FIRST LIGHT ACADEMY

HELIOS PROVING GROUNDS

1D Cadet Flight Manual

Motion in one dimension with a guided bridge to two dimensions

Learn to describe a flight before combining two axes. Use signed displacement, velocity, acceleration, elapsed time, and motion graphs. Work on paper, test your prediction in the Academy, then explain the result.

CADET _____

CLASS _____ DATE _____

INSTRUCTOR _____

Core activities K00 to K21 / Guided bridge T00 to T02
Optional AP Physics 1 activities A01 to A05 and P01 to P03
Connected-question activities C01 and C02

Edition FLA-1D-02 / Keep your first prediction when you revise.

READ BEFORE TRAINING

Your flight procedure

1 Read the situation

Mark the origin and positive direction. Decide whether each number is a coordinate, displacement, distance, velocity, acceleration, or time interval.

2 Predict and calculate with G.U.E.S.S.

Predict a sign or direction. G = Givens; U = Unknowns; E = Equation; S = Substitute; S = Solve. The work boxes group G/U and S/S, as in the 2D worksheets. Include units and signed directions. Use slope or area relationships for graph calculations.

3 Enter and observe

For C01-C02, submit the whole cluster before feedback. For flight lessons, open the matching activity ID in 1D flight school. Enter the requested values and explanation. Save prediction and observe records your first entry before playback. Use +1 s or Finish observation if you prefer stepping.

4 Explain and retry

Compare the result with your prediction. Keep the first answer visible on paper. Explain a correction before retrying. A replay does not create another attempt.

5 Keep a copy

The Pilot logbook exports both new and existing Academy records. Saves belong to the current browser and address. Export before changing devices. Your instructor reviews written work before certification.

Course section	Activity IDs	Pages
1D foundation	K00 to K21	4 to 25
Guided 2D bridge	T00 to T02	26 to 28
AP Physics 1 extensions	A01 to A05 / P01 to P03	29 to 36
Connected questions	C01 and C02	37 to 40
Instructor review record	Core and optional evidence	41

Planning has no time penalty. Numeric entry stays beside or below the display. Negative components indicate direction; speed, distance, and elapsed duration are nonnegative.

This manual uses NYSED notation. In the game, select NYSED, AP Physics 1, or Compare. The notation setting changes labels only; it does not change a flight or its physics.

REFERENCE DESK

Equations and graph relationships

Use SI units. In 1D, signed displacement d = final coordinate minus initial coordinate. The table uses t for an elapsed time interval. A bar over v denotes an average.

$$\bar{v} = d / t$$

Average velocity. Average speed uses total distance in the numerator.

$$a = (v_f - v_i) / t$$

Average acceleration; equals constant acceleration for these uniform intervals.

$$v_f = v_i + at$$

Constant acceleration over the selected interval.

$$d = v_i t + \tfrac{1}{2}at^2$$

Constant acceleration. Final coordinate equals initial coordinate plus d.

$$v_f^2 = v_i^2 + 2ad$$

Constant acceleration; recover velocity direction after taking a square root.

$$\bar{v} = (v_f + v_i) / 2$$

Endpoint averaging requires constant acceleration. The derived form is d = v̄t.

Graph	Slope	Signed area
Position or displacement vs time	Velocity	Not used here
Velocity vs time	Acceleration	Displacement
Acceleration vs time	Not used here	Change in velocity

For distance, add the magnitudes of velocity-time areas. For displacement, retain their signs. A position graph includes its starting coordinate; a displacement graph is measured from its stated starting point.

Notation bridge: NYSED d corresponds to AP $\Delta x = x - x_0$; initial v_i corresponds to AP v_{x0}. Apply the same equations separately to x and y, with one shared elapsed time.

Reference: NYSED Physical Science Physics Reference Tables, 2025 edition, pages 1-2. Graph rules and component forms are applications. AP extensions follow College Board AP Physics 1 Unit 1 and its science practices.

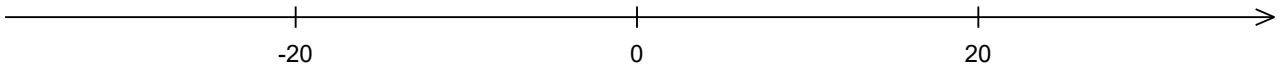
K00 / CORE / WORKED EXAMPLE

Your first displacement

A craft starts at x = -20 m and finishes at x = +20 m. Positive x points right. Predict its displacement, then observe the prescribed flight.

Initial position: -20 m / Final position: 20 m

Given coordinates on the x axis +x right / m



G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find signed displacement.

E: $d = x_f - x_i$

S / S: Substitute and solve with units.

Final position minus initial position: 20 - (-20) = +40 m.

The craft moves 40 m in the positive direction. A negative starting coordinate does not mean negative displacement.

Before observation

Predict the direction or sign. Explain it briefly: _____

Signed displacement: _____ m

Observe and explain

Open K00 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

If both coordinates increased by 100 m, would displacement change? Explain.

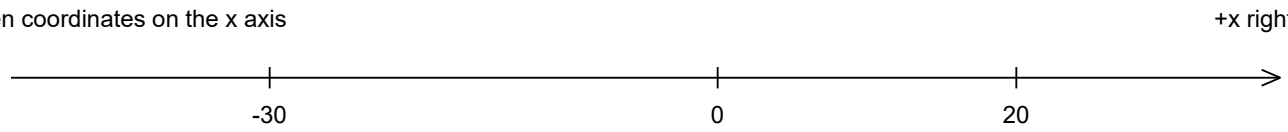
K01 / CORE / GUIDED PRACTICE

Across the origin

Move from x = -30 m to x = +20 m on the marked lane. Find the signed change in position.

Initial position: -30 m / Final position: 20 m

Given coordinates on the x axis



Guidance: Write final coordinate minus initial coordinate. Subtracting a negative adds its magnitude.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find signed displacement (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Signed displacement: _____ m

Observe and explain

Open K01 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Why is the final coordinate alone not the displacement?

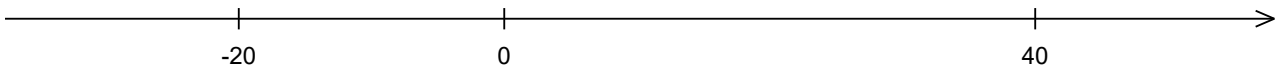
K02 / CORE / INDEPENDENT CHECK

Port-side transfer

The craft starts at x = +40 m and ends at x = -20 m. Find its displacement.

Initial position: 40 m / Final position: -20 m

Given coordinates on the x axis +x right / m



Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find signed displacement (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Signed displacement: _____ m

Observe and explain

Open K02 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Does the negative sign describe a position, a direction of change, or both in this problem?

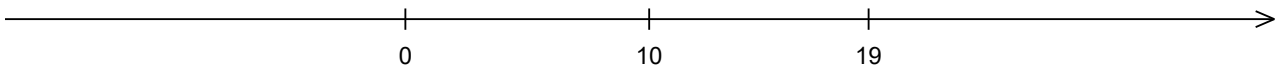
K03 / CORE / WORKED EXAMPLE

Return to the same marker

The prescribed route goes from x = 10 m to x = 19 m, then returns to x = 10 m. Find net displacement and total distance.

Start: 10 m / Turning position: 19 m / Finish: 10 m

Given coordinates on the x axis +x right / m



G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find net displacement; total distance.

E: $d = x_f - x_i$; distance = sum of the lengths of both legs

S / S: Substitute and solve with units.

Net displacement: 10 - 10 = 0 m.

Outward leg: 19 - 10 = 9 m. Return leg: 9 m. Total distance: 9 + 9 = 18 m.

Before observation

Predict the direction or sign. Explain it briefly: _____

Net displacement: _____ m Total distance: _____ m

Observe and explain

Open K03 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

How can the craft travel while its net displacement is zero?

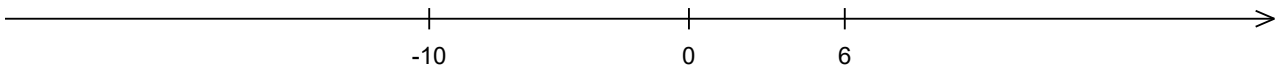
K04 / CORE / INDEPENDENT CHECK

Count both legs

The craft travels from x = -10 m to x = +6 m, then back to x = -10 m. Calculate displacement and distance.

Start: -10 m / Turning position: 6 m / Finish: -10 m

Given coordinates on the x axis +x right / m



Guidance: Use only the first and last coordinates for displacement. Add the lengths of both legs for distance.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find net displacement (m); total distance (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Net displacement: _____ m Total distance: _____ m

Observe and explain

Open K04 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

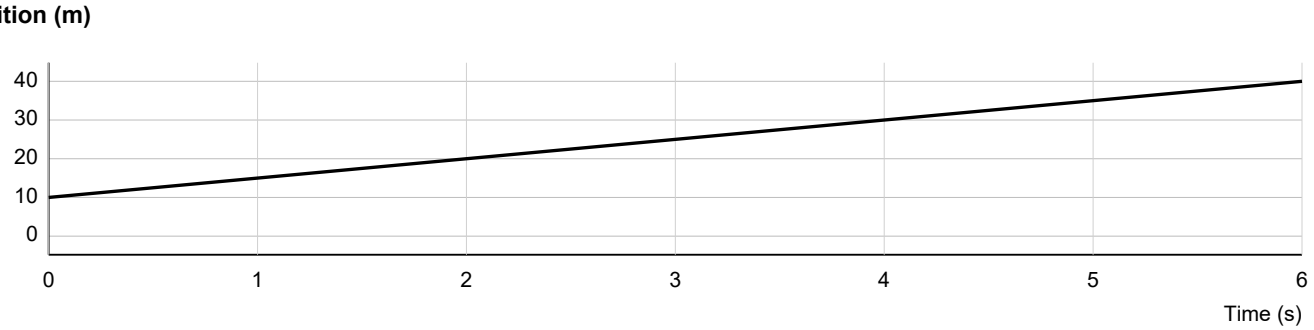
Explain why total distance cannot be negative.

K05 / CORE / WORKED EXAMPLE

Read the position trace

The craft moves from x = 10 m to x = 40 m in 6 s at constant velocity. Find its average velocity.

Initial position: 10 m / Final position: 40 m / Elapsed time: 6 s



G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find average velocity.

E: $d = x_f - x_i$; average velocity = d / t

S / S: Substitute and solve with units.

Displacement: 40 - 10 = 30 m.

Average velocity: 30 / 6 = +5 m/s. The position-time slope gives the same result.

Before observation

Predict the direction or sign. Explain it briefly: _____

Average velocity: _____ m/s

Observe and explain

Open K05 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

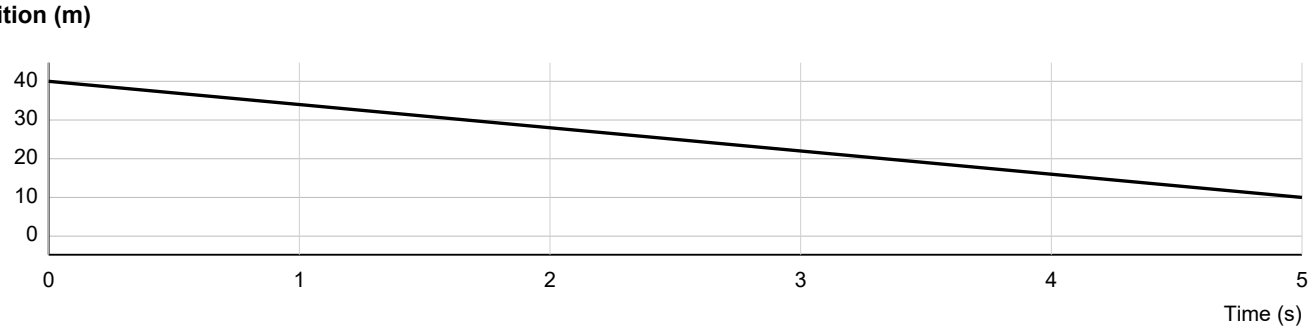
Why is the slope 5 m/s even though the graph starts at 10 m?

K06 / CORE / GUIDED PRACTICE

A descending position trace

Use the position-time graph to find the craft's average velocity and average speed from 0 to 5 s.

Initial position: 40 m / Elapsed time: 5 s



Guidance: Slope is change in position divided by change in time. Read both endpoints.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find average velocity (m/s); average speed (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Average velocity: _____ m/s

Average speed: _____ m/s

Observe and explain

Open K06 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Does a downward-sloping position graph mean that speed is decreasing?

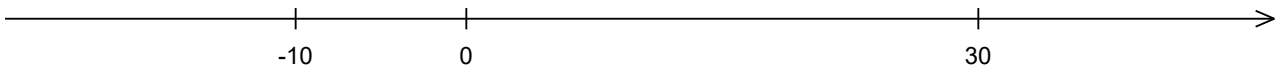
K07 / CORE / INDEPENDENT CHECK

Find the travel time

A craft coasts from x = -10 m to x = +30 m at +8 m/s. How much time does the trip take?

Initial position: -10 m / Final position: 30 m / Constant velocity: 8 m/s

Given coordinates on the x axis +x right / m



Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find elapsed time (s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Elapsed time: _____ s

Observe and explain

Open K07 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

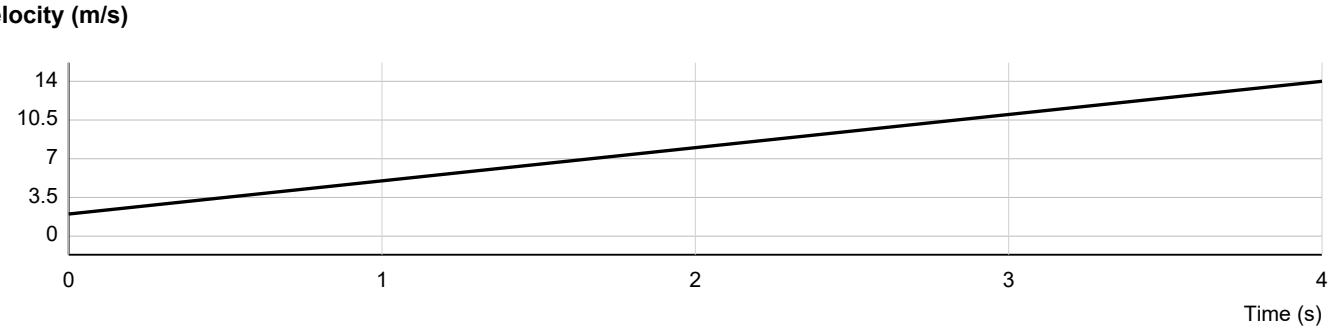
Show how you rearranged the average-velocity equation to isolate time.

K08 / CORE / WORKED EXAMPLE

Changing velocity

The craft's velocity changes uniformly from +2 m/s to +14 m/s in 4 s. Find its acceleration.

Initial velocity: 2 m/s / Final velocity: 14 m/s / Elapsed time: 4 s



G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find acceleration.

E: $a = (v_f - v_i) / t$

S / S: Substitute and solve with units.

Change in velocity: 14 - 2 = 12 m/s.

Acceleration: 12 / 4 = +3 m/s^2. The velocity-time slope is positive.

Before observation

Predict the direction or sign. Explain it briefly: _____

Acceleration: _____ m/s^2

Observe and explain

Open K08 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

What does +3 m/s^2 mean about each second of this motion?

K09 / CORE / GUIDED PRACTICE

Negative acceleration and speed

A craft already moving left at -4 m/s accelerates at -2 m/s^2 for 3 s. Predict its final velocity and change in speed.

Initial velocity: -4 m/s / Constant acceleration: -2 m/s^2 / Elapsed time: 3 s

Guidance: Add acceleration multiplied by time to the initial velocity. Compare velocity magnitudes for speed.

Before observation

Predict the direction or sign. Explain it briefly: _____

During this interval, the craft's speed...

( ) increases

( ) decreases

( ) stays constant

G.U.E.S.S. / flight calculation

Find final velocity (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Final velocity: _____ m/s

Observe and explain

Open K09 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Compare your first prediction with the observed motion. Explain any correction using an equation or graph.

K10 / CORE / INDEPENDENT CHECK

Brake to rest

A craft moving at +12 m/s slows uniformly to rest in 4 s. Determine its acceleration.

Initial velocity: 12 m/s / Final velocity: 0 m/s / Elapsed time: 4 s

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find acceleration (m/s^2).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Acceleration: _____ m/s^2

Observe and explain

Open K10 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Why is acceleration negative here? Would a negative acceleration always slow a craft?

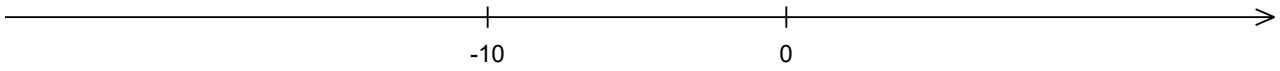
K11 / CORE / WORKED EXAMPLE

Travel while accelerating

A craft starts at x = -10 m with velocity +3 m/s. It accelerates at +2 m/s^2 for 4 s. Find its displacement and final position.

Initial position: -10 m / Initial velocity: 3 m/s / Constant acceleration: 2 m/s^2 / Elapsed time: 4 s

Given coordinates on the x axis +x right / m



G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find displacement; final position.

E: $d = v_i t + (1/2)at^2$; $x_f = x_i + d$

S / S: Substitute and solve with units.

Displacement: $(3)(4) + (1/2)(2)(4^2) = 12 + 16 = 28$ m.

Final position: -10 + 28 = 18 m.

Before observation

Predict the direction or sign. Explain it briefly: _____

Displacement: _____ m Final position: _____ m

Observe and explain

Open K11 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

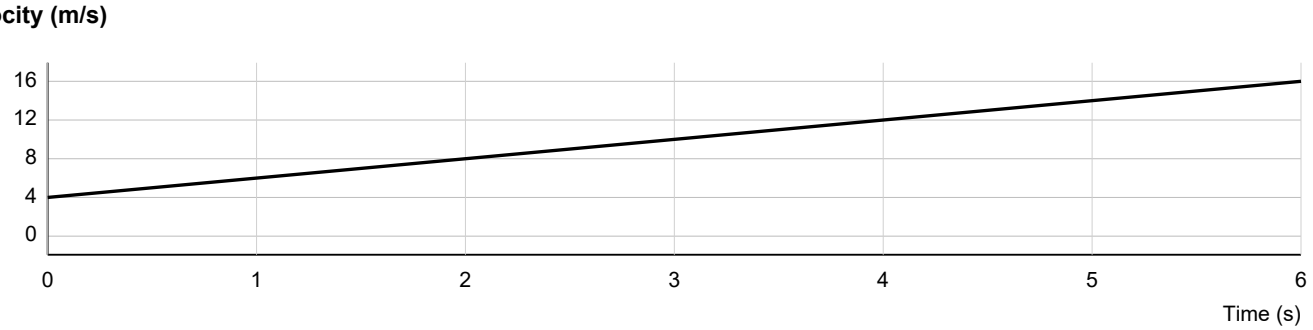
What contribution comes from initial velocity, and what contribution comes from acceleration?

K12 / CORE / GUIDED PRACTICE

Average the endpoints

Velocity increases uniformly from +4 m/s to +16 m/s in 6 s. Find average velocity and displacement.

Initial velocity: 4 m/s / Final velocity: 16 m/s / Elapsed time: 6 s



Guidance: Average the two velocities, then multiply by elapsed time. Confirm using the trapezoid area on the velocity-time graph.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find average velocity (m/s); displacement (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Average velocity: _____ m/s Displacement: _____ m

Observe and explain

Open K12 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Why must the acceleration be constant for this endpoint-average method?

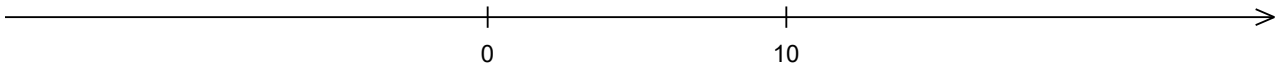
K13 / CORE / INDEPENDENT CHECK

A moving start

A craft begins at x = 10 m with velocity -2 m/s. Its constant acceleration is +3 m/s^2 for 4 s. Find displacement and final position.

Initial position: 10 m / Initial velocity: -2 m/s / Constant acceleration: 3 m/s^2 / Elapsed time: 4 s

Given coordinates on the x axis +x right / m



Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find displacement (m); final position (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Displacement: _____ m Final position: _____ m

Observe and explain

Open K13 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

The craft initially moves left. Explain how its final displacement can be positive.

K14 / CORE / WORKED EXAMPLE

Stop without knowing time

A craft moving at +10 m/s brakes at a constant -2 m/s^2 until it stops. Find its stopping displacement using an equation without time.

Initial velocity: 10 m/s / Final velocity: 0 m/s / Constant acceleration: -2 m/s^2

G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find stopping displacement.

E: $v_f^2 = v_i^2 + 2ad$; $d = (v_f^2 - v_i^2) / (2a)$

S / S: Substitute and solve with units.

Use $v_f^2 = v_i^2 + 2ad$.

$0 = 100 + 2(-2)d$, so $d = (0 - 100)/(-4) = +25$ m.

Before observation

Predict the direction or sign. Explain it briefly: _____

Stopping displacement: _____ m

Observe and explain

Open K14 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

How do the signs of the numerator and denominator give a positive stopping displacement?

K15 / CORE / INDEPENDENT CHECK

Stopping clearance

A craft moving at +8 m/s brakes at -2 m/s^2 to rest. Find the displacement needed to stop.

Initial velocity: 8 m/s / Final velocity: 0 m/s / Constant acceleration: -2 m/s^2

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find stopping displacement (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Stopping displacement: _____ m

Observe and explain

Open K15 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Explain why using only initial velocity multiplied by time would be incorrect during braking.

K16 / CORE / GUIDED PRACTICE

Recover the direction

Initial velocity is -4 m/s. Constant acceleration is -2 m/s^2. After a displacement of -12 m, find the final velocity.

Initial velocity: -4 m/s / Constant acceleration: -2 m/s^2 / Displacement: -12 m

Guidance: First solve for the square of velocity. Use the direction of motion to choose the sign of its square root.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find final velocity (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Final velocity: _____ m/s

Observe and explain

Open K16 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

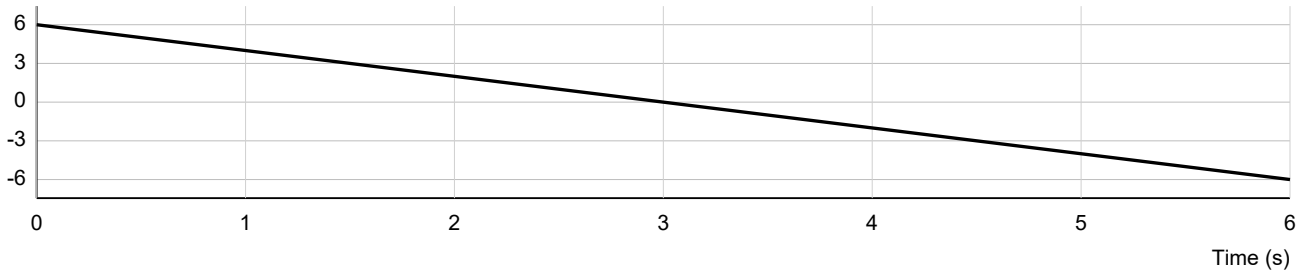
Why does taking only the positive square root give the wrong velocity?

K17 / CORE / WORKED EXAMPLE

Read a reversal

Use the velocity-time graph for this 6 s flight. Find displacement, distance, average velocity, and average speed, taking account of the reversal.

Initial position: 10 m / Elapsed time: 6 s



G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find displacement; total distance; average speed; average velocity.

E: triangle area = (1/2)(base)(height); d = signed area; distance = sum of area magnitudes; average velocity = d / t; average speed = distance / t

S / S: Substitute and solve with units.

Positive triangular area: (1/2)(3)(6) = +9 m.

Negative triangular area: -9 m. Displacement: 9 - 9 = 0 m.

Distance: 9 + 9 = 18 m. The reversal occurs when velocity crosses zero.

Average velocity: 0 / 6 = 0 m/s. Average speed: 18 / 6 = 3 m/s.

Before observation

Predict the direction or sign. Explain it briefly: _____

Displacement: _____ m

Total distance: _____ m

Average speed: _____ m/s

Average velocity: _____ m/s

Observe and explain

Open K17 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

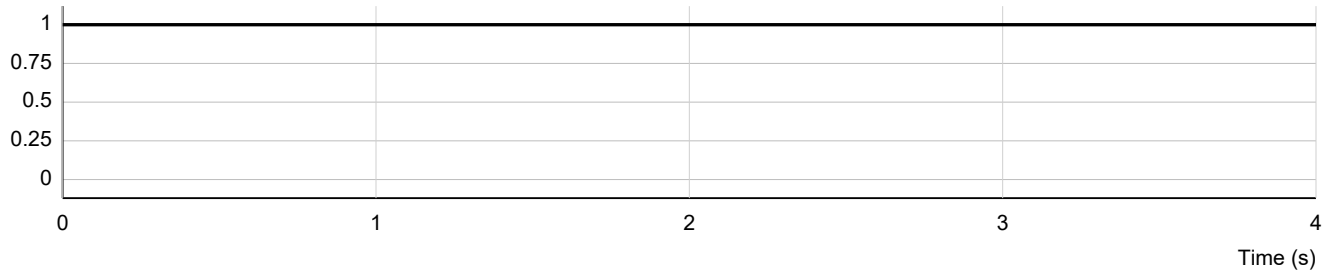
Which instant is the turning point, and what is the acceleration at that instant?

K18 / CORE / INDEPENDENT CHECK

From acceleration to position

The acceleration-time graph is given. Initial velocity is -2 m/s. Find final velocity, displacement, and average speed after 4 s.

Initial velocity: -2 m/s / Elapsed time: 4 s



Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find final velocity (m/s); displacement (m); average speed (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Final velocity: _____ m/s

Displacement: _____ m

Average speed: _____ m/s

Observe and explain

Open K18 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Why is acceleration-time area a change in velocity rather than displacement?

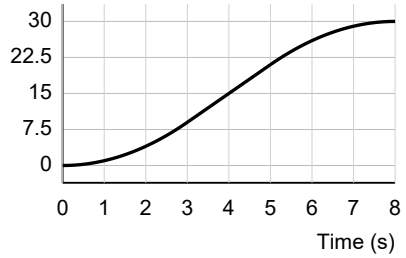
K19 / CORE / INDEPENDENT CHECK

Accelerate coast and brake

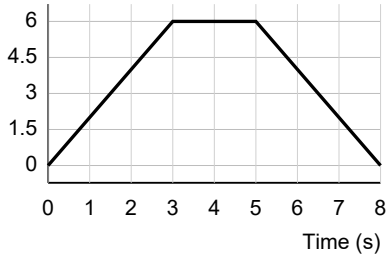
Use the supplied motion traces. The craft accelerates for 3 s, coasts for 2 s, then brakes for 3 s. Find total displacement and final velocity.

Initial velocity: 0 m/s / Total elapsed time: 8 s

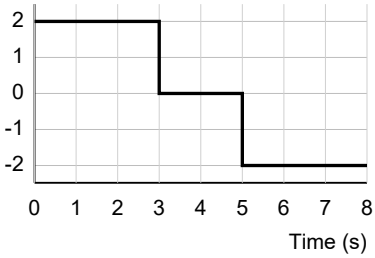
Position (m)



Velocity (m/s)



Acceleration (m/s²)



Before observation

Predict the direction or sign. Explain it briefly: _____

During the middle interval, zero acceleration means...

( ) the craft keeps its velocity

( ) the craft must be at rest

( ) its position resets to zero

G.U.E.S.S. / flight calculation

Find total displacement (m); final velocity (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Total displacement: _____ m

Final velocity: _____ m/s

Observe and explain

Open K19 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Calculate each interval separately. What carries over at the interval boundaries?

K20 / CORE / WORKED EXAMPLE

One dimension can be vertical

In an Earth-surface test chamber, a marker is released from y = 20 m. Positive y is upward. Ignore air resistance and use g = 9.8 m/s^2. Find its displacement and height after 2 s.

Initial height: 20 m / Initial velocity: 0 m/s / Vertical acceleration: -9.8 m/s^2 / Elapsed time: 2 s

G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find vertical displacement; final height.

E: $d_y = v_{iy} t + (1/2)a_y t^2$; $y_f = y_i + d_y$

S / S: Substitute and solve with units.

Vertical displacement: $0(2) + (1/2)(-9.8)(2^2) = -19.6$ m.

Final height: 20 - 19.6 = 0.4 m.

Before observation

Predict the direction or sign. Explain it briefly: _____

Vertical displacement: _____ m Final height: _____ m

Observe and explain

Open K20 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Why is acceleration negative when g itself is a positive magnitude?

K21 / CORE / INDEPENDENT CHECK

Up and back

In the Earth-surface chamber, a marker starts at y = 10 m moving upward at +9.8 m/s. Use constant acceleration -9.8 m/s^2 and ignore air resistance. Find displacement and final velocity after 2 s.

Initial height: 10 m / Initial velocity: 9.8 m/s / Vertical acceleration: -9.8 m/s^2 / Elapsed time: 2 s

Before observation

Predict the direction or sign. Explain it briefly: _____

At the highest point, acceleration is...

( ) -9.8 m/s^2

( ) zero

( ) +9.8 m/s^2

G.U.E.S.S. / flight calculation

Find vertical displacement (m); final vertical velocity (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Vertical displacement: _____ m

Final vertical velocity: _____ m/s

Observe and explain

Open K21 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Compare your first prediction with the observed motion. Explain any correction using an equation or graph.

T00 / CORE / WORKED EXAMPLE

Two axes one clock

Repeat the familiar horizontal flight while the craft also coasts vertically. Solve each component separately using the same 4 s. Then combine the components.

Initial x: -10 m / Initial y: 5 m / Initial horizontal velocity: 3 m/s / Initial vertical velocity: 1 m/s / Horizontal acceleration: 2 m/s^2 / Vertical acceleration: 0 m/s^2 / Shared elapsed time: 4 s

G.U.E.S.S. / worked calculation

G / U: Use the givens above. Find horizontal displacement; vertical displacement; final x coordinate; final y coordinate.

E: $d_x = v_{ix}\,t + (1/2)a_x\,t^2$; $d_y = v_{iy}\,t + (1/2)a_y\,t^2$; $x_f = x_i + d_x$; $y_f = y_i + d_y$

S / S: Substitute and solve with units.

Horizontal: $d_x = 3(4) + (1/2)(2)(4^2) = 28$ m. Final x = -10 + 28 = 18 m.

Vertical: $d_y = 1(4) + (1/2)(0)(4^2) = 4$ m. Final y = 5 + 4 = 9 m.

Displacement is (28, 4) m. Final position is (18, 9) m. Both components act during the same 4 s.

Before observation

Predict the direction or sign. Explain it briefly: _____

Horizontal displacement: _____ m

Vertical displacement: _____ m

Final x coordinate: _____ m

Final y coordinate: _____ m

Observe and explain

Open T00 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Why do the components share time even though their accelerations are different?

T01 / CORE / GUIDED PRACTICE

Coasting on two axes

The craft starts at (20, -10) m and coasts with velocity (-5, 3) m/s for 4 s. Find both displacement components and its final coordinates.

Initial x: 20 m / Initial y: -10 m / Horizontal velocity: -5 m/s / Vertical velocity: 3 m/s / Horizontal acceleration: 0 m/s^2 / Vertical acceleration: 0 m/s^2 / Shared elapsed time: 4 s

Guidance: Multiply each velocity component by the shared time. Add each displacement to its own starting coordinate.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find horizontal displacement (m); vertical displacement (m); final x coordinate (m); final y coordinate (m). Both axes use one shared elapsed time.

HORIZONTAL / x	VERTICAL / y
G / U Givens and unknowns	**G / U Givens and unknowns**
E Equation before substitution	**E Equation before substitution**
S / S Substitute and solve with units	**S / S Substitute and solve with units**

Horizontal displacement: _____ m

Vertical displacement: _____ m

Final x coordinate: _____ m

Final y coordinate: _____ m

Observe and explain

Open T01 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Compare your first prediction with the observed motion. Explain any correction using an equation or graph.

T02 / CORE / INDEPENDENT CHECK

Independent component check

A craft begins at (5, 10) m with velocity (2, -1) m/s. Constant acceleration is (1, 2) m/s^2 for 3 s. Find displacement and final velocity components.

Initial x: 5 m / Initial y: 10 m / Initial horizontal velocity: 2 m/s / Initial vertical velocity: -1 m/s / Horizontal acceleration: 1 m/s^2 / Vertical acceleration: 2 m/s^2 / Shared elapsed time: 3 s

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find horizontal displacement (m); vertical displacement (m); final horizontal velocity (m/s); final vertical velocity (m/s). Both axes use one shared elapsed time.

HORIZONTAL / x	VERTICAL / y
G / U Givens and unknowns	**G / U Givens and unknowns**
E Equation before substitution	**E Equation before substitution**
S / S Substitute and solve with units	**S / S Substitute and solve with units**

Horizontal displacement: _____ m

Vertical displacement: _____ m

Final horizontal velocity: _____ m/s

Final vertical velocity: _____ m/s

Observe and explain

Open T02 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Explain which quantities belong to each axis and which quantity is shared.

A01 / AP PHYSICS 1 / INDEPENDENT CHECK

Stopping distance scales

Compare two stopping flights with the same braking acceleration magnitude. The second craft has twice the initial speed. Derive the stopping-distance factor, then calculate the second craft's stopping displacement.

Second initial velocity: 20 m/s / Final velocity: 0 m/s / Braking acceleration: -5 m/s^2

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find stopping-distance factor (unitless); second stopping displacement (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Stopping-distance factor: _____ Second stopping displacement: _____ m

Observe and explain

Open A01 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Derive d in terms of initial speed and braking acceleration magnitude before substituting. State what is held constant.

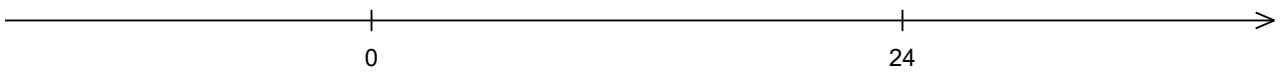
A02 / AP PHYSICS 1 / INDEPENDENT CHECK

Catch the courier

A pursuit craft starts at x = 0 from rest with constant acceleration +4 m/s^2. At the same instant, a courier is at x = 24 m coasting at +2 m/s. Find the positive meeting time and coordinate.

Pursuer initial position: 0 m / Pursuer initial velocity: 0 m/s / Pursuer acceleration: 4 m/s^2 / Courier initial position: 24 m / Courier velocity: 2 m/s

Given coordinates on the x axis +x right / m



Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find meeting time (s); meeting coordinate (m).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Meeting time: _____ s Meeting coordinate: _____ m

Observe and explain

Open A02 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Set the two position expressions equal. Explain why one algebraic time solution is not part of this flight.

A03 / AP PHYSICS 1 / INDEPENDENT CHECK

A delayed departure

The craft waits at rest for 2 s, then accelerates from rest at +2 m/s^2 for 4 s. Find its displacement and average velocity over the entire 6 s observation.

Waiting interval: 2 s / Acceleration interval: 4 s / Acceleration after waiting: 2 m/s^2 / Initial velocity: 0 m/s

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find total displacement (m); average velocity over 6 s (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Total displacement: _____ m

Average velocity over 6 s: _____ m/s

Observe and explain

Open A03 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

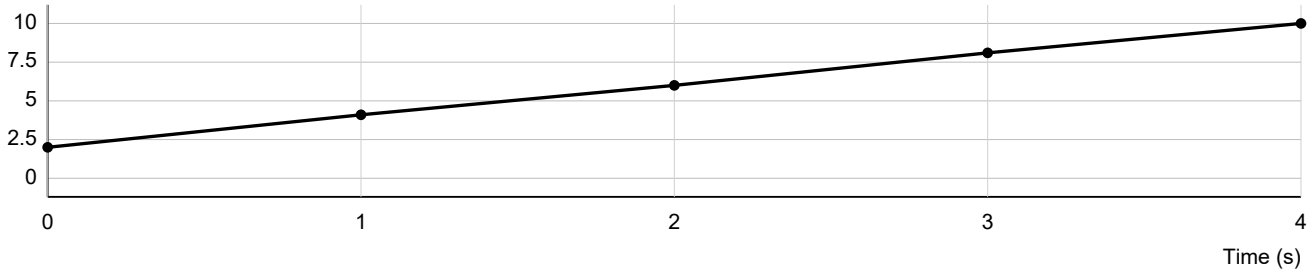
Why does the acceleration calculation use 4 s while average velocity uses 6 s?

A04 / AP PHYSICS 1 / INDEPENDENT CHECK

Measure acceleration

These simulated velocity measurements include small reading variations. Estimate acceleration using the first and last points, then choose a useful experimental graph. Write a procedure and discuss uncertainty in your manual.

Measured velocity (m/s)



Readings (time s, velocity m/s): (0, 2); (1, 4.1); (2, 6); (3, 8.1); (4, 10)

Before observation

Predict the direction or sign. Explain it briefly: _____

To estimate constant acceleration from all the measurements, plot...

( ) velocity against time and fit the slope

( ) position against time and read the intercept

( ) velocity against time and use its total area

G.U.E.S.S. / flight calculation

Find estimated acceleration (m/s^2).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Estimated acceleration: _____ m/s^2

Observe and explain

Open A04 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Describe how to collect independent position/time data, estimate velocities, and reduce timing uncertainty. What would curvature in the velocity-time graph suggest?

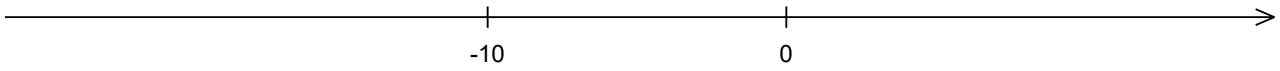
A05 / AP PHYSICS 1 / INDEPENDENT CHECK

Change the observer

In the map frame, a marker moves at +12 m/s and an observer coasts at +5 m/s. Find the marker's velocity relative to the observer.

Marker map velocity: 12 m/s / Observer map velocity: 5 m/s

Given coordinates on the x axis +x right / m



Guidance: Subtract the observer's map velocity from the marker's map velocity.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find velocity relative to observer (m/s).

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Velocity relative to observer: _____ m/s

Observe and explain

Open A05 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Describe what the observer measures. Why do both inertial observers agree that the acceleration is zero?

P01 / AP PHYSICS 1 / INDEPENDENT CHECK

Resolve a velocity vector

A craft coasts at speed 20 m/s at 53.13° above +x. Use cos(53.13°) = 0.60 and sin(53.13°) = 0.80. Find the velocity components and displacements after 2 s.

Speed: 20 m/s / Angle above +x: 53.13 degrees / Shared elapsed time: 2 s

Guidance: Horizontal component = speed × cosine. Vertical component = speed × sine. Use the same elapsed time for both.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find horizontal velocity (m/s); vertical velocity (m/s); horizontal displacement (m); vertical displacement (m). Both axes use one shared elapsed time.

HORIZONTAL / x	VERTICAL / y
G / U Givens and unknowns	**G / U Givens and unknowns**
E Equation before substitution	**E Equation before substitution**
S / S Substitute and solve with units	**S / S Substitute and solve with units**

Horizontal velocity: _____ m/s

Vertical velocity: _____ m/s

Horizontal displacement: _____ m

Vertical displacement: _____ m

Observe and explain

Open P01 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Reconstruct the speed from the two velocity components. What changes if only the launch angle changes?

P02 / AP PHYSICS 1 / GUIDED PRACTICE

Horizontal launch

In an Earth-surface chamber, a marker is launched horizontally at 15 m/s from height 19.6 m. Ground level is y = 0. Ignore air resistance and use g = 9.8 m/s^2. Find landing time, horizontal range, and final vertical velocity.

Initial height: 19.6 m / Landing height: 0 m / Horizontal velocity: 15 m/s / Initial vertical velocity: 0 m/s / Horizontal acceleration: 0 m/s^2 / Vertical acceleration: -9.8 m/s^2

Guidance: Use the vertical displacement to solve for positive flight time. Reuse that time in the horizontal equation.

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find landing time (s); horizontal range (m); final vertical velocity (m/s). Both axes use one shared elapsed time.

HORIZONTAL / x	VERTICAL / y
G / U Givens and unknowns	**G / U Givens and unknowns**
E Equation before substitution	**E Equation before substitution**
S / S Substitute and solve with units	**S / S Substitute and solve with units**

Landing time: _____ s

Horizontal range: _____ m

Final vertical velocity: _____ m/s

Observe and explain

Open P02 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

If the horizontal launch speed doubles, what happens to landing time and range? State your assumptions.

P03 / AP PHYSICS 1 / INDEPENDENT CHECK

Launch to a lower platform

A marker launches from (0, 14.7) m with velocity (12, 9.8) m/s and lands at y = 0. Ignore air resistance and use g = 9.8 m/s^2 downward. Find the positive flight time, horizontal range, and final vertical velocity.

Initial height: 14.7 m / Landing height: 0 m / Horizontal velocity: 12 m/s / Initial vertical velocity: 9.8 m/s / Horizontal acceleration: 0 m/s^2 / Vertical acceleration: -9.8 m/s^2

Before observation

Predict the direction or sign. Explain it briefly: _____

G.U.E.S.S. / flight calculation

Find landing time (s); horizontal range (m); final vertical velocity (m/s). Both axes use one shared elapsed time.

HORIZONTAL / x	VERTICAL / y
G / U Givens and unknowns	**G / U Givens and unknowns**
E Equation before substitution	**E Equation before substitution**
S / S Substitute and solve with units	**S / S Substitute and solve with units**

Landing time: _____ s

Horizontal range: _____ m

Final vertical velocity: _____ m/s

Observe and explain

Open P03 in the Academy. Enter your prediction, then observe. Record any difference.

Observed result: _____ ( ) Verified ( ) Retry

Explain why the equal-height range formula is not suitable. Design a measurement that could check your predicted range.

Patrol checkpoint log

After K06 and K07: signed displacement, distance, average speed and average velocity.

A cadet flies along a single fixed x-axis, with +x to the right. The craft travels from its start to a beacon, then reverses once and travels to a holding point. There are no additional reversals.

Checkpoint	Clock time (s)	Position x (m)
Start	0	-15
Beacon / turn	8	25
Holding point	14	10

This is a checkpoint log. It gives positions at three times, but does not establish constant velocity between checkpoints or the acceleration during the turn.

Q1. Select the three scalar quantities.

( ) Distance traveled
( ) Position vector relative to the stated origin
( ) Speed
( ) Displacement
( ) Elapsed time
( ) Velocity

Q2. Find the signed displacement from the start to the beacon.

Answer: _____ m

Q3. Compare total distance with the magnitude of net displacement over the full trip.

( ) They are equal because motion is one-dimensional.
( ) Distance is greater because the craft reverses direction.
( ) Distance is less because part of the trip is in -x.
( ) Net displacement is zero because the craft turns.

Continue on the next page. Keep all first responses before viewing feedback.

C01 / CONNECTED QUESTIONS / CONTINUED

Patrol checkpoint log / reasoning

Use signed displacement $d = x_f - x_i$ and elapsed time $t = t_f - t_i$. Average velocity $\bar{v} = d/t$; average speed = total distance/t.

Q4. Find the average velocity from the beacon to the holding point. Use that leg's elapsed time.

Answer: _____ m/s

Show your displacement and elapsed-time calculations for Q2 and Q4, including equations, substitution, units and direction.

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Q5. A cadet claims: 'The full-trip average speed differs from the magnitude of average velocity, so the computer must be wrong.' Support or refute this claim.

( ) Support
( ) Refute

Justify Q5 with the full-trip distance, net displacement, average speed and average velocity. Explain what the comparison means.

Submit and review

Submit every response together in C01 before viewing feedback. Keep your first answers. Record corrections separately. Written reasoning requires instructor review.

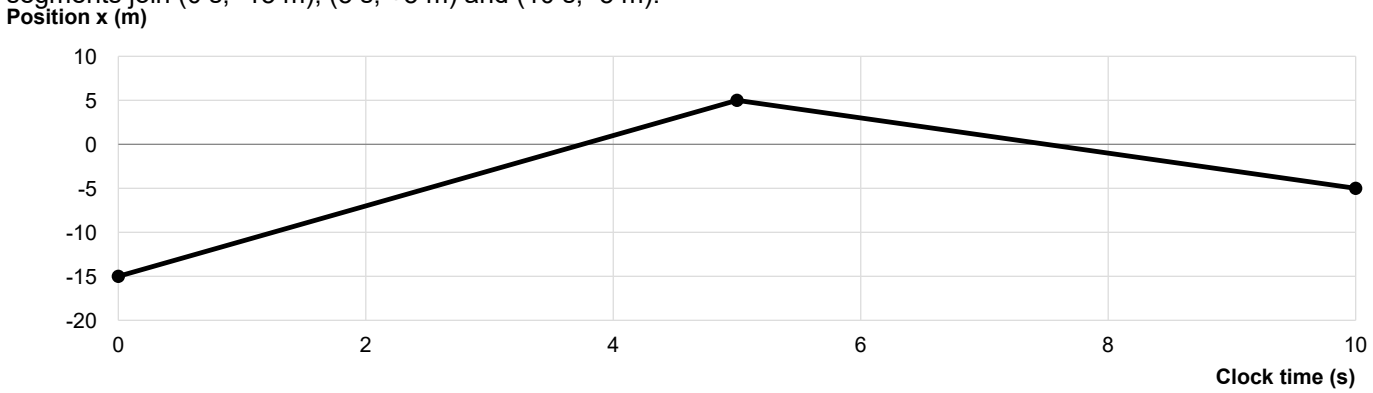
Strategy hint used? Yes / No Attempt: First / Retry Instructor: _____

C02 / CONNECTED QUESTIONS / EVIDENCE AND FIRST RESPONSES

Sensor trace review

After K06 and K07, plus instruction that slope of a position-time graph is velocity.

A training sensor records one-dimensional motion in the same fixed frame, with +x to the right. Straight graph segments join (0 s, -15 m), (5 s, +5 m) and (10 s, -5 m).



Clock time (s)	Position x (m)
0	-15
5	5
10	-5

This is an idealized position-time graph. Each straight segment represents constant velocity; the sharp corner represents an idealized turnaround, not a finite-thrust maneuver.

Q6. What is the velocity from 0 to 5 s?

( ) +4 m/s
( ) -4 m/s
( ) +2 m/s
( ) -2 m/s

Q7. Find the signed velocity from 5 to 10 s. Include its magnitude and direction in your working.

Answer: _____ m/s

Q8. Over 0 to 10 s, how does total distance compare with the magnitude of net displacement?

( ) They are equal.
( ) Distance is greater.
( ) Distance is less.
( ) Both are zero.

Continue on the next page. Keep all first responses before viewing feedback.

C02 / CONNECTED QUESTIONS / CONTINUED

Sensor trace review / reasoning

Velocity is the signed slope of a position-time graph: $v = (x_f - x_i)/(t_f - t_i)$. For a constant-velocity interval, $d = vt$. A duration is not a final clock reading.

Q9. After 10 s, the craft continues at -2 m/s until it reaches x = -29 m. Which expression gives this additional duration?

( ) [-29 - (-5)] / (-2)
( ) 10 + [-29 - (-5)] / (-2)
( ) (-29) / (-2)
( ) [-29 - (-5)] / (+2)

Q10. Calculate the additional duration described in Q9, in seconds. Do not give the final clock reading.

Answer: _____ s

Show the two graph slopes (Q6-Q7), distance and net displacement (Q8), and the displacement, equation and substitution for the extra duration (Q9-Q10). Include units.

G / U Givens and unknowns

E Equation before substitution

S / S Substitute and solve with units

Q11. A cadet claims: 'The craft is slowing down the whole time from 0 to 10 s.' Support or refute this claim.

( ) Support
( ) Refute

Justify Q11 using both graph slopes and their magnitudes. Distinguish direction reversal from continuously decreasing speed.

Submit and review

Submit every response together in C02 before viewing feedback. Keep your first answers. Record corrections separately. Written reasoning requires instructor review.

Strategy hint used? Yes / No Attempt: First / Retry Instructor: _____

INSTRUCTOR REVIEW

Cadet review record

Record practical evidence and discuss written reasoning with your instructor. Automatic numerical checks do not certify written explanations or experimental procedures.

Skill	Evidence to discuss	Reviewed
Displacement and distance	Signs, origin, and an out-and-back trip	_____
Velocity and time	Slope, units, average speed versus velocity	_____
Connected questions	C01-C02: calculations, claims, first/retry evidence	_____
Acceleration	Direction, speeding up, slowing down, and rest	_____
Equation selection	Knowns, unknowns, assumptions, and rearrangement	_____
Motion graphs	Slope, signed area, reversal, and multiple stages	_____
Vertical transfer	Positive-up convention and downward acceleration	_____
Guided 2D bridge	Separate components and one shared time	_____
Optional AP Physics 1	Derivation, experimental reasoning, relative motion	_____

An idea I can now explain

A mistake I corrected and why

My next practice target

Instructor _____ Date _____