 Name: _____

Lesson 3.6a. Average Velocity

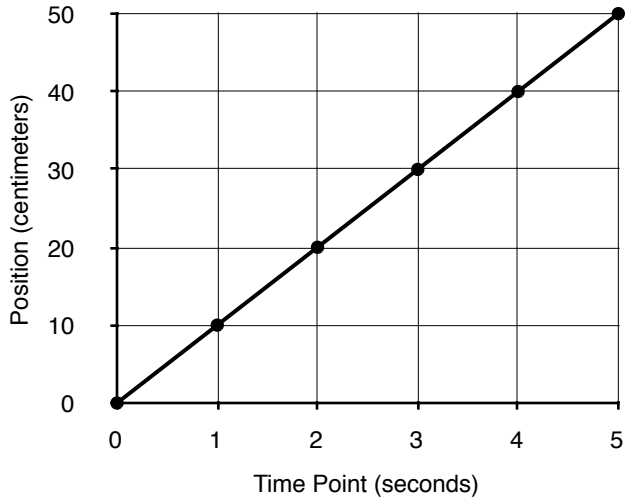
Date: _____ Period: _____

In physics, the phrase *average velocity* is used in two different ways.

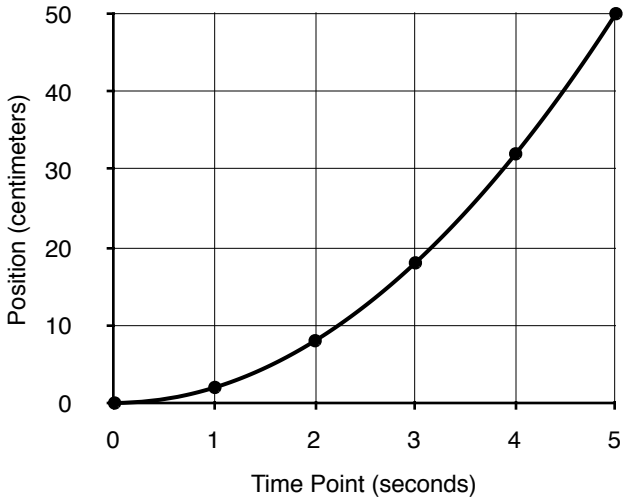
1) *Average velocity* is used to describe the motion of an object that we have good reasons to *expect* travels at a constant speed. Recall that our model of motion at a constant speed states that the object travels equal distances during equal time intervals. However, measurement data will always show *some* variations due to several sources of experimental uncertainty. So, the best we can do is to calculate the *average distance traveled during each time interval of one unit* and report that value, along with the interval of uncertainty, as the constant *average velocity* of the object.
2) *Average velocity* is also used when the object definitely *does not* travel at a constant speed; for example, where there are abrupt changes of speed or direction, or when the speed or direction changes gradually over time. In these situations, the *average velocity* is that *constant velocity* which accomplishes the same *total distance traveled* during the same *total time interval* as did the changing velocity. This second meaning of *average velocity* is the topic of this lesson.

A New Meaning of Average Velocity

Position *vs*. time point for a dune buggy traveling with **constant** velocity



Position *vs*. time point for a red truck traveling with **increasing** velocity



Consider the above position graphs.

- How far did the dune buggy travel during the interval from 0 s to 5 s? _____
- How far did the red truck travel during the interval from 0 s to 5 s? _____
- If both vehicles traveled equal distances during equal time intervals, then why are their trend lines so different?

_____

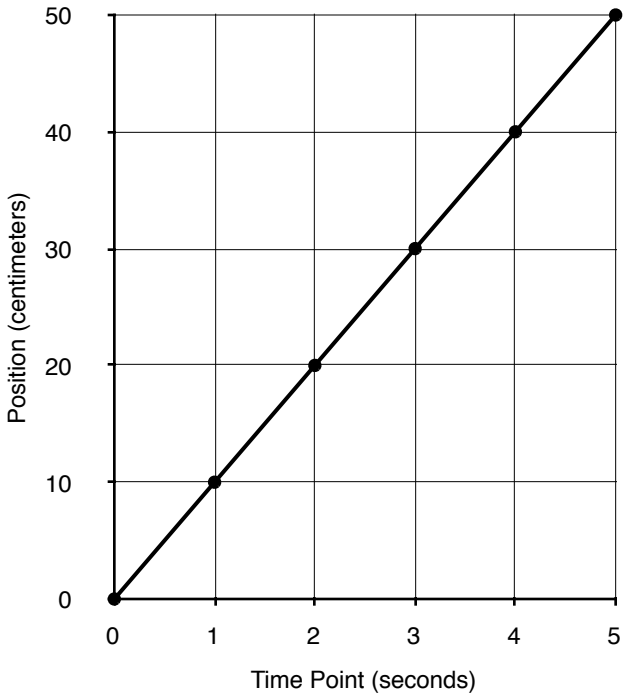
_____

_____

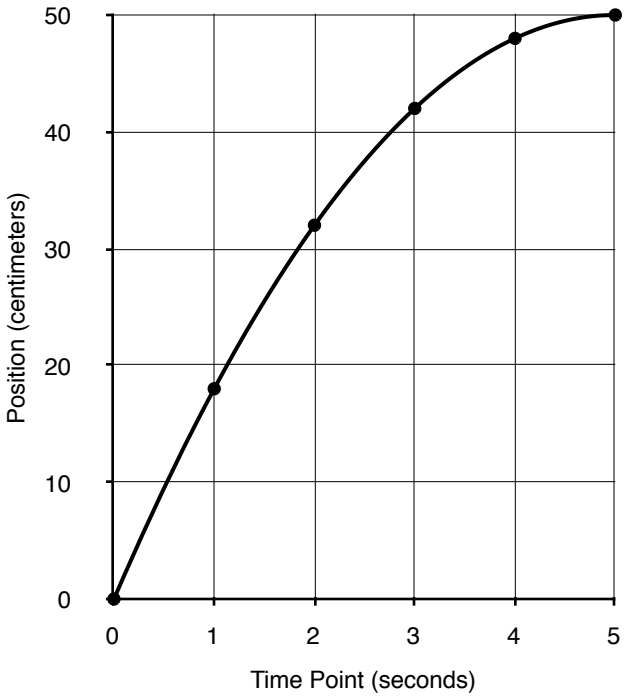
The trend lines are different because the dune buggy traveled at a constant velocity and the red truck accelerated from rest. At first, the red truck traveled more slowly than the dune buggy, but the truck's velocity kept increasing and soon it was traveling faster than the dune buggy. The truck finally caught up to the dune buggy at time point 5 seconds.

Nonetheless, they both traveled 50 centimeters during the first 5 seconds! That is, the dune buggy, moving at a *constant* velocity, traveled the same distance during that time interval as did the red truck, moving with *changing* velocity. Therefore, we say that the *constant velocity* of the buggy is equal to the *average velocity* of the truck ***during the interval from 0 seconds to 5 seconds***.

Position *vs.* time point for a dune buggy traveling with **constant** velocity



Position *vs.* time point for a red truck traveling with **decreasing** velocity



Here is another example!

☐ How far did the dune buggy travel during the interval from 0 s to 5 s? _____

☐ How far did the red truck travel during the interval from 0 s to 5 s? _____

☐ If both vehicles traveled equal distances during equal time intervals, then why are their trend lines so different?

_____

_____

_____

_____

_____

_____

_____

The trend lines are different because the dune buggy traveled at a constant velocity and the red truck started fast and slowed to a stop. At first, the red truck traveled faster than the dune buggy, but the truck's velocity kept decreasing and soon it was traveling more slowly than the dune buggy. The buggy finally caught up to the truck at time point 5 seconds, just as the truck came to a stop.

Once again, they both traveled 50 centimeters during the first 5 seconds! That is, the dune buggy, moving at a *constant* velocity, traveled the same distance during that time interval as did the red truck, moving with *changing* velocity. Therefore, we say that the *constant velocity* of the buggy is equal to the *average velocity* of the truck *during the interval from 0 seconds to 5 seconds.*

Calculating the Average Velocity

The ***definition*** of *average velocity* is still the same …

$$\overline{\text{velocity}}_{i\to f} \equiv \frac{\text{total displacement}_{i\to f}}{\text{total time interval}_{i\to f}}$$

… and so is the ***formula*** you use to calculate the *average velocity*!

$$\overline{\text{velocity}}_{i\to f} = \frac{\text{final position - initial position}}{\text{final time point - initial time point}}$$

Example 1. Determine the average velocity of the red truck during the interval from 0 seconds to 5 seconds.

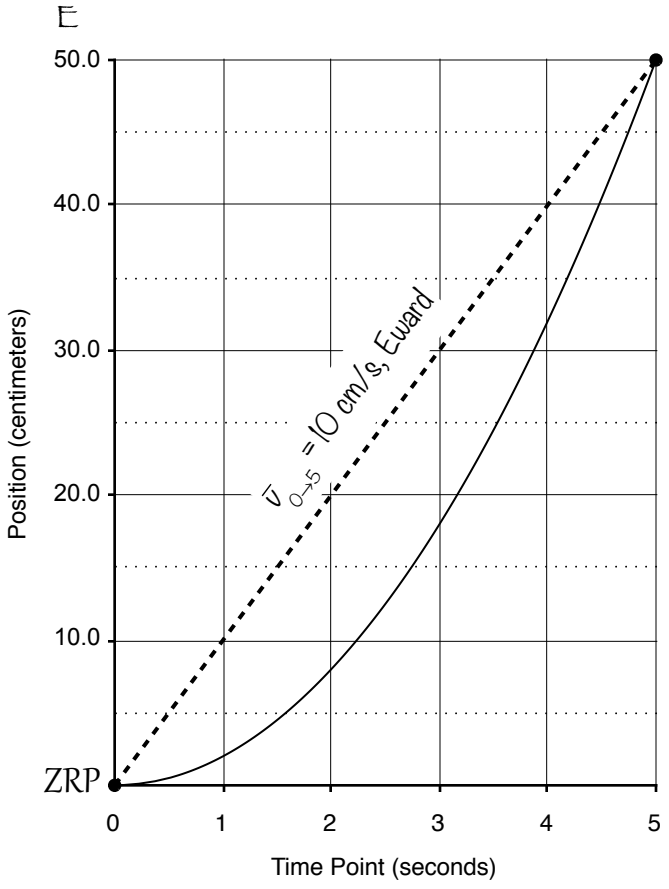
- ☐ Draw and label *blue* position arrows (or a dot) at at t_i = 0 seconds and t_f = 5 seconds.
- ☐ Draw and label a green *total displacement* arrow along with its dotted line for the interval from 0 seconds to 5 seconds.
- ☐ Calculate the average velocity during the interval from 0 seconds to 5 seconds.

$$\overline{\text{velocity}}_{0\to5} = \frac{\text{position}_5 - \text{position}_0}{\text{time point}_5 - \text{time point}_0}$$

$$\overline{\text{velocity}}_{0\to5} = \frac{(50-0)\text{ centimeters}}{(5-0)\text{ seconds}}$$

$$\overline{\text{velocity}}_{0\to5} = 10\text{ centimeters/second, E}$$

- ☐ With your regular writing pencil, draw and label a straight, dashed, *average velocity* line between the initial and final positions.



Practice 1. Determine the average velocity of the red truck during the interval from 1 s to 5 s. (*Hint: pay attention! What is the initial time point here?*)

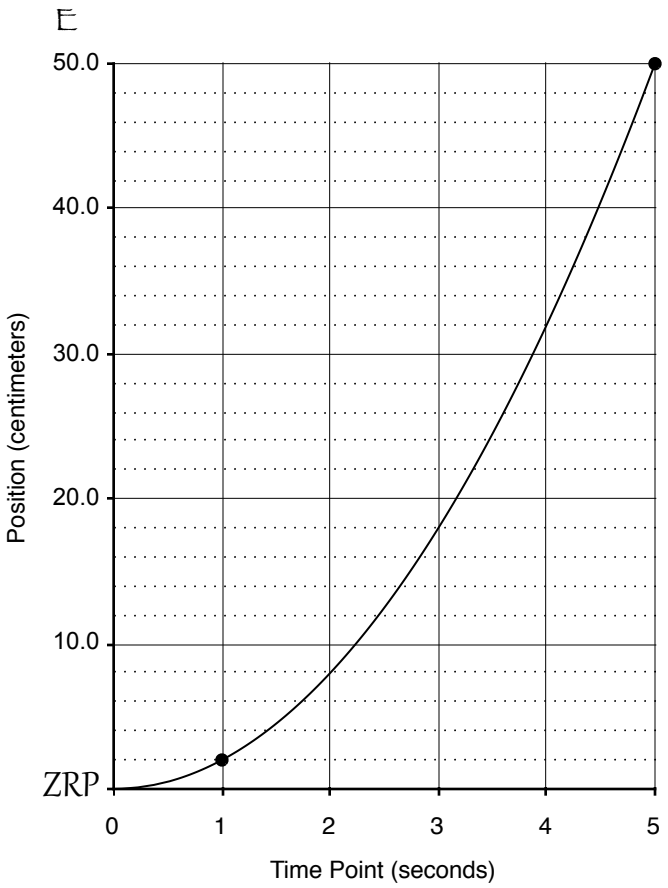
- ☐ Draw and label *blue* position arrows (or a dot) at at t_i = 1 second and t_f = 5 seconds.
- ☐ Draw and label a green *total displacement* arrow along with its dotted line for the interval from 1 second to 5 seconds.
- ☐ Calculate the average velocity during the interval from 1 second to 5 seconds.

(formula)

(calculation)

(answer)

- ☐ With your regular writing pencil, draw and label a straight, dashed, *average velocity* line between the initial and final positions.



Practice 2. Determine the average velocity of the red truck during the interval from 0 s to 4 s. (*Hint: pay attention! What is the final time point here?*)

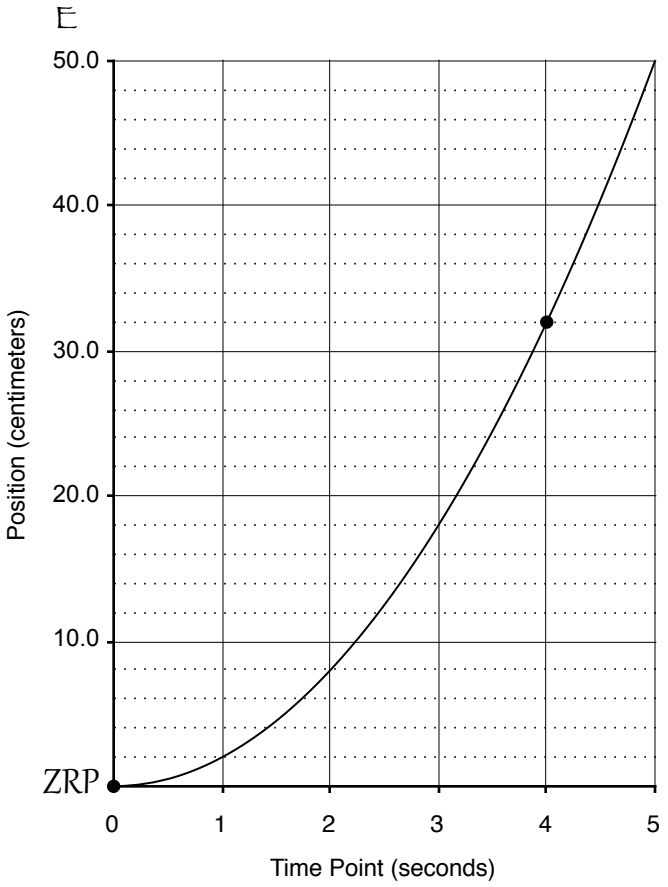
- ☐ Draw and label *blue* position arrows (or a dot) at t_i = 0 seconds and t_f = 4 seconds.
- ☐ Draw and label a green *total displacement* arrow along with its dotted line for the interval from 0 seconds to 4 seconds.
- ☐ Calculate the average velocity during the interval from 0 seconds to 4 seconds.

(formula)

(calculation)

(answer)

- ☐ With your regular writing pencil, draw and label a straight, dashed, *average velocity* line between the initial and final positions.



Answers: v_{av} = 12 cm/s, E; v_{av} = 8 cm/s, E

Name: _____

HW 3.6a. Average Velocity

Date: _____ Period: _____

1) Determine the average velocity of the red truck during the interval from 0 seconds to 3 seconds.

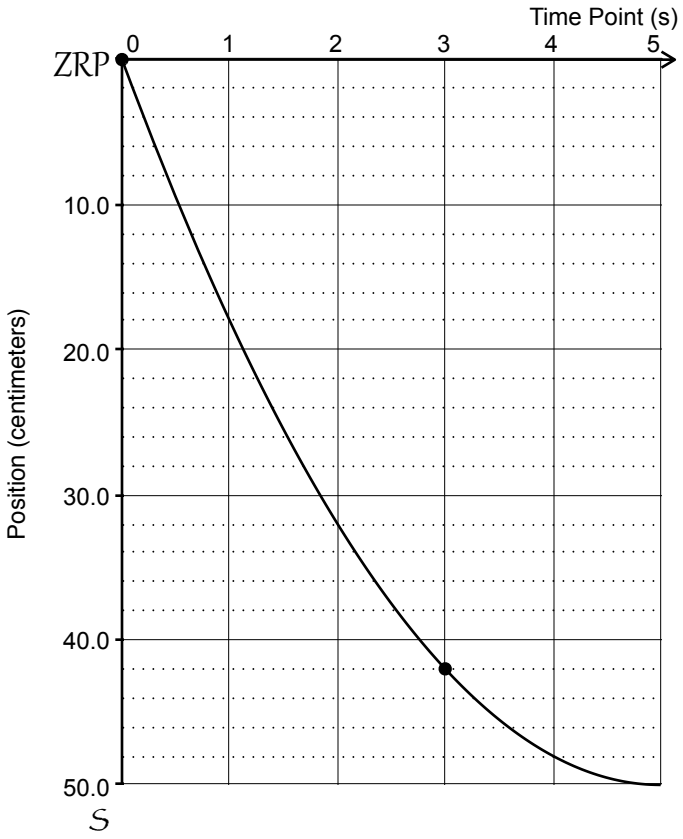
- ☐ Draw and label blue and green arrows (and dotted lines, as appropriate) as instructed in the lesson.
- ☐ Calculate the *average velocity* during the interval from 0 seconds to 3 seconds.

_____ (formula)

_____ (calculation)

_____ (answer)

- ☐ Draw and label the average velocity line, as instructed in the lesson.



2) Determine the average velocity of the red truck during the interval from 2 seconds to 5 seconds.

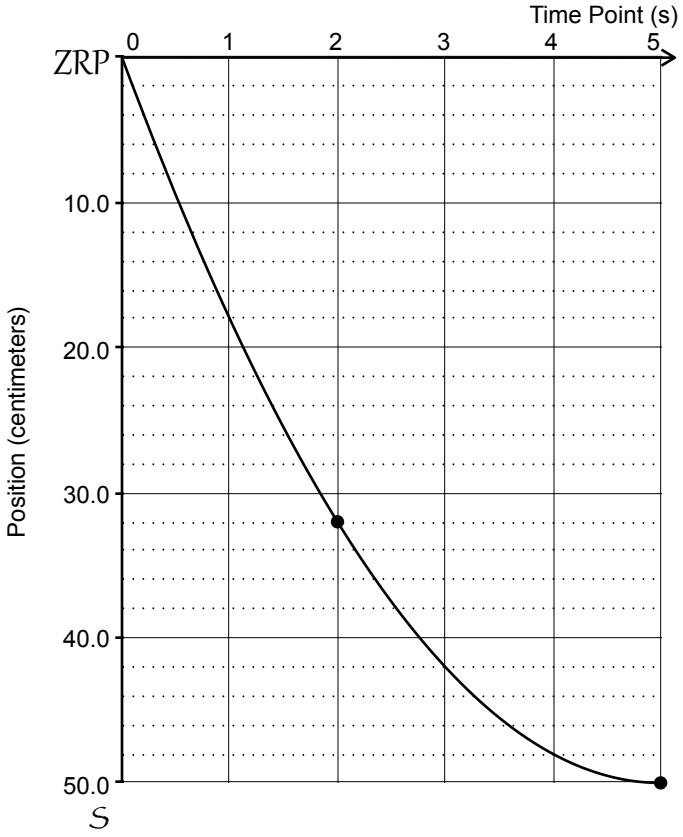
- ☐ Draw and label blue and green arrows (and dotted lines, as appropriate) as instructed in the lesson.
- ☐ Calculate the *average velocity* during the interval from 2 seconds to 5 seconds.

_____ (formula)

_____ (calculation)

_____ (answer)

- ☐ Draw and label the average velocity line, as instructed in the lesson.



3) Determine the average velocity of the red truck during the interval from t_i = 0 seconds to t_f = 3 seconds.

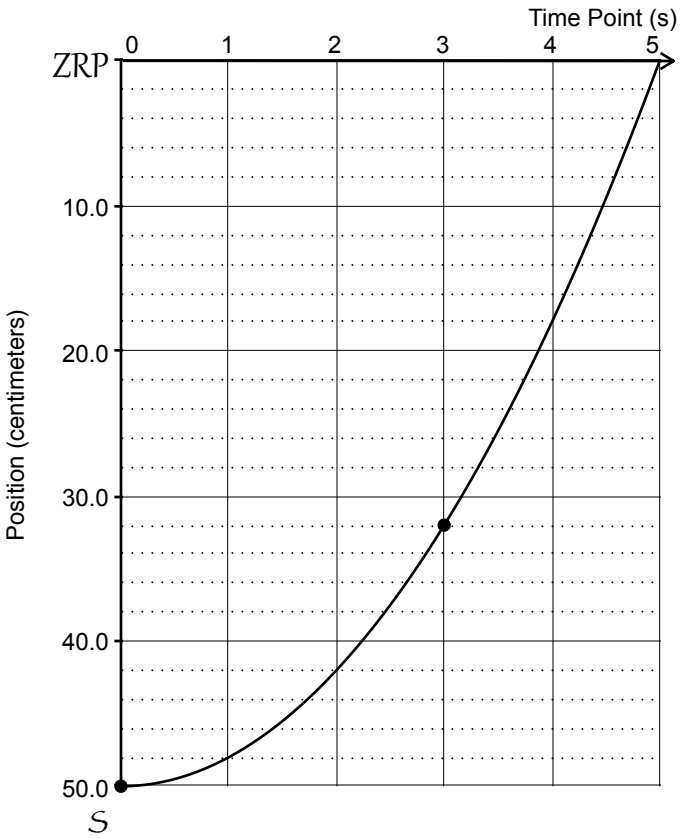
- ☐ Draw and label blue and green arrows (and dotted lines, as appropriate) as instructed in the lesson.
- ☐ Calculate the *average velocity* during the interval from t_i = 0 seconds to t_f = 5 seconds.
- ☐

(formula)

(calculation)

(answer)

- ☐ Draw and label the average velocity line, as instructed in the lesson.



4) Determine the average velocity of the red truck during the interval from *1* second to 4 seconds.

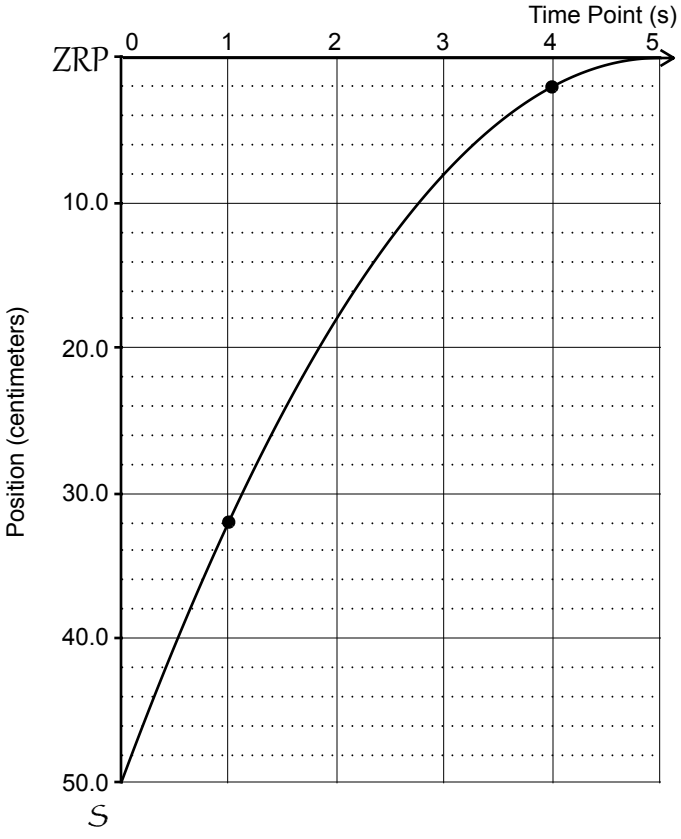
- ☐ Draw and label blue and green arrows (and dotted lines, as appropriate) as instructed in the lesson.
- ☐ Calculate the *average velocity* during the interval from 1 second to 4 seconds.

(formula)

(calculation)

(answer)

- ☐ Draw and label the average velocity line, as instructed in the lesson.



5) *Please answer this question neatly, in pencil, on a nice, clean sheet of lined notebook paper. Express your ideas as complete thoughts written in clear, declarative English sentences that connect the ideas in the question with the ideas in your answer. Make every pronoun refer unmistakably to a definite antecedent.*

Consider your answers to questions 1 and 2, in which you calculated the average velocity for the same motion during two different but equal time intervals. Explain why it makes sense that the average velocity was greater in question 1 than in question 2.