	No.
2	Double seat and cover only. (Bakelite, plastic).	1	No.
3	Glazed earthen ware water closet, squatter type (Orisa pattern), combined with foot rest. (White coloured)	2	Nos.
4	Glazed earthen ware wash hand basin 56x40 cm (22"x16") including bracket set, waste pipe and waste coupling, etc. white, with pedestal	2	Nos.
5	Plastic made low down flushing cistern 1363 litre (3 gallons) capacity, including bracket set, copper connection, etc. complete. (White, coloured)	2	Nos.
6	Chromium plated soap dish.	2	Nos.
7	Chromium plated toilet paper holder	2	Nos.
8	Chromium plated towel rail: - 60 cm (24") long, and 2 cm (¾") dia	2	Nos.
9	Looking glass 55x40 cm (22"x16") size, and 5 mm thick, first quality.	2	Nos.
10	Glass shelf 60x13 cm (24"x5"), with 5mm thick glass: with chromium plated brackets and railing	2	Nos.
11	Floor trap of cast iron, including concrete chamber all round, and C.I. grating: 10x5 cm (4"x2")	5	Nos.
12	"P" trap: 10 cm (4") glazed	2	Nos.
13	Providing and fitting 10 cm (4") gully trap, including cement concrete, cost of PVC grating 15x15 cm (6"x6") and masonry chamber 30x30 cm (12"x12").	3	Nos.
14	Providing and fitting, cast iron soil pipe with lead caulked, yarn joint:10 cm (4") i/d	10	Rft
15	Providing and fitting, cast iron sullage pipe with lead caulked, yarn joint:5 cm (2") i/d	20	Rft

16	Cast iron specials, such as tee bend, collar, cross, etc. plain type: lead caulked joint	20	kg
17	Providing and fitting, cast iron vent pipe with lead caulked, yarn joint: 5 cm (2") i/d	24	Rft
18	Providing and fixing stainless steel sink with drain board, size 120x60 cm (48"x24") including bracket set, waste pipe and waste coupling.	1	No.
19	Cast iron manhole cover with frame, etc. complete.30 cm (12") dia	3	Nos.
20	Intercepting Chamber 2' x 2'x 3'	4	Nos.
21	Cast iron manhole cover with frame, etc. complete.,60 cm (24") dia	4	Nos.
22	Providing and fitting R.C.C. pipe 10 cm (4") dia, including laying and jointing in trenches. (5.5+23+8.5+29+15 ft)	81	Rft
23	Providing and fitting R.C.C. pipe 15 cm (6") dia, including laying and jointing in trenches.	20	Rft
24	Steel toilet paper holder of standard size	03	Nos.

### Activity-7.3: Calculate the Quantities of Materials

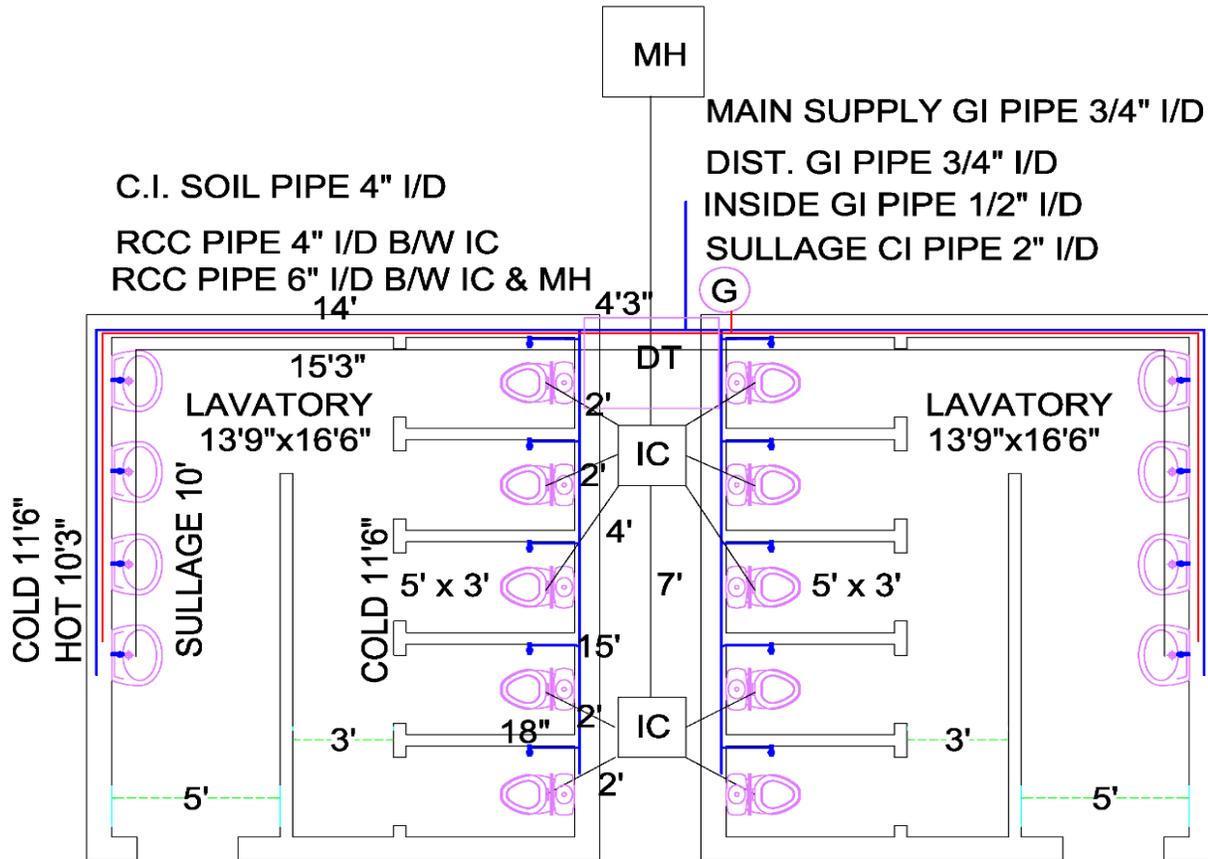
Calculate the quantities of materials required for the plumbing systems of the domestic building with the help of drawing of domestic building provided by the teacher/ instructor.

## 7.4: Materials for commercial building

The materials required for commercial building are nearly the same as are required for domestic building. However more fixtures are installed in a big single room.

### 7.4.1 Read the drawing of commercial building.

The same conventions/ symbols are used in the drawing of commercial building. The difference only is that in commercial building usually blocks are planned instead of separate baths or toilets. Two lavatory blocks are given, one for male and other for the female users.



#### 7.4.2 Calculation of Quantities of Materials

Length in feet or meters is calculated for all types of pipes mentioning the material of pipe, method of jointing, internal diameter of pipe, wall thickness and quality of pipe.

For Light quality GI pipes, rates of specials/ fittings are included in the rate of pipes. For billing purpose, the quantities of fittings are not calculated. But for purchasing purpose the quantities of all the fittings are calculated.

For medium quality GI pipes, fitting are included in the rates except for internal G.I piping (1"dia, 3/4"dia & 1/2"dia) for Bath rooms/ Lavatory.

For internal G.I piping (1"dia, 3/4"dia & 1/2"dia) Bath room(s)/ Lavatory of rate (composite) shall be reduced by 8% and specials mentioned above may be paid at the rates placed on Website as per actual quantity used.

For high quality GI pipes, pipes and fittings are paid separately.

Quantity of fittings of Cast Iron pipes are calculated in kilogram.

Quantity of fittings of pipes other than Cast Iron are calculated in numbers mentioning the material, internal diameter and quality.

Quantities of all other fittings, fixtures, appliances, appurtenances are calculated in numbers mentioning the material, specifications, diameter etc.

Refer to the plan given above, the quantities of materials are calculated for the commercial building as under:.

### Water Supply Plumbing System

S#	Description of item/ material	Quantity	Unit
1	GI pipe 1/2" i/d length in feet for w.c. =10 x 1.5'= 15 ft	15	Rft
2	GI pipe 3/4" i/d = Hot water pipe line (4.25'+14'+10.25'+14'+10.25')+ 4' from geyser to line= <b>56.75 ft</b> Cold water for basins=11.5'+ 14' + 4.25' + 14' + 11.5'+ 12 ft from tank= <b>67.25 ft</b> Main under ground= 10'+ 15'+2' up to top tank= <b>27 ft</b> For WCs = 15' x 2= <b>30 ft</b>	181	Rft
3	Ball Valve for 3/4 " dia pipe (2 with tank+ 1 at gate & 4 for basin and W.C. lines =7	07	Nos.
4	Bidet shower with taps composite 1/2" i/d	10	Nos.
5	Tee- Stop cock 1/2" (8+8+10=26)	26	Nos.
6	GI elbows for 1/2" i/d pipe for bidet showers	10	Nos.
7	GI Reducer elbow 3/4"x 1/2 " for last basin and WC 2+2	4	Nos.
8	GI Tee for 3/4"x 1/2 " i/d pipe (6+6+9+9=30)	30	Nos.
9	GI union for 3/4 " i/d pipe (1+2+1)	4	Nos.
10	PVC Dead plugs 1/2 "size	36	Nos.
11	GI elbows for 3/4" i/d pipe (4+2)	6	Nos.
12	GI union for 3/4" i/d pipe (2+2+2)	6	Nos.
13	Basin Mixer complete Set	8	Nos.

14	Electric Geyser 50 litre capacity with safety valve, and non-return valve complete set	1	No.
15	Water distribution tank 5000 litre capacity	1	No.

### Sanitary Plumbing System

S#	Description of item/ material	Quantity	Unit
1	Glazed earthen ware water closet European type, excluding seat and cover	10	No.
2	Double seat and cover only.(Bakelite , plastic).	10	No.
3	Glazed earthen ware wash hand basin 56x40 cm (22"x16") including bracket set, waste pipe and waste coupling, etc. i- white, with pedestal	8	Nos.
4	Chromium plated soap dish.	8	Nos.
5	Chromium plated toilet paper holder	10	Nos.
6	Chromium plated towel rail:- i- 60 cm (24") long, and 2 cm (¾") dia	8	Nos.
7	Looking glass 55x40 cm (22"x16") size, and 5 mm thick, first quality.	8	Nos.
8	Glass shelf 60x13 cm (24"x5"), with 5mm thick glass:- i- with chromium plated brackets and railing	8	Nos.
9	Floor trap of cast iron, including concrete chamber all round, and C.I. grating:- i- 10x5 cm (4"x2")	8	Nos.

10	Providing and fitting 10 cm (4") gully trap, including cement concrete, cost of PVC grating 15x15 cm (6"x6") and masonry chamber 30x30 cm (12"x12").	2	Nos.
11	Providing and fitting, PVC soil pipe :10 cm (4") i/d = 2 x (2+2+4+2+2)	24	Rft
12	Providing and fitting, PVC sullage pipe 5 cm (2") i/d =2x (10' + 15.25') = 50.5 ft	50.5	Rft
13	Providing and fitting, PVC vent pipe 5 cm (2") i/d= 14' x 2 =	28	Rft
14	Cast iron manhole cover with frame, etc. complete.30 cm (12") dia	2	Nos.
15	Intercepting Chamber 2' x 2'x 3'	2	Nos.
16	Providing and fitting R.C.C. pipe 10 cm (4") dia, including laying and jointing in trenches.(7 ft)	7	Rft
17	Providing and fitting R.C.C. pipe 15 cm (6") dia, including laying and jointing in trenches.(15 ft)	15	Rft

#### Activity- 7.4: Calculate the Quantities of Materials

Calculate the quantities of materials required for the plumbing systems of the commercial building with the help of drawing provided by the teacher/ instructor.

## Key Points

1. Ferrule valve is fitted on the service line to acquire water connection.
2. The valve fitted near the main gate is called gate valve whatever his structure is i.e., may be ball or sluice valve.
3. The underground water tank used to store in a house is termed as storage.
4. Water supply fittings socket, elbow, bend, Tee, cross, nipple, union, bush etc.
5. In a bath, the water supply fixtures are bib cock or faucet, stop cock, T-stop cock, shower rose, shower mixer, bath tub mixer, basin mixer or pillar cock, Muslim shower, etc. as per requirements.
6. In the kitchen, the water supply fixtures are pillar cock or sink mixer. T-Stop cock in the case that the mixer is to be fitted directly with the sink, for wall type mixer there is no need of T-Stop cock.
7. In a bath room sanitary fixtures are Wash hand basin, water closet, bath tub, floor trap, flushing cistern, and also the followings are included in sanitary- toilet paper holder, soap dish, towel rail, glass shelf, looking mirror.
8. The accessories with the basin are brackets, rowel bolt, rowel plug, nut bolts, waste coupling, waste pipe, plastic connection, cork plug with chain.
9. The accessories with the sink are brackets, waste coupling, waste pipe, plastic connection, cork plug with chain.
10. A complete set of Indian type WC comprises of WC combined with foot rest, P-trap, flush pipe, flushing cistern with coupling and float valve, and plastic connection.
11. The sink is used to wash utensils.
12. Urinals are usually installed in lavatory of commercial buildings.
13. Sanitary pipes are laid at a gradient of 1:48 for gravity flow.
14. The reducers have both ends of different diameter.

## EXERCISE

### Multiple Choice Questions

**Q-1. Tick ( ✓ ) the correct option for the following MCQs.**

- 1- The urinal is installed in:  
(A) Toilet (B) Lavatory  
(C) W.C. (D) All of these
  
- 2- Measuring unit of water closet for billing is.  
(A) Gallon (B) litre  
(C) Number (D) none of these
  
- 3- The Flow of water in sanitary pipe should be:  
(A) Pressure flow (B) Forced flow  
(C) Gravity flow (D) Combined flow
  
- 4- The name employed for a fitting, having a larger size at one end than on the other:  
(A) Elbow (B) Reducer  
(C) Tee joint (D) Union
  
- 5- The gully traps are used for:  
(A) Sewage (B) Sullage  
(C) fresh water (D) Hot water
  
- 6- Measuring unit of cast iron fittings is.  
(A) ton (B) kilogram  
(C) Number (D) none of these

- 7- The formula for calculation of area of isosceles triangle is:
- (A)  $\frac{1}{2} \times \text{base} \times \text{height}$                       (B) base x height  
 (C)  $= \frac{1}{2} \times a \times \sqrt{(b^2 - \frac{a^2}{4})}$                       (D) None of these
- 8- Hero's formula for area is applicable for the triangle whose given data is:
- (A) 2 sides & 1 angle                      (B) 3 sides  
 (C) 3 angles                      (D) 2 angles & 1 side
- 9- For this quality of pipe, the fittings are taken separately.
- (A) low quality                      (B) medium quality  
 (C) high quality                      (D) none of these
- 10- This pipe is usually made up of cast iron.
- (A) soil pipe                      (B) vent pipe  
 (C) sullage pipe                      (D) all of these

### Short Questions

**Short answer to the following questions.**

- 1- Enlist 08 items of work for water supply?
- 2- Enlist 08 items of work for sanitary?
- 3- Write the difference between fitting and fixture.
- 4- What is meant by soil pipe?
- 5- Enlist accessories of wash hand basin.
- 6- Enlist materials required to install water closet.
- 7- Why are sewage from WC and from wash basin conveyed separately to the intercepting chamber?
- 8- Why sink is installed in kitchen and not in the bath room?
- 9- Why are instant gas geysers installed outside the bath room?
- 10- What is the purpose of sullage pipe?

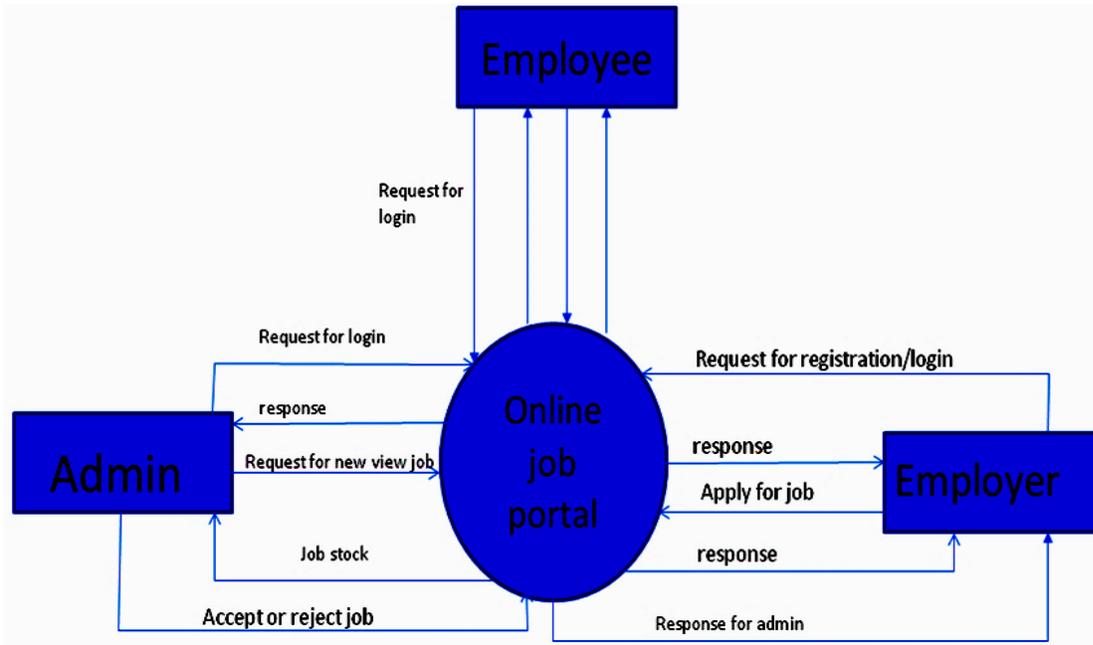
## Long Questions

### Answer the following question in detail

1. State all the items of water supply work for domestic and commercial building.
2. State all the items of sanitary work for domestic and commercial building.
3. Calculate the area of circle whose circumference is 26 inches. Also calculate the breadth of rectangle in centimeters whose area is equal to the area of circle and the ratio in breadth : length is 1:2.
4. Write down the quantities of materials required for the installation of each of the followings separately:
  - Water closet along with flushing cistern low level.
  - Bath tub
  - Wash hand basin
  - Sink
5. Project for preparation of material's list for plumbing systems for domestic and commercial buildings
  - Material Required:
    - Drawings of plumbing systems of domestic and commercial buildings, Steel Rule/ scales, Calculator, Pencil, Note Book
  - a- Get the drawings from the teacher/ instructor concerned for domestic and commercial buildings. Read them carefully.
  - b- Note down the materials of different pipes, fittings, fixtures and appliances.
  - c- Calculate the quantities for each of the materials to be used in these plumbing plans of domestic and commercial buildings.

# CHAPTER 8

## PERSONAL AND PROFESSIONAL DEVELOPMENT



### Students' Learning Outcome

After Studying this chapter students will be able to:

- learn the importance of cv in job application
- create and format cv/resume
- access and register email account on various online job portals
- search job as per job description and title
- familiarize oneself with online travel e-commerce websites
- learn about hotel websites
- learn about freelancing websites

## Introduction

Personal and professional development means to uplift one's personal & professional capabilities. There are different ways to reflect personal capabilities including Curriculum vitae (CV). In this chapter you will learn the structure, formats and understand the importance of curriculum vitae CV. Jobs portals are earning popularity because of the increasing access of the internet. In this modern age internet is widely used to promote businesses of various nature, e.g., work from home, travelling, shopping, hoteling, and freelancing.

### 8.1 CV & Resume Writing

A curriculum vitae (CV) is a marketing document that gives a summary of a job seeker's basic information, qualification, career history and potential. The phrase "curriculum vitae" is Latin which means "the story of your life".

#### 8.1.1 Importance of CV in Job Application

The resume acts as a bridge between job seeker and the prospective recruiter. CV is the first way to make a good impression, imparting in the minds of the recruiter, based purely on the words on the page they have in front of them. Where CV provides the required information to the recruiter, the job seeker reflects him/ her self as suitable one. CV making the first impression, enables an individual to stand out from the crowd first. Since employers do not have that much amount of time to interview each and every candidate, they require resumes from candidate to short list the best ones for final selection to work with them. A resume:

- is an important tool for job search because one can represent his/ her skills, qualities and potential.
- is showcase of one's knowledge, skills, experiences, expertise, and accomplishments. It is necessary to have a perfectly written resume which can portray a good professional
- helps employers make suitable decisions regarding the services.
- reaches the recruiter's table much before than you.
- helps the recruiter to know what all skills that one has acquired through different jobs and how going to utilize them for the betterment of the prospective organization.

To summarize CV is essentially a marketing tool that gives an opportunity to reflect one's abilities to employers.

#### 8.1.2 Creating CV/ Resume

A resume should have a positive outlook, clearly showing the most relevant strengths and experiences. It should be attractive enough to impress the employer. CV can be crafted in a number of formats, available online for free downloading. Choose and adapt one according needs. Think about your standout features, pick the most relevant and attractive to appeal your prospective employer.

A CV needs to be adaptive depending on the nature of the job you are applying for. Different jobs need different skills and experience. The CV should focus the skills and experience which are quite relevant and to the required job.

The key components of the standard CV are:

**A. Personal details and contact information:**

In this section basic personal information i.e., name, address, date of birth or age, phone number, email etc.

**B. Personal statement:**

This section describes briefly the strengths of the individual and suitability for the certain job focusing specific potential.

**C. Qualification:**

Give details of academic and professional qualifications starting with achieved recently.

**D. Employment history or work experience:**

This section contains career history (if any) and achievements during the career.

**E. Skills:**

Enlist the skills including personal, professional, communication etc.

**F. Strengths and achievements:**

Detailed things like team working, a school or college project or event you took part in, a hobby where you have gained an award such as a certificate, trophy or a medal

**G. Interests and voluntary work:**

Mention your interests and any volunteering work along with assigned responsibilities and assignments.

## Template of CV.

< Your name in bold case with photo>

### **A- Personal Information:**

Name: < your name >  
Father's Name: <your father's name>  
CNIC No: < your CNIC number >  
Date of birth: < dd/mm/yyyy>  
E-mail: (xyz@gmail.com)<  
Cell No.: <your cell number>  
Nationality: <Pakistani>  
Marital Status: <Married or unmarried>  
Gender: <Male or female>  
Languages: <Urdu, English (R.W.S)>  
Domicile: <district name (Punjab, Pakistan)>  
Postal Address: <postal address >  
Permanent Address: <permanent address>

### **B- Personal statement:**

<if no separate application showing your best fitness for job>

### **C- Educational Qualifications:**

(Highest to lowest upto matric)

### **D- Employment History/Experience:**

(Jobs detail from most present to past with dates, e.g., Administrator, supervisor, Engineer etc.)

### **E- Skills/ Trainings:**

<Job related skills, trainings, and computer literacy, e.g., computer software, designer>

### **F- Strengths and Achievements**

<Exceptional jobs, duties performed e.g., trained others, book writer, Award winner etc.>

### **G- Interests, Hobbies and Voluntary work**

<For example, book reading, game, gardening, social worker etc.>

#### **8.1.3 Formats applied in CV/ Resume**

- Avoid titling the document 'curriculum vitae' or 'CV'. It's a waste of space. Instead let your name serve as the title.
- Ensure they stand out by making them larger (font size 14 or 16) and bold.
- Choose a font and style which are clear and easy to read such Arial, Calibri or Times New Roman. Use a font size between 10 and 12 to make sure that potential employers can read your CV. Ensure all fonts and font sizes are consistent throughout.
- Save with a .PDF file extension to make sure it can be opened and read on any machine.
- Only print on one side and don't fold your CV.

#### **Activity 8.1: Create a CV with the help of teacher**

The teacher/ instructor is required to guide the students for writing of their CV as per seven heading and applying requisite format.

### **8.2 Job Portals**

Job portals or placement portals are the online platforms through which recruiters and job seekers are connected to each other. These portals have earned popularity because of the increasing access of the internet. Both, recruiters looking for the employees as well as job seekers, register with these portals and get linked without any hassles.

#### **8.2.1 Access and register email account on various online job portals**

##### ***A. Register with a Job Portal***

### *xli- For Candidates*

Access to the job portal, website etc. Find the advertisement that suits your skills and qualification. Read out the instructions carefully. Provide the required information in details like basic personal information, qualifications, skills, and experience. If demanded upload your CV.

### *xlii- For Recruiters (companies, consultants, agencies etc.)*

The recruiter has to create a profile giving details about their requirements providing an ID which can be logged in. It should be user friendly to upload the information including curriculum vitae. The portal should be designed in a way that it provides the required information are available in a systemic manner.

## ***B. Create Accounts on Job Sites***

Some job boards and company websites require users to create an account when they apply for jobs. It's a good idea to start your online job search by creating an account on at least one of the major job boards including [National Jobs Portal Government Jobs online \(njp.gov.pk\)](http://njp.gov.pk) for jobs.

To create an account, you'll need to register with a current email address so that your account can be confirmed. Your username will either be your email address or a name you select. You'll be able to choose a password for your account.

Some sites allow job seekers to register with their Facebook or LinkedIn information.

## ***C. Apply for Jobs on Company Websites***

Company websites are a good source of job listings, especially if you know what companies you are interested in working for. You can go directly to the site and search for and apply for jobs online directly on many company websites.

## ***D. Job Application Instructions***

It's important to follow all instructions when applying for jobs online. You may need to fill out a profile, upload your resume and cover letter, and/or take an employment test as part of the online application process.

Regardless of how you apply, it's important to follow the company's application instructions, to submit all the required materials, and to carefully proofread your application before you click the "Submit" button. Keep track of the job site accounts you create so you can track your applications.

## ***E. Email Job Applications***

In addition to applying for jobs directly online, you may also need to apply via email.

Some employers, especially smaller companies, don't have systems in place to handle online job applications. Set up a professional email account for your job search.

### 8.2.2 Search Job as per job description and title

When you look for jobs online, the most effective way to search is to use job keywords to find jobs in the career fields and industries you are interested in. Create a list of job search keywords that reflect your job interests, including the location where you want to work, type of position, industry, etc.

#### *Search for job-on-Job boards*

In addition to using job boards (which post jobs submitted by employers), using a job search engine can save you a lot of online job search time. When you use a job search engine, you can search for jobs found across various job boards and employer websites.

Search using the job search keywords list you created and you'll get a list of job openings that match your specifications very quickly. When you click on a job opening, you'll get instructions on how to apply and/or be directed to a company website to apply.

Jobs.com.pk

#### **Activity 8.2: Register on online job portals, follow job hunting procedure and steps to apply for an advertised job.**

- 1- Search for the job portals in Pakistan. Enlist at least 10 job portals.
- 2- The teacher/ instructor is required to guide the students for registering themselves on job portals e.g., “njp.gov.pk” and adopt job hunting procedure.  
Follow the steps to apply for advertised job.

### 8.3 Introduction to E-commerce

Electronic commerce is an emerging model of new selling and merchandising tools in which buyers are able to participate in all phases of a purchase decision, while stepping through those processes electronically rather than in a physical store or by phone (with a physical catalogue). The processes in electronic commerce include enabling a customer to access product information, select items to purchase, purchase items securely, and have the purchase settled financially. It is an emerging concept that describes the process of buying and selling or exchanging of products, services; and information via computer networks including the Internet across the borders.

- The first is by use of a relatively simple Web site consisting of a few pages whereby you tell potential customers who you are, what you do, where you are and how they can contact you ( easiest done by giving them your email address).
- The second way of enabling world-wide customers to buy from you is to provide them with an *On-Line Catalogue* of your products which they can browse at their leisure without having to go to your place of business.

## **On-Line Catalogue:**

On-Line Catalogue is that catalogue where people access via the Internet. On-Line Catalogue is an integral part of website, enabling customers to...

- Browse through stock list, read about an item or service;
- Look at photographs of the products.
- Select which items they want to purchase
- And drop them into a shopping cart as they go along.
- When they have completed their shopping, they go to the
- Check-Out.

The next step is to request the order by filling in their details and method of payment on a form which is waiting for them at the Check-Out. The form is already partially completed with a breakdown of the items in their shopping cart, prices inclusive of tax, and shipping & handling charges, if any. If they choose to pay by credit card, the form includes a place for them to fill in their credit card number. And then, with one press of a button, they send the order.

### **8.3.1 Online Travel E-Commerce Websites**

Travel booking and reservations by visiting travel agencies or ordering by phone have been long overtaken by travel websites and mobile apps which have largely facilitated making digital travel arrangements progressively easy.

Internet users are enabled by these travel ecommerce site to prepare their very own itineraries with the help of online tools, price comparison websites or portals that allow reviews, which frequently provide visitors with the option for directly booking accommodation at the desired locations.

E-commerce is creating new and exciting opportunities for the global travel and tourism industry. Travel and tourism-oriented institutions and Internet companies are joining to tap the potential market created by e-commerce. Travel and tourism service providers are increasing joining the online platform to tap into the splurging customers in the Ecommerce market.

#### **A- How to Book online seat for Travel**

Online ticketing / booking is a convenient way of booking your travel over the internet. Using PIA online services you can:

- Book a flight and pay online for your travel
- Request for a particular seat, special meal or service
- Check Flight status with availability of price
- View the Schedule/timetable

You can start by visiting [www.piac.aero](http://www.piac.aero) and then follow the process:

- Search flights - Find a suitable flight/routing/date
- Select flights - Display of fares and selection of suitable fares
- Seat Selection – Select normal free seat or purchase bulk head seat (if required)
- Passengers & Payments – Insert details of passengers and payment card details on a secured web-page
- Confirmation – Generation of confirmation of the web booking

In one online transaction, you can book up to nine (9) passengers, including (6) adults and children in your traveling party as seats will be occupied. Infants are co-related to the number of adults in the traveling party.

### **8.3.2 Hotel Websites**

E-commerce is creating new and exciting opportunities for the global hoteling. Hotel and Internet companies are joining to tap the potential market created by e-commerce. Hotel service providers are increasingly joining the online platform to tap into the splurging customers in the Ecommerce market.

Here you can book rooms, seminar halls etc. on the globe through internet by use of computer systems and mobile phone apps. Followings are some links for international hotel booking websites

### **8.3.3 Freelancing Websites**

Freelance work is a form of self-employment, where an individual takes on contract work for a company or client. Often referred to as “contractors,” freelancers are not employees of any individual company and may work independently for several companies or clients at one time.

#### *xliv- Chose Freelance Websites*

To ensure that each freelance website on the following list is reliable and trustworthy, we’ve weighed in several factors, such as:

28. **Terms and conditions.** Chosen freelance websites have well-documented terms and conditions that protect both freelancers and employers on said platforms.
29. **Customer support.** Each freelance site provides customer support to guide users and resolve any disputes.
30. **Payment and withdrawal methods.** Local and global freelancers can receive payment from freelance websites through multiple options, such as bank transfers and electronic payments.

However, don't forget to double-check everything when applying for a job since there is always a possibility of being scammed.

### **A- Create an account on any freelancing website**

There are two ways you can sign up on Guru.

#### ***xliv- Method 1***

Create your Freelancer account using your **email**.

1. Click on "Sign Up."
2. Enter your full name, email and agree to our Terms of Service.
3. Select "Freelancer" as the account type.
4. Set a password.
5. Click on "Proceed."
6. Enter the security code received in your email inbox.
7. Click on "Verify" to create your account.

#### ***xliv- Method 2:***

Create your Freelancer account using **social login**.

1. Click on "Sign Up."
2. Choose from Facebook, LinkedIn or Google and log in with your credentials.
3. Select "Freelancer" as the account type.
4. Click on "Proceed" to create your account.

As next steps, we encourage you to build your Profile by adding services and portfolios. Within 24 hours, you will start receiving Job Matches relevant to the skills you add.

### **Activity-8.3: Create a travel booking on any online travel website**

The students are required to perform necessary steps for online booking of travel booking under the supervision of teacher/ instructor.

### **Activity-8.4: Create an account on any freelancing website**

The students are required to create an account online by use of freelancing techniques under the supervision of teacher/ instructor.

## **KEY POINTS**

1. A curriculum vitae (CV) is a marketing document that gives a summary of a job seeker's career history, academic qualifications and also explains their future potential.
2. A resume is an important tool for your job search because it offers a page or two where you can display your top skills and qualities.
3. A completed CV aims to impress recruiters and is sent as an application to jobs adverts or as a speculative approach to prospective companies.
4. Main components of CV are 1- Personal Detail, 2- Personal Statement/ Objective, 3- Education, 4- Employment History 5- Skills, 6- Achievements 7- Area of Interest.
5. Job portals or placement portals are the online platforms through which recruiters and job seekers are connected to each other.
6. A candidate just has to fill in the details like Qualification details, Experience, Personal details, Skills and CV.
7. When you look for jobs online, the most effective way to search is to use job keywords to find jobs in the career fields and industries you are interested in.
8. Electronic commerce is an emerging model of new selling and merchandising tools in which buyers are able to participate in all phases of a purchase decision, while stepping through those processes electronically rather than in a physical store or by phone (with a physical catalogue).
9. On-Line Catalogue is that catalogue where people access via the Internet.

## EXERCISE

### Multiple Choice Questions

**Q. No. 1: Tick mark ( ✓ ) on the correct option for the following MCQs.**

1. This is a component of CV:  
(A) Education                      (B) Skills  
(C) Areas of Interest              (D) All of these
  
2. One of the factors to ensure that each freelance website is reliable and trustworthy, it must have  
(A) Terms & Conditions              (B) Customer support  
(C) Transactions' methods              (D) All of these
  
3. Job portals collect data of:  
(A) Job seekers                      (B) Job Providers  
(C) Both a & b                      (D) None of these
  
4. This is an online travel service provider:  
(A) indriver                      (B) Air lift  
(C) Swvl                      (D) all of these
  
5. Recruiter can be in the form of:  
(A) Firm                      (B) Consultant  
(C) Agency                      (D) All of these
  
6. The online platforms through which recruiters and job seekers are connected to each other:  
  
(A) Job portals                      (B) placement portals

(C) both A & B                      (D) None of these

7. This one of the jobs portals in Pakistan:

- (A) Jobs.pk                              (B) Indeed.pk  
(C) RoziRoti.pk                      (D) All of these

8. This is the Pakistan Government's first job portal:

- (A) Rozee.pk                              (B) njp.gov.pk  
(C) jobs.pk                              (D) pakistanjobsbank.pk

9. These are involved in freelancing:

- (A) sellers                              (B) gigs  
(C) buyers                              (D) All of these

10. A curriculum vitae (CV) is a that gives a summary of a job seeker's career history, academic qualifications and also explains their future potential Recruiter can be in the form of:

- (A) academic document              (B) marketing document  
(C) history document                  (D) All of these

## Short Questions

### Short answer to the following question

1. What is a freelance
2. Define CV.
3. What are job portals?
4. How can you e-mail your CV to the recruiter?
5. Enlist 2 points for seeking job on job portal.

6. How travel in a city is booked.
7. What is meant by E-commerce?
8. Enlist main features of curriculum vitae.
9. Enlist steps for booking online room in a hotel.
10. How can we judge that the job portal is genuine.

## Long Questions

### **Answer of the following question in detail**

1. Explain E-commerce with the help of example of travel.
2. Explain structure of CV.
3. Write down the procedure to grasp a job on the job portal.
4. Explain E-commerce in terms of hotels.
5. Write down the importance of CV for seeking job.

## Glossary

**Bathroom:**

Means a room meant for bathing and washing designed in a building as such;

**Branch:**

Any part of the piping system other than the main, riser, or stack.

**Branch Vent:**

A vent connecting one or more individual vents with a vent stack.

**Brass:**

An ancient alloy, composed primarily of copper and zinc, used in the manufacture of faucets and other plumbing fittings. Small amounts of other alloying materials are also added for various types of brass to address the requirements of specific applications. Brass is also the term for a faucet finish, also known as polished brass.

**Building Drain:**

The part of the lowest piping of a drainage system that receives the discharge from soil, waste, or other drainage pipes inside the walls of the building (house) and conveys it to the building sewer beginning 3 feet outside the building wall.

**Cess Pool:**

Means a tank intended to receive waste water and sewage

**Copper:**

One of the basic elements (Cu), copper is used for plumbing piping, and is one of the alloys used to make brass, a key material in the manufacture of faucets and fittings.

**Drain:**

Any pipe that carries waste water or water-borne waste in a building (house) drainage system.

**Dual-Flush:**

A high-efficiency toilet that gives users the choice of flushing with the maximum amount of water allowed by law (1.6 gpf in the United States) or less water. The average amount of water used by the toilet cannot be more than 20 percent less than the maximum allowable, qualifying it to be considered high-efficiency and eligible for Water Sense labelling.

**Fitting:**

A device designed to control and guide the flow of water. Examples include faucets, shower heads, shutoff valves, shower valves, and drinking fountain spouts. Some people call these "fixtures," but that term means something different to the plumbing industry. The differing usage of "fitting vs.

fixtures" can lead to unintended consequences, such as when legislation calls for changes in fixtures, although the true intent involves changes in fittings. (See "Fixtures.")

**Fixture:**

A device for receiving water and/or waste matter that directs these substances into a sanitary drainage system. Examples include toilets, sinks, bathtubs, shower receptors, and water closet bowls. The term is used erroneously in common vernacular to describe fittings. (See "Fittings.")

**Flush valve:**

Located at the bottom of a toilet tank, the flush valve discharges the water from the tank into the bowl when the toilet is flushed.

**Foul Air:**

Includes exhaust air from lavatories, bathrooms, urinals, toilets, kitchens, canteens, chemical stores, restaurants, hair dresser shops, laboratories, dark rooms, battery room, car parks or similar areas and air discharged from smoke extract system associated with fire protection services of buildings;

**Gallons per flush (GPF or gpf):**

A measure of the total volume of water required to flush a water closet or urinal, measured in gallons.

**Gallons per minute (GPM or gpm):**

A measure of the rate at which water flows through a fixture or fitting at a certain pressure. It is measured by the number of gallons flowing from the device in one minute at a given water supply pressure.

**Kitchen:**

Means a room intended to be used wholly for preparing or cooking food for human consumption;

**Kitchenette:**

Means a small space for warming food on a floor having no kitchen;

**Lavatory:**

While sometimes used by the general public to mean a bathroom or washroom, the plumbing industry uses lavatory to mean a bathroom washbowl or basin permanently installed with running water. The plumbing industry uses the term "sink" in reference to kitchen sinks.

**Leach:**

In the case of plumbing systems, leaching refers to the process of dissolving a soluble component out of a constituent material at a wetted surface. Materials commonly leached into drinking water from water distribution systems include copper, lead, and nickel.

**Lead:**

One of the basic elements (Pb), lead is a soft metal that has been used in plumbing systems for thousands of years. The word "plumbing" derives from the Latin word for lead, plumbum. Lead has a unique ability to resist pinhole leaks, while being soft enough to form into shapes that deliver water most efficiently. Its softness and malleability were for a long time highly desirable properties for manufacturing everything from pipe to paint. Lead is a neurotoxin that can accumulate in the body in soft tissues, as well as bone.

**Metered toilets, or metered flush:**

A toilet with a mechanism that delivers a precise, non-variable amount of water with each flush.

**Plan:**

Means the building plans showing the proposed details of the arrangement of intended building uses /functions.

**Potable Water:**

Water that is satisfactory for drinking, culinary and domestic purposes. Water having no impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming in its bacteriological and chemical quality to the requirements of the Public Health Service drinking water standards or meeting the regulations of the public health authority having jurisdiction.

**P Trap:**

A trap with a vertical inlet and a horizontal outlet.

**Public Sewer:**

A common sewer directly controlled by public authority.

**Rain Water Pipe:**

Means a pipe (not being a drain) which conveys/ or carries only rain water; Sewerage and storm water drainage lines shall be laid separately and connected to respective sewerage system mains.

**Septic Tank:**

Means a system of chambers made of imperious material, intended for reception and treatment of sewage. OR A watertight receptacle that receives the discharge of a building's sanitary drain system or part thereof and is designed and constructed so as to separate solid from the liquid, digest

organic matter through a period of detention, and allow the liquids to discharge into the soil outside of the tank through a system of open-joint or perforated piping, or through a seepage pit.

**Sewerage System:**

A sewerage system comprises all piping, appurtenances, and treatment facilities used for the collection and disposal of sewage, except plumbing inside and in connection with buildings served and the building drain.

**Soak Pit:**

Means a pit filled with aggregate, boulders or brick bats and intended for the reception of waste water.

**Soil Pipe:**

Means a pipe for conveying foul water carrying human excreta to a sewer. It directs the sewage of a house to the receiving sewer, building drain, or building sewer.

**Soil Stack:**

The vertical piping that terminates in a roof vent and carries off the vapours of a plumbing system.

**Stack Vent:**

An extension of a solid or waste stack above the highest horizontal drain connected to the stack. Sometimes called a waste vent or a soil vent.

**Storm Sewer:**

A sewer used for conveying rain water, surface water, condensate, cooling water, or similar liquid waste.

**Toilet:**

Means a space for washing up and dressing purpose and may include urinals and water closets.

**Trap:**

A trap is a fitting or device that provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or waste water through it.

**Valve:**

A fitting with a movable part that opens or closes one or more passages and thereby allows a liquid flow to be started, stopped, and regulated. In plumbing, valves are used in faucets and showers, and can be called mixing valves because they control the mix of hot and cold water to achieve desired water temperatures.

**Vent Stack:**

The vertical vent pipe installed to provide air circulation to and from the drainage system and that extends through one or more stories.

**Ventilating Pipe:**

Means a pipe open to the external air at its highest point, which ventilates a drainage or a sewage system or part thereof and does not convey / carry any soil water, waste water or rain water.

**Vitreous China:**

A type of pottery most commonly used for plumbing fixtures, such as toilets. It is a compound of ceramic materials fired at a high temperature to form a nonporous body. Exposed surfaces are coated with a ceramic glaze that fuses to the China when fired and gives vitreous China plumbing fixtures their colours and glossy appearance.

**Waste Water:**

Means used water not being soil water.

**Water Closet (W.C):**

Means a fixture which is connected to a sanitary system so that the excreta may be carried away by flushing and may also refer to an enclosure containing such a fixture; and connected to respective CDA mains.

**Water Hammer:**

The loud thump of water in a pipe when a valve or faucet is suddenly closed.

**Water Service Pipe:**

The pipe from the water main or other sources of potable water supply to the water-distributing system of the building served.

**Water Supply System:**

The water supply system consists of the water service pipe, the water-distributing pipes, the necessary connecting pipes, fittings, control valves, and all appurtenances in or adjacent to the building or premises.

## Answers to the Multiple-choice Questions (9<sup>th</sup> Class-Book-II)

### Chapter No. 1

1	A	2	D	3	B	4	C	5	B
6	D	7	B	8	B	9	C	10	B

### Chapter No. 2

1	D	2	C	3	C	4	D	5	D
6	D	7	C	8	B	9	A	10	C

### Chapter No. 3

1	D	2	D	3	C	4	A	5	C
6	B	7	B	8	C	9	C	10	D

### Chapter No. 4

1	A	2	D	3	D	4	C	5	B
6	B	7	S	8	C	9	C	10	A

### Chapter No. 5

1	B	2	B	3	C	4	A	5	B
6	A	7	B	8	C	9	B	10	B

### Chapter No. 6

1	A	2	A	3	A	4	D	5	B
6	C	7	D	8	A	9	D	10	A

### Chapter No. 7

1	D	2	C	3	C	4	B	5	B
6	B	7	C	8	B	9	C	10	D

### Chapter No. 8

1	D	2	D	3	B	4	D	5	D
6	C	7	D	8	B	9	D	10	B

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