LESSON MAKER PRO

Motion in Numbers

Find velocity and acceleration from motion data.

HIGH SCHOOL · P.1

P.1 "Obtain, evaluate, and communicate ideas about kinematics, including scalar quantities (distance and speed) and vector quantities (position, displacement, velocity, and acceleration). a..."

NAME _____ DATE _____

CHANGES OVER TIME

Average velocity over a time interval is the change in position divided by elapsed time: $v_{avg} = (x_f - x_i)/(t_f - t_i)$. On a position-time graph, find it from the slope between two points. Average acceleration over an interval is the change in velocity divided by elapsed time: $a_{avg} = (v_f - v_i)/(t_f - t_i)$.

WORKED EXAMPLE

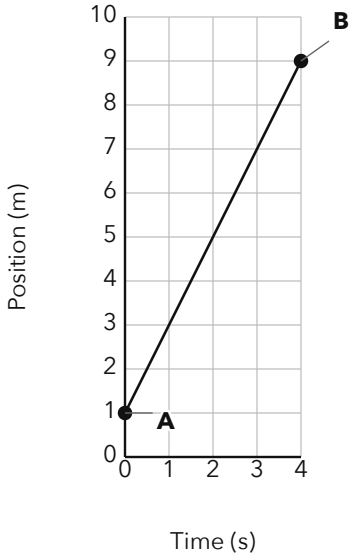
A cart is at position 23 m at 11 s and position 55 m at 15 s. Find its average velocity over this interval.

1. Change in position: 55 - 23 = 32 m.
2. Elapsed time: 15 - 11 = 4 s.
3. Average velocity: 32/4 = 8 m/s.

Answer: 8 m/s

PRACTICE 6 problems

1 Find the cart's average velocity from A to B on the position-time graph.



ANSWER _____

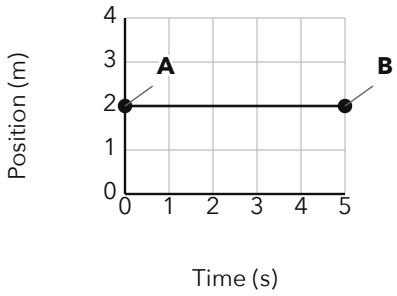
2 Find the average velocity from 2 s to 6 s. Positive positions are to the right of the origin.

CART POSITION

Time (s)	Position (m)
0	10
2	6
6	-2

ANSWER _____

3 Find the object's average velocity from A to B on the position-time graph.



ANSWER _____

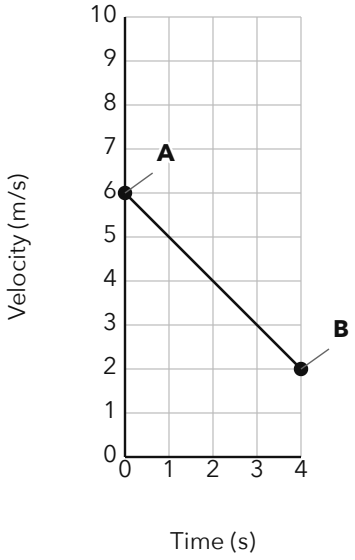
4 Find the cart's average acceleration from 2 s to 6 s.

CART VELOCITY

Time (s)	Velocity (m/s)
0	1
2	5
6	13

ANSWER _____

5 Find the object's average acceleration from A to B on the velocity-time graph.



ANSWER _____

6 Find the average velocity from 0 s to 2 s and from 2 s to 4 s. Positive positions are to the right of the origin.

ROBOT POSITION

Time (s)	Position (m)
0	1
2	7
4	3

ANSWER _____

APPLY IT Show your work

1 A student films a foam ball in free fall. Ignoring air resistance, its downward velocity changes from 0 m/s to 20 m/s in 2 s. What value of acceleration due to gravity does this footage give? Include a direction.

WORK SPACE

ANSWER _____

2 A skateboarder moves along a straight path. Right is positive. At 1 s, her position is 18 m. At 4 s, her position is 6 m. Find her displacement and average velocity over this interval.

WORK SPACE

ANSWER _____

CHALLENGE One step up

A robot moves along a straight track. Its positions are recorded in the table. It does not reverse direction between consecutive readings. From 0 s to 6 s, find its total distance traveled, displacement, and average velocity.

ROBOT POSITION

Time (s)	Position (m)
0	0
2	6
4	2
6	10

WORK SPACE AND ANSWER

Motion in Numbers

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Find the cart's average velocity from A to B on the position-time graph.	**2 m/s**
2	Find the average velocity from 2 s to 6 s. Positive positions are to the right of the origin.	**-2 m/s**
3	Find the object's average velocity from A to B on the position-time graph.	**0 m/s**
4	Find the cart's average acceleration from 2 s to 6 s.	**2 m/s^2**
5	Find the object's average acceleration from A to B on the velocity-time graph.	**-1 m/s^2**
6	Find the average velocity from 0 s to 2 s and from 2 s to 4 s. Positive positions are to the right of the origin.	**0 to 2 s: 3 m/s; 2 to 4 s: -2 m/s**

PART 2 · APPLY IT

1. **10 m/s^2 downward** Average acceleration is (20 - 0)/2 = 10 m/s^2. The velocity increases downward, so the acceleration is downward.
2. **Displacement: -12 m; average velocity: -4 m/s** Displacement is 6 - 18 = -12 m. Divide by the elapsed time, 4 - 1 = 3 s, to get -4 m/s.

CHALLENGE

Total distance: 18 m; displacement: 10 m; average velocity: 5/3 m/s

Accept equivalent acceleration units such as m/s/s. In the challenge, total distance is 6 + 4 + 8 = 18 m; average velocity uses displacement, not total distance.