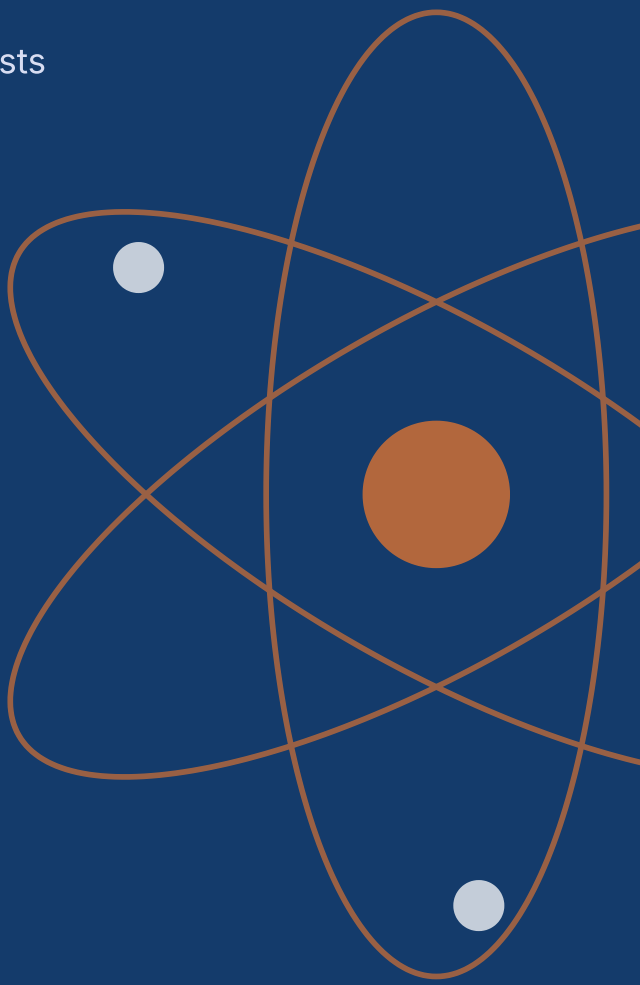
EXAM READY PHYSICS

Exam Ready Physics

GRADE 11

Study Guide, Worked Examples and Practice Tests for the Grade 11 Examination



- ✓ 7 units with clear key ideas, diagrams and “Watch out!” boxes
- ✓ 149 worked examples and 395+ practice questions at three levels
- ✓ 134 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 11 Physics textbook

ERMIAS WEDAJE TEGBARU

Exam Ready Physics

Grade 11 · Study Guide, Worked Examples and Practice Tests

By Ermias Wedaje Tegbaru
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First edition, 2026

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This is an independent study guide. It follows the units and order of the Ethiopian Grade 11 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.

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Unit 3 · Motion in One and Two Dimensions

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

- distinguish distance, displacement, speed, velocity and acceleration
- use $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$ and $s = \frac{1}{2}(u + v)t$ to solve problems
- draw and read displacement–time, velocity–time and acceleration–time graphs
- solve problems on free fall and vertical motion under gravity ($g = 10\ m/s^2$)
- describe uniform circular motion with period, frequency, angular speed and centripetal acceleration

Before you start — check yourself. (a) Convert 72 km/h to m/s. (b) A car covers 150 m in 10 s. What is its speed? (c) Solve $3t = 12$. (d) What is the area of a triangle with base 6 and height 4?
Answers: (a) 20 m/s (b) 15 m/s (c) t = 4 (d) 12

Key words: displacement · velocity · acceleration · free fall · slope · area under graph · period · frequency · angular speed · centripetal

How this unit is examined

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

- Equations of motion: find v, s, t or a from the other quantities
- Reading a velocity–time graph: acceleration from the slope and distance from the area
- Free fall and objects thrown upward: maximum height and time of flight
- Circular motion: period, frequency, speed and centripetal acceleration

3.1 Uniformly Accelerated Motion in One Dimension

Key ideas

- **Distance** is the total length of the path (scalar). **Displacement** $\Delta x = x_2 - x_1$ is the change of position in a straight line with direction (vector).
- **Average speed** = total distance ÷ total time. **Average velocity** = displacement ÷ time = $\Delta x/\Delta t$.
- **Acceleration** is the rate of change of velocity: $\mathbf{a = (v - u)/t}$ = $\Delta v/\Delta t$, in m/s^2. Positive means speeding up in the positive direction; negative (deceleration) means slowing down.
- Motion is **uniformly accelerated** when the acceleration is constant. Free fall near Earth is an example: $g \approx 9.8\ m/s^2$. In this book we use $\mathbf{g = 10\ m/s^2}$ unless a question says otherwise.
- To change km/h to m/s, **divide by 3.6**. To change m/s to km/h, multiply by 3.6.

Example 3.1 — Speed of a runner

A runner covers 100 m in 12.5 s. Find her average speed in m/s and in km/h.

Solution. $v = 100 \div 12.5 = \mathbf{8\ m/s} = 8 \times 3.6 = \mathbf{28.8\ km/h}$.

Example 3.2 — Speed and velocity are different

A man walks 60 m east and then 40 m west in 50 s. Find (a) the average speed and (b) the average velocity.

Solution. (a) distance = 60 + 40 = 100 m, so speed = 100 ÷ 50 = **2 m/s**. (b) displacement = 60 − 40 = 20 m east, so velocity = 20 ÷ 50 = **0.4 m/s east**.

Example 3.3 — Finding acceleration

A car goes from rest to 72 km/h in 10 s. Find its acceleration.

Solution. 72 km/h = 20 m/s. a = (v − u)/t = (20 − 0)/10 = **2 m/s²**.

Example 3.4 — Deceleration

A bus slows from 30 m/s to 6 m/s in 8 s. Find the acceleration.

Solution. a = (6 − 30)/8 = **-3 m/s²**. The negative sign shows deceleration.

⚠ Watch out!

× Wrong	✓ Right
Average speed = average of the speeds at the start and the end, always.	Average speed = total distance ÷ total time. The shortcut ½(u + v) works only for uniform acceleration.
72 km/h = 72 m/s.	72 km/h = 72 ÷ 3.6 = 20 m/s.
Negative acceleration always means the object slows down.	It slows down only if the velocity is positive. A negative velocity with a negative acceleration speeds up.
Zero velocity means zero acceleration.	At the top of a throw the velocity is zero but the acceleration is still g downward.

Practice 3.1

Level 1 — Basic

1. Convert 54 km/h to m/s.
2. Convert 25 m/s to km/h.
3. A cyclist travels 90 m in 15 s. Find her speed.
4. State the SI unit of acceleration.

Level 2 — Standard

5. A car increases its speed from 10 m/s to 25 m/s in 5 s. Find the acceleration.
6. A walker goes 300 m north and then 400 m east in 500 s. Find average speed and average velocity.
7. A train slows from 20 m/s to rest in 40 s. Find its acceleration.
8. How long does a car at 15 m/s take to reach 27 m/s if its acceleration is 1.5 m/s²?

Level 3 — Challenge

9. A ball moving at 12 m/s east is hit and moves at 8 m/s west. The contact lasts 0.02 s. Find the average acceleration.
10. A runner does one lap of a 400 m track in 50 s. Find her average speed and her average velocity.
11. A car travels the first half of a 120 km journey at 40 km/h and the second half at 60 km/h. Find the average speed for the whole journey.

3.2 Equations of Uniformly Accelerated Motion in One Dimension

Key ideas

- Let **u** = initial velocity, **v** = final velocity, **a** = constant acceleration, **t** = time, **s** = displacement.
- The four equations: **(1) $v = u + at$**, **(2) $s = ut + \frac{1}{2}at^2$**, **(3) $v^2 = u^2 + 2as$**, **(4) $s = \frac{1}{2}(u + v)t$**.
- **How to choose:** write down the three quantities you know and the one you want, then choose the equation that has exactly those four letters. Equation (3) has no t; equation (1) has no s; equation (2) has no v; equation (4) has no a.
- Choose a positive direction first. Velocities, accelerations and displacements opposite to it are negative.
- The distance in the n-th second is $s_n - s_{n-1} = u + a(2n - 1)/2$.

Quantity	Formula	Unit
Final velocity	$v = u + at$	m/s
Displacement	$s = ut + \frac{1}{2}at^2$	m
No time	$v^2 = u^2 + 2as$	m^2/s^2
Average velocity	$s = \frac{1}{2}(u + v)t$	m

Example 3.5 — Starting from rest

A car starts from rest and accelerates at 2.5 m/s^2 for 8 s. Find its final speed and the distance covered.

Solution. $v = u + at = 0 + 2.5 \times 8 =$ **20 m/s**. $s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 2.5 \times 8^2 =$ **80 m**.

Example 3.6 — Braking distance

A car moving at 25 m/s brakes with a constant deceleration of 5 m/s^2. Find the braking distance and the time to stop.

Solution. Use $v^2 = u^2 + 2as$ with $v = 0$, $a = -5$: $0 = 25^2 + 2(-5)s$, so $s = 625 \div 10 =$ **62.5 m**. Time: $t = (v - u)/a = (0 - 25)/(-5) =$ **5 s**.

Example 3.7 — Finding acceleration from distance

A train speeds up from 10 m/s to 30 m/s over 400 m. Find the acceleration and the time taken.

Solution. $a = (v^2 - u^2)/(2s) = (900 - 100)/800 =$ **1 m/s^2**. $t = (v - u)/a = 20/1 =$ **20 s**.

Example 3.8 — Exam Booster · Distance in the 4th second

A particle with initial velocity 2 m/s has a constant acceleration of 3 m/s². Find the distance covered in the 4th second.

Solution. Distance in 4 s: 2(4) + ½(3)(16) = 32 m. In 3 s: 2(3) + ½(3)(9) = 19.5 m. The 4th second: 32 − 19.5 = **12.5 m**. (Check: u + a(2n − 1)/2 = 2 + 3 × 7/2 = 12.5 m.)

Example 3.9 — Exam Booster · A car overtakes

Car A moves at constant 20 m/s. Car B starts from rest at the same place and the same moment with acceleration 4 m/s². When and where does B catch A?

Solution. They meet when the distances are equal: 20t = ½(4)t² = 2t². So 2t² − 20t = 0, giving t = 0 (start) or **t = 10 s**. Distance = 20 × 10 = **200 m**. B's speed then is 4 × 10 = 40 m/s, twice A's.

⚠ Watch out!

× Wrong	✓ Right
Use s = ut + ½at² when you know v but not t.	Pick the equation that contains your four letters. With v, u, a and s known, use v² = u² + 2as.
Use a = 5 for braking.	Braking is deceleration: a = −5 m/s² when forward is positive.
Put u = v when the car "starts from rest".	Starting from rest means u = 0.
Mix units: 72 km/h and seconds in one equation.	Convert to m/s first. Keep SI units throughout.

Practice 3.2

Level 1 — Basic

1. A body starts from rest with a = 3 m/s². Find v after 4 s.
2. A cyclist at 4 m/s accelerates at 1 m/s² for 6 s. Find v.
3. Write the equation of motion that has no time in it.
4. A car at 10 m/s travels for 5 s at constant speed. Find the distance.

Level 2 — Standard

5. A car starts from rest and travels 90 m in 6 s with uniform acceleration. Find the acceleration.
6. A bullet at 400 m/s enters a wall and stops after 0.2 m. Find the deceleration.
7. A motorcycle at 20 m/s brakes at 4 m/s². Find the stopping distance.
8. A plane must reach 60 m/s for take-off over 900 m of runway. Find the acceleration needed.

Level 3 — Challenge

9. A car moving at 15 m/s accelerates at 2 m/s² for 10 s. Find the distance travelled and the final speed.
10. A driver sees an obstacle 40 m ahead when travelling at 20 m/s. The reaction time is 0.5 s, then the car decelerates at 6 m/s². Does the car stop in time?
11. A ball rolls up a slope with initial speed 12 m/s and constant deceleration 2 m/s². Find the time to stop and the distance covered.

3.3 Graphical Representation of Uniformly Accelerated Motion

Key ideas

- **Position–time (x–t) graph:** the **slope** is the velocity. A horizontal line means at rest; a straight sloping line means constant velocity; a curve means changing velocity.
- **Velocity–time (v–t) graph:** the **slope** is the acceleration and the **area** between the graph and the time axis is the displacement. Areas below the axis count as negative.
- **Acceleration–time (a–t) graph:** the **area** is the change in velocity. A horizontal line means constant acceleration.
- For a v–t graph: a straight line through the origin means uniform acceleration from rest. A horizontal line means constant velocity.

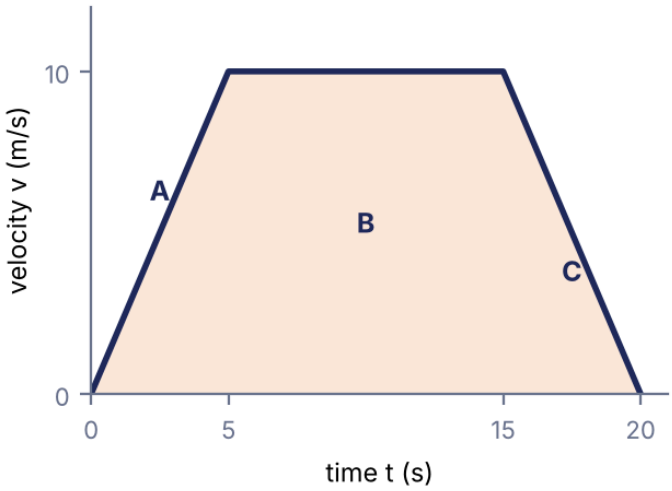


Figure 3.1 — a v–t graph: speeding up (A), constant speed (B), slowing down (C).

Example 3.10 — Area under a v–t graph

Use Figure 3.1. Find (a) the acceleration in part A, (b) the total distance and (c) the average speed.

Solution. (a) slope of A = (10 − 0)/5 = **2 m/s²**. (b) Area = ½(5)(10) + (10)(10) + ½(5)(10) = 25 + 100 + 25 = **150 m**. (c) average speed = 150 ÷ 20 = **7.5 m/s**.

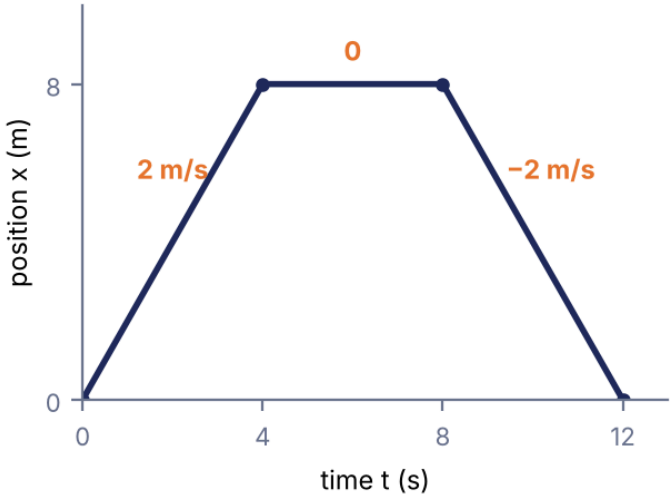


Figure 3.2 — an x–t graph: the slope in each part is the velocity.

Example 3.11 — Slope of an x–t graph

Use Figure 3.2. Find the velocity in each part of the journey and the final displacement.

Solution. 0–4 s: slope = 8/4 = **2 m/s**. 4–8 s: **0** (at rest). 8–12 s: (0 − 8)/4 = **-2 m/s** (returning). The object ends where it started, so the displacement is **0**, though the distance is 16 m.

Example 3.12 — Distance from a v–t triangle

A car accelerates uniformly from rest to 24 m/s in 6 s. Find the distance travelled.

Solution. Area of the triangle = ½ × 6 × 24 = **72 m**.

⚠ Watch out!

× Wrong	✓ Right
The slope of a v–t graph is the velocity.	The slope of a v–t graph is the **acceleration**. The slope of an x–t graph is the velocity.
A horizontal line on an x–t graph means constant speed.	It means the object is **at rest**. A horizontal line on a v–t graph means constant velocity.
A v–t graph that goes down means the object moves backward.	Moving backward means the graph is **below the time axis**. A falling line above the axis is slowing down.
Area under a v–t graph is the acceleration.	It is the displacement.

Practice 3.3

Level 1 — Basic

1. What does the slope of a displacement–time graph represent?
2. What does the area under a velocity–time graph represent?
3. What does a horizontal line on a v–t graph show?
4. What shape is the v–t graph of uniform acceleration from rest?

Level 2 — Standard

5. A v–t graph goes in a straight line from (0, 0) to (5 s, 20 m/s). Find the acceleration and the distance in 5 s.
6. An x–t graph is a straight line through (2 s, 6 m) and (6 s, 18 m). Find the velocity.
7. A body moves at 8 m/s for 5 s and then at 4 m/s for 10 s. Find the total distance and the average speed.
8. A v–t graph falls in a straight line from (0, 12 m/s) to (4 s, 0). Find the acceleration and the stopping distance.

Level 3 — Challenge

9. A lift accelerates from rest at 2 m/s² for 3 s, moves at constant speed for 6 s, then stops uniformly in 3 s. Find the total distance.
10. A car moves at 20 m/s for 10 s. A second car starts from rest and accelerates uniformly to 20 m/s in 10 s. Compare their distances.
11. From a v–t graph you find that a body's velocity is +6 m/s at t = 0 and −6 m/s at t = 4 s with a straight line between. Find the total displacement and the distance over 4 s.

Key Formula Sheet

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

Unit 2 · Vectors

$R = \sqrt{(A^2 + B^2 + 2AB\cos\theta)}$

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

$A \cdot B = AB\cos\theta$

$|A \times B| = AB\sin\theta$

Unit 3 · 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: $H = u^2/2g$, $t = 2u/g$

$T = 1/f$, $v = 2\pi r/T$, $\omega = 2\pi f$

$a_c = v^2/r = \omega^2 r$

Unit 4 · Dynamics

$\Sigma F = ma$, $W = mg$

$f = \mu N$, slope: $a = g(\sin\theta - \mu\cos\theta)$

$W = Fs\cos\theta$, $P = W/t = Fv$

$Ek = \frac{1}{2}mv^2$, $Ep = mgh$

$p = mv$, $J = F\Delta t = \Delta p$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Unit 5 · Heat

$T(K) = T(°C) + 273$

$Q = mc\Delta T$, $C = mc$

$Q = mL$ ($L_f = 3.4\times10^5$, $L_v = 2.3\times10^6$ J/kg)

$\Delta L = \alpha L_o \Delta T$, $\gamma = 3\alpha$, $\beta = 2\alpha$

Heat lost = heat gained

$Q/t = kA\Delta T/L$

Unit 6 · Electricity

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

$E = F/q = kQ/r^2$, $E = V/d$

$V = W/q = kQ/r$

$I = Q/t$, $V = IR$, $R = \rho L/A$

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

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

$C = Q/V$, $U = \frac{1}{2}CV^2$

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

Unit 7 · Nuclear

$N = A - Z$

$N = N_o(\frac{1}{2})^n$, $n = t/T_{\frac{1}{2}}$

$T_{\frac{1}{2}} = 0.693/\lambda$, $A = \lambda N$

$E = mc^2$, 1 u = 931.5 MeV

α: $A - 4$, $Z - 2$; β^-: $Z + 1$

Mock Examination 1

60 multiple-choice questions · 90 minutes · one mark each. Use g = 10 m/s². Circle one answer. Mark with the answer key at the back and use the unit number to see where to revise.

1. Which scientific step comes first?

A. observation and question B. a law C. conclusion D. publishing

2. A hypothesis must be

A. a law B. a unit C. testable D. proved true already

3. Which device is based on nuclear radiation?

A. a bicycle pump B. a tap C. a mirror D. a smoke detector

4. Which is a vector quantity?

A. time B. mass C. displacement D. speed

5. Which is a scalar quantity?

A. force B. momentum C. energy D. velocity

6. The resultant of two equal forces F acting at 90° is

A. F B. F/2 C. F√2 D. 2F

7. Two perpendicular forces of 6 N and 8 N act on a body. The magnitude of the resultant is

A. 2 N B. 10 N C. 14 N D. 48 N

8. The horizontal component of a 20 N force acting at 30° above the horizontal is

A. 20 N B. 10 N C. 11.5 N D. 17.3 N

9. Two forces of 18 N and 9 N act along the same line in opposite directions. The resultant is

A. 162 N B. 9 N C. 2 N D. 27 N

10. The scalar product of vectors of magnitudes 4 and 5 at 60° to each other is

A. 0 B. 17.3 C. 20 D. 10

11. At the highest point of a ball thrown up, its velocity is

A. zero B. maximum C. g D. 10 m/s

12. The slope of a displacement–time graph is the

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

13. The area under a velocity–time graph is the

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

14. The acceleration due to gravity near Earth's surface is about

A. 10 m/s² downward B. 100 m/s² C. 1 m/s² D. 10 m/s upward

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

A. 12 m/s B. 52 m/s C. 16 m/s D. 48 m/s

16. A car starts from rest with acceleration 6 m/s². The distance covered in 5 s is

A. 75 m B. 150 m C. 30 m D. 15 m

17. A car moving at 20 m/s brakes uniformly at 5 m/s². The stopping distance is

A. 40 m B. 80 m C. 4 m D. 1×10^3 m

18. A stone is dropped from 80 m (g = 10 m/s²). The time to reach the ground is

A. 16 s B. 8 s C. 4 s D. 2.83 s

19. A ball is thrown vertically upward at 40 m/s (g = 10 m/s²). The maximum height is

A. 4 m B. 320 m C. 160 m D. 80 m

20. A speed of 36 km/h in m/s is

A. 1 m/s B. 10 m/s C. 130 m/s D. 6 m/s

21. A wheel rotates 5 times per second. Its period is

A. 5 s B. 1.26 s C. 0.2 s D. 0.1 s

22. Newton's first law is also called the law of

A. action B. momentum C. gravity D. inertia

23. Which law explains the recoil of a gun?

A. the third law and conservation of momentum
B. the first law only
C. Ohm's law
D. Hooke's law

24. Friction depends on

A. the speed only
B. the area of contact
C. the nature of the surfaces and the normal force
D. the colour

25. Static friction is

A. zero B. always μkN
C. larger than the applied force D. at most μsN

26. The SI unit of work is

A. watt B. joule C. pascal D. newton

27. A net force acts on a 8 kg body and gives it an acceleration of 3 m/s². The force is

A. 0.375 N B. 2.67 N C. 11 N D. 24 N

28. The weight of a 12 kg mass (g = 10 m/s²) is

A. 1.2×10^3 N B. 12 N C. 1.2 N D. 120 N

29. The kinetic friction on a 10 kg block on a horizontal floor with μ = 0.3 (g = 10 m/s²) is

A. 30 N B. 100 N C. 3 N D. 60 N

30. A 50 N force acts at 60° to the direction of motion of a body that moves 4 m. The work done is

A. 200 J B. 100 J C. 173 J D. 400 J

31. The kinetic energy of a 6 kg body moving at 10 m/s is

A. 60 J B. 300 J C. 600 J D. 30 J