

Why Maths Is Essential in Plumbing and Heating

Accurate mathematical skills help you to:

1. Measure pipe runs, offsets, and fitting positions.
2. Calculate area, volume, and capacity.
3. Work out flow rates and filling times.
4. Understand gradients, pressure, and head.
5. Estimate heat demand and system output.
6. Calculate material quantities, labour time, and costs.
7. Read drawings, tables, specifications, and manufacturer data.

Accuracy in these areas is closely linked to safe installation, good workmanship, compliance, and professional credibility.

How This Book Is Structured

This book follows a logical learning path:

1. Core number skills, including basic operations, fractions, decimals, and percentages.
2. Ratios, proportion, and unit conversions.
3. Perimeter, area, volume, and practical measurement.
4. Formulas and rearranging simple equations.
5. Applied plumbing and heating calculations for pipework, water, heating systems, drainage, and costing.
6. More advanced Level 3 topics including heat loss, stored energy, pumps, and system design.

Each chapter includes clear explanations, step-by-step worked examples, trade-based applications, and practice questions designed to build understanding gradually. The intention is not simply to teach mathematics in isolation, but to teach plumbing and heating maths in a way that makes sense on site and in training.

How to Use This Book

For best results:

1. Work through the chapters in order.
2. Attempt all practice exercises and check your answers carefully.
3. Do not skip the foundation topics, even if they seem familiar at first.
4. Revisit earlier sections whenever a later topic feels difficult.
5. Practice methods by hand before relying entirely on a calculator.

Confidence in maths comes from repetition, understanding, and steady use, not from memorising isolated answers.

A Final Word

Becoming a skilled plumber or heating engineer involves much more than fitting systems and connecting components. It requires accuracy, logical thinking, and the ability to solve problems in real conditions. Mathematics supports all of those skills.

Develop it, practice it, and apply it consistently, and it will strengthen every stage of your training and professional work.

Why This Book?

This book was written from a simple and repeated observation: many plumbing and heating learners struggle with calculations not because the maths is too advanced, but because earlier building blocks were never properly secured. When those basics are explained clearly and linked to real trade tasks, learners make progress much faster.

The approach behind this guide combines:

- An understanding of the mathematical demands of plumbing and heating training.
- Awareness of the common difficulties faced by vocational learners.
- Clear explanations without unnecessary academic language.
- Practical examples drawn from domestic and light commercial work.
- Step-by-step progression from foundation maths to applied calculations.

Unit 2: Fractions

Learning Outcomes

By the end of this unit, you will be able to:

- Understand what fractions represent and identify different types.
- Simplify fractions to their lowest terms.
- Convert between fractions, decimals, and percentages.
- Add, subtract, multiply, and divide fractions confidently.
- Work with mixed numbers in practical contexts.
- Apply fractions to plumbing and heating calculations.
- Solve real-world plumbing and heating problems using fractions.
- Calculate flow sharing, pressure drops, and diversity factors in systems.

Introduction

Fractions are commonly used when working with measurements, pipe lengths, fittings, and equipment specifications. This unit helps learners:

- Interpret and calculate partial values such as flow and capacity.
- Work with imperial measurements still used on site.
- Accurately divide materials and components.
- Understand ratios expressed as fractions.

Strong fraction skills prevent costly mistakes in measurement, installation, and commissioning of plumbing and heating systems.

What This Solves

Fractions are essential in plumbing and heating work. You will use them regularly when:

- Working with pipe sizes such as 15 mm and 22 mm.
- Calculating pressure drops such as 10% loss across a run of pipework.

- Determining flow sharing and diversity factors in heating and hot water systems.
- Working with time-based calculations for heating cycles and pump run times.
- Converting between different measurement units, including litres, cubic metres, minutes, and hours.
- Estimating heat outputs and boiler duties as fractions of maximum demand.
- Determining balancing settings on radiators and manifolds.
- Splitting total flow between branches in proportion to demand.

This guide focuses on fractions as a fundamental mathematical skill that enables precise calculations and clear communication of plumbing and heating values.

2.1 Introduction to Fractions

A fraction represents part of a whole. It consists of two numbers separated by a line:

Numerator / Denominator

- Numerator: the top number, showing how many parts you have.
- Denominator: the bottom number, showing how many equal parts make the whole.

Example: $\frac{3}{4}$ means 3 parts out of 4 equal parts.

2.2 What Are Fractions?

Basic Concept

Common ways to read fractions:

- $\frac{1}{2}$ = one half or one over two.
- $\frac{3}{4}$ = three quarters or three over four.
- $\frac{2}{3}$ = two thirds or two over three.
- $\frac{5}{8}$ = five eighths or five over eight.

Types of Fractions

1. Proper fractions: numerator is less than denominator, so the value is less than 1.

Example: $\frac{1}{2}, \frac{3}{4}, \frac{5}{8}, \frac{2}{3}$

2. Improper fractions: numerator is greater than or equal to denominator, so the value is

1 or more. Example: $\frac{5}{3}, \frac{7}{4}, \frac{9}{2}, \frac{8}{8}$

3. Mixed numbers: a whole number plus a proper fraction. Example: $1\frac{1}{2}, 2\frac{3}{4}, 3\frac{5}{8}$

Equivalent Fractions

Different fractions can represent the same value:

- $\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{4}{8} = \frac{5}{10}$
- $\frac{2}{3} = \frac{4}{6} = \frac{6}{9} = \frac{8}{12}$

Rule: multiply or divide both numerator and denominator by the same number to create equivalent fractions.

Example:

$$\frac{1}{2} \times \frac{3}{3} = \frac{3}{6}$$

Both fractions represent the same amount.

Fractions in Plumbing and Heating Work

- Pipe sizes: 15 mm and 22 mm.
- Pressure limits: maximum 10% loss over a branch.
- Diversity factors: three-quarters flow $\frac{3}{4}$, two-thirds heat demand $\frac{2}{3}$.
- Time: half hour $\frac{1}{2}$, quarter hour $\frac{1}{4}$, three quarters of an hour $\frac{3}{4}$, often used for boiler run times and hot water recovery.

2.3 Simplifying Fractions

Why Simplify?

Simplified fractions are:

- Easier to understand.
- Easier to work with in calculations.
- The standard way to express final answers.

Example: $\frac{6}{8}$ simplified is $\frac{3}{4}$.

The Method

Step 1: Find the Highest Common Factor (HCF) of numerator and denominator.

Step 2: Divide both by the HCF.

Finding the Highest Common Factor

Method 1: List factors.

For $\frac{12}{16}$:

- Factors of 12: 1, 2, 3, 4, 6, 12
- Factors of 16: 1, 2, 4, 8, 16
- Common factors: 1, 2, 4
- HCF = 4

Method 2: Divide by obvious common factors.

For $\frac{12}{16}$:

- Both divide by 2: $\frac{6}{8}$
- Both divide by 2 again: $\frac{3}{4}$

Mixed Numbers

Method 1: convert to improper fractions.

Example:

$$2\frac{3}{4} + 1\frac{1}{2} = \frac{11}{4} + \frac{3}{2} = \frac{11}{4} + \frac{6}{4} = \frac{17}{4} = 4\frac{1}{4}$$

Method 2: handle whole numbers and fractions separately.

Example:

$$2\frac{3}{4} + 1\frac{1}{2} = 2 + 1 + \frac{3}{4} + \frac{1}{2} = 3 + \frac{3}{4} + \frac{2}{4} = 4\frac{1}{4}$$

Plumbing and Heating Application

A heating system runs for $2\frac{1}{4}$ hours in the morning and $3\frac{1}{2}$ hours in the afternoon.

Total time:

$$2\frac{1}{4} + 3\frac{1}{2} = 5\frac{3}{4} \text{ hours.}$$

2.6 Multiplying Fractions

Basic Rule

Multiply numerators together, multiply denominators together, then simplify.

Examples:

- $\frac{2}{3} \times \frac{3}{4} = \frac{6}{12} = \frac{1}{2}$
- $\frac{5}{6} \times \frac{2}{5} = \frac{10}{30} = \frac{1}{3}$
- $\frac{3}{8} \times \frac{4}{9} = \frac{12}{72} = \frac{1}{6}$
- $\frac{7}{10} \times \frac{5}{14} = \frac{35}{140} = \frac{1}{4}$

Plumbing and Heating Applications

1. A heating circuit must handle $2\frac{1}{2}$ times the normal design flow. Normal flow is 16 litres per minute.

$$16 \times 2\frac{1}{2} = 16 \times \frac{5}{2} = 40 \text{ l/min.}$$

2. Diversity factor is $\frac{3}{4}$ of installed heat demand. Total heat demand is 32 kW.

$$32 \times \frac{3}{4} = 24 \text{ kW.}$$

3. A boiler runs for $3\frac{1}{2}$ hours at 2 kW heat output.

$$\text{Heat delivered} = 2 \times 3\frac{1}{2} = 7 \text{ kWh.}$$

2.7 Dividing Fractions

The Key Rule

To divide by a fraction, flip it and multiply.

Examples:

- $\frac{3}{4} \div \frac{2}{3} = \frac{3}{4} \times \frac{3}{2} = \frac{9}{8} = 1\frac{1}{8}$

- $\frac{5}{6} \div \frac{1}{3} = \frac{5}{6} \times 3 = \frac{15}{6} = 2\frac{1}{2}$

- $\frac{7}{8} \div \frac{1}{4} = \frac{7}{8} \times 4 = 3\frac{1}{2}$

- $\frac{2}{3} \div \frac{4}{5} = \frac{2}{3} \times \frac{5}{4} = \frac{10}{12} = \frac{5}{6}$

Dividing Mixed Numbers

Convert to improper fractions first.

Example:

$$2\frac{1}{4} \div 1\frac{1}{2} = \frac{9}{4} \div \frac{3}{2} = \frac{9}{4} \times \frac{2}{3} = \frac{18}{12} = \frac{3}{2} = 1\frac{1}{2}$$

2.10 Practice Exercises

Using the guidance examples above, work through the following practice questions.

Answers are given at the end of this unit.

Set A: Simplifying Fractions

1. $\frac{12}{16}$

2. $\frac{15}{25}$

3. $\frac{18}{24}$

4. $\frac{20}{100}$

5. $\frac{50}{200}$

Set B: Converting Between Forms

6. Convert $\frac{7}{3}$ to a mixed number.

7. Convert $3\frac{5}{8}$ to an improper fraction.

8. Convert $\frac{5}{8}$ to a decimal.

9. Convert 0.375 to a fraction.

10. Convert $\frac{3}{4}$ to a percentage.

Set C: Addition and Subtraction

11. $\frac{2}{5} + \frac{1}{3}$

12. $\frac{5}{6} - \frac{1}{4}$

13. $\frac{3}{8} + \frac{1}{4}$

14. $2\frac{1}{4} + 1\frac{1}{2}$

15. $3\frac{2}{3} - 1\frac{1}{4}$

Set J: Mixed Problems

46. Convert 0.625 to a fraction in simplest form.

$$0.625 = \frac{625}{1000}$$

Divide numerator and denominator by 125:

$$\frac{625}{1000} = \frac{5}{8}$$

Answer: $\frac{5}{8}$.

47. A branch takes $\frac{7}{8}$ of a 40 l/min total flow.

Flow in the branch:

$$40 \times \frac{7}{8} = \frac{280}{8} = 35 \text{ l/min.}$$

Answer: 35 l/min.

48. Four heating circuits share flow equally, each taking $\frac{1}{4}$. Total flow is 80 l/min.

Flow per circuit:

$$\frac{1}{4} \times 80 = 20 \text{ l/min.}$$

Answer: 20 l/min per circuit.

49. Express $\frac{5}{8}$ as a decimal and a percentage.

Decimal:

$$\frac{5}{8} = 0.625$$

Percentage:

$$0.625 \times 100 = 62.5\%.$$

Answer: 0.625 and 62.5%.

50. Pipe length $18\frac{3}{4}$ m is cut into 5 equal pieces.