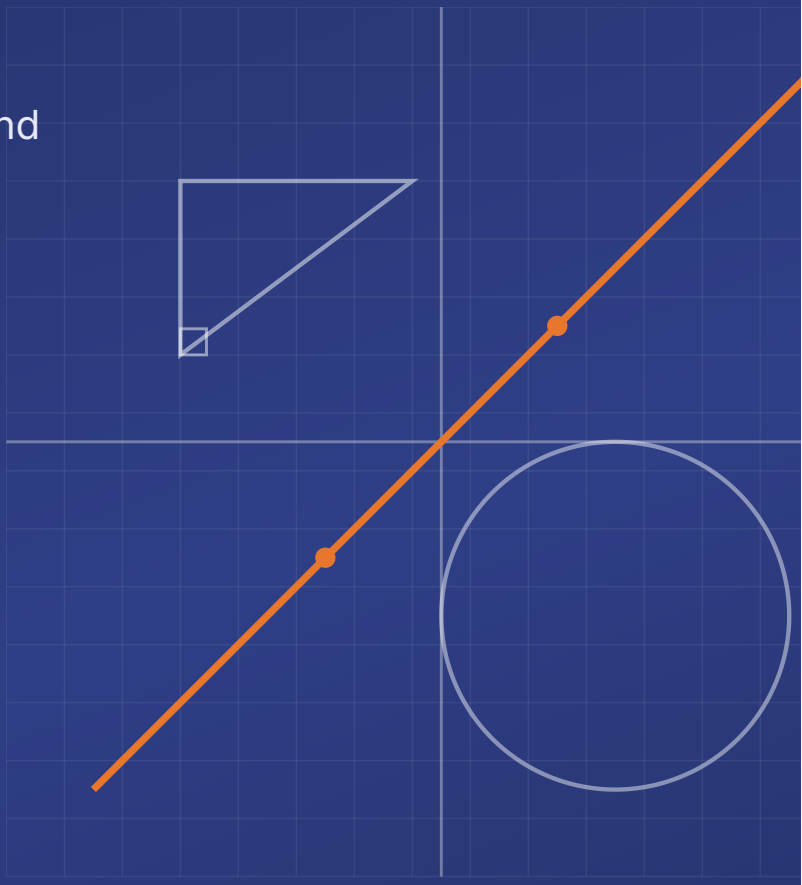
EXAM READY MATHEMATICS

Exam Ready Mathematics

GRADE 8

Study Guide, Worked Examples and Practice Tests for the Grade 8 Examination



- ✓ **8 units** with clear key ideas and “Watch out!” boxes
- ✓ **155 worked examples** and **260 practice questions** at three levels
- ✓ **160 unit-quiz questions** and **3 full mock exams** (40 MCQ each)
- ✓ Diagnostic test · Top 20 Mistakes page · teacher notes for every unit

Follows the units and order of the Addis Ababa Grade 8 Mathematics textbook

ERMIAS WEDAJE TEGBARU

Exam Ready Mathematics

Grade 8

Study Guide, Worked Examples and Practice Tests

ERMIAS WEDAJE TEGBARU

© 2026 Ermias Wedaje Tegbaru. All rights reserved. No part of this book may be copied, shared or sold without the written permission of the author.

This is an independent study guide. It follows the Grade 8 Mathematics curriculum used in Addis Ababa, but it is not an official publication of the Addis Ababa City Administration Education Bureau or the Ministry of Education. All explanations, examples and questions are original.

Every answer in this book was checked by computer. If you find a mistake, please tell the author on Telegram (@Ermias_Wedaje) so it can be corrected in the next edition.

First edition, 2026.

Thank you for buying this book from ye-buna.com/ermiaswedaje. This copy is for your own family or classroom use. Please do not share the file; recommend the book to friends instead, so the author can keep writing.

How to Use This Book

Each unit follows the same pattern, so you always know where to look. Examples marked **Exam Booster** cover question types that appear often in recent model examinations.

Key ideas
The rules and facts of the section, short and clear.

Worked examples
Step-by-step solutions. Cover the solution and try first.

Watch out!
The mistakes students make most often, and the right way.

Practice
Level 1 Basic · Level 2 Standard · Level 3 Challenge.

Exam-style quiz
20 multiple-choice questions in the national exam style.

For the Teacher
Timing, starters, misconceptions, activities and assessment.

For students

- Begin with the **Diagnostic Test** on page 1. It shows which units need the most work.
- Read the key ideas, then study each example with the solution covered.
- Do Level 1 and Level 2 practice for every section; try Level 3 when you are ready.
- Take the quiz in 30 minutes, mark it with the answers at the end of the unit, and redo every question you got wrong.
- In the final weeks, learn the Formula and Fact Sheet and the Top 20 Mistakes page, and sit the three mock exams in one hour each. The mock answer keys show which unit each question comes from, so you know what to revise.

For teachers

- Each unit follows the textbook sections, so the book can be used alongside your lessons.
- The “For the Teacher” page gives a suggested number of periods, five-minute starters, common misconceptions with fixes, and ideas for activities and differentiation.
- The quizzes and mock exams can be used as class tests; the answer tables include a short reason for each answer.

Contents

Start	Diagnostic Test · Where Should I Start?	1
Unit 1	Rational Numbers	3
Unit 2	Squares, Square Roots, Cubes and Cube Roots	16
Unit 3	Coordinates, Linear Equations and Inequalities	28
Unit 4	Similar Figures	43
Unit 5	Theorems on Triangles	55
Unit 6	Circles	66
Unit 7	Solid Figures: Surface Area and Volume	76
Unit 8	Introduction to Probability	86
	Formula and Fact Sheet	95
	Top 20 Mistakes to Avoid	97
	Exam Strategy	98
	Mock Examination 1 · First Semester (Units 1–3)	99
	Mock Examination 2 · Full Year	102
	Mock Examination 3 · Full Year	105
	Answers to the Mock Examinations	108

Page numbers refer to the numbers printed at the foot of each page.

Diagnostic Test · Where Should I Start?

16 questions · 20 minutes. Take this test **before** you start the book. There are two questions on each unit. Do not worry about your score: the test only shows you where to spend your time.

1. $-\frac{2}{3}+\frac{3}{4}=$
   A. $-\frac{1}{12}$ **B.** $\frac{5}{12}$ **C.** $\frac{1}{7}$ **D.** $\frac{1}{12}$

2. The simple interest on 5000 birr at 6% per year for 2 years is
   A. 5600 birr **B.** 60 birr **C.** 600 birr **D.** 300 birr

3. $\sqrt{0.0081}=$
   A. 0.0405 **B.** 0.009 **C.** 0.9 **D.** 0.09

4. The smallest whole number that 50 must be multiplied by to give a perfect square is
   A. 10 **B.** 2 **C.** 25 **D.** 5

5. The slope of the line through $(0,1)$ and $(2,7)$ is
   A. $\frac{1}{3}$ **B.** 3 **C.** 6 **D.** 4

6. The solution of $4-3x>10$ is
   A. $x>-2$ **B.** $x<2$ **C.** $x>2$ **D.** $x<-2$

7. Two similar triangles have scale factor 4. The smaller has area 3 cm². The larger has area
   A. 48 cm² **B.** 7 cm² **C.** 192 cm² **D.** 12 cm²

8. On a map with scale $1:50\,000$, 4 cm represents
   A. 200 m **B.** 2 km **C.** 0.2 km **D.** 20 km

9. The angles of a triangle are x, $3x$ and $5x$. The largest angle is
   A. 100° **B.** 20° **C.** 120° **D.** 60°

10. The legs of a right triangle are 7 and 24. The hypotenuse is
    A. 25 **B.** 17 **C.** 625 **D.** 31

11. An inscribed angle is 38°. The central angle on the same arc is
    A. 19° **B.** 76° **C.** 38° **D.** 142°

12. The circumference of a circle of diameter 14 cm ($\pi=\frac{22}{7}$) is
    A. 44 cm **B.** 154 cm **C.** 88 cm **D.** 22 cm

13. The volume of a cuboid 8 cm by 5 cm by 2 cm is
    A. 15 cm³ **B.** 40 cm³ **C.** 132 cm³ **D.** 80 cm³

14. The surface area of a cube of edge 3 cm is
    A. 36 cm² **B.** 27 cm² **C.** 54 cm² **D.** 9 cm²

15. A bag holds 2 red and 6 blue balls. $P(\text{red})=$
    A. $\frac{3}{4}$ **B.** $\frac{1}{3}$ **C.** $\frac{1}{4}$ **D.** $\frac{1}{2}$

16. Two coins are tossed. $P(\text{no heads})=$
    A. 0 **B.** $\frac{1}{2}$ **C.** $\frac{1}{4}$ **D.** $\frac{3}{4}$

Answers and Study Plan

Q	Unit	Ans	Why
1	1	D	$\frac{-8+9}{12}$
2	1	C	$\frac{5000\times6\times2}{100}$
3	2	D	Halve the decimal places
4	2	B	$50 = 2 \times 5^2$
5	3	B	$\frac{6}{2}$
6	3	D	$-3x > 6$; reverse the sign
7	4	A	3×4^2
8	4	B	200 000 cm
9	5	A	$9x = 180^\circ$
10	5	A	$\sqrt{49 + 576}$
11	6	B	Double
12	6	A	$\frac{22}{7} \times 14$
13	7	D	$8 \times 5 \times 2$
14	7	C	6×9
15	8	C	$\frac{2}{8}$
16	8	C	Only TT

How to use your result

- **Both questions right in a unit:** you know the basics. Read the Watch out! boxes, then go straight to the Level 2 and Level 3 practice and the quiz.
- **One right:** work through the unit normally, from the key ideas.
- **None right:** start with that unit first, slowly, and do every worked example yourself before looking at the solution.
- Take the test again after you finish the book and compare your two scores.

Unit 1 · Rational Numbers

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

- define rational numbers and write them as fractions
- show rational numbers on a number line
- explain how $\mathbb{N}$, $\mathbb{W}$, $\mathbb{Z}$ and $\mathbb{Q}$ are related
- find absolute values and solve simple absolute-value equations
- compare and order rational numbers
- add, subtract, multiply and divide rational numbers, and use their properties
- use rational numbers to solve real problems, including sharing, interest and loans

Before you start — check yourself. (a) $\frac{1}{2}+\frac{1}{4}$ (b) $-5+8$ (c) $(-3)\times(-4)$ (d) the LCM of 4 and 6
Answers: (a) $\frac{3}{4}$ (b) 3 (c) 12 (d) 12

Key words: rational number · numerator · denominator · integer · whole number · natural number · absolute value · reciprocal · additive inverse · simple interest · principal · rate

1.1 The Concept of Rational Numbers

Key ideas

- A **rational number** is any number that can be written as $\frac{a}{b}$, where a and b are integers and $b \neq 0$.
- Every integer is rational: $5=\frac{5}{1}$, $-3=\frac{-3}{1}$, $0=\frac{0}{1}$.
- Terminating decimals ($0.75=\frac{3}{4}$) and repeating decimals ($0.\overline{3}=\frac{1}{3}$) are rational.
- **The number sets:**
  $\mathbb{N}=\{1,2,3,\dots\}$ natural numbers · $\mathbb{W}=\{0,1,2,3,\dots\}$ whole numbers · $\mathbb{Z}=\{\dots,-2,-1,0,1,2,\dots\}$ integers · $\mathbb{Q}$ rational numbers
- Each set is inside the next: $\mathbb{N}\subset\mathbb{W}\subset\mathbb{Z}\subset\mathbb{Q}$.
- The **absolute value** $|a|$ is the distance of a from 0 on the number line. It is never negative: $|-3|=3$, $|3|=3$.

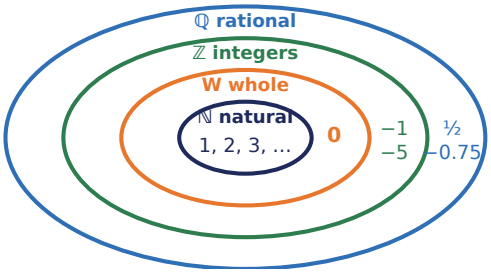


Figure 1.1 — N ⊂ W ⊂ Z ⊂ Q

Example 1.1 — Writing numbers in the form a/b

Write each number as $\frac{a}{b}$: (a) 5 (b) -0.4 (c) $1\frac{3}{4}$ (d) 0

Solution.
(a) $5 = \frac{5}{1}$
(b) $-0.4 = -\frac{4}{10} = -\frac{2}{5}$
(c) $1\frac{3}{4} = \frac{4+3}{4} = \frac{7}{4}$
(d) $0 = \frac{0}{1}$

Example 1.2 — Rational numbers on a number line

Show $-\frac{3}{2}$, $-\frac{1}{2}$, $\frac{3}{4}$ and $\frac{5}{4}$ on a number line.

Solution. Divide each unit into quarters. $-\frac{3}{2} = -1\frac{1}{2}$ is halfway between -2 and -1; $\frac{5}{4} = 1\frac{1}{4}$ is one quarter past 1.

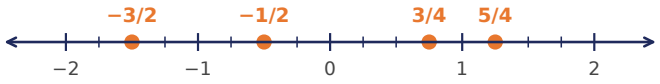


Figure 1.2

Example 1.3 — Classifying numbers

Put each number into every set it belongs to: 12, 0, -7, $\frac{3}{5}$, -2.5

Solution.

Number	$\mathbb{N}$	$\mathbb{W}$	$\mathbb{Z}$	$\mathbb{Q}$
12	✓	✓	✓	✓
0		✓	✓	✓
-7			✓	✓
$\frac{3}{5}$				✓
-2.5				✓

Example 1.4 — Absolute value

Find (a) $|-8|$ (b) $\left|\frac{3}{4}\right|$ (c) $|-2.5| + |1.5|$ (d) $-|-6|$

Solution.
(a) 8 (b) $\frac{3}{4}$ (c) $2.5 + 1.5 = 4$
(d) First $|-6| = 6$, then the minus sign outside: -6.

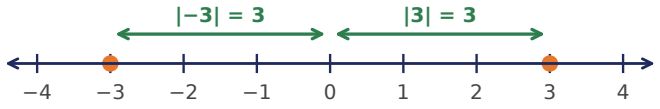


Figure 1.3 — 3 and −3 are both 3 units from 0

Example 1.5 — Absolute-value equations

Solve (a) $|x| = 5$ (b) $|x - 2| = 3$

Solution.
(a) The numbers 5 units from 0 are $x = 5$ or $x = -5$.
(b) $x - 2 = 3$ or $x - 2 = -3$, so $x = 5$ or $x = -1$.
Check: $|5 - 2| = 3$ ✓ and $|-1 - 2| = |-3| = 3$ ✓

Example 1.6 — Decimals to fractions

Write (a) 0.36 (b) $0.\overline{4}$ as fractions in lowest terms.

Solution.
(a) $0.36 = \frac{36}{100} = \frac{9}{25}$
(b) Let $x = 0.444\ldots$ Then $10x = 4.444\ldots$ Subtract: $9x = 4$, so $x = \frac{4}{9}$.

Watch out!

✗ Wrong	✓ Right
"0 is a natural number"	0 is a **whole** number, not a natural number
$\lvert -6\rvert = -6$	Absolute value is never negative: $\lvert -6\rvert = 6$
$\lvert x\rvert = 5 \Rightarrow x = 5$	**Two** answers: $x = 5$ or $x = -5$
$\frac{5}{0}$ is a rational number	Division by 0 is undefined; the denominator must not be 0

Practice 1.1

Level 1 — Basic

1. Write in the form $\frac{a}{b}$: (a) 7 (b) -3 (c) 0.6 (d) -1.25 (e) $2\frac{1}{3}$
2. True or false? (a) Every whole number is an integer. (b) Every integer is a natural number. (c) -4 is a rational number. (d) 0 is a natural number. (e) $\frac{2}{3}$ is an integer.
3. Find: (a) $|-9|$ (b) $|0|$ (c) $\left|\frac{7}{8}\right|$ (d) $-|-4|$

Level 2 — Standard

4. For the set $\{-6,\ 0,\ 5,\ \frac{3}{4},\ -1.2,\ \frac{9}{3}\}$, list the members that are (a) natural (b) whole (c) integers (d) rational.
5. Draw a number line from -2 to 2 and mark $-1\frac{1}{2}$, $\frac{1}{4}$, $-\frac{3}{4}$ and 1.75.
6. Evaluate $|-5| - |3| + |-2|$.
7. Write as fractions in lowest terms: (a) 0.45 (b) -0.125

Level 3 — Challenge

8. Solve: (a) $|x| = 7$ (b) $|x + 1| = 4$ (c) $|2x - 3| = 5$
9. Write as fractions: (a) $0.\overline{7}$ (b) $0.\overline{12}$
10. How many integers lie between -3.5 and 2.5?

1.2 Comparing and Ordering Rational Numbers

Key ideas

- On a number line, the number further to the **right is greater**.
- Every positive number is greater than every negative number. For two negatives, the one **closer to 0 is greater**: $-\frac{1}{2} > -\frac{3}{4}$.
- **Same denominator:** compare the numerators.
- **Different denominators:** rewrite with the LCM as the common denominator, or change both to decimals.
- **Cross-multiplication** (positive denominators): $\frac{a}{b} < \frac{c}{d}$ exactly when $ad < bc$.
- Between any two rational numbers there is always another one, for example their average $\frac{x+y}{2}$.

Example 1.7 — Using a common denominator

Which is greater, $\frac{3}{4}$ or $\frac{5}{7}$?

Solution. The LCM of 4 and 7 is 28.

$$\frac{3}{4} = \frac{21}{28}, \qquad \frac{5}{7} = \frac{20}{28}$$

Since $21 > 20$, $\frac{3}{4} > \frac{5}{7}$.

Example 1.8 — Comparing negative fractions

Compare $-\frac{2}{3}$ and $-\frac{3}{5}$.

Solution. $-\frac{2}{3} = -\frac{10}{15}$ and $-\frac{3}{5} = -\frac{9}{15}$. Since $-10 < -9$,

$$-\frac{2}{3} < -\frac{3}{5}$$

($-\frac{3}{5}$ is closer to 0.)

Example 1.9 — Ordering a mixed list

Arrange in ascending order: $0.6,\ \frac{2}{3},\ -\frac{1}{2},\ \frac{5}{8},\ -0.55$

Solution. Change all to decimals: $0.6,\ 0.666\ldots,\ -0.5,\ 0.625,\ -0.55$.
Ascending order: $-0.55,\ -\frac{1}{2},\ 0.6,\ \frac{5}{8},\ \frac{2}{3}$

Example 1.10 — A number in between

Find a rational number between $\frac{1}{3}$ and $\frac{1}{2}$.

Solution. Take the average:

$$\frac{1}{2}\left(\frac{1}{3} + \frac{1}{2}\right) = \frac{1}{2} \times \frac{5}{6} = \frac{5}{12}$$

Check: $\frac{1}{3} = \frac{4}{12} < \frac{5}{12} < \frac{6}{12} = \frac{1}{2}$ ✓

Watch out!

✗ Wrong	✓ Right
$-7 > -4$ "because 7 is bigger than 4"	-7 is further left: $-7 < -4$
$\frac{1}{5} > \frac{1}{3}$ "because 5 is bigger"	Bigger denominator → **smaller** pieces: $\frac{1}{5} < \frac{1}{3}$
$0.305 > 0.35$ "because 305 > 35"	Compare place by place: $0.35 = 0.350 > 0.305$

Practice 1.2

Level 1 — Basic

1. Write $<$ or $>$: (a) $\frac{2}{5} \square \frac{3}{5}$ (b) $-4 \square -7$ (c) $-\frac{1}{2} \square \frac{1}{3}$ (d) $0.35 \square 0.305$
2. Arrange in ascending order: $-3,\ 2,\ -\frac{1}{2},\ 0,\ 1.5$

Level 2 — Standard

3. Compare: (a) $\frac{5}{6}$ and $\frac{7}{9}$ (b) $-\frac{3}{4}$ and $-\frac{5}{7}$
4. Arrange in descending order: $\frac{3}{4},\ 0.7,\ \frac{2}{3},\ 0.72$
5. Find a rational number between $\frac{2}{5}$ and $\frac{3}{5}$.

Level 3 — Challenge

6. Arrange in ascending order: $-\frac{5}{6},\ -0.8,\ -\frac{7}{9},\ -\frac{13}{16}$
7. Find three rational numbers between $-\frac{1}{4}$ and $-\frac{1}{5}$.
8. Which number is closest to 1: $\frac{7}{8}$, $\frac{9}{10}$, $\frac{11}{12}$ or 1.1?

1.3 Operations on Rational Numbers and Their Properties

Key ideas

- **Add or subtract:** use a common denominator, then add or subtract the numerators.
- **Multiply:** multiply the numerators and multiply the denominators: $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$
- **Divide:** multiply by the **reciprocal**: $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c}$
- **Sign rules** for $\times$ and $\div$: same signs → positive; different signs → negative.
- Change **mixed numbers** to improper fractions before multiplying or dividing.
- **Order of operations:** brackets → powers → $\times$ and $\div$ (left to right) → $+$ and $-$ (left to right).

Property	Addition	Multiplication
Commutative	$a + b = b + a$	$a \times b = b \times a$
Associative	$(a + b) + c = a + (b + c)$	$(a \times b) \times c = a \times (b \times c)$
Identity	$a + 0 = a$	$a \times 1 = a$
Inverse	$a + (-a) = 0$	$a \times \frac{1}{a} = 1\ (a = 0)$
Distributive	$a \times (b + c) = a \times b + a \times c$	

/

Example 1.11 — Adding with different signs

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

Example 1.12 — Subtracting mixed numbers

$$2\frac{1}{3}-3\frac{3}{4}=\frac{7}{3}-\frac{15}{4}=\frac{28}{12}-\frac{45}{12}=-\frac{17}{12}=-1\frac{5}{12}$$

Example 1.13 — Multiplying

$$\left(-\frac{4}{9}\right)\times\frac{3}{8}=-\frac{4\times 3}{9\times 8}=-\frac{12}{72}=-\frac{1}{6}$$

Tip: cancel first to keep the numbers small: $\frac{4}{8}=\frac{1}{2}$ and $\frac{3}{9}=\frac{1}{3}$.

Example 1.14 — Dividing

$$\left(-\frac{5}{6}\right)\div\left(-\frac{10}{9}\right)=\left(-\frac{5}{6}\right)\times\left(-\frac{9}{10}\right)=\frac{45}{60}=\frac{3}{4}$$

Same signs, so the answer is positive.

Example 1.15 — Order of operations

Evaluate $\frac{1}{2}+\frac{2}{3}\times\left(-\frac{3}{4}\right)$.

Solution. Multiply first:

$$\frac{2}{3}\times\left(-\frac{3}{4}\right)=-\frac{1}{2},\qquad\text{so}\qquad\frac{1}{2}+\left(-\frac{1}{2}\right)=0$$

Example 1.16 — Decimals

$$-2.4\times 0.5+1.8=-1.2+1.8=0.6$$

Example 1.17 — Using a property to calculate quickly

Evaluate $\frac{3}{5}\times 7+\frac{3}{5}\times 3$.

Solution. Use the distributive property:

$$\frac{3}{5}\times(7+3)=\frac{3}{5}\times 10=6$$

Watch out!

✗ Wrong	✓ Right
$\frac{1}{2}+\frac{1}{3}=\frac{2}{5}$	Use a common denominator: $\frac{3}{6}+\frac{2}{6}=\frac{5}{6}$
$\frac{2}{3}\div\frac{4}{5}=\frac{2}{3}\times\frac{4}{5}$	Turn the **second** fraction over: $\frac{2}{3}\times\frac{5}{4}=\frac{5}{6}$
$2\frac{1}{2}\times 3=6\frac{1}{2}$	Change to $\frac{5}{2}$ first: $\frac{5}{2}\times 3=\frac{15}{2}=7\frac{1}{2}$
$\frac{1}{2}+\frac{1}{2}\times 4=4$ (adding first)	Multiply first: $\frac{1}{2}+2=2\frac{1}{2}$

Practice 1.3

Level 1 — Basic

1. Calculate: (a) $\frac{2}{7}+\frac{3}{7}$ (b) $\frac{5}{8}-\frac{7}{8}$ (c) $\left(-\frac{2}{3}\right)\times\frac{3}{5}$ (d) $\frac{4}{9}\div\frac{2}{3}$
2. Name the property shown: (a) $a+b=b+a$ (b) $\frac{3}{4}\times 1=\frac{3}{4}$ (c) $-\frac{2}{5}+\frac{2}{5}=0$ (d) $2(x+3)=2x+6$
3. Write the reciprocal of: (a) 5 (b) $-\frac{3}{8}$ (c) $1\frac{1}{4}$

Level 2 — Standard

4. Calculate: (a) $-\frac{5}{6}+\frac{3}{4}$ (b) $1\frac{1}{2}-2\frac{2}{3}$ (c) $\left(-3\frac{1}{3}\right)\times\left(-\frac{3}{5}\right)$ (d) $\left(-\frac{7}{12}\right)\div 1\frac{1}{6}$
5. Evaluate $\frac{2}{3}-\frac{1}{2}\times\frac{4}{9}$.
6. Evaluate $(-0.25+1.5)\times(-4)$.

Level 3 — Challenge

7. Evaluate $\left(\frac{3}{4}-\frac{5}{6}\right)\div\left(\frac{1}{2}+\frac{1}{3}\right)$.
8. Simplify $\dfrac{\frac{1}{2}-\frac{1}{3}}{\frac{1}{2}+\frac{1}{3}}$.
9. Use the distributive property to evaluate $\frac{7}{8}\times 19-\frac{7}{8}\times 11$ without a calculator.
10. If $a=-\frac{1}{2}$, $b=\frac{2}{3}$ and $c=-\frac{3}{4}$, find (a) $a+b\times c$ (b) $(a+b)\times c$.

1.4 Real-Life Applications of Rational Numbers

Key ideas

- **A fraction of a quantity:** $\frac{3}{5}$ of $400=\frac{3}{5}\times 400=240$
- **The remaining fraction** after parts are shared: $1-$ (sum of the parts)
- **Simple interest:**

$$I=\frac{P\times R\times T}{100}$$

  where P = principal (the money saved or borrowed), R = rate in % per year, T = time in years. The total amount is $A=P+I$.
- **Doubling at simple interest:** the money doubles when $I=P$, that is after $T=\frac{100}{R}$ years.
- **Percent:** $p\%$ of $Q=\frac{p}{100}\times Q$. An increase of $p\%$ multiplies by $1+\frac{p}{100}$; a decrease multiplies by $1-\frac{p}{100}$.
- **Working together:** if A finishes a job in a days and B in b days, together they do $\frac{1}{a}+\frac{1}{b}$ of the job each day.

Example 1.18 — Sharing land

Ato Kebede gives $\frac{1}{3}$ of his land to Almaz and $\frac{1}{4}$ to Dawit. Hana gets the rest. What fraction does Hana get? If the land is 2400 m², how much is Hana's part?

Solution.

$$\frac{1}{3}+\frac{1}{4}=\frac{7}{12}, \qquad 1-\frac{7}{12}=\frac{5}{12}$$

Hana's part: $\frac{5}{12}\times 2400 = 1000$ m².

Example 1.19 — Dividing into equal parts

How many $\frac{1}{4}$ kg bags can be filled from $2\frac{3}{4}$ kg of coffee?

Solution.

$$2\frac{3}{4}\div\frac{1}{4}=\frac{11}{4}\times 4 = 11 \text{ bags}$$

Example 1.20 — Simple interest on savings

Meron saves 20 000 birr in a bank at 7% per year simple interest for 3 years. Find the interest and the total amount.

Solution.

$$I=\frac{20\,000\times 7\times 3}{100}=4200 \text{ birr}, \qquad A=20\,000+4200=24\,200 \text{ birr}$$

Example 1.21 — A loan with monthly payments

Tesfaye borrows 60 000 birr at 12% simple interest per year for 2 years. He repays the total in 24 equal monthly payments. How much is each payment?

Solution.

$$I=\frac{60\,000\times 12\times 2}{100}=14\,400, \qquad A=74\,400 \text{ birr}$$

Each payment: $74\,400 \div 24 = 3100$ birr.

Example 1.22 — Finding the rate

15 000 birr grows to 18 000 birr in 4 years at simple interest. Find the rate.

Solution. $I = 18\,000 - 15\,000 = 3000$. Rearranging $I = \frac{PRT}{100}$:

$$R=\frac{100\,I}{P\,T}=\frac{100\times 3000}{15\,000\times 4}=5\%$$

Example 1.23 — Percent increase, then decrease

A school uniform costs 800 birr. The price rises by 15%, and later the new price falls by 10%. What is the final price?

Solution.

$$800 \times 1.15 = 920, \qquad 920 \times 0.90 = 828 \text{ birr}$$

Note: it is *not* $800 \times 1.05 = 840$. The 10% is taken from the new price, 920.

Example 1.24 — Working together

Tap A fills a water tank in 6 hours and tap B fills it in 3 hours. How long do they take together?

Solution. In one hour they fill

$$\frac{1}{6} + \frac{1}{3} = \frac{1}{6} + \frac{2}{6} = \frac{1}{2} \text{ of the tank}$$

So the whole tank takes **2 hours**.

Example 1.25 — When does money double?

Saba deposits 8000 birr at 12.5% simple interest per year. After how many years will her money be doubled?

Solution. Doubled means the interest equals the principal: $I = 8000$.

$$T = \frac{100\,I}{P\,R} = \frac{100 \times 8000}{8000 \times 12.5} = 8 \text{ years}$$

Shortcut: $T = \frac{100}{R} = \frac{100}{12.5} = 8$. The amount of money does not matter.

Watch out!

✗ Wrong	✓ Right
Interest $= 20\,000 \times 7 \times 3 = 420\,000$	Divide by 100: R is a **percentage**
"Total to repay = the interest"	Total $A = P + I$
Time of 6 months used as $T = 6$	T is in **years**: $T = \frac{6}{12} = \frac{1}{2}$
Together: $6 + 3 = 9$ hours	Add the **rates**, not the times: $\frac{1}{6} + \frac{1}{3} = \frac{1}{2}$ per hour → 2 hours

Practice 1.4

Level 1 — Basic

1. Find $\frac{2}{5}$ of 650 birr.
2. Find the simple interest on 8000 birr at 6% per year for 2 years.

Level 2 — Standard

3. In a class of 40 students, $\frac{3}{8}$ walk to school and $\frac{1}{4}$ come by bus. The rest come by taxi. What fraction come by taxi, and how many students is that?

4. Find the interest and the total amount when 30 000 birr is saved at 7.5% per year for 4 years.
5. A rope $12\frac{3}{4}$ m long is cut into pieces of $\frac{3}{4}$ m. How many pieces are there?

Level 3 — Challenge

6. How many years does it take 25 000 birr to earn 6000 birr of simple interest at 8% per year?
7. Abebe spends $\frac{1}{3}$ of his monthly salary on rent and $\frac{1}{4}$ on food. He saves the rest, which is 6000 birr. What is his salary?
8. A loan of 45 000 birr at 10% simple interest per year for 3 years is repaid in 36 equal monthly payments. Find the monthly payment.
9. In Debre Sina the temperature at 6 a.m. was -2.5°C. By noon it had risen by 8.75°C, and by evening it had fallen by 3.4°C. What was the evening temperature?
10. Find 40% of $\frac{3}{4}$ of 600 birr.
11. Selam can type a report in 4 hours and Hanna can type it in 12 hours. How long will it take them working together?
12. At what rate of simple interest will money double in 8 years?
13. A trader's profit was 62.4% in one year. The next year it was 4.75 percentage points lower. What was the profit in the second year?

Unit 1 Summary

Topic	Remember
Rational number	$\frac{a}{b}$ with a, b integers, $b \neq 0$
Number sets	$\mathbb{N} \subset \mathbb{W} \subset \mathbb{Z} \subset \mathbb{Q}$ · 0 is whole, not natural
Absolute value	distance from 0 · never negative · $\lvert x \rvert = a$ gives $x = \pm a$
Comparing	common denominator, decimals, or cross-multiply · right on the number line is greater
Add / subtract	common denominator first /
Multiply / divide	change mixed numbers first · divide = multiply by the reciprocal
Signs ($\times$, $\div$)	same → $+$ · different → $-$
Order of operations	brackets → powers → $\times \div$ → $+ -$
Simple interest	$I = \frac{PRT}{100}$ · $A = P + I$ · T in years · doubles after $\frac{100}{R}$ years
Percent change	$+p\%$: $\times \left(1 + \frac{p}{100}\right)$ · $-p\%$: $\times \left(1 - \frac{p}{100}\right)$
Working together	add the rates: $\frac{1}{a} + \frac{1}{b}$ per day

Unit 1 Exam-Style Quiz

Choose the correct answer. Suggested time: 30 minutes.

1. Which of these is **not** a rational number?

   A. $\frac{5}{0}$ **B.** $-\frac{7}{3}$ **C.** 2.5 **D.** 0

2. Which statement is true?

   A. Every rational number is an integer. **B.** Every whole number is a natural number. **C.** Every integer is a whole number. **D.** Every natural number is an integer.

3. $|-12| + |5| =$

A. 7 **B.** -7 **C.** -17 **D.** 17

4. Which number does point P represent?



A. $1\frac{1}{4}$ **B.** $-1\frac{1}{4}$ **C.** $-1\frac{3}{4}$ **D.** $-\frac{3}{4}$

5. The solutions of $|x| = 6$ are

A. 0 **B.** 6 only **C.** 6 and -6 **D.** -6 only

6. Which number is the greatest?

A. $\frac{3}{5}$ **B.** $\frac{5}{8}$ **C.** 0.61 **D.** 0.6

7. Which list is in ascending order?

A. $-\frac{1}{2}, 0, -\frac{2}{3}$ **B.** $-\frac{2}{3}, -\frac{1}{2}, 0$ **C.** $-\frac{1}{2}, -\frac{2}{3}, 0$ **D.** $0, -\frac{1}{2}, -\frac{2}{3}$

8. Which number lies between $\frac{1}{4}$ and $\frac{1}{2}$?

A. $\frac{1}{8}$ **B.** $\frac{2}{3}$ **C.** $\frac{1}{5}$ **D.** $\frac{3}{8}$

9. $-\frac{3}{4} + \frac{5}{8} =$

A. $-\frac{1}{8}$ **B.** $\frac{1}{8}$ **C.** $-\frac{2}{4}$ **D.** $\frac{2}{12}$

10. $2\frac{1}{2} - 3\frac{3}{4} =$

A. $-1\frac{1}{4}$ **B.** $-1\frac{3}{4}$ **C.** $-6\frac{1}{4}$ **D.** $1\frac{1}{4}$

11. $\left(-\frac{2}{3}\right) \times \frac{9}{10} =$

A. $\frac{3}{5}$ **B.** $-\frac{3}{5}$ **C.** $-\frac{20}{27}$ **D.** $-\frac{7}{13}$

12. $\left(-\frac{4}{5}\right) \div \left(-\frac{8}{15}\right) =$

A. $-\frac{3}{2}$ **B.** $\frac{32}{75}$ **C.** $\frac{2}{3}$ **D.** $\frac{3}{2}$

13. The reciprocal of $-1\frac{1}{3}$ is

A. $-\frac{3}{4}$ **B.** $\frac{3}{4}$ **C.** $\frac{4}{3}$ **D.** $-\frac{4}{3}$

14. $\frac{2}{5} \times (3 + 4) = \frac{2}{5} \times 3 + \frac{2}{5} \times 4$ shows the

A. identity property **B.** associative property **C.** distributive property **D.** commutative property

15. The additive inverse of $-\frac{7}{9}$ is

A. $\frac{7}{9}$ **B.** 0 **C.** $\frac{9}{7}$ **D.** $-\frac{9}{7}$

16. $\frac{1}{2} + \frac{1}{3} \times \frac{3}{4} =$

A. $\frac{5}{8}$ **B.** 1 **C.** $\frac{3}{4}$ **D.** $\frac{5}{12}$

17. $0.\overline{6}$ written as a fraction is

A. $\frac{1}{6}$ **B.** $\frac{6}{10}$ **C.** $\frac{3}{5}$ **D.** $\frac{2}{3}$

18. The simple interest on 12 000 birr at 5% per year for 3 years is

A. 13 800 birr **B.** 1800 birr **C.** 180 birr **D.** 600 birr

19. A family spends $\frac{2}{5}$ of its income on food and $\frac{1}{4}$ on rent. What fraction is left?

A. $\frac{1}{3}$ **B.** $\frac{3}{9}$ **C.** $\frac{7}{20}$ **D.** $\frac{13}{20}$

20. A $\frac{3}{4}$ kg bag of coffee is shared equally among 6 people. Each person gets

A. $\frac{1}{2}$ kg **B.** $\frac{2}{9}$ kg **C.** $\frac{1}{8}$ kg **D.** $4\frac{1}{2}$ kg

For the Teacher — Unit 1

Suggested timing (about 12 periods). 1.1: 3 periods · 1.2: 2 periods · 1.3: 4 periods · 1.4: 3 periods · Quiz and review: 1 period.

5-minute starters.
- *Where do I live?* Show a number and ask students to stand under the cards $\mathbb{N}$, $\mathbb{W}$, $\mathbb{Z}$ or $\mathbb{Q}$ for **every** set it belongs to.
- *Human number line:* give students cards like $-\frac{3}{4}$, 0.5, -1.2, $\frac{5}{4}$ and ask them to stand in order.

Common misconceptions and how to fix them.
- **"A bigger denominator means a bigger fraction."** Use injera or a drawn circle: cut one into 3 pieces and one into 5. Which piece is bigger?
- **"$-7 > -4$."** Use temperature: which is colder, -7°C or -4°C?
- **Adding the denominators** ($\frac{1}{2} + \frac{1}{3} = \frac{2}{5}$). Ask: is $\frac{2}{5}$ less than $\frac{1}{2}$? Then the answer can't be right, because we added something.
- **Forgetting the second answer to $|x| = a$.** Always draw the number line and mark both points.

Activity ideas.
- *Bank visit research:* students find the savings interest rate of two banks and calculate what 10 000 birr would earn in 3 years at each.
- *Recipe sharing:* scale a family recipe (for example shiro for 4 people) to 6 or 10 people using fractions.

Differentiation. Supported learners: Level 1, Examples 1.1–1.4 and 1.11–1.14. Extension: Level 3, then write a word problem about sharing an inheritance, a harvest or a loan.

Assessment. Quiz questions 1–5 check concepts, 6–13 check procedures, and 14–20 check properties and applications.

Answers and Worked Solutions — Unit 1

Practice 1.1

1. (a) $\frac{7}{1}$ (b) $\frac{-3}{1}$ (c) $\frac{3}{5}$ (d) $-\frac{5}{4}$ (e) $\frac{7}{3}$
2. (a) True (b) False (-1 is an integer but not natural) (c) True (d) False (e) False
3. (a) 9 (b) 0 (c) $\frac{7}{8}$ (d) -4
4. Note $\frac{9}{3} = 3$. (a) $5, \frac{9}{3}$ (b) $0, 5, \frac{9}{3}$ (c) $-6, 0, 5, \frac{9}{3}$ (d) all six numbers
5. $-1\frac{1}{2}$ halfway between -2 and -1; $-\frac{3}{4}$ three quarters of the way from 0 to -1; $\frac{1}{4}$ one quarter past 0; 1.75 three quarters of the way from 1 to 2.
6. $5 - 3 + 2 = 4$
7. (a) $\frac{45}{100} = \frac{9}{20}$ (b) $-\frac{125}{1000} = -\frac{1}{8}$
8. (a) $x = 7$ or -7 (b) $x + 1 = \pm 4$, so $x = 3$ or -5 (c) $2x - 3 = \pm 5$, so $x = 4$ or -1
9. (a) $\frac{7}{9}$ (b) $x = 0.1212\ldots$, $100x = 12.1212\ldots$, $99x = 12$, $x = \frac{12}{99} = \frac{4}{33}$
10. $-3, -2, -1, 0, 1, 2$: **6 integers**

Practice 1.2

1. (a) $<$ (b) $>$ (c) $<$ (d) $>$
2. $-3, -\frac{1}{2}, 0, 1.5, 2$
3. (a) $\frac{15}{18} > \frac{14}{18}$, so $\frac{5}{6} > \frac{7}{9}$ (b) $-\frac{21}{28} < -\frac{20}{28}$, so $-\frac{3}{4} < -\frac{5}{7}$
4. $0.75, 0.72, 0.7, 0.666\ldots$: $\frac{3}{4}, 0.72, 0.7, \frac{2}{3}$
5. $\frac{1}{2}$ (or any number between 0.4 and 0.6)
6. Decimals: $-0.833, -0.8, -0.778, -0.8125$. Ascending: $-\frac{5}{6}, -\frac{13}{16}, -0.8, -\frac{7}{9}$
7. $-\frac{1}{4} = -\frac{20}{80}$, $-\frac{1}{5} = -\frac{16}{80}$. For example $-\frac{19}{80}, -\frac{9}{40}, -\frac{17}{80}$.
8. Distances from 1: $\frac{1}{8}, \frac{1}{10}, \frac{1}{12}, \frac{1}{10}$. Closest: $\frac{11}{12}$.

Practice 1.3

1. (a) $\frac{5}{7}$ (b) $-\frac{2}{8} = -\frac{1}{4}$ (c) $-\frac{2}{5}$ (d) $\frac{4}{9} \times \frac{3}{2} = \frac{2}{3}$
2. (a) commutative (addition) (b) identity (multiplication) (c) additive inverse (d) distributive
3. (a) $\frac{1}{5}$ (b) $-\frac{8}{3}$ (c) $\frac{4}{5}$
4. (a) $-\frac{10}{12} + \frac{9}{12} = -\frac{1}{12}$ (b) $\frac{9}{6} - \frac{16}{6} = -\frac{7}{6} = -1\frac{1}{6}$ (c) $\left(-\frac{10}{3}\right)\left(-\frac{3}{5}\right) = 2$ (d) $-\frac{7}{12} \times \frac{6}{7} = -\frac{1}{2}$
5. $\frac{2}{3} - \frac{2}{9} = \frac{6}{9} - \frac{2}{9} = \frac{4}{9}$
6. $1.25 \times (-4) = -5$
7. $\left(-\frac{1}{12}\right) \div \frac{5}{6} = -\frac{1}{12} \times \frac{6}{5} = -\frac{1}{10}$
8. $\frac{1}{6} \div \frac{5}{6} = \frac{1}{5}$
9. $\frac{7}{8} \times (19 - 11) = \frac{7}{8} \times 8 = 7$
10. (a) $-\frac{1}{2} + \left(-\frac{1}{2}\right) = -1$ (b) $\frac{1}{6} \times \left(-\frac{3}{4}\right) = -\frac{1}{8}$

Practice 1.4

1. $\frac{2}{5} \times 650 = 260$ birr

2. $\frac{8000\times6\times2}{100} = 960$ birr
3. $1 - \frac{3}{8} - \frac{1}{4} = \frac{3}{8}$; $\frac{3}{8} \times 40 = 15$ students
4. $I = \frac{30\,000\times7.5\times4}{100} = 9000$ birr; $A = 39\,000$ birr
5. $\frac{51}{4} \div \frac{3}{4} = 17$ pieces
6. $T = \frac{100\times6000}{25\,000\times8} = 3$ years
7. Saved fraction $= 1 - \frac{1}{3} - \frac{1}{4} = \frac{5}{12}$. $\frac{5}{12}S = 6000$, so $S = 14\,400$ birr.
8. $I = \frac{45\,000\times10\times3}{100} = 13\,500$; total $58\,500$; monthly $58\,500 \div 36 = 1625$ birr
9. $-2.5 + 8.75 - 3.4 = 2.85°\text{C}$
10. $\frac{3}{4} \times 600 = 450$; $0.4 \times 450 = 180$ birr
11. $\frac{1}{4} + \frac{1}{12} = \frac{4}{12} = \frac{1}{3}$ per hour → **3 hours**
12. $R = \frac{100}{8} = 12.5\%$
13. $62.4 - 4.75 = 57.65\%$

Unit 1 Quiz

Q	Ans	Why
1	A	The denominator cannot be 0
2	D	$\mathbb{N} \subset \mathbb{Z}$
3	D	$12 + 5$
4	B	One and a quarter units left of 0
5	C	Two numbers are 6 units from 0
6	B	0.625 is the largest
7	B	$-\frac{2}{3} < -\frac{1}{2} < 0$
8	D	$\frac{1}{4} = \frac{2}{8} < \frac{3}{8} < \frac{4}{8}$
9	A	$-\frac{6}{8} + \frac{5}{8}$
10	A	$\frac{10}{4} - \frac{15}{4} = -\frac{5}{4}$
11	B	$-\frac{18}{30} = -\frac{3}{5}$
12	D	$\frac{4}{5} \times \frac{15}{8} = \frac{3}{2}$
13	A	$-\frac{4}{3} \to -\frac{3}{4}$
14	C	Distributive
15	A	$-\frac{7}{9} + \frac{7}{9} = 0$
16	C	Multiply first: $\frac{1}{2} + \frac{1}{4}$
17	D	$9x = 6$
18	B	$\frac{12\,000\times5\times3}{100}$
19	C	$1 - \frac{13}{20}$
20	C	$\frac{3}{4} \div 6 = \frac{1}{8}$

END OF FREE SAMPLE

Want the full book?

Mathematics Grade 8

ye-buna.com/ermiaswedaje

299 birr · instant PDF download

Ermias Wedaje Tegbaru · Civil engineer and author, Addis Ababa