

CHAPTER 2: RAINWATER HARVEST AND DISPOSAL

Unit of learning code CON/CU/PL/CR/02/5/A

Related Unit of Competency in Occupational Standard; Install rainwater harvesting and disposal

2.1 Introduction to the unit of learning

This unit specifies the competencies required to harvest and dispose rain water. It involves preparing working drawings, quantifying materials and costing, using tools and equipment, installing rain water goods, testing rainwater goods and harvesting / disposing rainwater. It applies in the construction industry.

2.2 Summary of Learning Outcomes

1. Prepare working drawings
2. Quantify materials
3. Use tools and equipment
4. Install rainwater goods
5. Test rainwater goods

2.2.1. Learning Outcome 1: Prepare working drawings

2.2.1.1. Introduction to the learning outcome

This learning outcome specifies the competencies required to prepare working drawings for rain water harvesting and disposal. It involves preparing working drawings like pictorial, isometric, line, freehand sketching and also conversion of measurements, interpretation of symbols on rainwater goods and harvesting / disposing rainwater as it applies in the construction industry.

2.2.1.2. Performance Standard

- 1.1 Drawings are identified and selected based on the job.
- 1.2 Scale of the drawing is determined based on the specifications.
- 1.3 Measurements are converted based on scale.
- 1.4 Symbols are identified based on standard practices.
- 1.5 Isometric pipework drawings are sketched based on drawings.

1.6 Simple working drawings are produced based on specifications.

2.2.1.3. Information Sheet

- **Terms and Concepts**

Working drawing; is a drawing or blueprint based on explanations. It is completed with a thorough plan and views (details, notes, and dimensions) to ensure the product construction or replication without any additional information.

This is a scale drawing which serves as a guide for the construction of a building or for the fabrication of a component. It provides dimensions and graphical information that will be used during construction of a building or fabrication of a component.

There are different types of working drawings:

- i **Pictorial drawing**
- ii **Isometric Drawing**
- iii **Oblique Drawing**
- iv **Perspective Drawing**
- v **Line Drawing**
- vi **Plans**

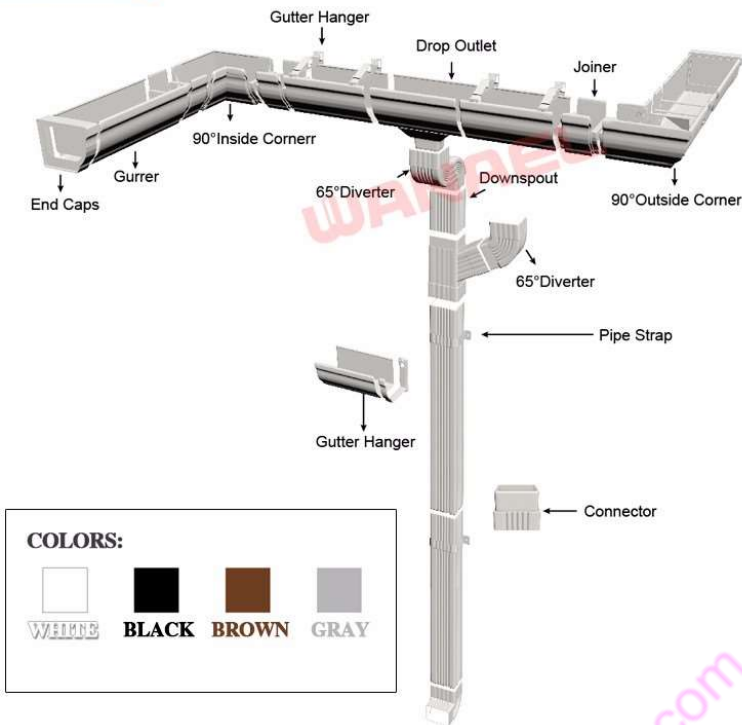
Pictorial drawing; looks very much like isometric drawing but it does not include any measurement.

Isometric drawing; is the first subcategory of pictorial drawing. Isometric drawings project all sides of a three-dimensional object in a non-foreshortened way. It is based on 30° angles and the same scale is used for all axes.

A Plumbing Isometric drawing is the plumbing drawing scheme and will show the pipes length and direction, pipe fittings, and fixtures at a 30° angle.

An isometric drawing will also depict all components and give details even on the method of connection.

Structure Diagram



Oblique drawing; depicts the front view of a 3D object with the sidelines emerging at a 45° angle from the front side to the back. Opposing isometric drawing, oblique drawing doesn't depict an object with an edge in the foreground.

Perspective drawing; is a drawing technique that allows the artist to project three-dimensional objects as a human would actually see them. This method always includes lines converging into one or up to six so-called vanishing points

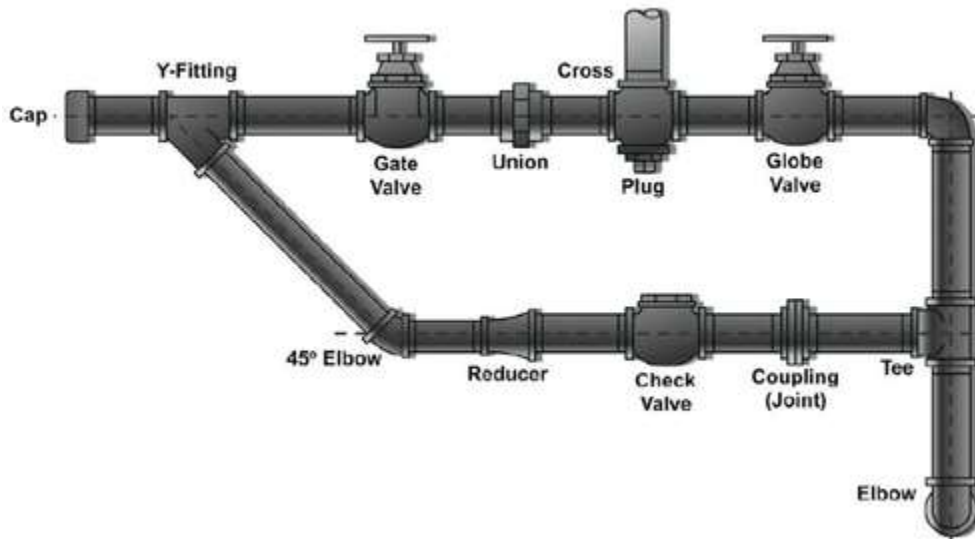


Figure 129: Perspective drawing

Line drawing;

There are different ways in which line drawings can be done.

2.2.2.1. Line drawings can be done using the measuring instruments as depicted

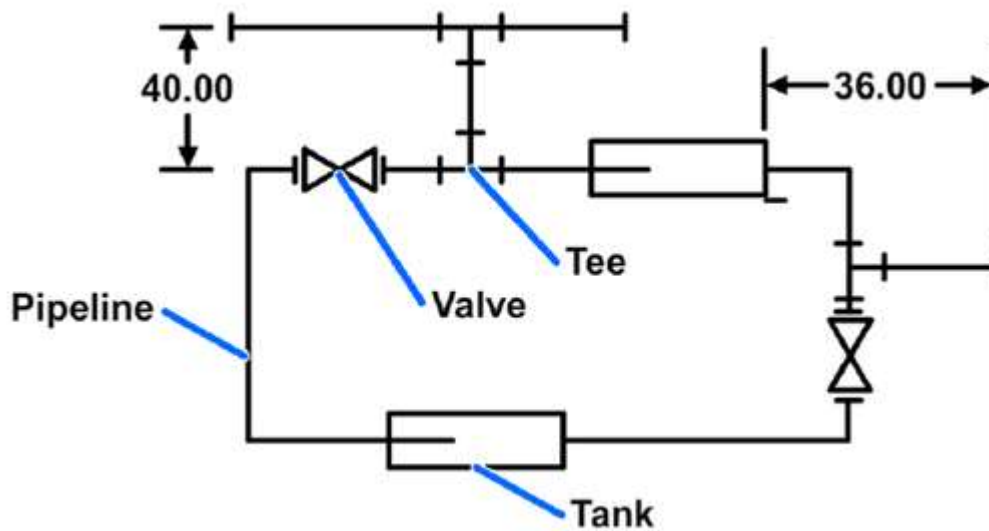


Figure 130: line drawing

2.2.2.2. Free Hand Sketching

Freehand sketching; Freehand drawing is done on many occasions: to explain a piece of design quickly to a colleague and to develop a design. A **free hand sketch** is drawn without measuring instruments. This drawing is drawn with the help of pencil and eraser only. Such drawing is drawn before every type of actual drawing because it takes less time. Then the actual drawing is prepared.

Free hand sketches are commonly used to easily explain a plumbing concept on site.

Principles of Free Hand Sketching.

Following principles should be followed for free hand sketching:

1. The object should be seen thoroughly and pondered over its objectives and concepts.
2. More detailed aspect is considered for selection of a view.
3. Space is specified on a drawing sheet according to the sizes of views.
4. Firstly, the dim lines are drawn so that extra lines may be erased easily.
5. Scale and ruler are not used in drawing, although, ratio and proportion of different parts of an object are considered.
6. Firstly, horizontal lines are drawn then vertical lines are drawn, and arcs and circles are drawn lastly.

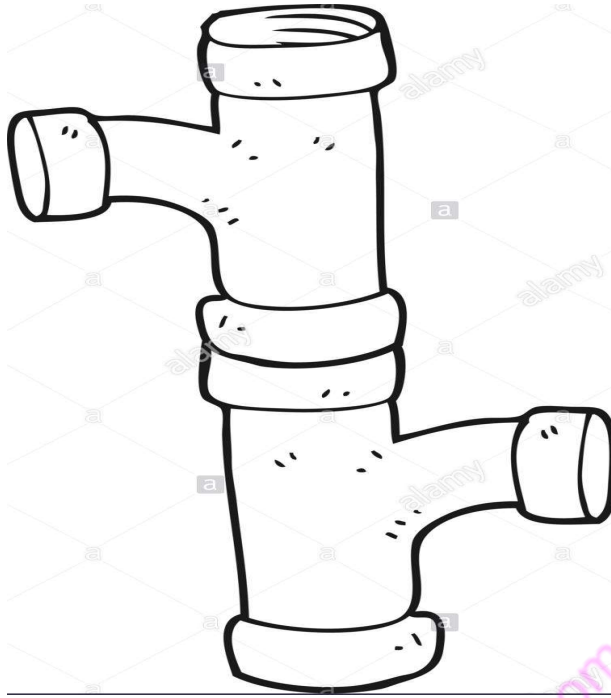


Figure 131: Free hand sketch of a pipe and pipe fittings

Except for the freehand sketches, all other working drawings will be done using the drawing instruments. Scaling will be very important since different scales will be used to adjust the actual measurement of a project to fit into a paper

Purpose of a scale drawing

Scale drawings are a useful tool for any designer, because they can be used to plan, visualize and adjust landscape plans before breaking ground. Scale drawings assign each object the same scale compared to the actual objects

Types of scale






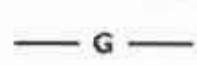
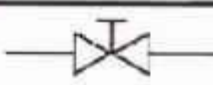







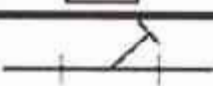
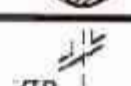
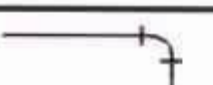
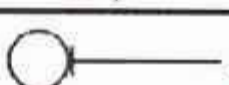




There are Four Scales of Measurement. nominal, ordinal, interval or ratio. Each level of measurement has some important properties that are useful to know. For example, only the ratio scale has meaningful zeros

Symbol

Symbols will be used in Plumbing working drawings to represent different elements.

Plumbing symbols are used when drawing house plans are being designed. The purpose of these symbols is to indicate where the different elements of your plumbing system are located.

It is necessary for the trainee to understand the different plumbing components and their subsequent symbols. Some examples of Plumbing symbols are illustrated on the table below.

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

2.2.1.4. Learning Activities

Practical Activity

Using the knowledge on Plumbing Symbols, study the Architectural drawing given and identify the different types of sanitary appliances represented.

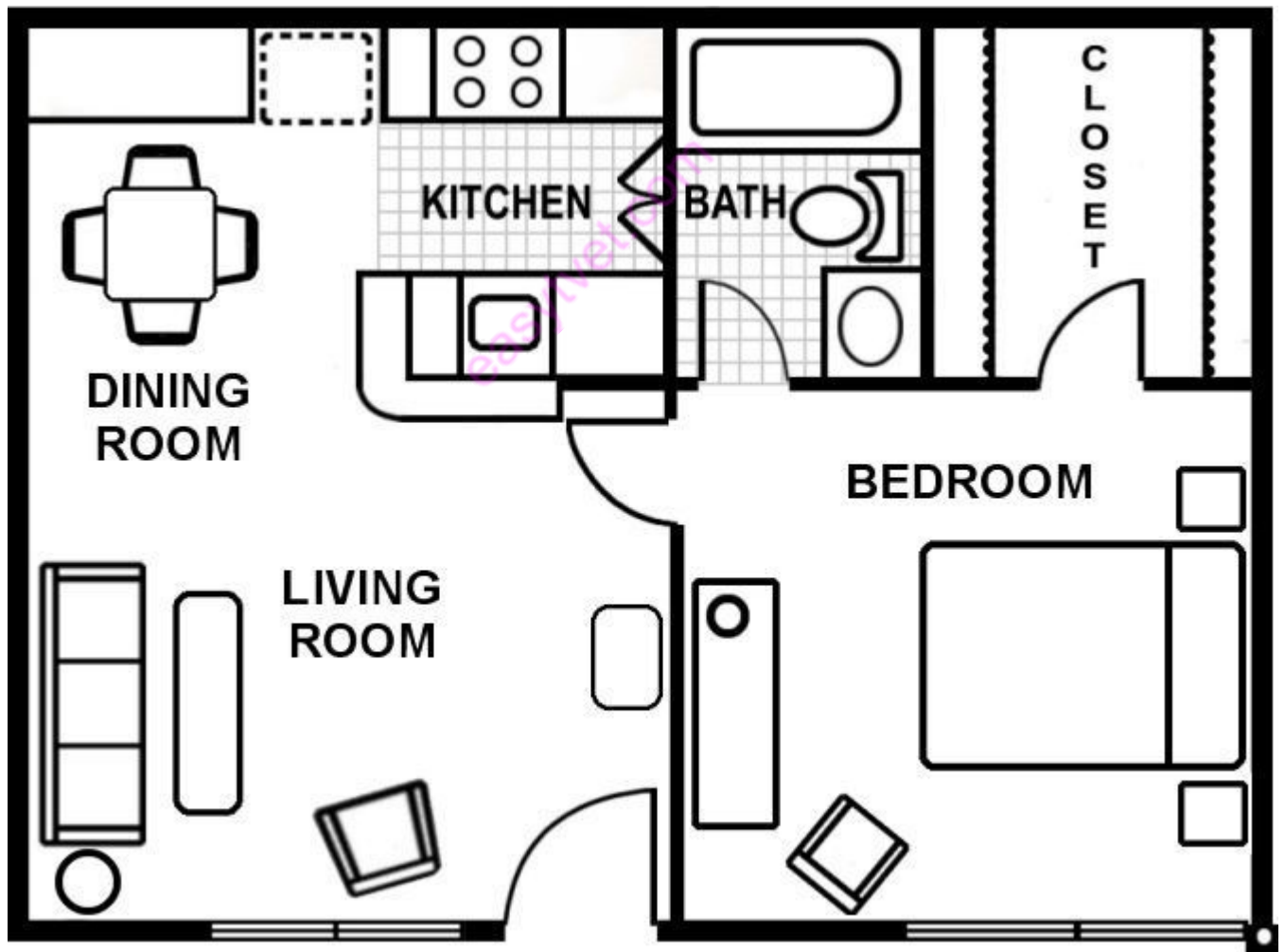


Figure 132: Floor Plan

2.2.1.5. Self-Assessment

6. Define a plumbing layout.
2. What are the THREE functions of building drawings?
3. Why is it appropriate to supply the manufacturer with the engineering drawing?
4. What are rainwater goods parts?
5. In which blueprint would you find specifications on what type of rainwater goods to use?

2.2.1.6. Tools, Equipment, Supplies and Materials

Tools/Equipment:	Materials:
<ul style="list-style-type: none">• Drawing boards• T square• Set square• Blueprint machine/printer• Steel rule• Scale rule• Compass & Dividers• Protractor• Erasers	<ul style="list-style-type: none">• Drawing papers• Drawing pencils• Drawing sets• Masking tape• Construction drawings• Classroom and classroom resources• Manufacturer's drawings

2.2.1.7. References

- Black & Decker (2008). *The Complete Guide to Plumbing (4th ed)*. Minneapolis: Creative Publishing international, Inc. Retrieved from <https://www.pdfdrive.com/>
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2.2.1.8. Model Answers

1. Define a plumbing layout?

The plumbing layout is usually drawn into a copy of the floor plan for proper orientation with existing plumbing fixtures, walls and partition outlines, and other utility features.

2. What are the THREE functions of building drawings?

- to develop a design idea into a coherent proposal,
- to communicate ideas and concepts,
- to convince clients of the merits of a design,
- to enable a building contractor to construct it,
- as a record of the completed work.

3. Why is it appropriate to supply the manufacturer with the engineering drawing?

Engineering drawings are extremely important as they provide a plethora of information to the manufacturer, including:

- Type of material required for manufacturing and supply
- Detailed product dimensions
- Surface and cosmetic finishes
- Welding information
- Hardware requirements

4. What are rainwater goods parts?

There are really only two main toilet tank parts: The toilet flush valve, which lets water gush into the bowl during the flush, and the fill valve, which lets water refill the tank after the flush. When a toilet runs constantly or intermittently, one of these valves is usually at fault.

5. In which blueprint would you find specifications on what type of rainwater goods to use?

- Plumbing and Sanitary Drawings
- Mechanical drawing

2.2.2. Learning Outcome 2: Quantify and cost materials

2.2.2.1. Introduction to the learning outcome

This outcome specifies the competencies required to quantify and cost materials for rainwater harvesting and disposal. It involves, identifying materials, quantifying and costing during harvesting and disposal of rainwater. Costing of materials is a key concept in the construction industry.

2.2.2.2. Performance Standard

1. Materials are classified based on specifications
2. Materials are estimated and costed as per the market rate
3. Materials schedule are prepared based on best practice
4. Supplies are identified based on specification

2.2.2.3. Information Sheet

Rain water disposal refers to the mechanism of collection and disposal of rain water from the roofs to a storage vessel or directed to a storm drain. There are different materials that can be used for rain water disposal.

- P.V.C Plastics
- Metals. There are two categories of metals. Ferrous Metals and non-ferrous metals. Ferrous metals contain a percentage of iron in them e.g cast iron and steel whereas non-ferrous metals do not contain iron. E.g Aluminium and zinc.
- UPVC ; Plastic is most affordable upfront and quality has improved dramatically, with better seals and more attractive profiles.
- Cupper
- Glass reinforced polyester (GRP)

Rain water components

These are parts of the rainwater disposal system that are inter-connected during water harvesting;

- Gutters
- Gutter unions
- Gutter clips
- Gutter outlets
- Stop ends

- Swan necks
- Down pipes
- Down pipe unions
- Down pipe clips

Others include;



Figure 133: Rainwater components

Factors affecting gutters performance

- Drainage Area. This refers to the sum of the areas of each of your roof's surface.
- Roof Pitch. This will also determine the amount of rainwater it can collect.
- Gutter Pitch. The standard gutter pitch is a quarter-inch drop for every 10 feet.
- Gutter Material.
- Gutter Condition.
- Quality of Installation.

Factors to Consider When Choosing Gutter Sizes

Your Local Climate. One of the biggest factors when picking the right gutter size is your local climate.

The Pitch of The Roof. Your ideal gutter size is also affected by the slope of your roof.

The Size of Your Roof. A low-pitched roof may still require a bigger gutter option if it's large enough.

The Gutter Style.

How to choose rainwater goods material

The rainwater good material chosen depends on the application, water quality and amount of the anticipated rainfall.

Materials are selected based on the following specifications

- Manufacturer's specification
- Clients' specifications based on economic and ergonomic factors
- Standard specifications; these are from the industrial experts i.e., experienced

How is rainwater downpipe calculated?

To calculate the minimum number of downpipes, divide the roof catchment area by the allowable maximum catchment per downpipe. To calculate the average catchment per downpipe, divide the roof catchment area by the number of downpipes.

How to create a schedule of materials using a drawing.

You can opt to use one of either method while creating the schedule of material;

- Using a cutting list: this is where all the material required are broken down and the units put in a table.

2.2.2.4. Learning Activities

To cover:

- Prepare the schedule of material for the rainwater goods if the height of the building is 3m from the ground level. Assume any other relevant information from the figure below:



2.2.2.5. Self-Assessment

- 1) Which materials are used for water supply and drain pipes?
- 2) What is the difference between plumbing and sanitary?
- 3) What is difference between drainage and sewage?
- 4) What are the FIVE general installation requirements for pipe work in water goods?

2.2.2.6. Tools, Equipment, Supplies and Materials

Tools/Equipment:	Materials:
<ul style="list-style-type: none">• Plumb bob• Measuring tools (Tape measure, infra-red light, rule etc.)• Marking tools• Cutting tools• Fastening tools• files• Wire brushes• Holding tools• Drilling equipment	<ul style="list-style-type: none">• Hardhat• Gloves• Dustcoat / overall• Safety shoes / boots• Pipes• Gutters• Pipe fittings• Accessory• Adhesives• Sealant

2.2.2.7. References

Black & Decker (2008). *The Complete Guide to Plumbing (4th ed)*. Minneapolis:

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Chudley, R.G (1988). *Building Construction Handbook (4th ed)*. MA: Reed Educational and Professional Publishing Ltd.

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2.2.2.9. MODEL ANSWERS

1) Which materials are used for water supply and drain pipes?

- Cast iron, PVC, and ABS for plumbing waste (drain) lines.
- Chromed brass, copper, galvanized iron, CPVC, and PEX for water supply lines

2) What is the difference between plumbing and sanitary?

Plumbing is a controlled system of conveyance of water in a fitted and regulated line. Sanitary systems consist of an assembly of pipes, fixtures, and fittings which gather and directs sewage to the drainage system and from there it is drained to the sewer.

3) What is difference between drainage and sewage?

A drain is a pipe that serves only one building, conveying water and waste water away to a sewer. Sewers (sewerage), are the underground networks of pipes that carry sewage (waste water and excrement), waste water and surface water run-off, from drains to treatment facilities or disposal points

4) What are the FIVE general installation requirements for pipe work in water goods?

- Comply with the durability requirement.
- Be compatible with the support.
- Be installed to allow for thermal movement.
- Be protected from damage.
- Be protected from freezing by insulation.
- Be wrapped in flexible material or sleeved when penetrating masonry/concrete.

2.2.3. Learning Outcome 3:Use tools and equipment

2.2.3.1. Introduction To The Learning Outcome

This learning outcome specifies the competencies required in the use of tools and equipment. It involves, identifying and use of correct tool and equipment during standard installation of the rainwater harvesting and disposal system as it applies in the construction industry.

2.2.3.2. Performance Standard

1. Personal Protective Equipment is used in line with occupational safety and health requirements
2. Rainwater goods tools and equipment are identified based on the requirements of the job.
3. Rainwater goods tools and equipment are used based on manufacturer's instructions.
4. Rainwater goods tools and equipment are cared for and maintained based on manufacturer's manual and workplace place policy.
5. Rainwater goods tools and equipment are stored based on manufacturer's instructions

2.2.3.3. Information Sheet

Tools for Fixing Rainwater Pipes

Tools are essential for proper pipe works, roof works and other construction works.

There are various types of tools used for fixing rai.

1. Plier: it is a handy tool primarily used for gripping and cutting. It is a common tool for many handy trades and occupations.



Figure 134: plier

2. Parrot Plier: it is another shape of plier.



Figure 135: parrot plier

3. Spanner Set: it is a tool usually operated by hand to tighten bolts and nuts.



Figure 136:Spanners

4. Pipe Wrench: A pipe wrench is a tool with two serrated jaws, one adjustable for gripping and turning pipe and the other is fixed.

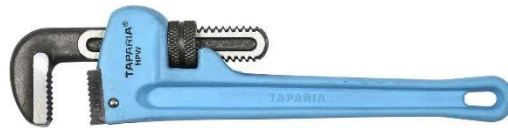


Figure 137: Pipe wrench

5. Adjustable Wrench: This wrench has an adjustable head to fit into various sizes of nuts and bolts. The wrench can be fitted into fasteners of different sizes.



Figure 138: Adjustable spanner

6. Chain Wrench: it is used for turning large pipes. An adjustable chain circles the pipe with its ends connected to the head whose teeth engage the pipe.



Figure 139: Chain wrench

7. File: it is used to sharpen/grind the pipe.



Figure 140: File

8. Pipe Vice: the vice is used for gripping the pipe.



Figure 141: Pipe vice

9. Hand Hacksaw: it is used for cutting the guttering components. Some hacksaws have pistol grips which keep hacksaw firm and easy in grip. It is used to cut in straight lines also.



Figure 142: Hacksaw

11. Tap Wrench: Tap wrench is a handy tool to operate any small tool that has a square driving head as a part of its body. These are usually cutting tools. Other small handy tools such as hand hammer might employ a tap wrench.



Figure 143: Tap Wrench

12. Measuring Tape: Measuring tape is a ribbon of cloth, plastic or metal with linear measure markings.



Figure 144: Tape measure

13. Calipers: it is an instrument used to measure the diameter of any object.



Figure 145: Calipers

14. Hammer: it is a handy tool with heavy rigid head and a handle used to deliver an impulsive force by striking.



Figure 146:Hammer

15. Steel Rule: it is a flat, linear measuring instrument having different levels of graduations such as $1/4$, $1/8$, $1/16$, $1/32$ and $1/64$ for standard inch and 1 or 0.5 mm for metric.



Figure 147:Steel rule

16. Trowel: it is a small handy tool with a handle and flat metal blade which is used for digging, spreading plaster or similar materials.



Figure 148: Trowel

17. Screw Driver: it is a tool used for driving screws into their places. It has a thin end which enters the nick in the head of screw.



Figure 149: Screw driver

18. Try Square: it is a tool used for marking and measuring a piece of wood. Square refers to the primary use of tool. It measures accuracy of a right angle. It is a piece of wood; that is rectangular, flat having all edges (faces, sides, ends) at 90 degrees.



Figure 150: Tri square

19. Bench Vice: it is a holding device attached to workbench which has two jaws to hold work piece firmly in place.



Figure 151: Bench vice

20. Chisel: it is a tool used for cutting a hard material such as wood, stone or metal. It is typically made of hard/tempered steel. It is rarely made of common steel which consists of a sharp end (called the blade) attached to a straight handle. The handle and blade of some chisels are made of one piece.



Figure 152: Chisel

21. Spirit Level: A spirit level is an instrument designed to indicate whether a surface is leveled or not.



Figure 153: Spirit Level

22. Caulking Tools: A spigot and socket joint in which the joining material such as lead is compacted by means of caulking tool and hammer.



Figure 154: Caulking tool

23. Ratchet Brace: Ratchet brace is equipped with a four-jaw chuck suitable for bit stock, round or hex shanks.



Figure 155: Ratchet Brace

Personal Protective Equipment

Safety Equipment, as implied by its name, includes the gadgets that are used (worn, used) for the protection of life and to avoid injuries or casualties. Generally, safety equipment is the protection that is used by workers to avoid injuries, casualties, life threatening situations etc They include but not limited to;

- protective clothing,

- helmets,
- gloves
- face shields,
- goggles,
- facemasks and/or respirators or other equipment designed to protect the wearer from injury or the spread of infection or illness.

EQUIPMENT MAINTENANCE

It includes routine upkeep as well as corrective repair work. Equipment may include heavy workshop machines.

Types of maintenance

There 4 general types of maintenance; corrective, preventive, risk-based and condition-based maintenance.

1. **Corrective maintenance;** Maintenance is carried out following detection of an anomaly and aimed at restoring normal operating conditions.
2. **Preventive maintenance;** Maintenance carried out at predetermined intervals or according to prescribed criteria, aimed at reducing the failure risk or performance degradation of the equipment.
3. **Risk-based maintenance;** Maintenance carried out by integrating analysis, measurement and periodic test activities to standard preventive maintenance
4. **Condition-based maintenance;** Maintenance based on the equipment performance monitoring and the control of the corrective actions taken as a result.

Why is it important to use the correct tools and equipment?

Each tool is precisely designed for a specific purpose, so choosing the correct tool will also decrease the amount of effort required to get a job done right without causing damage to either the equipment or the surface being worked on

Tools and equipment storage

Why should tools and equipment be securely stored?

You are responsible for making sure that all tools and equipment are well organized and maintained in good working condition. They should be stored in a separate secure place so that they are safe and easy to find. This is usually best done in a place which is separate from the office.

Proper storage of tools and equipment

Section a space on your building and make it a storage place for tools.

Tools Preparation and Storage

Preparation

- Clean tools after each use
- Repair any broken parts
- Defective tools must be isolated
- Use metal protectant spray on all metal parts
- Never store tools on the unprepared ground
- Get creative with storage options the heavy ones near/on the prepared raised ground and the lighter ones on top
- Make a list of all items that are stored

Storage

To keep these tools safe and in good working condition, it's better to keep them in and not limited to:

- Tool Store
- Racks
- Cabinets
- Drawers
- Pegs on wall
- Shelves
- Tool boxes

Make sure to label the boxes with its contents so you will be able to find the tool when you need it. Keep an inventory list of the tools that you have and where they are stored.



Figure 156: pegging on wall



3. Tool Rack

These are wall-mounted or free-standing units that may be designed for specific tool types, or suitable for general use. Tool racks are used to store and organize tools in an exposed manner so that tools are easy to identify, retrieve, and return.



4. TOOL BOX

This is a box or container in which one keeps or carries tools especially those used for a particular task.



2.2.3.4. Learning Activities

1. You are required to visit a site and identify
 - a) The different ways of care and maintenance done to their tools
 - b) Methods of workplace safety applied
 - c) The different methods of storage of tools

2.2.3.5. Self-Assessment

- 1) Types of personal protective equipment (PPE) to guarantee your safety
- 2) What is the importance of tools in plumbing?
- 3) What tools do plumbers use to unclog drains?
- 4) Which material will you use to threaded pipe connection to prevent leakage?
- 5) What is a tool often kept on a plumber's tool belt? It is used to take and make measurements.
- 6) What materials can sanitary appliances be made from?
- 7) What is a sanitary connection?
- 8) I need to cut a new piece of copper pipe for the supply run to my sink. What are the best tools and techniques to use?

- 9) We want to add a second sink in the master bathroom. Can we extend the pipes that are already there?

2.2.3.6. Tools, Equipment, Supplies And Materials

Tools/Equipment:	Materials:
<ul style="list-style-type: none"> • Measuring tools • Hacksaw • Bench-vice • Tin Snips • Files • Scribes • Screwdrivers • Mallets • Blowlamp 	<ul style="list-style-type: none"> • Hardhat • Gloves • Dustcoat / overall • Safety shoes / boots • Gutters • Assorted gutter connectors • Adhesives • Sealant • Soldering sticks & Soldering flux

2.2.3.7. References (Motivate series Plumbing)

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<https://makezine.com/2016/08/18/25-brilliant-tool-storage-solutions/>

2.2.3.8. Model Answers

1) Types of personal protective equipment (PPE) to guarantee your safety

- Safety for the head. Wearing a helmet offers protection and can prevent head injuries.
- Protect your eyes.
- Hearing protection.
- Maintain a good respiration.
- Protect your hands with the right gloves.
- Protection for the feet.
- Wear the correct work clothing

2) What is the importance of tools in plumbing?

A plumber requires several tools for the fitting work for plumbing, fixing a tap or to carryout repairs. These tools help the plumber in performing his/her work properly, and therefore it is important that the tools are used systematically and handled carefully to avoid any damage

3) What tools do plumbers use to unclog drains?

To dislodge clogs located farther down the drainpipe, use a cable auger, or plumber's snake, a long, flexible steel cable wound around a spool that's fitted with a hand crank

4) Which material will you use to threaded pipe connection to prevent leakage?

- Teflon tape

5) What is a tool often kept on a plumber's tool belt? It is used to take and make measurements.

- Tape measure

6) What materials can sanitary appliances be made from?

Can made from a wide range of materials, including metals, acrylics, glass, and so on, and 'sanitaryware' is sometimes now interpreted to include a wider range of appliances that might be found in sanitary installations such as baths, showers, bins, incinerators, macerators, and so on.

7) What is a sanitary connection?

Like regular fittings, sanitary fittings connect sections of piping systems to regulate the flow of fluid, but sanitary fittings are specially designed and made to prevent the entrapment, formation, and spread of bacteria in the piping system.

8) I need to cut a new piece of copper pipe for the supply run to my sink. What are the best tools and techniques to use?

It's best to use a pipe cutter with a specially designed blade for copper pipe. You can also use a fine-toothed hacksaw, but making a straight cut with it is more difficult. After you've cut the pipe, clean off any burrs (inside or out) with a half-round file.

9) We want to add a second sink in the master bathroom. Can we extend the pipes that are already there?

Yes. You'll need to tap into the existing supply, drain, and vent pipes, run new piping to the desired location, and hook up the new fixture.

2.2.4. Learning Outcome 4: Install rain water goods

2.2.4.1. Introduction to the learning outcome

This outcome specifies the competencies required to install rain water goods. It involves, identifying and use of correct tool and equipment for the correct tool during standard installation of rain water goods in buildings as it applies in the construction industry.

2.2.4.2. Performance Standard

4.1 Types of water harvesting methods are identified based on the local authority by- laws

4.2 Types of rain water disposal methods are identified based on the local authority by- laws

4.3 **Rainwater goods** are identified based on the drawing

4.4 Measurements are taken and marking out is done based on the drawing

4.5 Material is cut based on drawings.

4.6 Pieces are jointed based on specifications

4.7 Pieces are assembled based on working drawing

2.2.4.3. Information Sheet

Rainwater Harvesting – is a technology used to collect, convey, and store rainwater from relatively clean surfaces like the roof, rock catchment, or land surface – essentially for later use. This collected rainwater is either directed to recharge groundwater or stored in a rainwater tank.

Methods of Rainwater Harvesting

- Surface Runoff Harvesting. In urban areas, rainwater flows away as surface runoff.
- Rooftop Rainwater Harvesting. It is a system of catching rainwater where it falls.
- Catchment.
- Transportation.
- First Flush.
- Filter.
- Storage of Direct Use.
- Recharging Groundwater Aquifers

Gutter Installation Steps

1. Make a plan; for the rainwater goods to be installed
2. Set a budget; for all materials you need
3. Cover the basis of the project; ensure you have all you require before you start your installation.
4. Prepare your fascia and soffits; perform a thorough inspection of the fascia and soffits. Look for chipped, cracked, or peeling paint, as well as wood rot or missing pieces.
5. Get a helping hand; this is your helper

6. Direct your drainage; ensure you install you with a slight angle for water to drain toward the downspouts and out to the yard.

7. Measure twice, cut once; this is to avoid wastage of materials.

NOTE; when in doubt then consult the experts to avoid double purchase of materials.

How to install rainwater goods

1. Before starting work, identify position of drain, run a plumb-line and fix gutter outlet. Check fascia is level.

2. Fix support bracket at furthest end and run a string-line to the outlet.

3. From outlet, fix support brackets at a maximum of one metre centres.

4. Insert gutter to the 'insert to here' line on the first fitting. At the other end of the gutter mark the position of the next fitting on the fascia.

5. Remove gutter and fix next fitting using your mark line. Ensuring fittings are level by using a string line.

6. Fit length of gutter and stopend, with support bracket at furthest end.

7. Fit top offset bend to outlet, then using bottom offset determine length of pipe required.

8. Fit a pipe clip below the bottom offset, then at a maximum of two metres apart.

9. Check water tightness by blocking off any outlet and performing a static water test.

Types of Rainwater Harvesting Systems

1. **Water Butt**; One of the most basic types of rainwater harvesting systems; water Butt collects rainwater in a container from natural rainfall and/or drain pipes. The collected water is used mainly for laundry services and watering the garden.

2. **Direct-Pumped**; there two categories

Submersible – Used particularly in domestic settings and is the easiest systems to install. The pump is placed within the underground tank and the harvested water is pumped directly to WCs or other appliances used daily for domestic purposes.

Suction – In this system, the pump is located within the control unit of the house (e.g. utility room). This unit also deals with backup from the mains water supply, hence there is no need to direct mains water down to the underground tank.

Most rainwater harvesting systems need pumps to transfer the collected rainwater from storage tanks to the point of use. Submersible pumps are generally more efficient than suction pumps and do not suffer from the same limitations.

3. **Indirect Pumped;** This type of rainwater harvesting system doesn't rely on gravity to supply water to the outlets. Instead, it pumps the harvested water to a tank which can be at any level in the building. Furthermore, a booster pump is used to provide a pressurized water supply. One of the most significant benefits of this system is that it offers great flexibility to tailor the booster pumps to adjust the flow and pressure requirements of a building.

4. **Indirect Gravity;** This system ensures water is supplied to the outlets by gravity alone. For this, the harvested water is first pumped to the header tank, i.e. high-level tank and then allowed to free-flow. In Indirect gravity systems, the pump works only to fill the header tank.

5. **Gravity Only;** In few conditions, a system which functions purely through gravity may be needed. Such systems do not demand pumps hence involves no energy use. With such an arrangement, water can be collected only when collection tanks are located below the level of gutters, yet higher than the outlets which it will supply. Here the only power of gravity is needed to feed collected and harvested water to various parts of the household. Gravity only is one of the most energy-efficient rainwater harvesting systems.

6. **Retention Ponds;** Retention ponds are used to collect surface runoff water and improve the quality of water by natural processes like sedimentation, decomposition, solar disinfection, and soil filtration. This type of pond normally has a mud bottom, but in some cases, it may be lined with concrete. The most common use of water collected and harvested by pond harvesting is watering livestock, however, it can also be used for groundwater recharge, irrigation or any other purpose other than potable uses.

7. **In-Ground Storage;** Underground storage tanks are very popular in areas where the majority of rainfall occurs in one single season. These underground tanks are insulated and have a very low rate of evaporation. In addition, the water stored in these doesn't freeze if it is buried below the frost line, this is a huge advantage that surface storage tanks do not offer. Underground

tanks need to be connected to an electric pump to ensure supply of the stored water to the outlets

Methods of Rainwater Harvesting

- Surface Runoff Harvesting. In urban areas, rainwater flows away as surface runoff. ...
- Rooftop Rainwater Harvesting. It is a system of catching rainwater where it falls at the coverings then it is stored in the underground tanks
- Catchment.
- Transportation.
- First Flush.
- Filter.
- Storage of Direct Use.

Roof top rainwater harvesting



Figure 157: Roof rainwater harvesting

Common gutter and downpipe problems on buildings

- **Blocked gutters;** Check for a build-up of leaves, silt and slate debris, as these can often lead to vegetation growth and block up guttering.



Figure 158: blocked gutters

- **Blocked downpipes;** Look for water backing up into the gutter, the gutter overflowing or water forced out of downpipe joints in heavy rain. Water trapped in blocked downpipes can freeze causing the cast iron to split open.



Figure 159: Blocked downpipes

- **Blocked gulley's;** Ensure any open gulley traps at ground level are free from debris, plant growth and gravel. Check there are no blockages in the underground drainage system.
- **Broken Gutter brackets;** Check to see if there are any broken or loose gutter brackets, possibly putting the gutter out of alignment.



Figure 160: gutter brackets

•**Downpipe brackets;** Check for broken, loose or missing brackets possibly causing downpipes to disconnect at the joints. Look for water staining and algae growth on the wall behind joints and down the pipe.

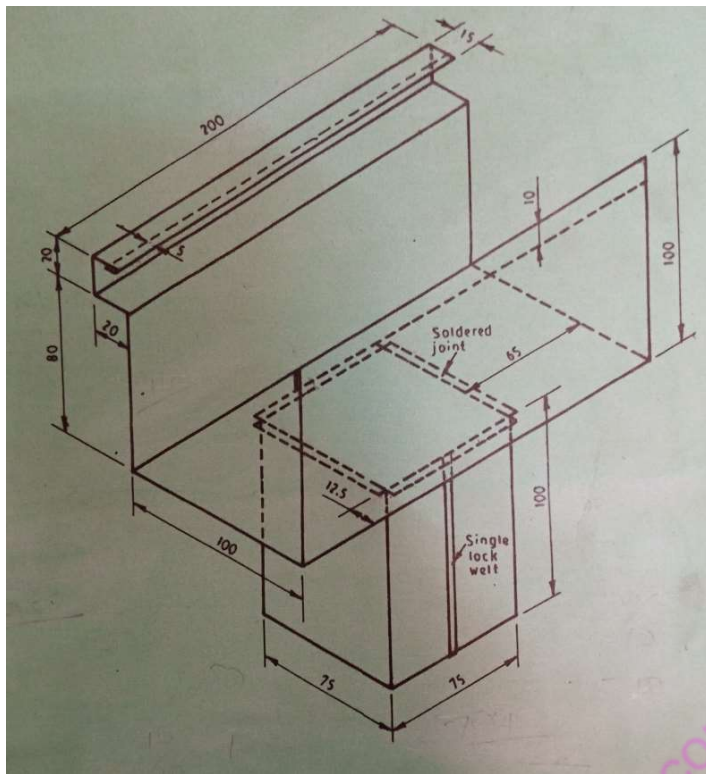


Figure 161:Downpipe brackets

- **Condition of cast iron;** Look for chipped, spilt, flaking paint finishes or rust on cast iron. Problem areas to look out for are the back of gutters where they are tight against the wall or tucked under slates and behind downpipes and at the joints. Check for small holes, tears and thinning of the surface in lead gutters.

2.2.4.4. Learning Activities

Using suitable tools, Fabricate and assemble the guttering system shown



2.2.4.5. Self-Assessment

- 1) What do you understand with the following faults;
 - Installation faults
 - Manufacturer's faults
- 2) What are the basic things do you require while installing gutters?
- 3) What are the different types of sanitary fittings?
- 4) How can you unclog a sink drain using chemicals?
- 5) Which three methods are suitable for testing modern Drainage Water vent systems (DWV systems) for leaks?
- 6) Which three factors may limit you to use a certain appliance and not the other?
- 7) Why does a toilet whistle when flushed?

2.2.4.6. Tools, Equipment, Supplies and Materials

Tools/Equipment:	Materials:
<ul style="list-style-type: none">• Pipe wrench• Pipe cutter• Hacksaw• Pipe Threading Equipment• Vise - Bench• Tap and Punch• Files• Screwdrivers• Drill with various sizes of bits• Rivets• Mallet• Ball hammer• Masonry chisel• Pipe bender	<ul style="list-style-type: none">• Hardhat• Gloves• Dustcoat / overall• Safety shoes / boots• Pipes• Gutters• Pipe fittings• Accessory• Adhesives• Sealant• Caulking material

2.2.4.7. References

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2.2.4.8. Model Answers

6. What do you understand with the following faults;

- **Installation faults;** this are mistakes made by the plumber during assembling or fixing the sanitary appliance thereby making it to leak/ work inefficiently.
- **Manufacturer's faults;** this is where the appliance itself had problems/make problems during manufacture. It can only be returned to the manufacturer or be rectified by the help of the expert from the manufacturer.

7. What are the basic things do you require while installing gutters?

- Step or extension ladder, depending on the height of your roof
- Work gloves
- Safety goggles
- Power drill and two or more rechargeable battery packs
- Permanent markers with a fine tip
- 25-foot tape measure
- Wood screws
- Gutter brackets
- Construction glue and gutter sealant
- Caulking gun (for the glue and sealant)
- Tin Snips (for cutting gutter pieces)

8. What are the different types of sanitary fittings?

- Toilet, kitchen sinks, wash basins, sanitary ware & fittings
- Wash basins. Pedestal wash basin
- Toilet seats. One piece toilet seat
- Wall hung toilets. Wall mounted closets
- Kitchen sinks. Stainless steel kitchen sinks
- Sanitary ware. Wash basins
- Sanitary fittings. Waste couplings
- Urinals. Urinal sensor

- Toilet fittings.

9. How to Unclog a Sink Drain Using Chemicals

- Be sure to follow all the directions on the packaging and make sure not to use too much.
- Wear gloves and goggles for safety.
- Don't mix chemicals. This can produce poisonous gas.
- Pour chemicals down the drain.

Note: Chemicals can cause damage to your drainage pipes if used repeatedly, so I would recommend not resorting to this method lightly.

10. Which three methods are suitable for testing modern Drainage Water vent systems (DWV systems) for leaks?

Air

Water

Smoke

11. Which three factors may limit you to use a certain appliance and not the other

Manufacturer's specifications

Engineer's specifications

Client's specifications

12. Why does a toilet whistle when flushed?

Likely, a small chip or hole in your tank cover is allowing air to pass through and causing a whistling sound. It could also be caused by your fill valve, which takes a quick adjustment to fix.

2.2.5. Learning Outcome 5: Test rainwater goods

2.2.5.1. Introduction to the learning outcome

This outcome specifies the competencies required to test rainwater goods. It involves, identifying and use of correct tool and equipment for the correct tool during standard installation of rainwater goods as it applies in the construction industry.

2.2.5.2. Performance Standard

1. Rain water goods are installed based on working drawings
2. Water test is conducted based on best practices.
3. Faults in structure and functionality of rainwater goods are corrected based on best practice
4. *Housekeeping* is conducted based on workplace procedures

2.2.5.3. Information Sheet

Rainwater goods; Rainwater goods is a loose term for all products installed on the exterior of a building to protect it from the rain. This includes continuous spouting, downpipes and rainwater heads. Continuous spouting and downpipes assist with drainage, while rainwater heads store water that drips when travelling around the corners of a roof.

Spouting; propelled in a narrow stream of gutter under the eaves of a building.

Downpipes; are the pipes that are usually fixed vertically, extending downwards from your roof to the base of a building; it ensures that rainwater that is collected in the gutter can be channeled effectively to the sewer. Also called downspouts

Rainwater heads/sump; is a container located between the gutter and downpipe that aids the flow of water away from the roof.

Rainwater harvesting; is the collection and storage of rain for reuse on-site, rather than allowing it to run off. These stored waters are used for various purposes, such as gardening, irrigation

Rules for Putting Up Gutters

- Gutter (Fascia) brackets should never be more than 1m apart
- Gutter angles, Stop-ends, Running Outlets, Unions and other gutter fittings should have a bracket (both sides of the fitting where appropriate) within 150mm of the fitting

- A supporting pipe clip should be used on all Shoes, Branches and Bends of the down pipes where necessary and in all cases these pipe brackets should be no more than 1.8m apart
- Silicone spray lubricant should be used on all joints to allow for expansion and contraction

Procedure of Installing New Gutters

Step 1 - Map Out Your Gutter Run

Step 2 - Mark Gutter Positions

Step 3 - Install Downspout Outlets

Step 4 - Hang the Gutter Hangers

Step 5 - Cover the Gutter Corners

Step 6 - Cut the Gutter Sections

Step 7 - Install Gutter Sections

Step 8 - Install the Drain Pipes

How to Remove Old Gutters from Your House

- Remove the Downspout
- Remove the downspout first. Remove the elbow where it's attached to the drop outlet on the gutter, and then the downspout assembly can easily be removed and placed out of your way.
- Remove the Gutters
- Repair Holes
- You can use caulk to fill holes left in the siding once the gutters and downspouts are removed.

Faults in structure and functionality of rainwater goods

1. Blockage. Your gutters can be clogged with debris such as build up from natural materials like leaves or from unnatural materials like tennis balls.

2. Sag. When gutters are leaning on the fascia to avoid rotting of fascia board and total gutter collapse. The reason for your gutter sag is most likely the result of a broken hanger or spike. Inspect the problem area and replace broken hardware as necessary.

3. Leaks. Leaking of gutters is mainly brought by blockage. A leak sometimes opens at the joints between sections of gutter, which can simply be resealed. You can patch these leaks, but once a weak spot is established, it will likely be a recurring problem.

4. Poor pitch. If gutters are not placed in a good gradient, then this means that there shall be backflow which will lead to pooling back and high weight. This could have happened during a poorly done gutter installation or can be the result of a house settling. This problem may be hard to identify, but it's important to address as pooling water can lead to corrosion or provide a breeding ground for pests such as mosquitos.

INSPECTION AND TESTING

INSPECTION

Work should be inspected during installation and tests applied on completion, care being taken that all work to be encased or concealed is tested before it is finally enclosed.

TESTING

When rainwater installations are complete, gutters should be tested for watertightness under working

conditions and internal downpipes should also be tested as prescribed in the relevant Building Regulations. Attention should be paid to the requirements of local authorities simple as removing each gutter hanger or other device that holds the gutter in place.

PIPING CALCULATION:

To calculate the minimum number of downpipes, divide the roof catchment area by the allowable maximum catchment per downpipe. To calculate the average catchment per downpipe, divide the roof catchment area by the number of downpipes

Housekeeping solutions

As a good plumber you need to perform the following as housekeeping procedures.

- You should protect the existing works and sanitary appliances

- You should clean your working area at all times during work progress.
- Clearing work area after the job should be done immediately.
- Keeping of work area tidy is always necessary.

2.2.5.4. Learning Activities

- Study the plan and propose the best possible water harvesting methods.
- Identify the faults that may likely occur due to cleaning water in the drainage systems and offer recommendations.



2.2.5.5. Self-Assessment

1. Is harvested rainwater good and safe for my family to drink?
2. How long can rainwater be stored?
3. What do you understand with the following faults;
 - Installation faults
 - Manufacturer's faults
4. What are the precautions should you take while Executing Layout of Pipes?
5. What are the different types of sanitary fittings?
6. How can you unclog a sink drain using chemicals?

7. Which three methods are suitable for testing modern Drainage Water vent systems (DWV systems) for leaks?
8. Which three factors may limit you to use a certain appliance and not the other?
9. Why does a toilet whistle when flushed?

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2.2.5.6. Tools, Equipment, Supplies and Materials

Tools/Equipment:	Materials:
<ul style="list-style-type: none">• Pipe wrench• Pipe cutter• Hacksaw• Pipe Threading Equipment• Vise - Bench• Tap and Punch• Files• Screwdrivers• Drill with various sizes of bits• Mallet• Ball hammer• Masonry chisel• PPR machine / Heat Fusion equipment• Pipe bender	<ul style="list-style-type: none">• Hardhat• Gloves• Dustcoat / overall• Safety shoes / boots• Various types of pipe support• Sandpapers• Threading oil• Thread tape• Caulking material

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<https://www.youtube.com/watch?v=ghcdZRUZ0MU>

2.2.5.8. Model Answers

1. Is harvested rainwater good and safe for my family to drink?

Yes. 100%. Rainwater harvesting provides water that is healthy, safe, and tastes great.

2. How long can rainwater be stored?

Rainwater can be stored from anywhere between one week and indefinitely. The more consideration you put into your storage system – using the right materials, preventing algae and mosquitos

3. What do you understand with the following faults;

- **Installation faults;** this are mistakes made by the plumber during assembling or fixing the sanitary appliance thereby making it to leak/ work inefficiently.
- **Manufacturer's faults;** this is where the appliance itself had problems/make problems during manufacture. It can only be returned to the manufacturer or be rectified by the help of the expert from the manufacturer.

4. Precautions while Executing Layout of Pipe

- Pipe work and appliances should be arranged in such a way that allows close grouping of connections with water closet near main soil pipe.
- The branch pipes should be kept short to reduce noise.
- When the basin and bath are at some distance from the stack, it would be cheaper and simpler to combine the waste pipes into one.

- Any bends in the waste pipe should be of large radius.
- The pipe work in branch connections should be arranged to allow free drainage for the system.
- All connections to main or branch pipes should be arranged in such a way that prevents cross flow from one appliance to another.
- Branch connections should be of large radius along the invert.
- The minimum diameter of soil and waste stacks should be 100 mm and 75 mm respectively.
- When the pipes are covered, hard to find along the internal face of the walls, they should be of cast iron.
- All pipes including those laid on external face of the wall should be of cast iron on the ground floor.

5. Which three methods are suitable for testing modern Drainage Water vent systems (DWV systems) for leaks?

- Air
- Water
- Smoke

6. Which three factors may limit you to use a certain material for guttering and not the other

- Manufacturer's specifications
- Engineer's specifications
- Client's specifications