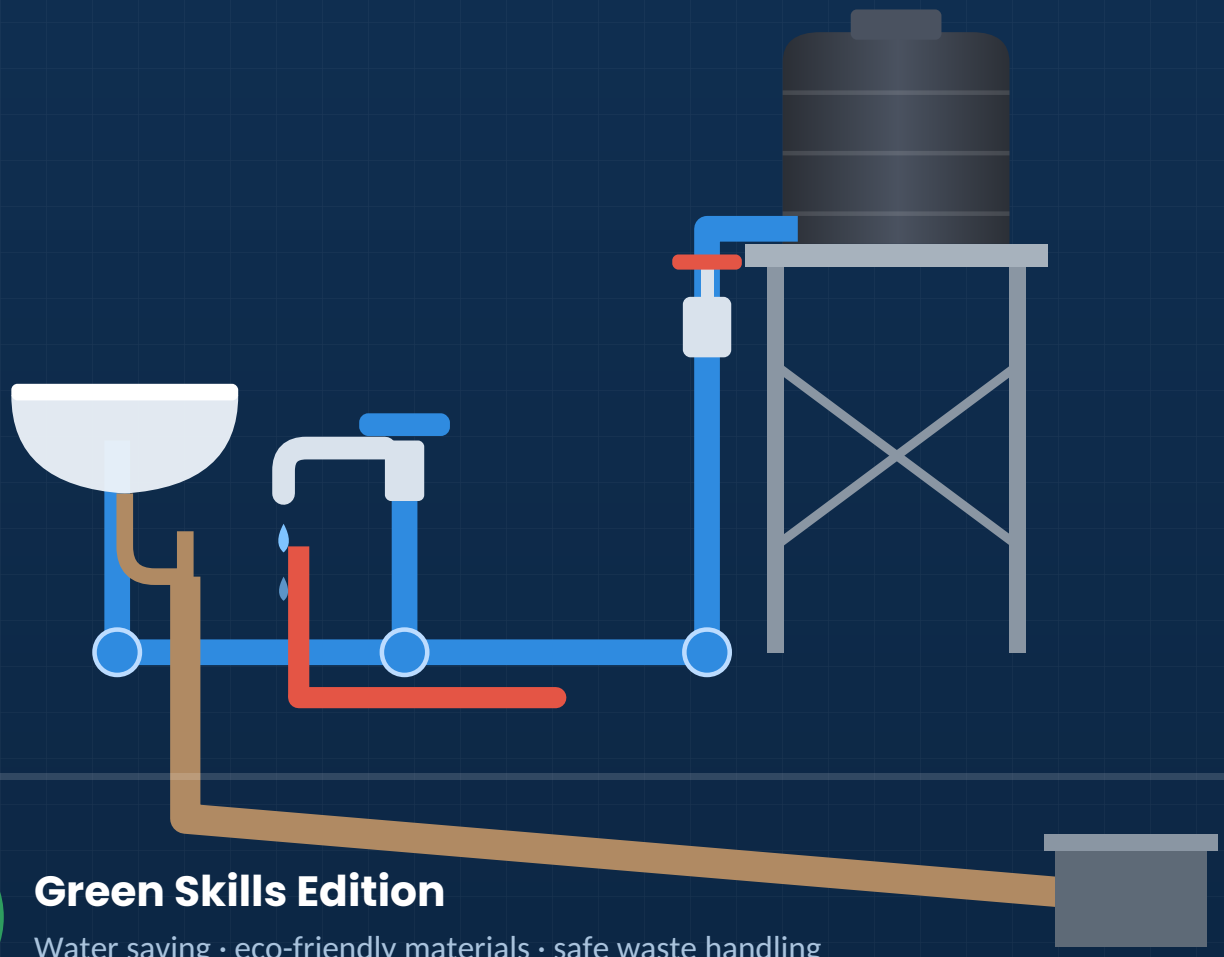
KNQF LEVEL 3 · TVET CDACC CYCLE 3

Plumbing Level 3

A Practical Study Guide for Kenyan Trainees

Water supply · Sanitary appliances · Drainage systems



Green Skills Edition

Water saving · eco-friendly materials · safe waste handling

Alphonce Kimutai Kirui

Aligned to the TVET CDACC Competency-Based Modular Curriculum, Plumbing KNQF Level 3

Plumbing Level 3

A Practical Study Guide for Kenyan Trainees

Water Supply Systems · Sanitary Appliances · Drainage Systems
Kenya National Qualifications Framework (KNQF) Level 3 · Green Skills Edition

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Plumbing Level 3: A Practical Study Guide for Kenyan Trainees
First edition, October 2026

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Published by the author. Website: alphoncekirui.com

About the curriculum

This book is an independent study guide. It follows the topics and units of the TVET CDACC Competency-Based Modular Curriculum and Occupational Standard for Plumbing, KNQF Level 3 (Cycle 3, unit codes CON/CU/PLM/CR/01–04/3/MB). Unit titles and codes are used for reference only. The book is not published, endorsed or approved by TVET CDACC, TVETA or the Ministry of Education. Always follow the current official curriculum and your trainer's guidance.

Safety and accuracy notice

Plumbing work can cause injury, flooding, contamination and damage to property. The methods in this book are for training under the supervision of a qualified trainer. Figures given as "typical" (pipe support spacing, test pressures, falls, heights, times and prices) are general guidance only. Always follow the approved drawings, the manufacturer's instructions, county requirements and relevant Kenyan standards. Electrical work on water heaters and pumps must be done by a licensed electrician. Prices are approximate (2026) and will vary.

Names of people, schools and places used in examples are made up for teaching.

Illustrations

All drawings and diagrams in this book were drawn for it. They are teaching drawings and are not to scale unless a scale is shown.

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How to use this book

This book follows the Plumbing Level 3 course from start to finish. It covers the three core units and the industry training, in the same order as your training. You can read it cover to cover, or study one unit at a time if you are taking a part qualification.

The course at a glance

Part	What it covers	Training time
1. Getting started	The trade, the course, assessment, safety and green plumbing	Used throughout
2. Water supply systems	Unit 1: Install Water Supply System I	100 hours
3. Sanitary appliances	Unit 2: Install Sanitary Appliances I	100 hours
4. Drainage systems	Unit 3: Install Drainage System I	100 hours
5. Industry training and assessment	Industry training and getting ready to be assessed	240 hours

What is in each chapter

- **What you will learn:** the chapter's goals, with the unit, learning outcome and training hours it belongs to.
- **Key words:** the trade words you need, explained simply. More are in the Glossary at the back.
- **Explanations and drawings:** each topic explained step by step, with labelled diagrams.
- **Practical tasks:** workshop jobs with the tools, materials, steps and safety points. Do them with your trainer.
- **Check your competence:** a checklist of what an assessor will expect you to show. Tick each item when you can do it without help.
- **Practice questions:** answers are at the back of the book.

Look out for these boxes

SAFETY FIRST

Hazards and how to stay safe. Never skip these.

GREEN TIP

Ways to save water, energy and materials, and to handle waste correctly. Green skills are part of your assessment.

TRAINER'S TIP

Advice from experienced trainers to help you work faster and better.

COMMON MISTAKES

Errors trainees often make, and how to avoid them.

> **ON SITE IN KENYA**
>
> How the topic looks on real jobs in Kenyan homes and sites.

Colours in the drawings

Blue lines are cold water. Red lines are hot water. Brown lines are drainage (waste and soil). Green marks show water-saving or eco-friendly items.

PART 1

Getting Started

What a Level 3 plumber does, how you will be trained and assessed, and the safety and green habits you will use on every job.

Chapter 1: Becoming a Plumber in Kenya
Chapter 2: Safety and Green Plumbing Basics

CHAPTER 1

Becoming a Plumber in Kenya

WHAT YOU WILL LEARN

- Describe the work a Level 3 plumber does on Kenyan homes, plots and building sites.
- Explain how you can grow from Level 3 to higher levels and into related trades.
- Use the key words of competency-based training: unit, element, performance criteria, portfolio and RPL.
- Read your course map and know how many hours each unit takes.
- Work out a unit score from formative and summative marks and name the rating it earns.
- Behave like a professional with customers, supervisors and fellow workers.

Introduction to the qualification · Plumbing KNQF Level 3 · 3 core units + industry training · 540 hours · 54 credits

Every home in Kenya needs clean water coming in and dirty water going out safely. The person who makes that happen is the plumber. Whether it is a new maisonette in Kitengela, a rental plot in Kisumu or a school in Bomet, someone must fit the tank, run the pipes, fix the toilet and connect the drain. This chapter shows you what that job looks like, how your training is organised and how you will be judged competent.

Key words

Plumber
A tradesperson who installs and repairs water supply, sanitary appliances and drainage.

CBET
Competency-Based Education and Training: you are trained and judged on what you can actually do.

Unit of competency
One complete area of work, for example installing a water supply system.

Element
A main task inside a unit, such as preparing materials or testing pipework.

Performance criteria
Statements that describe how well each task must be done.

Learning outcome
What you should be able to do at the end of a block of training.

Formative assessment
Assessment done during training to check progress.

Summative assessment
The final assessment at the end of a unit.

Portfolio of evidence (PoE)
A file of your work records, photos, sketches and signed reports that proves your skills.

RPL
Recognition of Prior Learning: getting certified for skills you already gained on the job.

Credit
A measure of learning time; in this course one credit equals ten hours.

Jua kali
Kenya's informal, self-employed trades sector.

1.1 What a Level 3 plumber does

A Level 3 plumber is a skilled worker who can do domestic plumbing jobs under light supervision. "Domestic" means work in homes and small buildings such as shops, clinics and classrooms. You will not design a hospital water system at this level, but you will install, test and repair the pipework that people use every day.

1.1.1 Where plumbers work

- **Building sites.** You work for a contractor or a plumbing sub-contractor, fitting pipes as the walls go up and fixing appliances at the end.
- **Maintenance teams.** Schools, hospitals, hotels, estates and county offices employ plumbers to keep taps, toilets and drains working.
- **Water service providers.** County water companies hire plumbers to connect customers, fit meters and repair leaks on supply lines.
- **Hardware shops.** Many hardware owners recommend plumbers to their customers or employ one to advise buyers.
- **Self-employment.** Many Kenyan plumbers run their own small business, getting jobs through landlords, caretakers, churches and word of mouth.

1.1.2 Typical jobs at Level 3

The three units of this course match the three main kinds of domestic work. Table 1.1 lists jobs you should be able to do by the end of the course.

Table 1.1 Typical Level 3 plumbing jobs

Area of work	Example jobs
Water supply	Mount a plastic tank on a stand, connect the inlet, outlet and overflow; run PPR pipes to the kitchen and bathroom; fit stop valves and taps; pressure-test the pipework; repair a burst pipe.
Sanitary appliances	Fix a wash hand basin, a close-coupled WC or a squat pan, a kitchen sink and a shower; replace a leaking tap washer; adjust a running cistern.
Drainage	Install uPVC waste and soil pipes to the correct fall; build or connect to an inspection chamber; clear a blocked drain; test drains with water or air.

1.1.3 Self-employment and the jua kali sector

A good plumber does not wait for a job advert. Water rationing, old galvanised pipes and fast building in towns mean there is steady repair work. If you work alone you must also price jobs, buy materials, keep records and treat customers well. Chapter 15 gives more detail on starting a small business. For now, remember that your reputation is your best advert. One neat, leak-free job brings the next three.

> **ON SITE IN KENYA**
>
> On many rental plots the landlord lives far away and the caretaker calls the plumber. Save the caretaker's number, send a clear message after each job ("Kitchen tap washer replaced, no leaks, KSh 500 paid") and you will often become the plot's regular plumber. Prices here are approximate, 2026.

1.2 Your career path

Level 3 is the first rung of a ladder. Figure 1.1 shows how you can climb. At each step you need two things: the next qualification and real experience. The Kenya National Qualifications Framework (KNQF) places every qualification on a numbered level so that employers can compare them.

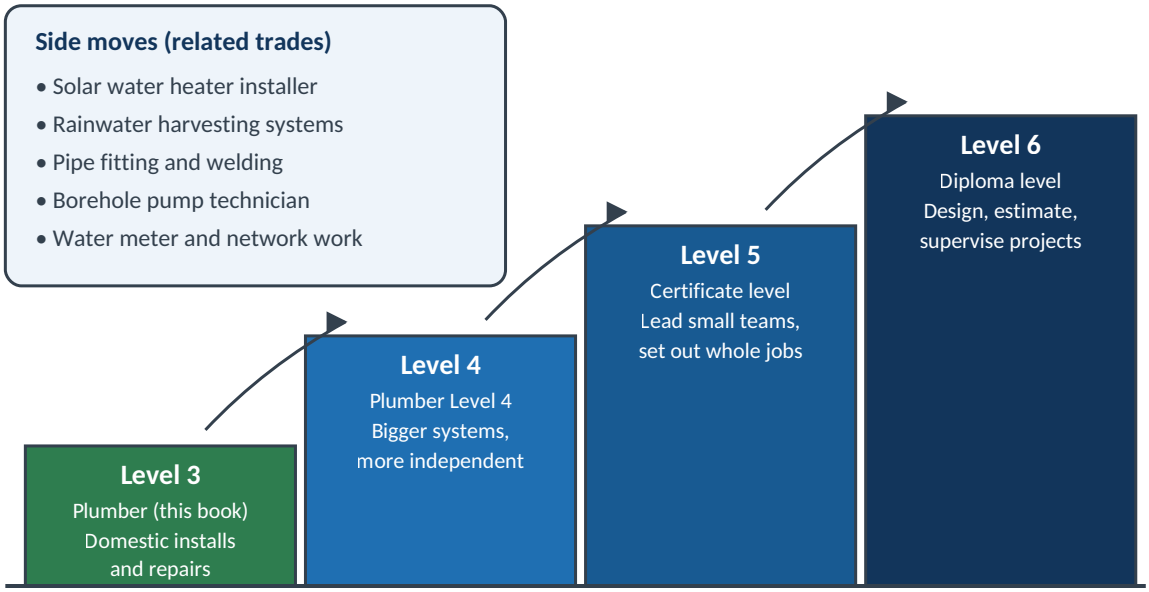


Figure 1.1 The plumbing career ladder from Level 3 upwards, with related trades you can move into.

The exact names of the higher awards depend on the institution and the curriculum in force, so check with your trainer. What stays the same is the idea: each level adds responsibility. A Level 3 plumber follows a drawing. A Level 5 or 6 person may produce that drawing, prepare the bill of quantities and supervise several plumbers.

You can also move sideways. Kenya has a growing market for solar water heaters, rainwater harvesting tanks, borehole pumps and water-saving fittings. A plumber who adds one of these skills earns more and is busy all year. The National Construction Authority (NCA) keeps a register of accredited construction workers; ask your trainer about the current requirements once you qualify.

1.3 How competency-based training works

Your course follows CBET. In the old system you sat a written exam at the end and passed or failed on paper. In CBET the main question is: *can you do the job to the standard industry expects?* You prove this mostly with your hands, while an assessor watches and asks questions.

1.3.1 The building blocks

Two documents guide your training. The **occupational standard** was written with employers. It says what a competent plumber must be able to do at work. The **curriculum** turns that standard into training: it lists learning outcomes, content, hours and resources. They fit together like this:

- A **unit of competency** is one big area of work (for example, installing drainage).

- Each unit has several **elements**, the main tasks inside it (for example, testing a drain).
- Each element has **performance criteria** that describe what good work looks like.
- In the curriculum, each element becomes a **learning outcome** with set hours and topics.
- Related units are grouped into a **module**, so you can finish part of a qualification, go to work and come back later.

1.3.2 Certificates you can earn

Because training is built from units, you can be certified bit by bit. TVET CDACC issues the certificates:

- **Statement of Attainment** for being competent in a certifiable part of a unit.
- **Certificate of Competency** for each complete core unit you pass, for example Install Water Supply System I.
- **Kenya National TVET Certificate in Plumbing Level 3** when you are competent in all the units of the qualification.

This means a trainee who must leave college early still leaves with something useful. It also means a fundi who has worked for years without papers can be assessed through **Recognition of Prior Learning (RPL)**. If the fundi shows the required competence, they can receive part or all of the qualification without sitting through every class.

> **TRAINER'S TIP**
>
> Ask your trainer for a copy of the performance criteria for each unit. Tick them off in pencil as you practise. When every line is ticked, you are ready for assessment.

1.4 Your course map

The full course is 540 hours. That is three core units of 100 hours each, plus 240 hours of industry training. One credit equals ten hours, so the course is worth 54 credits. Figure 1.2 shows the whole map, and the chapters of this book follow the same order.

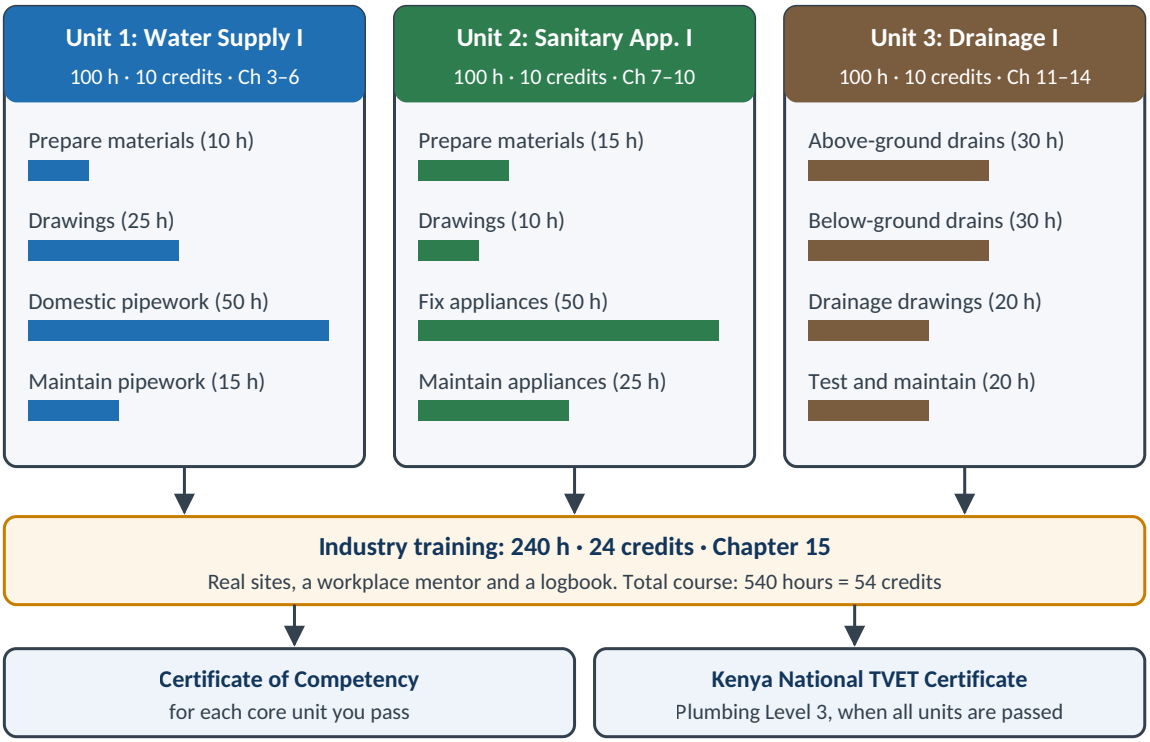


Figure 1.2 Course map. Bar lengths show the hours for each learning outcome. The three units lead into industry training and certification.

Notice where the hours go. The longest blocks are the hands-on ones: installing pipework (50 hours) and fixing appliances (50 hours). The course is mostly practical, so expect to spend most of your time in the workshop, not the classroom. The entry requirement is primary school level (KCPE) or an equivalent approved by TVETA, so nobody should feel left behind. If maths or reading is a challenge, ask for help early.

Industry training can be done after all three units, or split between the units if you are studying for a part qualification. Either way you will need a logbook signed by your workplace supervisor.

1.5 How you will be assessed

Assessment in CBET is not a single exam. You are assessed many times, mostly while you work. Figure 1.3 sums up the rules.

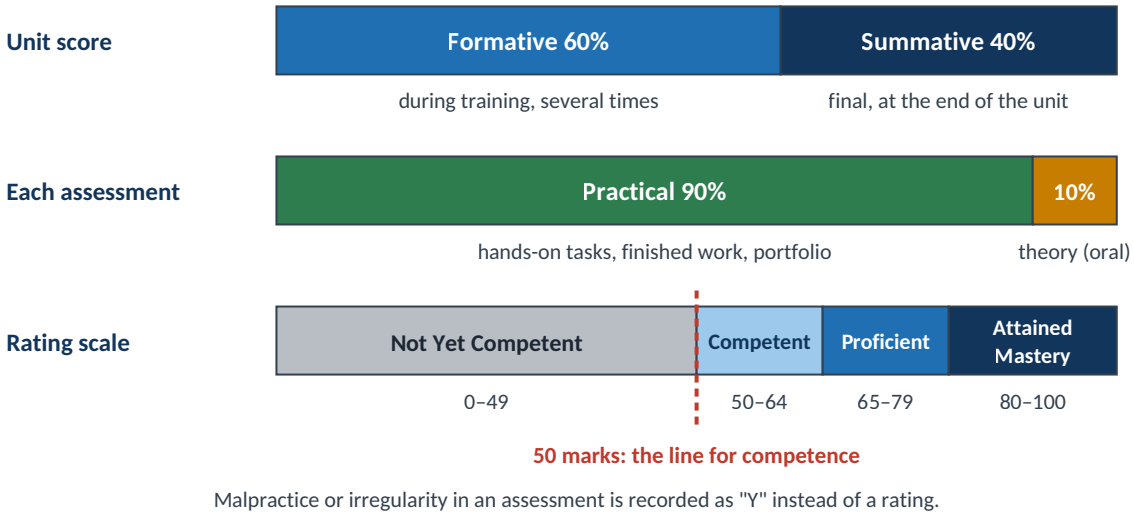


Figure 1.3 How a unit is scored: formative and summative weights, the practical and theory split, and the four-band rating scale.

1.5.1 Formative and summative assessment

Formative assessments happen while you are learning. Your trainer sets practical tasks, watches you work and asks questions. There will be at least as many formative assessments as there are elements in the unit, so in a four-element unit expect four or more. Together they count for **60%** of your unit score.

Summative assessment comes at the end of the unit. It is usually one larger practical task with oral questions. It counts for **40%**.

1.5.2 Practical and theory

In every assessment, practical work carries **90%** and theory **10%**. Theory is not a separate written paper. The assessor asks you questions as you work: "Why did you leave that gap?" or "What test pressure will you use?" Answer clearly, using the correct trade words. Every performance criterion has a weighting, so tasks that matter more on site, such as mounting pipes correctly, carry more marks than small tasks.

1.5.3 Working out your unit score

Your unit score combines the two parts:

Unit score = (formative average × 0.6) + (summative score × 0.4)

Worked example. Wanjiru's formative marks in Unit 1 average 72. Her summative mark is 68.

- Formative part: 72 × 0.6 = 43.2
- Summative part: 68 × 0.4 = 27.2
- Unit score: 43.2 + 27.2 = 70.4, which rounds to 70

A score of 70 falls in the 65–79 band, so Wanjiru is rated **Proficient**. Table 1.2 gives all four bands.

Table 1.2 Competence rating bands

Marks	Rating	What it means in practice
80–100	Attained Mastery	Works accurately and quickly, explains every step, could guide a new trainee.
65–79	Proficient	Good, reliable work with only small slips.
50–64	Competent	Meets the standard; needs more practice to gain speed and finish.
49 and below	Not Yet Competent	Not yet at the standard; more training, then reassessment.

1.5.4 Your portfolio of evidence

A **portfolio of evidence (PoE)** is a file that proves what you have done. Assessors use it alongside practical tasks, projects, oral questions and reports from third parties such as your industry supervisor. Start it on day one. A good portfolio contains:

- completed task sheets and assessment records signed by your trainer;
- your own sketches, isometric drawings and material lists;
- dated photos of your work (always ask permission before photographing a customer's home);
- test record sheets showing pressures and hold times;
- your industry training logbook and supervisor reports.

COMMON MISTAKES

- Leaving the portfolio until the last week, then trying to remember what you did months ago.
- Treating oral questions as unimportant. They are your 10% theory mark.
- Rushing a practical to finish first. Assessors mark quality and safety, not speed alone.
- Forgetting to clean up after a task. Housekeeping is a performance criterion in every unit.

Practical task 1.1: Start your portfolio of evidence

Tools and equipment

- Phone camera (or borrowed camera)
- Steel tape measure
- Pen and pencil

Materials

- Box file or ring binder with dividers
- Plastic sleeves
- Copy of the unit performance criteria

Steps

1. Label the file with your name, admission number, course and year.
2. Make four dividers: Unit 1, Unit 2, Unit 3 and Industry training.
3. Behind each divider, place the list of performance criteria for that unit.
4. Walk round the workshop with your trainer. List ten tools and five pipe materials you can see, with a sketch of each.
5. Photograph one installation in the workshop. Write the date, what it shows and who installed it.
6. Ask your trainer to check and sign the first page.

Safety

- Do not touch machines or hot tools while walking round; observe only.
- Keep to marked walkways and wear your overall and safety boots.

1.6 Study habits that work

Plumbing is learned with the hands, the eyes and the head together. These habits help:

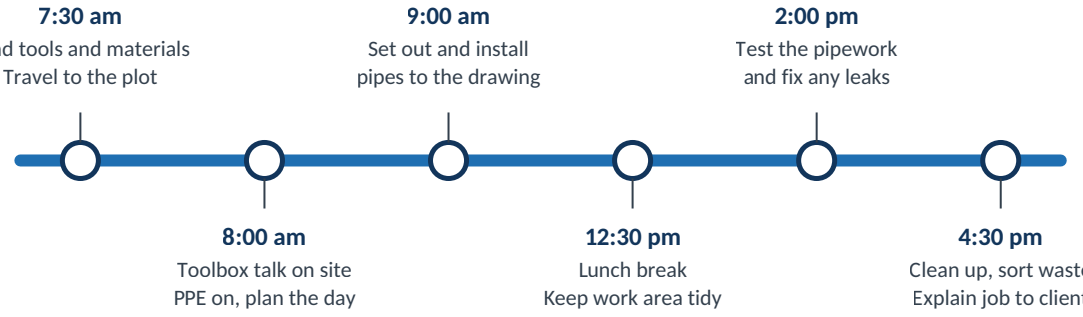
- **Read before practicals.** Read the matching section of this book the night before. You will understand the demonstration faster.
- **Keep a pocket notebook.** Write new words, sizes and tips as soon as you hear them.
- **Sketch everything.** If you can draw a fitting or a system from memory, you understand it.
- **Practise the numbers.** Measuring, adding pipe lengths and working out falls come up daily. Do the worked examples yourself.
- **Learn in pairs.** Ask each other the oral questions at the end of each chapter.
- **Visit sites.** Look at plumbing in your church, school, market or a neighbour's new house. Ask the fundi what they are doing and why.

GREEN TIP

Your course is a "greened" curriculum. That means every unit expects you to save water, use non-toxic and low-VOC materials, use energy-efficient tools and handle waste responsibly. Get into the habit early: switch off machines when not in use, keep offcuts for reuse and report any dripping tap you see.

1.7 Professional conduct and customer care

Employers often say they can teach skills, but they cannot teach attitude. A trainee who is on time, honest and polite will be called back for the next job. Figure 1.4 shows a typical working day for a plumber on a house job.



Times are an example only. Safety, testing and clean-up appear in every working day.

Figure 1.4 A day in the life of a plumber on a domestic job.

1.7.1 Conduct at work

- **Be on time.** If you will be late, call before the agreed time, not after.
- **Dress for work.** Clean overall, safety boots and the PPE the job needs (Chapter 2).
- **Follow instructions.** Work to the drawing and the supervisor's directions. If something looks wrong, ask before you change it.
- **Be honest.** Never charge for materials you did not use. Return unused materials to the store or the client.
- **Respect the property.** Cover floors, protect finished tiles, and do not use the client's things without asking.
- **No alcohol or drugs** at work. They cause accidents and destroy trust.

1.7.2 Customer care

Customers judge you by how you treat them as much as by your pipework. Greet the customer and introduce yourself. Listen to the problem fully before you touch anything. Explain what you found and what you will do, in simple language and before you start. Give a clear price and agree it first. Warn them if you must shut off water, and for how long. When you finish, show them the work, run the taps together and explain any care needed, for example "Do not pour cooking fat in this sink."

> **SAFETY FIRST**
>
> Professional conduct includes safety. Never start a job on someone's property without checking for live electrical cables, gas cylinders and children nearby. If a job is beyond your level, such as rewiring a water heater, say so and call the right person. Chapter 2 covers safe working in detail.

Chapter summary

- A Level 3 plumber installs, tests and repairs domestic water supply, sanitary appliances and drainage.
- Plumbers work for contractors, maintenance teams and water companies, or run their own businesses.
- Level 3 is the first step on a ladder that leads to higher levels and related trades such as solar water heating.
- CBET judges what you can do. Units are made of elements, and each element has performance criteria.
- The course has three 100-hour units and 240 hours of industry training: 540 hours and 54 credits.
- Unit score = 60% formative + 40% summative; each assessment is 90% practical and 10% oral theory.
- Ratings: 80–100 Attained Mastery, 65–79 Proficient, 50–64 Competent, 49 and below Not Yet Competent.
- Keep your portfolio of evidence up to date and treat every customer with respect.

Check your competence

- [ ] I can describe at least five jobs a Level 3 plumber does.
- [ ] I can name the three core units of this course and their hours.
- [ ] I can explain the difference between a unit, an element and a performance criterion.
- [ ] I can name the three types of certificate and when each is given.
- [ ] I can calculate a unit score and state the rating it earns.
- [ ] I can list what goes into a portfolio of evidence, and I have started mine.
- [ ] I can explain how RPL helps an experienced fundi.
- [ ] I can describe how to greet a customer, explain a job and hand it over.

Practice questions

1. List four places where a Level 3 plumber in Kenya might find work.
2. What is the difference between an occupational standard and a curriculum?
3. Name the three core units of Plumbing Level 3 and state the hours for each.
4. How many hours of industry training are required, and how many credits is the full course worth?
5. Explain in your own words what RPL is and who it helps.
6. Calculation: Otieno's formative average is 60 and his summative mark is 75. Work out his unit score and rating.
7. In each assessment, what are the weights for practical and theory? How is theory usually assessed?
8. Give five items you should keep in your portfolio of evidence.
9. Oral: A customer asks why you need to shut off the water for two hours. How would you explain it politely?
10. Practical: Visit a building on your campus. Record three plumbing items you see, sketch one of them, and note any water being wasted.

CHAPTER 2

Safety and Green Plumbing Basics

WHAT YOU WILL LEARN

- Choose, wear and care for the right personal protective equipment for each task.
- Follow workshop rules and use hand and power tools safely.
- Lift loads, use ladders and work near trenches without getting hurt.
- Spot hazards, carry out a simple risk assessment and give basic first aid.
- Save water and energy, choose non-toxic materials and handle waste by the waste hierarchy.
- Carry out housekeeping: stack and store, collect, segregate, package and dispose.

Applies to all three units · Safety measures and housekeeping are performance criteria in every element

Plumbers work with sharp tools, heavy pipes, heat, electricity, ladders and dirty water. Most accidents in the trade are small cuts and strains, but falls from tank stands and trench collapses can kill. Safety and housekeeping are assessed in every unit of your course, so the habits in this chapter are marked every time you pick up a tool.

Key words

Hazard
Anything that could cause harm, such as a live cable or an open trench.

Risk
How likely the harm is, and how bad it would be.

PPE
Personal protective equipment: gear you wear to protect your body.

SOP
Standard operating procedure: the agreed safe way of doing a task.

Risk assessment
Looking at a job, listing hazards and deciding how to control them.

Manual handling
Lifting, carrying, pushing or pulling loads by hand.

VOC
Volatile organic compound: harmful vapour given off by some glues, solvents and sealants.

Waste hierarchy
The order for dealing with waste: reduce, reuse, recycle, recover, then dispose.

Segregate
Separate waste into types, such as PPR, uPVC and metal.

Housekeeping
Keeping the work area clean, tidy and safe during and after a job.

Toolbox talk
A short safety briefing before work starts.

2.1 Why safety comes first

Safety protects you, your workmates, the customer and the public. It also protects your income. A plumber with a crushed foot or a burnt hand cannot work for weeks. In Kenya, workplace safety and health is governed by national law, and county and national inspectors can stop unsafe work. Employers must provide safe conditions and PPE. You, as a worker, must use the PPE, follow the rules and report hazards.

Think of safety in this order, from the strongest control to the weakest:

1. **Remove the hazard** (for example, isolate the water and power before cutting a pipe).
2. **Replace it with something safer** (use a pipe cutter instead of an angle grinder where possible).
3. **Guard or separate it** (barrier tape around a trench, guards on machines).
4. **Safe ways of working** (SOPs, signs, training, supervision).
5. **PPE**, the last line of defence when the hazard is still there.

2.2 Personal protective equipment

PPE only works if it fits, is in good condition and is worn the whole time the hazard is present. Figure 2.1 shows a plumber dressed for general site work.

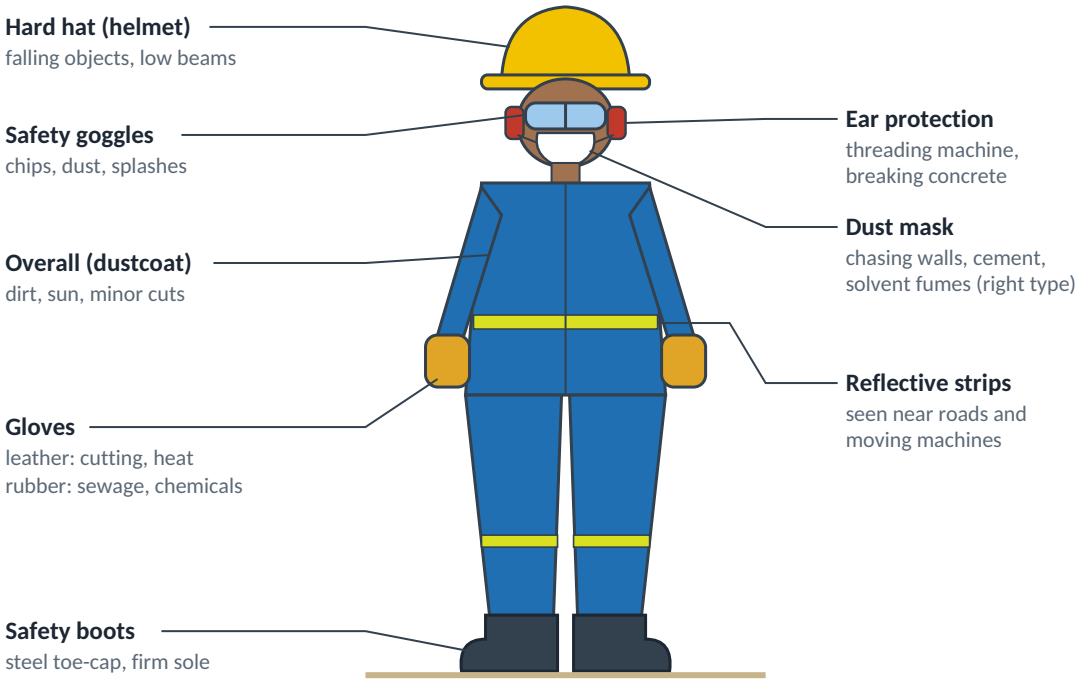


Figure 2.1 A plumber wearing PPE for general site work.

Table 2.1 Choosing PPE for common plumbing tasks

Task	Main hazards	PPE needed
Cutting and threading GI pipe	Sharp burrs, oil, noise, flying chips	Leather gloves, goggles, ear protection, overall, boots
PPR fusion welding	Heater plate at about 260 °C, burns	Heat-resistant gloves, goggles, overall, boots
Chasing a wall or breaking concrete	Dust, flying fragments, noise	Goggles, dust mask, ear protection, gloves, hard hat
Solvent welding uPVC	Vapour, skin and eye irritation	Chemical-resistant gloves, goggles, good ventilation (mask if confined)
Clearing a blocked drain	Sewage, germs, splashes	Long rubber gloves, goggles, overall, rubber boots
Working in a trench or near scaffolds	Falling objects, collapse	Hard hat, boots, high-visibility overall

2.2.1 Caring for PPE

Check your PPE before every use. Throw away a hard hat that is cracked or has been hit hard, even if it looks fine. Replace gloves with holes and goggles you cannot see through. Wash overalls regularly, and keep sewage-soiled gloves and boots apart from clean items. Store PPE in a dry place out of the sun, because sunlight weakens plastic helmets.

2.3 Workshop rules and SOPs

Every workshop has rules, usually posted at the door. They differ a little from college to college, but most include these:

- Enter only with permission and wear your overall and boots at all times.
- No running, pushing or playing. No eating or drinking at workbenches.
- Use a machine only after you have been shown how and been allowed to use it.
- Report every accident, near miss, damaged tool or spill to the trainer at once.
- Keep walkways and exits clear. Never block a fire extinguisher or an exit door.
- Return tools to the store, clean, at the end of each session.

An **SOP** is the agreed step-by-step way to do a particular task safely, such as using the threading machine or pressure-testing a pipe. Read the SOP before the task and follow it exactly. If an SOP is missing or seems unsafe, ask your trainer.

2.4 Safe use of hand and power tools

2.4.1 Hand tools

- Use the right tool for the job. A pipe wrench is not a hammer, and a screwdriver is not a chisel.
- Check tools before use: loose hammer heads, mushroomed chisel heads, worn wrench jaws and blunt hacksaw blades all cause injuries.

- Cut away from your body and keep the other hand behind the cutting edge.
- Hold the work firmly in a pipe vice, not in your hand.
- Carry sharp tools pointing down, and never in your pocket.

2.4.2 Power tools and electrical safety

Drills, threading machines, chasing machines and PPR welders all use mains electricity, and plumbing work brings water close to them. That mix can kill.

- Inspect the cable, plug and casing before use. Do not use a tool with cut or taped cables.
- Plug in through a socket protected by a residual current device (RCD) where one is available.
- Keep cables and extension leads out of water and away from sharp edges. Unroll extension reels fully to stop overheating.
- Switch off and unplug before changing bits, blades or dies.
- Never touch a power tool with wet hands or while standing in water.
- Before drilling or chasing a wall, look for sockets and switches. Cables usually run straight up or down from them, so do not drill in that line.

2.4.3 Heat and fire safety

PPR welders reach about 260 °C. Blowlamps and gas torches, used in some copper and bending work, are hotter still. Place hot welders on their stand, never on the floor or on plastic. Keep a fire extinguisher or a bucket of sand nearby when using a flame. Remove paper, thinners and rags from the area first. Never leave a hot tool unattended, and let it cool before packing it away. Solvent cements and primers are flammable: keep lids on and keep them away from flames.

> **SAFETY FIRST**
>
> If someone is in contact with a live electrical supply, do not touch them. Switch off the power at the plug or main switch first. If you cannot, push them clear with a dry wooden broom handle while standing on dry ground. Then call for help and give first aid.

2.5 Manual handling

Plumbers carry pipes, bags of cement, plastic tanks, WC pans and cast-iron covers. Back injuries are common and can last for life. Before lifting, ask: can I use a trolley or wheelbarrow? Can I break the load into smaller parts? Do I need a second person?

To lift safely: stand close to the load with feet apart, bend your knees not your back, get a firm grip, keep your back straight and lift smoothly with your legs. Keep the load close to your body and turn with your feet, not by twisting your waist. Long pipes are best carried by two people, one at each end, on the same shoulder. A 6 m pipe swinging round can easily hit someone, so look behind you before turning.

2.6 Working at height

Many Kenyan homes store water in tanks on steel or concrete stands, or on the roof. Falls from these are among the most serious accidents plumbers suffer.

2.6.1 Ladder safety and the 1-in-4 rule

A leaning ladder must be set at the right angle. The rule is **1 out for every 4 up**: for every 4 metres of height to where the ladder rests, the foot should be 1 metre out from the wall. This gives an angle of about 75° to the ground (see Figure 2.2).

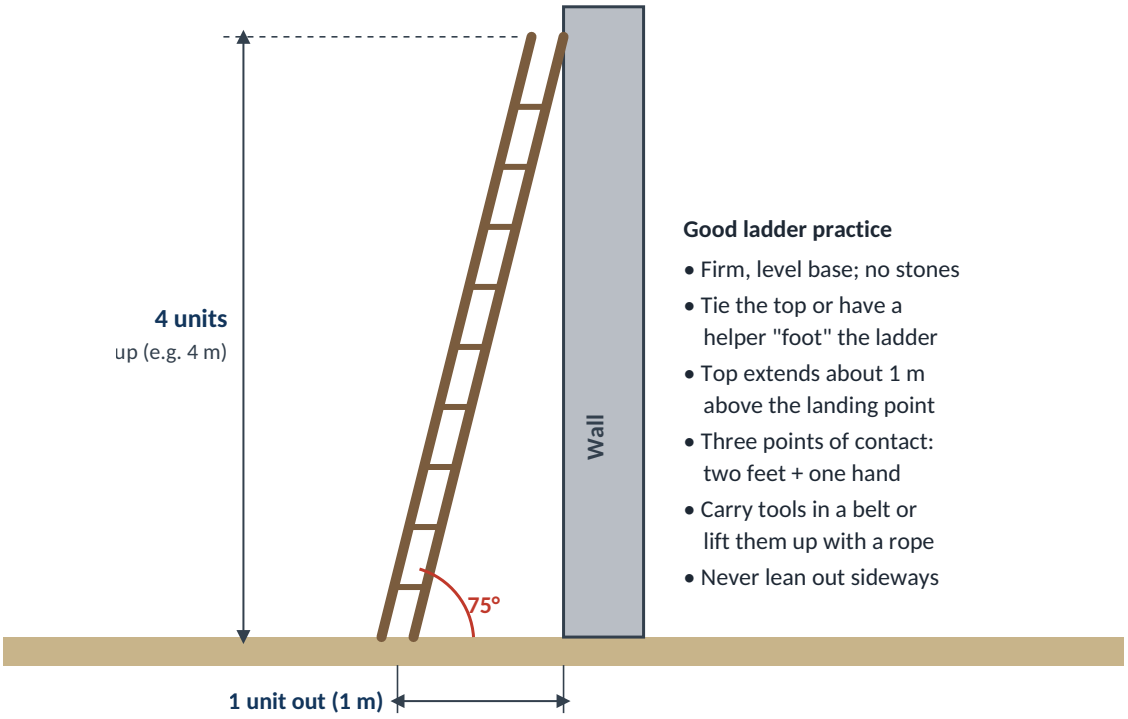


Figure 2.2 The 1-in-4 rule: the ladder foot is one unit out for every four units of height, giving about 75°.

Worked example. A tank stand platform is 3.2 m above the ground. How far from the base of the stand should the ladder foot be? Distance out = height ÷ 4 = 3.2 ÷ 4 = **0.8 m**. The ladder must also be long enough to reach about 1 m above the platform so you can step off safely.

2.6.2 Roofs and tank stands

- Never work at height alone. Someone must be at the bottom to hold the ladder and call for help.
- On iron-sheet roofs, walk only on the line of the nails, where the sheets sit on the purlins. Use crawl boards on fragile roofs.
- Do not climb on a tank stand that is rusted, cracked or shaking. Report it.
- Lift tanks with ropes and enough people. An empty 1,000-litre tank is light but catches the wind like a sail.
- Do not work at height in strong wind, rain or when you feel unwell.

2.7 Trench safety (introduction)

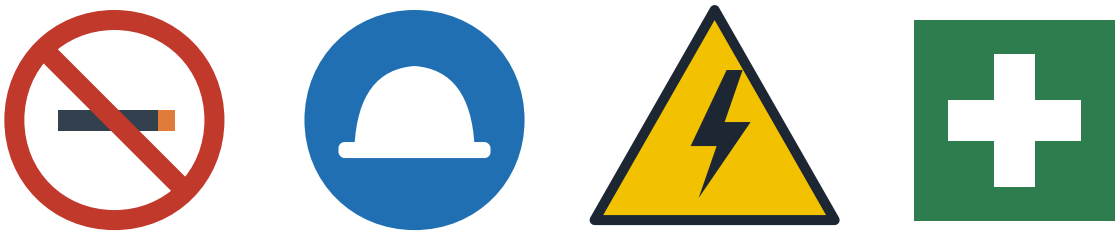
Below-ground drainage and supply pipes are laid in trenches. Soil can collapse without warning, and one cubic metre of soil weighs over a tonne. Chapter 12 covers trenches in detail, but learn these rules now:

- Support (shore) the sides of deep trenches, or cut them back to a safe slope. Your trainer or supervisor decides the method for the soil type.

- Keep the spoil heap (dug-out soil) and materials at least about 1 m back from the edge, or more for deep trenches.
- Use a ladder to get in and out, never the trench sides.
- Put barrier tape or a fence around open trenches, especially near homes and schools.
- Never stay in a trench after rain until it has been checked.

2.8 Safety signs

Safety signs use colour and shape so that you can understand them even before you read the words. Figure 2.3 shows the four main families of signs you will see on Kenyan sites and in workshops.



Prohibition
Red circle, bar
"You must NOT"
e.g. No smoking

Mandatory
Blue circle
"You MUST"
e.g. Wear hard hat

Warning
Yellow triangle
"Danger, take care"
e.g. Electric shock

Safe condition
Green square
"This way to safety"
e.g. First aid

Fire equipment: red square, white symbol (extinguisher, hose reel, fire alarm)

Figure 2.3 Safety sign families: shape and colour tell you the type of message.

2.9 Hazard identification and simple risk assessment

Before any job, stop for a few minutes and look around. A simple risk assessment has five steps:

1. **Look for hazards:** what could cause harm here?
2. **Decide who could be harmed and how:** you, workmates, the family, passers-by.
3. **Rate the risk:** how likely, and how serious? Use Low, Medium or High.
4. **Decide on controls:** using the order in Section 2.1.
5. **Record and review:** write it down and check again if things change.

Table 2.2 Example risk assessment: replacing a tank outlet valve on a 3 m stand

Hazard	Who / how harmed	Risk	Controls
Fall from ladder or stand	Plumber; broken bones, head injury	High	Ladder at 1-in-4, footed by helper; check stand condition; three points of contact; hard hat.
Tools dropped from height	Helper below; head injury	Medium	Tool belt; lift tools with rope; helper wears hard hat and stands clear.
Water spilling onto electrical socket below	Anyone; electric shock	Medium	Close tank outlet first; drain to a bucket or garden; isolate nearby socket.
Slippery wet ground	Plumber and helper; slips	Low	Mop up; put down sand; wear boots with grip.

> **ON SITE IN KENYA**
>
> Many sites start the day with a short toolbox talk. Use it to share the day's hazards: "Today we connect the tank on the roof; the trench at the back is open; the electrician is working in the kitchen." Five minutes of talk can prevent weeks in hospital.

2.10 First aid basics

Every workshop and site should have a stocked first aid box and a trained first aider. Know where the box is and who the first aider is. Basic actions while help arrives:

- **Cuts:** press a clean pad firmly on the wound to stop bleeding. Raise the limb if you can. Wear gloves when treating others.
- **Burns** (from PPR welders or torches): cool under clean running water for at least 20 minutes. Remove rings or watches near the burn. Cover loosely with clean cling film or a clean cloth. Do not apply butter, toothpaste or oil.
- **Eye injuries:** rinse with clean running water for at least 15 minutes, holding the eyelid open. Do not rub. Seek medical help for anything stuck in the eye.
- **Chemical splash on skin:** remove soaked clothing, rinse with plenty of running water for at least 15 minutes and check the product label or safety sheet.
- **Falls:** do not move a person who may have a back or neck injury unless they are in danger. Call for help.
- **Electric shock:** switch off the power first, then check breathing and call for help.

Report every injury and record it in the accident book, however small. Records help stop the same accident happening again.

2.11 Green plumbing

Your curriculum is "greened". This means you must work in a way that protects the environment, saves water and energy, and reduces waste. In Kenya, environmental protection is overseen by NEMA, water resources by the Water Resources Authority (WRA), and household water supply by county water service providers. Green plumbing is also good business: customers want lower water bills.

2.11.1 Saving water

- Fix drips and leaks quickly. A tap that drips once a second can waste over 10 litres a day.
- Recommend water-efficient fittings: aerated taps, self-closing taps, dual-flush cisterns and low-flow showerheads.
- When you test pipework, collect the test water and reuse it (for example for mixing mortar or watering plants) instead of pouring it away.
- Suggest rainwater harvesting from roofs, which suits most of Kenya's rainy seasons.

2.11.2 Non-toxic and low-VOC materials

Some glues, primers and sealants give off VOCs. These vapours can cause headaches and breathing problems, and they pollute the air. Choose water-based or low-VOC sealants where possible, buy KEBS-marked pipes and fittings, use lead-free materials for drinking water, and always ventilate when using solvent cement. Close tins after use so vapour does not escape and the product does not dry out.

2.11.3 Energy-efficient tools and working

- Choose energy-efficient power tools and keep them well maintained. Sharp cutters and dies use less power.
- Switch off PPR welders and threading machines between jobs; do not leave them heating all day.
- Use hand tools for small jobs where a power tool is not needed.
- Plan your trips to the hardware shop. One well-planned trip saves fuel and time.

2.11.4 The waste hierarchy

The waste hierarchy (Figure 2.4) ranks ways of dealing with waste from best to worst. Always start at the top.

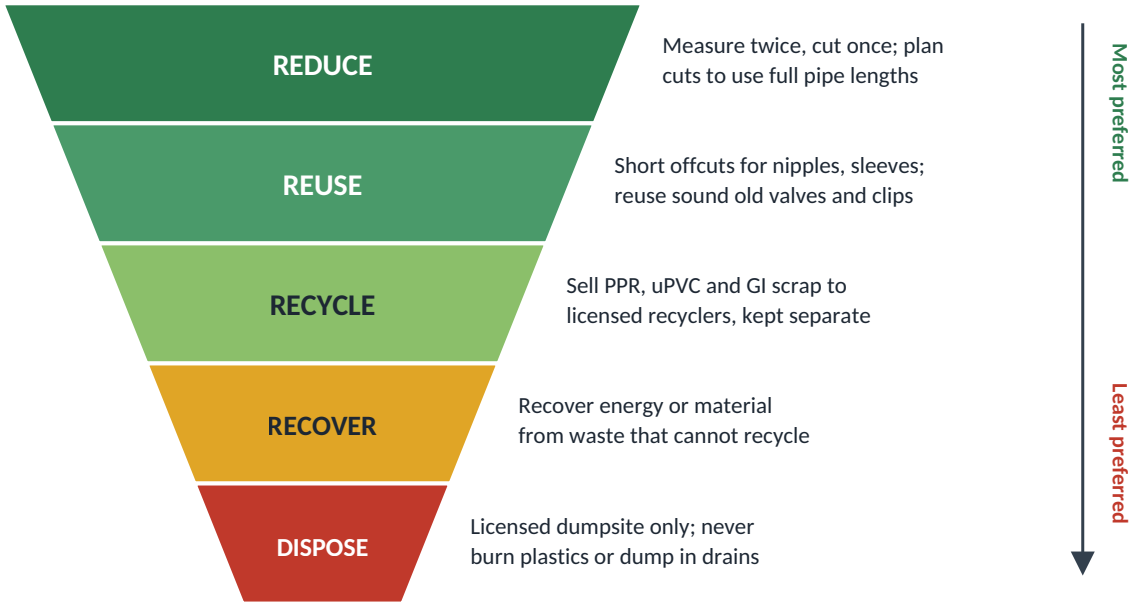


Figure 2.4 The waste hierarchy with plumbing examples. Work from the top: reduce first, dispose last.

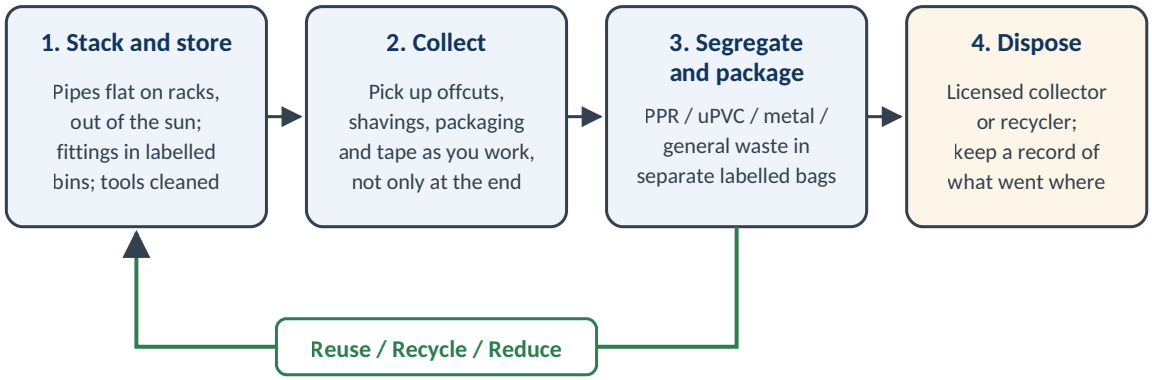
- **Reduce:** order the right amount, plan cuts, and store materials so they are not damaged by sun or knocks. Less waste starts with good measuring.

- **Reuse:** use offcuts for short nipples, sleeves through walls or training practice. Reuse sound pipe clips, valves and packaging.
- **Recycle:** PPR, uPVC, HDPE and GI metal are all recyclable, but only if they are kept separate and clean.
- **Recover:** where recycling is not possible, some waste can still give useful energy or material through licensed operators.
- **Dispose:** the last option. Use licensed waste collectors and dumpsites. Never burn plastic pipes, which gives off toxic smoke, and never pour solvents, oils or cement slurry into drains.

> **GREEN TIP**
>
> Keep three labelled sacks on every job: "PPR/PE", "uPVC" and "Metal". Scrap dealers in most towns buy clean GI and copper, and some plastic recyclers take PPR and uPVC. The money can pay for your lunch, and the pipes stay out of rivers.

2.12 Housekeeping

Housekeeping means keeping the work area clean, orderly and safe. It is assessed in every unit. Good housekeeping prevents trips and cuts, protects materials and leaves the customer happy. It follows a cycle, shown in Figure 2.5.



Useful offcuts and sorted scrap go back into stock or to a recycler, so less reaches the dumpsite.

Figure 2.5 The housekeeping cycle used on every job, with the green loop back into reuse and recycling.

2.12.1 Stack and store

Store pipes flat on racks so they do not bend, with the same sizes together. Keep plastic pipes under cover, because sunlight makes PPR and uPVC brittle. Keep fittings in labelled boxes by type and size. Store solvent cements, primers and fuels in a cool, ventilated, locked place away from heat. Clean, dry and oil tools before putting them away.

2.12.2 Collect, segregate and package

Clean as you go. Sweep up PPR beads, metal filings and plastic shavings. Wipe up cutting oil before someone slips. Segregate waste into plastic types, metal, packaging and general waste. Package sharp metal offcuts in a strong sack or box so they cannot cut the person who carries them.

2.12.3 Disposal

Hand recyclable materials to recyclers. Give general waste to a licensed collector. Used oil, solvent tins and chemical containers must not go into drains or open ground; return them to the supplier or a licensed handler. Leave the customer's home cleaner than you found it.

COMMON MISTAKES

- Wearing PPE only when the trainer is watching.
- Standing a ladder too steep or too flat, or working from the top rung.
- Leaving a hot PPR welder on the floor where someone can step on it.
- Throwing all offcuts into one sack, so nothing can be recycled.
- Pouring solvent, cement slurry or cutting oil into the nearest drain.
- Leaving the cleanup until the end of the day, by which time someone has tripped.

Practical task 2.1: Risk assessment and housekeeping of a workshop bay

Tools and equipment

- Full PPE: overall, boots, gloves, goggles
- Ladder (for the ladder check)
- Steel tape measure
- Broom, dustpan, bucket
- Clipboard and pen

Materials

- Risk assessment form (as Table 2.2)
- Four labelled sacks: PPR/PE, uPVC, Metal, General
- Marker pen and labels
- Barrier tape

Steps

1. Put on and check your PPE. Ask a partner to check you against Figure 2.1.
2. Walk round your assigned bay. List at least five hazards on the form.
3. For each hazard, note who could be harmed, rate the risk and write a control.
4. Set up the ladder against a wall to reach a 2 m mark. Measure the distance out and check it is about 0.5 m (1 in 4).
5. Collect all offcuts and waste in the bay. Sort them into the four sacks and label each sack.
6. Stack pipes by type and size on the rack; put fittings in labelled boxes; clean and return tools.
7. Present your risk assessment and sorted waste to your trainer for checking and signing. Add the form to your portfolio.

Safety

- Wear gloves when handling metal offcuts; they have sharp edges.
- Have your partner foot the ladder; do not climb above the second rung for this exercise.
- Do not move or switch on any machine during the inspection.

Chapter summary

- Control hazards in order: remove, replace, guard, safe working methods, then PPE as the last line of defence.
- Choose PPE for the task and check it before every use.
- Follow workshop rules and SOPs; keep power tools away from water and switch off before changing bits.
- Lift with your legs, not your back, and get help with long or heavy loads.
- Set ladders at 1 out for every 4 up (about 75°), footed or tied, extending about 1 m above the landing.
- A simple risk assessment lists hazards, who is harmed, the risk level and the controls.
- Green plumbing saves water and energy, uses non-toxic, low-VOC materials and follows the waste hierarchy.
- Housekeeping: stack and store, collect, segregate and package, dispose, and loop back to reuse and recycle.

Check your competence

- [ ] I can select and wear the correct PPE for cutting, welding, chasing and drain work.
- [ ] I can check PPE and tools for damage before use.
- [ ] I can follow the workshop rules and the SOP for a machine.
- [ ] I can set up a ladder using the 1-in-4 rule.
- [ ] I can identify hazards on a job and write a simple risk assessment.
- [ ] I can give first aid for a minor cut or burn and report the accident.
- [ ] I can explain the waste hierarchy using plumbing examples.
- [ ] I can segregate, package and correctly dispose of plumbing waste.
- [ ] I can suggest at least three ways to save water on a domestic job.

Practice questions

1. Explain the difference between a hazard and a risk, with one plumbing example.
2. List the PPE you would wear to (a) thread a GI pipe and (b) clear a blocked sewer.
3. Why is PPE called "the last line of defence"?
4. Calculation: A ladder must reach a tank platform 3.6 m high. How far from the wall should its foot be? About how long must the ladder be if it extends 1 m above the platform?
5. Describe how to lift a WC pan safely from the floor.
6. State four safety rules for using power tools near water.
7. What do the colours and shapes of these signs mean: a blue circle, a yellow triangle, a red circle with a bar, a green square?
8. Describe the first aid for a burn from a PPR welding machine.
9. Oral: What does VOC stand for? Why should a plumber choose low-VOC sealants?
10. Practical: After installing a bathroom, you have PPR offcuts, uPVC offcuts, GI nipples, cardboard boxes and an empty solvent tin. Explain how you will deal with each using the waste hierarchy.

PART 2

Water Supply Systems

Unit 1: Install Water Supply System I. Pipes and materials, drawings, installing domestic pipework, and keeping it working.

Chapter 3: Pipes and Materials
Chapter 4: Reading and Sketching Plumbing Drawings
Chapter 5: Installing Domestic Pipework
Chapter 6: Maintaining Domestic Pipework