

B R I G H T S C H O L A R S

AP+ EXAM PREP WORKBOOKS

PHYSICS 1

REVIEW WORKBOOK

MAY 2027 EXAM

Aligned to the May 2027 AP Physics 1 exam

Model Motion. Explain Forces. Solve with Reasoning.

Algebra-Based Physics • Graphing Practice • Lab Skills • FRQ Strategy •
Exam Prep

THIS BOOK BELONGS TO

Student Name _____

School / Class _____

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Diagnostic Test

This diagnostic samples every major skill in AP Physics 1. Work through it under quiet, timed conditions, then score yourself with the Diagnostic Answer Key that follows. Do not study beforehand; the goal is an honest starting snapshot.

Task 1: Vectors

A hiker walks 3.0 km east, then 4.0 km north.

Find the magnitude and direction of the total displacement.

Task 2: Motion Graphs

A cart's position-time graph is a straight line from (0 s, 0 m) to (2.0 s, 4.0 m), then curves as the cart speeds up, reaching (4.0 s, 14 m). The matching velocity-time graph is flat at 2.0 m/s from 0-2.0 s, then rises linearly to 8.0 m/s at 4.0 s.

Identify the interval of constant velocity and the interval of the greatest acceleration.

Task 3: Free-Body Diagrams

A 4.0 kg box slides down a 25° incline with a coefficient of kinetic friction of 0.30.

Draw and label every force acting on the box.

Task 4: Newton's Laws

A rope pulls two connected crates (3.0 kg and 5.0 kg, with the rope pulling the 3.0 kg crate) across a frictionless floor with a horizontal force of 24 N.

UNIT

1

Kinematics

Kinematics describes motion without asking what causes it. This unit builds your ability to move fluently between motion diagrams, graphs, and equations: the representational flexibility tested throughout the exam.



TOPICS COVERED

- ☐ Scalar vs. vector quantities
- ☐ Distance and displacement
- ☐ Speed and velocity
- ☐ Acceleration
- ☐ 1D motion and motion graphs
- ☐ Reference frames and relative motion
- ☐ 2D motion and projectile motion
- ☐ Horizontal and vertical components



KEY VOCABULARY

- ☐ Scalar
- ☐ Vector
- ☐ Displacement
- ☐ Velocity
- ☐ Acceleration
- ☐ Reference frame
- ☐ Relative motion
- ☐ Projectile motion
- ☐ Component
- ☐ Trajectory



CORE CONCEPTS

Scalars vs. Vectors



KNOW IT

A scalar has magnitude only (distance, speed). A vector has magnitude and direction (displacement, velocity, acceleration). Always state direction for vector quantities.

Constant Acceleration Relationships



KNOW IT

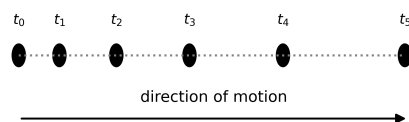
Under constant acceleration, velocity changes linearly with time and position changes quadratically with time; this is why velocity-time graphs are straight lines but position-time graphs are curved.



DIAGRAM IT

Draw a motion diagram (dots showing position at equal time intervals) for an object speeding up, then for one moving at constant velocity.

Motion Diagram: Object Speeding Up



Motion diagram: object speeding up (increasing spacing)

MODEL IT

Use constant-velocity equations when acceleration is zero. Use constant-acceleration (kinematic) equations when acceleration is constant and nonzero. For 2D projectile motion, model horizontal and vertical motion as two independent 1D problems that share only time.

 CALCULATE IT

Show your model, equation, substitution, and units for every problem.

- 1** A car accelerates from rest at 2.5 m/s^2 . Find its velocity after 6.0 s .

- 2** A ball is thrown horizontally at 8.0 m/s from a 20 m cliff. Find the time to reach the ground.

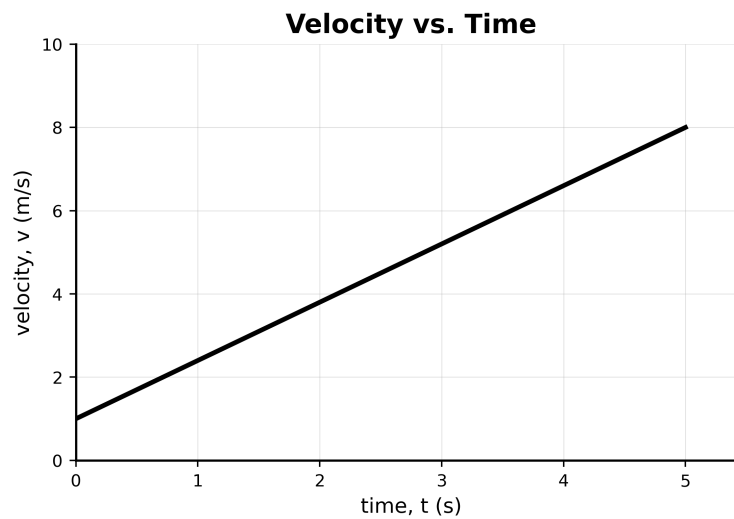
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- 3** Using your answer above, find the horizontal distance traveled.

- 4** A runner's velocity-time graph shows a straight line from 0 to 4.0 m/s over 8.0 s. Find the displacement using the area under the graph.

 GRAPH IT

On a position-time graph, slope equals velocity. On a velocity-time graph, slope equals acceleration and area equals displacement. Always state units and physical meaning, not just numbers.



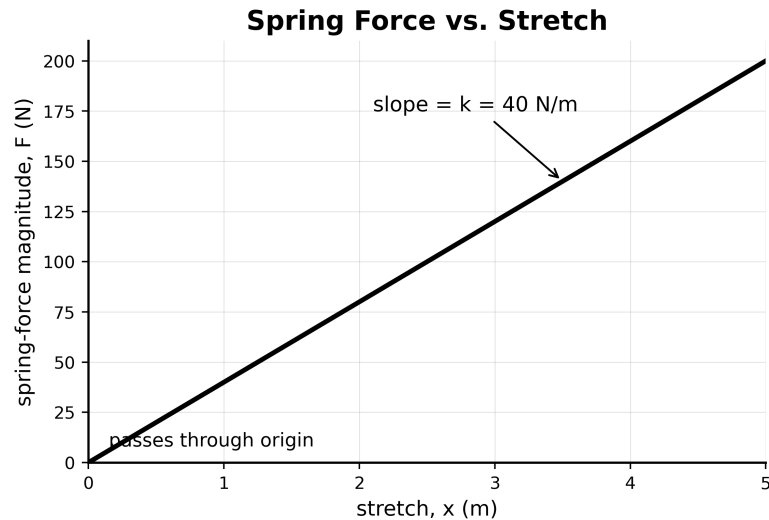
Velocity vs. time graph

✓ PROPORTION CHECK

In displacement = $\frac{1}{2}at^2$ (starting from rest), doubling the time quadruples the displacement, since displacement depends on the square of time.

**GRAPH IT**

A spring force graph (force vs. stretch) is linear with slope equal to the spring constant, k . Reading the slope, not just a single point, gives k .



Spring force vs. stretch graph

**PROPORTION CHECK**

In $F_{\text{net}} = ma$, doubling the net force while mass stays constant doubles the acceleration: a direct proportion, not a squared or inverse relationship.

**LAB LENS**

A student pulls a block at constant velocity across a level board with a force sensor, adds mass between trials, and graphs friction force versus normal force to find the coefficient of kinetic friction from the slope.

**JUSTIFY IT**

Use the C-L-E-R method: Claim, Law, Evidence, Reasoning.

Complete Worked Answer Key

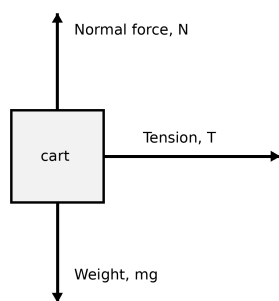
Use these solutions after attempting each problem. Numerical answers are rounded reasonably; equivalent algebraic forms and small rounding differences are acceptable. For diagrams, arrows must begin on the chosen object and point in physically correct directions.

DIAGNOSTIC FRQ: MODEL RESPONSE

Cart Pulled by String on a Horizontal Track

A. Draw weight mg downward, normal force N upward, tension T horizontally in the direction of the pull, and friction f opposite the motion. From 0-2.0 s the velocity is constant, so friction must balance the tension; a cart pulled on a truly frictionless track could not move at constant velocity.

Free-Body Diagram: Cart Pulled by a String



Assumes negligible friction; every arrow begins on the cart.

Model free-body diagram: cart pulled by a string (add friction opposite the motion; it balances T from 0-2.0 s)

B. From 0-2.0 s the graph is horizontal, so $a = 0 \text{ m/s}^2$. From 2.0-4.0 s, $a = \Delta v / \Delta t = (8.0 - 2.0) / (4.0 - 2.0) = 3.0 \text{ m/s}^2$.

C. Newton's Second Law gives $\Sigma F = ma$. From 0-2.0 s the net force is zero because tension and friction balance; from 2.0-4.0 s the net force is $m(3.0 \text{ m/s}^2)$ in the direction of the pull. The acceleration always points in the direction of the net force.

D. At the same net applied force, doubling mass halves acceleration because $a = F_{\text{net}}/m$.

E. Example: motion-detector timing/position noise can make the slope fluctuate. Repeat trials and fit a best-fit line to the velocity-time data to reduce random error.

Required reasoning elements: Reference the slope of the scaled graph and explicitly connect net force, mass, and acceleration.

Acceptable alternatives: Air resistance or small track friction may be discussed if its direction and effect are correct.

Diagram/graph expectation: FBD must show only forces acting on the cart. The velocity-time slope must be calculated from labeled coordinates.

Common point-loss errors: Adding velocity or acceleration as forces; using graph height instead of slope; saying doubled mass doubles acceleration.

UNIT 1: KINEMATICS

CALCULATE IT

1. Car acceleration

Model/Law: Constant-acceleration kinematics

Equation: $v_f = v_i + at$

Substitution and algebra: $v_f = 0 + (2.5 \text{ m/s}^2)(6.0 \text{ s})$

Final answer: 15 m/s

Interpretation: The car gains 15 m/s of speed in 6.0 s.

2. Horizontal projectile fall time

Model/Law: Vertical free fall

Equation: $\Delta y = \frac{1}{2}gt^2$

Substitution and algebra: $20 \text{ m} = 0.5(9.8)t^2$; $t = \sqrt{(40/9.8)}$

Final answer: 2.02 s

Interpretation: Horizontal speed does not affect the fall time.

3. Horizontal distance

Model/Law: Constant horizontal velocity

Equation: $\Delta x = v_x t$

Substitution and algebra: $\Delta x = (8.0 \text{ m/s})(2.02 \text{ s})$

Final answer: 16.2 m

Interpretation: The ball travels about 16 m horizontally before impact.

4. Area under velocity-time graph

Model/Law: Displacement from v-t area

Equation: $\Delta x = \text{area of triangle}$

Substitution and algebra: $\Delta x = 0.5(8.0 \text{ s})(4.0 \text{ m/s})$

Final answer: 16 m

Interpretation: The positive area represents 16 m of displacement.

Additional Practice

Additional Practice 1, Practice 1: Braking distance

Model/Law: Constant-acceleration kinematics

Equation: $v_f^2 = v_i^2 + 2a\Delta x$

Substitution and algebra: $0 = (20)^2 + 2(-4.0)\Delta x$

Final answer: 50 m

Interpretation: The car needs 50 m to stop.

Additional Practice 1, Practice 2: Projectile at 30 m/s, 40°

Model/Law: Projectile components

Equation: $v_{y0} = v \sin\theta$; $h_{\text{max}} = v_{y0}^2/(2g)$; $T = 2v_{y0}/g$

Substitution and algebra: $v_{y0} = 30 \sin 40^\circ = 19.3 \text{ m/s}$; $h = 19.3^2/19.6$; $T = 2(19.3)/9.8$

Final answer: $h_{\text{max}} = 19.0 \text{ m}$; total time = 3.94 s

Interpretation: Vertical motion determines height and flight time.

Additional Practice 2, Practice 1: Two runners

Model/Law: Relative speed

Equation: $t = \text{separation}/(v_1 + v_2)$

Substitution and algebra: $t = 100/(3.0 + 2.0)$

Final answer: 20 s

Interpretation: Their closing speed is 5.0 m/s.