The Graph That Looks Like a Hill

Student Worksheet

Motion Foundations · Lab Activity 1 · 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 walk (before any screen)

The class agrees the +x direction points: _____. The walk: start at x = 2 m, walk to x = 7 m, return to x = 4 m.

clock reading t (claps → s)	position x (m)

Each row is one event: one position paired with one clock reading.

1(a) Total distance travelled = _____ m

1(b) Displacement = _____ m Sign: _____

1(c) The two answers are different. In one sentence, why?

_____

1(d) For how long is the walker at *exactly* x = 5.0 m as she passes it on her way out? _____ s

What makes this a different question from "how long does she take to go from x = 4.5 m to x = 5.5 m on her way out"?

_____

Part 2 — Predict the graph, then face it (Scene 2)

Round 1 commit (before Reveal):
A B C D
What convinced you? _____

Round 2 commit (steady walk): **A B C D**
After the reveal — if your circled graph was wrong: what did it claim that the walk did not do? If it matched: which wrong graph tempted the most hands, and what did *it* claim?

_____

2(a) The correct graph for the out-and-back walk rises and falls — yet the walker never left the level floor. Complete: *the graph shows the position* _____ *changing with the* _____. *It is not a picture of the path.*

Part 3 — Match, and the graph nobody can match (Scene 3)

3(a) Level 2: the target is curved although the track is straight. What is changing, and how do you know from the graph?

_____

3(b) Level 3 cannot be matched by anyone. Complete: *at t = 4 s that graph shows more than one* _____ *at a single* _____ *— no motion can do this.*

Part 4 — Two cars, one crossing (Scene 4)

Q1 commit — at the frozen instant t = 4 s:
Ahead: Car A / Car B / neither · Faster: Car A / Car B / cannot tell

Q2 commit — the crossing tells you:
A B C D

4(a) After the reveal, complete: *crossing lines on an x–t graph mean the same* _____ *at the same* _____. *Velocity is read from each line's* _____, *and the two slopes here are* _____ *m/s and* _____ *m/s.*

Going further

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

Layer B — quantitative

B1 From the Scene 4 graph: Car A goes from x = 0 m at t = 0 s to x = 18 m at t = 6 s; Car B from x = 8 m to x = 14 m over the same interval.
velocity of A = _____ m/s velocity of B = _____ m/s Which fact about the lines carries this information?
_____

B2 Origin shift. Move the origin 5 m to the left of where it was; the walk itself is unchanged. Fill the table, then answer.

	start position label	farthest position label	displacement	distance travelled
original origin	2 m	7 m		
shifted origin				

What changed, and what could not change? _____

B3 Two runners on a straight path: P's position is x = 4t; Q's is x = 10 + 2t (metres, seconds).
At t = 3 s: who is **ahead**? _____ who is **faster**? _____
They are alongside each other when t = _____ s, at x = _____ m. At that instant, are their speeds equal? _____
One sentence: what does being alongside tell you, and what does it not tell you?

B4 Still on the Scene 4 graph: (a) instant(s) at which one car passes the other: _____ (b) which car is faster at t = 2 s: _____ (c) instant(s) at which the two cars have the same velocity: _____
If the answer to (c) is "none", say so — and say how the graph shows it.

Layer C — the deep end

C1 For the Scene 3 curve, the position follows $x = t^2/4$. Average velocity over shrinking intervals ending at t = 4 s:

interval	Δt (s)	average velocity (m/s)
2 s → 4 s	2	1.5
3 s → 4 s	1	1.75
3.5 s → 4 s	0.5	
3.9 s → 4 s	0.1	

These averages are approaching _____ m/s. That limiting value is called the _____ at t = 4 s.

C2 On these axes, steeper means faster. What would a nearly-vertical piece of an x–t graph say about the motion? Why is a perfectly vertical piece impossible for any real object?

C3 Sketch (on the back) two x–t graphs for two walkers that cross twice — they cannot both be straight lines. At each crossing, state one thing that is true and one thing that is commonly — but wrongly — concluded.

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