The Negative That Doesn't Mean Less

Student Worksheet

Motion Foundations · Lab Activity 2 · ConceptArc Education (FundaFirst HS) · fundafirsths.com

Name: _____ Class: _____ Date: _____

How this sheet works. *You will commit answers* **in ink, before every reveal**. *A crossed-out first answer next to a better second one is exactly what this sheet is for — keep both visible.*

Part 1 — The metronome walks (before any screen)

The class agrees the +x direction points: _____. **Walk 1:** start at x = 1 m, one metre toward larger x on every clap. **Walk 2:** start at x = 6 m, same tempo, toward smaller x.

clap (s)	Walk 1: x (m)	Walk 2: x (m)
0		
1		
2		
3		
4		

Each row holds two events: one per walker, both at the same clock reading.

1(a) Walk 1, from clap 1 to clap 3: change in position Δx = _____ m over Δt = _____ s → average velocity = _____ m/s

1(b) Walk 2, same two claps: Δx = _____ m → average velocity = _____ m/s

1(c) The two walks share one thing and differ in one thing. Same: _____. Different: _____

1(d) A classmate says: *"−1 m/s is less than +1 m/s, so Walk 2 is the slower walk."* What does the sign of a velocity report — and which part of the number carries the "how fast"?

_____

Part 2 — The rate machine (Scene 1)

Commit (before the machine runs): the clock reads 2 s, the walker is at x = 1 m, moving at a steady +2.5 m/s. Position when the clock reads 6 s: _____ m

2(a) A classmate answers 16 m. Which number did they treat as "the seconds that passed"?

_____

2(b) Now the machine is set to v = −1.5 m/s from x_0 = 7 m. After 3 hops (3 seconds), the walker is at x = _____ m.

Write the hop out: 7 m, then one hop of −1.5 m at a time.

Part 3 — Two walkers, one meeting (Scene 2)

Q1 commit — at the frozen meeting, moving faster is: Walker A / Same speed / Walker B / Cannot tell

Q2 commit — their velocities are:
A **B** **C** **D**

3(a) After the reveal, complete: *a velocity of −2.5 m/s means a speed of _____ m/s, moving toward _____ x. Of the two walkers, the faster one is _____.*

3(b) The meeting fixes where both walkers are at that instant. It does not, by itself, fix either walker's _____.

Part 4 — Out and back: two averages, one journey (Scene 4)

Q1 commit — instantaneous velocity at the first freeze: _____ m/s
Q2 commit — at the second freeze (same position again!): _____ m/s

Q3 commit — whole journey: **A** **B** **C** **D**

4(a) After the reveal: distance = _____ m, displacement = _____ m, total time = _____ s, average velocity = _____ m/s, average speed = _____ m/s.

4(b) Complete: *average velocity is built from the _____; average speed is built from the _____ — both divided by the total time.*

Going further

Layer B for Grades 11–12 · Layer C if you want the deep end

Layer B — quantitative

B1 A walker starts at x = 0 m: velocity +2.5 m/s for 2 s, then −0.5 m/s for **3 s**. Fill the table.

distance travelled	displacement	total time	average velocity	average speed

The average of the two velocities is +1 m/s. Your average velocity is not. Why not — and what would have to be true of the two stretches for the simple average to give the right answer?

B2 A student computes an average speed of 90 m/s for a walker crossing the classroom. Using rough anchors you choose yourself (room size, walking tempo), evaluate the claim in one sentence.

B3 Four readings of one walker's instantaneous velocity: at t = 1 s, +2 m/s; at t = 2 s, +2 m/s; at t = 3 s, 0 m/s; at t = 4 s, −3 m/s.
(a) At which clock reading is the walker moving toward smaller x? _____ (b) At which is it at rest at that instant? _____
(c) Can this table tell you where the walker **is** at t = 3 s? _____ — one sentence why:

B4 At clock reading t = 2 s a walker is at x = 9 m, moving at a steady −2 m/s. Position at clock reading t = 6 s: _____ m.
The tempting wrong answer is _____ m — it treats a clock reading as the number of seconds that passed.

Layer C — the deep end

C1 For Scene 3's curve, average velocities over intervals shrinking onto t = 4 s from BOTH sides:

from the left	average velocity (m/s)	from the right	average velocity (m/s)
3 s → 4 s	+3.5	4 s → 5 s	+4.5
3.5 s → 4 s	+3.75	4 s → 4.5 s	+4.25
3.9 s → 4 s		4 s → 4.1 s	

Both columns close in on _____ m/s. That value — the limit — is called the _____ at t = 4 s.

C2 A student objects: *"At one clock reading, Δx = 0 and Δt = 0, and 0/0 is meaningless — so velocity at an instant cannot mean anything."* Answer in your own words. Your answer must use the word **limit**.

C3 Explain why average speed can never be smaller than the size of the average velocity — and state exactly when the two are equal.

Grounded in PER: Knight, Arons, Trowbridge–McDermott, Moore, Chabay–Sherwood