

KINEMATICS DAY 2: MOTION GRAPHS

WARMUP Day 1 Review

A walker goes 30 m east, then 10 m west. Taking east as positive, which pair is correct?

- ☐ A. Distance = 20 m; displacement = +40 m ☐ B. Distance = 40 m; displacement = +20 m
☐ C. Distance = 40 m; displacement = -20 m ☐ D. Distance = 20 m; displacement = -40 m

Check one → convince your neighbor in one sentence.

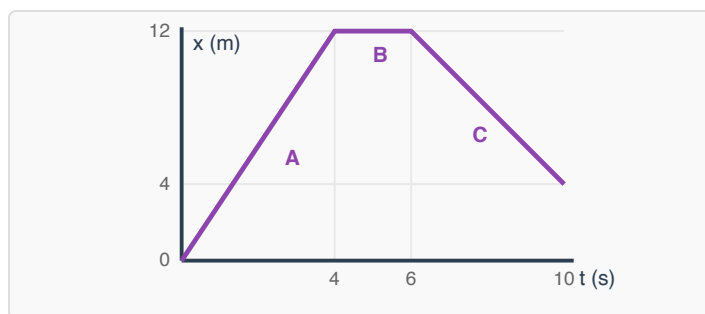
Physics in the Wild — Race Engineers Read Graphs, Not Numbers: A Formula 1 team gets thousands of numbers per second from the car. Nobody reads them as numbers — engineers stare at *velocity-time traces* to see exactly where a driver brakes late or gets on the throttle early. By the end of today you'll read motion graphs the same way: not as pictures of hills, but as stories about motion.

POSITION-TIME (X-T) GRAPHS

Slope = velocity.

- Straight line → constant velocity
- Flat (horizontal) → at rest
- Steeper → faster
- Sloping down → negative velocity (moving backward)

The graph is NOT a picture of the path — a downhill x-t line doesn't mean going downhill!



WE DO Exercise 1: Read the Story

Using the x-t graph above: **(a)** find the velocity during each segment A, B, and C. **(b)** What is the displacement for the whole 10 s? **(c)** What is the average velocity for the whole trip?

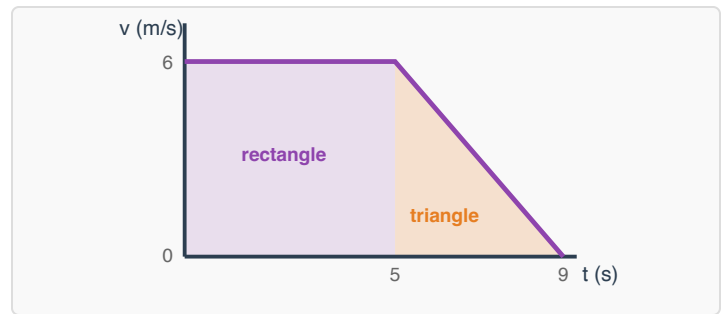
VELOCITY-TIME (V-T) GRAPHS

AREA = DISPLACEMENT

On a v-t graph, the area between the line and the time axis is the displacement.

- Area above the axis → positive displacement
- Area below the axis → negative displacement
- **The units prove it:** height × width = (m/s) × (s) = m — distance units
- Reading the height tells you the velocity at that instant

Break weird shapes into rectangles and triangles.



WE DO Exercise 2: Total the Areas

Using the v-t graph above: a bus travels at a constant 6 m/s for 5 s, then slows steadily to rest over the next 4 s. **(a)** Find the displacement during each piece — multiply the units along with the numbers (m/s × s = m). **(b)** Find the total displacement for all 9 s.

YOU DO Exercise 3: Signed Areas

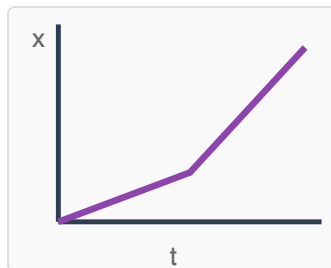
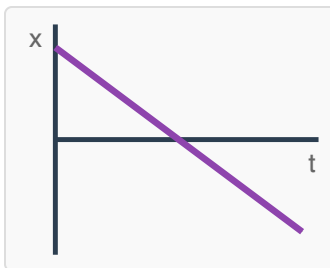
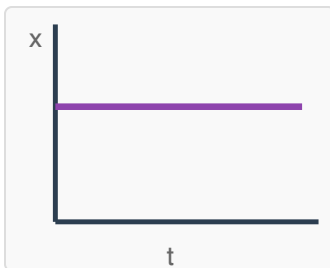
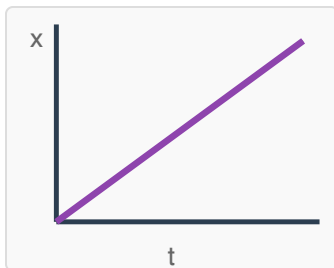
An object moves at +4 m/s for 3 s, then at −2 m/s for 2 s. **(a)** Sketch the v-t graph in the box. **(b)** Find the displacement. **(c)** Find the total distance traveled. **(d)** Why are the answers to (b) and (c) different?

The #1 graph mistake: on a v-t graph, when the line touches the time axis the object is momentarily *at rest* — NOT back at the start. The graph never tells you "where" directly; only areas do.

MATCHING GRAPHS TO MOTION

YOU DO Exercise 4: Match Each Graph to Its Story

Each x-t graph below shows 6 s of motion. Write the letter of the matching description under each graph.



A. Standing still, away from the origin. **B.** Walking forward at a steady pace. **C.** Walking slowly forward, then suddenly walking faster. **D.** Walking backward at a steady pace, passing the origin.

YOU DO Exercise 5: Story → Graph

An elevator moves up at 2 m/s for 4 s, holds still for 3 s, then moves down at 3 m/s for 2 s (up = positive).

(a) Sketch the v-t graph. **(b)** Use areas to find the total displacement.

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Velocity From x-t

An x-t graph shows an object at $x = +12$ m at $t = 2$ s and at $x = +4$ m at $t = 6$ s, connected by a straight line. Find the velocity. Is the object moving toward or away from the origin?

P2 Area From v-t

A v-t graph shows velocity rising steadily from 0 to 8 m/s over 4 s (a straight ramp). Find the displacement. *Hint: it's a triangle.*

P3 Displacement vs Distance Again

An object moves at +5 m/s for 4 s, then at -5 m/s for 4 s. Using areas: **(a)** what is its displacement? **(b)** what distance did it travel? **(c)** where does it end up relative to its start?

P4 Graph Detective

A friend claims: "My x-t graph crosses the time axis, so I must have stopped." Explain what crossing the time axis on an x-t graph *actually* means, and describe what "stopped" really looks like on that graph.