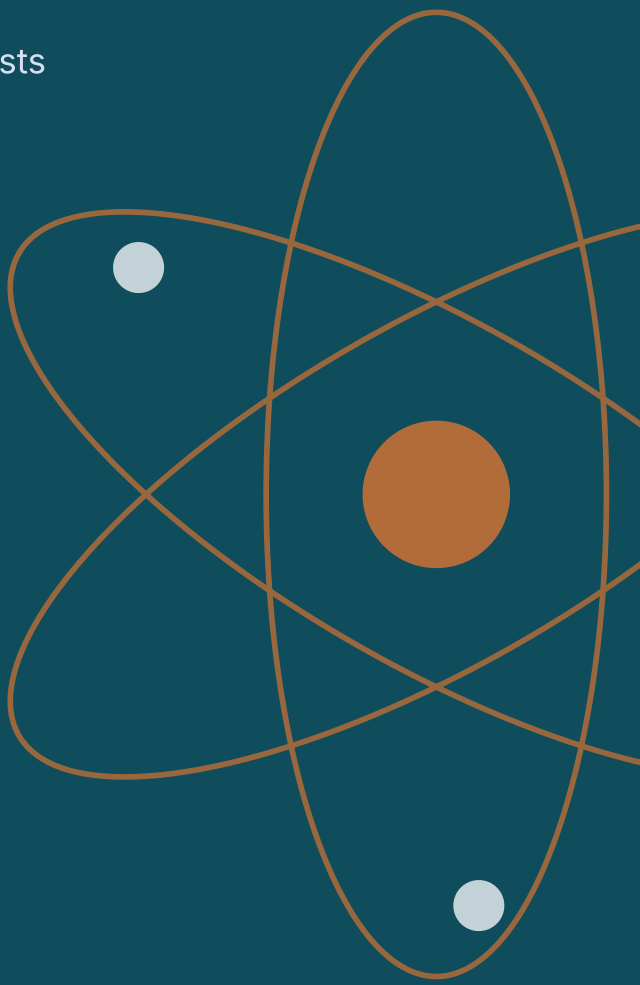
EXAM READY PHYSICS

Exam Ready Physics

GRADE 10

Study Guide, Worked Examples and Practice Tests for the Grade 10 Examination



- ✓ 6 units with clear key ideas, diagrams and “Watch out!” boxes
- ✓ 136 worked examples and 411+ practice questions at three levels
- ✓ 120 unit-quiz questions and 3 full mock exams (60 MCQ each)
- ✓ Diagnostic test · Key Formula Sheet · Top 20 Mistakes · teacher notes

Follows the units and order of the Ethiopian Grade 10 Physics textbook

ERMIAS WEDAJE TEGBARU

Exam Ready Physics

Grade 10 · Study Guide, Worked Examples and Practice Tests

By Ermias Wedaje Tegbaru
Civil engineer and author, Addis Ababa
First edition, 2026

© 2026 Ermias Wedaje Tegbaru. All rights reserved. This book is licensed to its reader for personal study on the Exam Ready Ethiopia website. It may not be copied, photographed, shared or sold, in whole or in part, without the author's written permission.

This is an independent study guide. It follows the units and order of the Ethiopian Grade 10 Physics student textbook, but it is not published or endorsed by the Ministry of Education. All explanations, examples and questions are original. Keep your textbook and your teacher's notes beside this book.

The answers were calculated and checked before printing, but no book is free of errors. If you find a mistake or disagree with an answer, please tell the author on Telegram (@Ermias_Wedaje) and it will be reviewed for the next edition.

How to Use This Book

Each unit follows the same pattern, so you always know where to look.

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.

Unit quiz
20 multiple-choice questions in the style of the national examination.

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

For students

- Begin with the Diagnostic Test. 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 each quiz in 30 minutes, mark it, and redo every question you got wrong.
- In the last weeks, learn the Key Facts Sheet and the Top 20 Mistakes page, and sit the three mock exams. Their answer keys show which unit each question comes from.

For teachers

- Each unit follows the textbook sections, so the book can sit beside your lessons.
- The “For the Teacher” page gives timing, starters, misconceptions and activities.
- The quizzes and mock exams can be used as class tests; every answer has a short reason.

For parents

- Ask your child to explain one worked example to you each day. Teaching is the best way to learn.
- Look at the quiz score after each unit, and celebrate progress, not only high marks.

Contents

Start	Diagnostic Test · Where Should I Start?	5
Unit 1	Vector Quantities	7
Unit 2	Motion in One Dimension	21
Unit 3	Elasticity and Static Equilibrium of a Rigid Body	35
Unit 4	Static and Current Electricity	48
Unit 5	Magnetism	68
Unit 6	Electromagnetic Waves and Geometrical Optics	85
Reference	Key Formula Sheet	102
Reference	Top 20 Mistakes to Avoid	103
Reference	Exam Strategy	104
	Mock Examination 1	105
	Mock Examination 2	109
	Mock Examination 3	113
	Answers to the Mock Examinations	117

Page numbers are the numbers shown at the foot of each page (and in the online reader).

Diagnostic Test · Where Should I Start?

12 questions · 15 minutes. Take this test before you start the book. There are two questions on each unit. Your score only shows you where to spend your time.

1. Using a scale of 1 cm = 5 N, a force of 25 N is drawn as an arrow of length
   A. 25 cm B. 5 cm C. 50 cm D. 10 cm
2. Which of these is a vector?
   A. temperature B. acceleration C. energy D. density
3. A stone is dropped from rest. Its speed after 2 s is ($g = 9.8\ m/s^2$)
   A. 9.8 m/s B. 19.6 m/s C. 39.2 m/s D. 4.9 m/s
4. Two cars move in the same direction at 30 m/s and 20 m/s. The relative speed is
   A. 50 m/s B. 600 m/s C. 10 m/s D. 25 m/s
5. A force of 100 N acts on a wire of cross-section $2 \times 10^{-6}\ m^2$. The tensile stress is
   A. 200 Pa B. 0.0002 Pa C. 5×10^7 Pa D. 50 Pa
6. A body floats in water if its density is
   A. exactly zero B. less than 1000 kg/m³
   C. more than 1000 kg/m³ D. equal to its mass
7. A resistor of 10 Ω carries a current of 0.5 A. The p.d. across it is
   A. 5 V B. 20 V C. 10.5 V D. 0.05 V
8. 1 kWh equals
   A. 3.6×10^3 J B. 3600 J C. 3.6×10^6 J D. 1000 J
9. A wire of length 2 m carrying 5 A is perpendicular to a field of 0.2 T. The force on it is
   A. 2 N B. 7.2 N C. 0.08 N D. 0.5 N
10. A compass needle points to
    A. the Sun B. east C. true south D. magnetic north
11. A ray passes from air into a medium of refractive index 1.5 at an angle of incidence of 30°. The angle of refraction is
    A. 30° B. 48.6° C. 70.5° D. 19.5°
12. A camera forms an image that is
    A. virtual and upright B. real and inverted
    C. real and upright D. virtual and inverted

Unit 1 · Vector Quantities

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

- distinguish scalar and vector quantities and give examples of each
- represent a vector algebraically and by a scale drawing
- add and subtract vectors
- use the triangle, parallelogram and polygon methods to find a resultant
- resolve a vector into perpendicular components

Before you start — check yourself. (a) Is speed a scalar or a vector? (b) A student walks 3 km east and 4 km north: what is the distance walked? (c) Find sin 30° and cos 60°. (d) Write 36 km/h in m/s.
Answers: (a) scalar (b) 7 km (c) 0.5 and 0.5 (d) 10 m/s

Key words: scalar · vector · magnitude · direction · resultant · scale · component · head-to-tail · parallelogram law · unit vector

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- Scalars and vectors
- Vector representation and types of vectors
- Vector addition and subtraction
- Graphical methods of vector addition
- Vector resolution

1.1 Scalars and Vectors

Key ideas

- A **scalar** is completely described by a number and a unit: mass 12 kg, time 5 s, temperature 30 °C, volume, density, energy and power.
- A **vector** needs a number, a unit **and a direction**: velocity 100 km/h east, force 20 N downward, displacement, acceleration, momentum, weight and electric field strength.
- Only vectors of the **same kind** can be added: two forces, or two velocities, but never a force and a velocity.
- Scalars are added by ordinary arithmetic (2 kg + 3 kg = 5 kg). Vectors must be added **with their directions**.

Scalar	Vector
distance, speed	displacement, velocity
mass, density, volume	weight, force, acceleration
time, temperature	momentum, impulse
energy, work, power	electric field strength

Example 1.1 — Classify

Write scalar or vector: (a) 60 km/h (b) 60 km/h due south (c) 9.8 m/s² downward (d) 25 °C.

Solution. (a) scalar (speed) (b) **vector** (velocity) (c) **vector** (acceleration) (d) scalar.

Example 1.2 — Distance and displacement

A student walks 3 km east then 4 km north. Find (a) the distance and (b) the displacement.

Solution. (a) Distance is a scalar: 3 + 4 = **7 km**. (b) The legs are at right angles, so the displacement is $\sqrt{(3^2 + 4^2)}$ = **5 km**, north of east.

Example 1.3 — Exam Booster · Lap of a track

A runner completes one lap of a 400 m track. State the distance and the displacement.

Solution. Distance **400 m**; displacement **0** (she is back at the start).

⚠ Watch out!

× Wrong	✓ Right
Speed and velocity mean the same.	Speed is a scalar; velocity is a vector with direction.
Temperature has a direction because it rises.	Temperature is a scalar.
A force and a velocity can be added.	Only vectors of the same kind can be added.

Practice 1.1

Level 1 — Basic

1. Name two scalars and two vectors.
2. Is the weight of a stone a vector? Why?
3. Is density a scalar or vector?
4. Define a vector quantity.

Level 2 — Standard

5. A boat sails 6 km west then 8 km south. Find the magnitude of the displacement.
6. Why is “10 m/s” an incomplete velocity?
7. Give a case where distance and the magnitude of displacement are equal.
8. Why can we not add 5 N and 3 m/s?

Level 3 — Challenge

9. A hiker walks 5 km north, 12 km east and 5 km south. Find the distance and the displacement.
10. Can distance be less than the magnitude of displacement? Explain.
11. Is the average speed of a lap equal to the average velocity? Explain.

1.2 Vector Representation and Types of Vectors

Key ideas

- **Algebraically** a vector is written in bold, **A**, or with an arrow above the letter. The magnitude is written A or $|\mathbf{A}|$. For example **S** = 50 km southwest.
- **Geometrically** a vector is an arrow: the **length** is the magnitude (to a chosen scale) and the **arrowhead** shows the direction. The start is the **tail**, the end is the **head**.
- **To draw to scale:** (1) choose a scale (e.g. 1 cm = 4 km); (2) find the length; (3) draw the arrow with a ruler and protractor; (4) label the magnitude.
- **Types:** a **zero vector** has magnitude 0; a **unit vector** has magnitude 1; **equal vectors** have the same magnitude and direction; the **negative** of a vector, **−A**, has the same magnitude but opposite direction.

Example 1.4 — Scale drawing

Draw the vector 16 km east to scale.

Solution. Choose 1 cm = 4 km. Then 16 km = 16 ÷ 4 = **4 cm**. Draw a 4 cm arrow pointing east and write "16 km east" beside it.

Example 1.5 — Length of an arrow

A force of 60 N is drawn with the scale 1 cm = 20 N. How long is the arrow?

Solution. 60 ÷ 20 = **3 cm**.

Example 1.6 — Exam Booster · Negative vector

What is the negative of a velocity of 8 m/s east?

Solution. 8 m/s west.

⚠ Watch out!

× Wrong	✓ Right
The length of the arrow does not matter.	It must be proportional to the magnitude, using a stated scale.
−A is a smaller vector.	−A has the same length as A but points the other way.

Unit 3 · Elasticity and Static Equilibrium of a Rigid Body

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

- distinguish elasticity from plasticity and state Hooke's law
- calculate density and specific gravity
- define stress and strain and calculate them
- use the Young modulus Y = stress/strain
- apply the two conditions of static equilibrium (ΣF = 0 and Στ = 0)

Before you start — check yourself. (a) Find the area of a circle of diameter 2.0 mm. (b) What is the SI unit of force? (c) Write 1 g/cm³ in kg/m³. (d) Define the moment of a force.
Answers: (a) 3.14 mm² (b) newton (c) 1000 kg/m³ (d) force × perpendicular distance from the pivot

Key words: elasticity · plasticity · density · specific gravity · stress · strain · Young modulus · torque · equilibrium · centre of gravity

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- Elasticity and plasticity
- Density and specific gravity
- Stress and strain
- The Young modulus
- Static equilibrium

3.1 Elasticity and Plasticity

Key ideas

- **Elasticity** is the property of a body to regain its original shape and size after the deforming force is removed (steel spring, rubber band, bone).
- **Plasticity** is the property of a body to stay deformed after the force is removed (clay, dough, lead).
- The **elastic limit** is the largest stress a body can take and still return to its original size. Beyond it the body is permanently deformed.
- **Hooke's law:** within the elastic limit the extension of a spring is proportional to the force: **F = kx**. k is the spring constant (N/m).
- Engineers choose elastic materials for springs and bridges; plastic materials are used for moulding.

Unit 5 · Magnetism

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

- describe magnets, poles and magnetic fields
- explain the Earth's magnetic field and use a compass
- find the field of a current-carrying wire and use the right-hand rules
- calculate the magnetic force on a moving charge and on a current-carrying wire
- describe the force between parallel wires and applications of magnetism

Before you start — check yourself. (a) State the law of magnetic poles. (b) Name two magnetic materials. (c) Which direction does a compass needle point? (d) State the unit of current.
Answers: (a) like poles repel; unlike poles attract (b) iron, nickel or cobalt (c) towards the Earth's magnetic north (d) ampere

Key words: magnet · pole · magnetic field · compass · right-hand rule · tesla · solenoid · electromagnet · magnetic force · permanent magnet

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- Magnets
- Magnetic field
- The Earth's magnetic field and the compass
- Magnetic field of a current-carrying conductor
- Magnetic force on a moving charge
- Magnetic force on a current-carrying wire
- Force between parallel wires
- Applications of magnetism

Unit 6 · Electromagnetic Waves and Geometrical Optics

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

- describe electromagnetic waves and the electromagnetic spectrum
- use $c = f\lambda$
- apply the laws of reflection and refraction, Snell's law and total internal reflection
- use the mirror and lens equations and find the nature of images
- describe the human eye, defects and optical instruments
- explain primary colours and colour addition and subtraction

Before you start — check yourself. (a) State the unit of frequency. (b) Solve $3 \times 10^{8} = f \times 5 \times 10^{-7}$. (c) State the law of reflection. (d) What is a ray of light?
Answers: (a) hertz (b) $f = 6 \times 10^{14}$ Hz (c) angle of incidence = angle of reflection (d) a line showing the path of light

Key words: electromagnetic wave · spectrum · wavelength · frequency · refraction · critical angle · focal length · real image · virtual image · primary colour

How this unit is examined

Question types that appear again and again in Ethiopian model examinations:

- Electromagnetic waves
- The electromagnetic spectrum
- Light as a wave
- Laws of reflection and refraction
- Mirrors and lenses
- The human eye and optical instruments
- Colours of light and filters

Key Formula Sheet

Learn these by heart. Cover the right-hand side and write the formula from memory.

Unit 1 · Vectors

$R = \sqrt{(A^2 + B^2)}$ (perpendicular)

$A_x = A\cos\theta$, $A_y = A\sin\theta$

$\tan\theta = A_y/A_x$

Opposite: $R = A - B$; same: $R = A + B$

Unit 2 · Motion

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

$s = \frac{1}{2}(u + v)t$

Free fall: $g = 9.8\ m/s^2$; $H = u^2/2g$

km/h ÷ 3.6 = m/s

Unit 3 · Elasticity and statics

$F = kx$

$\rho = m/V$; $SG = \rho/\rho(water)$

$\sigma = F/A$, $\varepsilon = \Delta L/L_o$

$Y = FL_o/(A\Delta L)$

$\tau = Fd$; $\Sigma F = 0$, $\Sigma\tau = 0$

Unit 4 · Electricity

$F = kq_1q_2/r^2$, $k = 9\times10^9$

$E = F/q = kQ/r^2$

$I = Q/t$, $V = IR$

$P = VI = I^2R = V^2/R$

Series: $R = \Sigma R$; parallel: $1/R = \Sigma 1/R$

$1\ kWh = 3.6\times10^6\ J$

Unit 5 · Magnetism

$B = \mu_o I/(2\pi d)$, $\mu_o = 4\pi\times10^{-7}$

Solenoid: $B = \mu_o nI$

$F = qvB\sin\theta$

$F = BIL\sin\theta$

$F/L = \mu_o I_1 I_2/(2\pi d)$

Unit 6 · Waves and optics

$c = f\lambda$, $c = 3\times10^8\ m/s$

$n = c/v$; $n_1\sin\theta_1 = n_2\sin\theta_2$

$\sin C = 1/n$

$1/f = 1/u + 1/v$; $m = v/u$

$f = R/2$; $P = 1/f$ (f in m)

Mock Examination 1

60 multiple-choice questions · 90 minutes · one mark each. Use g = 9.8 m/s² and c = 3 × 10⁸ m/s. Circle one answer. Mark with the answer key at the back and use the unit number to see where to revise.

1. Which of the following is a scalar?

A. force B. velocity C. mass D. displacement

2. The negative of a vector has

A. a smaller magnitude B. zero magnitude
C. the same direction D. the opposite direction

3. The head-to-tail method is also called the

A. parallelogram method B. triangle method
C. polar method D. scale method

4. Two perpendicular forces of 3 N and 4 N act on a body. The magnitude of the resultant is

A. 7 N B. 12 N C. 1 N D. 5 N

5. The horizontal component of a 20 N force acting at 60° above the horizontal is

A. 20 N B. 10 N C. 17.3 N D. 34.6 N

6. Two forces of 15 N and 9 N act along the same line in opposite directions. The resultant is

A. 1.67 N B. 24 N C. 135 N D. 6 N

7. Displacement is

A. always positive B. the change in position
C. the total path length D. speed × time

8. The slope of an x–t graph is

A. distance B. force C. acceleration D. velocity

9. The area under a v–t graph is

A. force B. speed C. displacement D. acceleration

10. A body with initial speed 5 m/s accelerates at 3 m/s² for 4 s. The final speed is

A. 12 m/s B. 17 m/s C. 53 m/s D. 60 m/s

11. A car starts from rest with acceleration 2 m/s². The distance covered in 3 s is

A. 6 m B. 3 m C. 18 m D. 9 m

12. A car moving at 20 m/s brakes uniformly at 4 m/s². The stopping distance is

A. 50 m B. 100 m C. 800 m D. 5 m

13. A stone is dropped from rest. Its speed after 2 s is (g = 9.8 m/s²)

A. 9.8 m/s B. 19.6 m/s C. 39.2 m/s D. 4.9 m/s

14. A train travels 120 km in 4 h. Its average speed in km/h is

A. 116 km/h B. 480 km/h C. 30 km/h D. 24 km/h

15. A body accelerates uniformly from rest to 12 m/s in 6 s. The distance covered is

A. 36 m B. 1 m C. 72 m D. 2 m

16. Two cars approach each other at 20 m/s and 10 m/s. Their relative speed is

A. 15 m/s B. 30 m/s C. 10 m/s D. 200 m/s