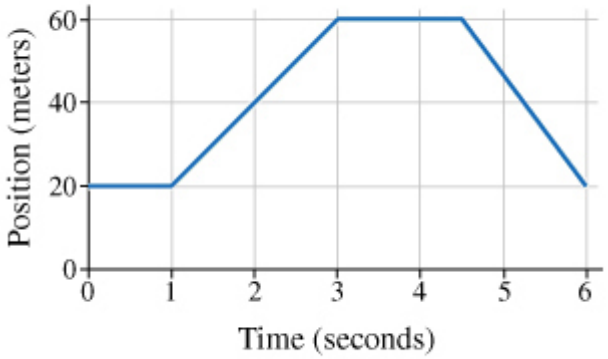
Description: ± Includes Math Remediation. Given a plot of position vs. time, determine average velocity over different time intervals.

Constants | Periodic Table

Learning Goal:

To learn to read a graph of position versus time and to calculate average velocity.

In this problem you will determine the average velocity of a moving object from the graph of its position $x(t)$ as a function of time t. A traveling object might move at different speeds and in different directions during an interval of time, but if we ask at what *constant* velocity the object would have to travel to achieve the same displacement over the given time interval, that is what we call the object's *average velocity*. We will use the notation $v_{\text{ave}}[t_1, t_2]$ to indicate average velocity over the time interval from t_1 to t_2. For instance, $v_{\text{ave}}[1, 3]$ is the average velocity over the time interval from $t = 1$ to $t = 3$.



Part A

Consulting the graph shown in the figure, find the object's average velocity over the time interval from 0 to 1 second.

Answer to the nearest integer.

▸ **View Available Hint(s)** (1)

ANSWER:

$v_{\text{ave}}[0, 1] =$ 0 m/s

Part B

Find the average velocity over the time interval from 1 to 3 seconds.

Express your answer in meters per second to the nearest integer.

View Available Hint(s) (2)

ANSWER:

$v_{\text{ave}}[1,3] =$ 20 m/s

A note about instantaneous velocity. The instantaneous velocity at a certain moment in time is represented by the slope of the graph at that moment. For straight-line graphs, the (instantaneous) velocity remains constant over the interval, so the instantaneous velocity at any time during an interval is the same as the average velocity over that interval. For instance, in this case, the instantaneous velocity at any time from 1 to 3 seconds is the same as the average velocity of $20\ \text{m/s}$.

Part C

Now find $v_{\text{ave}}[0,3]$.

Give your answer to three significant figures.

View Available Hint(s) (1)

ANSWER:

$v_{\text{ave}}[0,3] =$ 13.3 m/s

Note that $v_{\text{ave}}[0,3]$ is not equal to the simple arithmetic average of $v_{\text{ave}}[0,1]$ and $v_{\text{ave}}[1,3]$, i.e., $\frac{v_{\text{ave}}[0,1]+v_{\text{ave}}[1,3]}{2}$, because they are averages for time intervals of different lengths.

Part D

Find the average velocity over the time interval from 3 to 6 seconds.

Express your answer to three significant figures.

View Available Hint(s) (2)

ANSWER:

$v_{\text{ave}}[3.0,6.0] =$ -13.3 m/s

Part E

Finally, find the average velocity over the whole time interval shown in the graph.

Express your answer to three significant figures.

View Available Hint(s) (1)

ANSWER:

$v_{\text{ave}}[0.0, 6.0] = \quad 0 \quad \text{m/s}$

Note that though the *average* velocity is zero for this time interval, the *instantaneous* velocity (i.e., the slope of the graph) has several different values (positive, negative, zero) during this time interval.

Note as well that since average velocity over a time interval is defined as the change in position (displacement) in the given interval divided by the time, the object can travel a great distance (here 80 meters) and still have zero average velocity, since it ended up exactly where it started. Therefore, zero average velocity does not necessarily mean that the object was standing still the entire time!