Name:_____ Peer-Leader:_____

Date: _____ _____

Position, Displacement, and Velocity

This workshop focuses on the relationships between position, displacement, velocity and speed in one dimension.

Excercise 1:

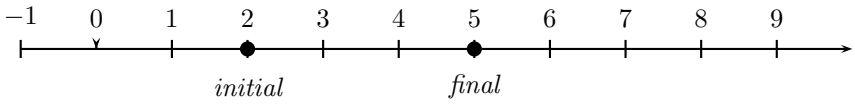
Position and Displacement

Displacement is a difference between two positions. For an object that moves from an initial position x_i at an initial time t_i to a final position x_f at a final time t_f, the **displacement** is defined as

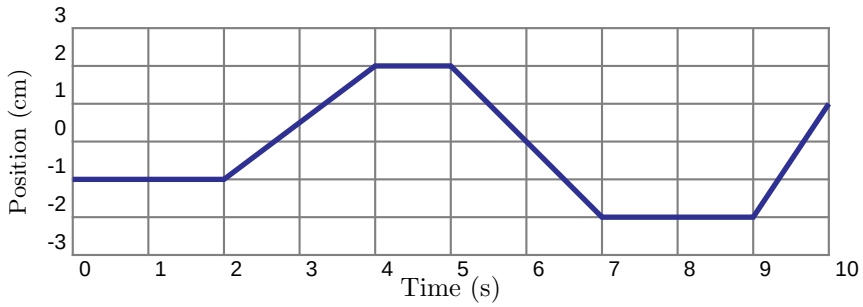
$$\Delta x = x_f - x_i.$$

Question 1.1 *Why is the displacement defined as $\Delta x = x_f - x_i$ and not $\Delta x = x_i - x_f$?*

Question 1.2 *Consider a three meter displacement from an initial position of 2m to a final position of 5m as shown below. Does the displacement depend on the origin of the coordinate system? Explain. Give an example of a different initial and final position that would yield the same displacement.*



The figure below shows the vertical position of an ant as a function of time as it crawls along the stem of a plant. The origin of the coordinate system has been chosen at the vertical center of the stem.



Question 1.3 *For the graph above what is the displacement between 0 seconds and 2 seconds? What is the displacement between 2 seconds and 4 seconds? What is the net displacement from zero to ten seconds?*

Question 1.4 *If the ant has a tiny odometer, what is the reading on the ant's odometer after two seconds? After four seconds? After ten seconds? Is the odometer reading different than displacement? Explain.*

Question 1.5 *Starting from the initial time $t = 0$, at what later time(s) is the net displacement zero? Give a time interval for which the displacement is negative.*

Question 1.6 *During the time period shown on the graph, choose an initial time and a final time that gives the greatest displacement.*

Excercise 2:
Average Velocity

For an object that moves from an initial position x_i at an initial time t_i to a final position x_f at the final time t_f, the average **velocity** is defined as

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

Question 2.1 *In the definition of velocity, why do we use displacement in the numerator as opposed to a position?*

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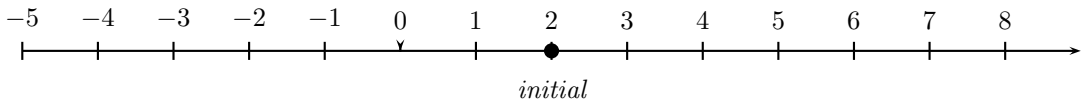
Question 2.2 *Does our formula for velocity depend on the origin of the time coordinate? That is to say if you were going to compute the average velocity of an object using the formula above would it matter what the initial time was on your stopwatch when you began? Explain.*

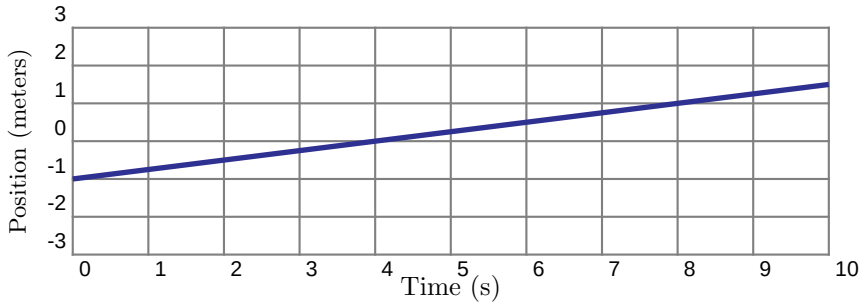
Question 2.3 *Consider an object which starts from an initial location of 2 meters as shown below. If the average velocity of the object is* $3\,\mathrm{m/s}$*, where is the object located after two seconds*

have elapsed? What would the average velocity be if instead the object was found at the position -4 *m after two seconds?*

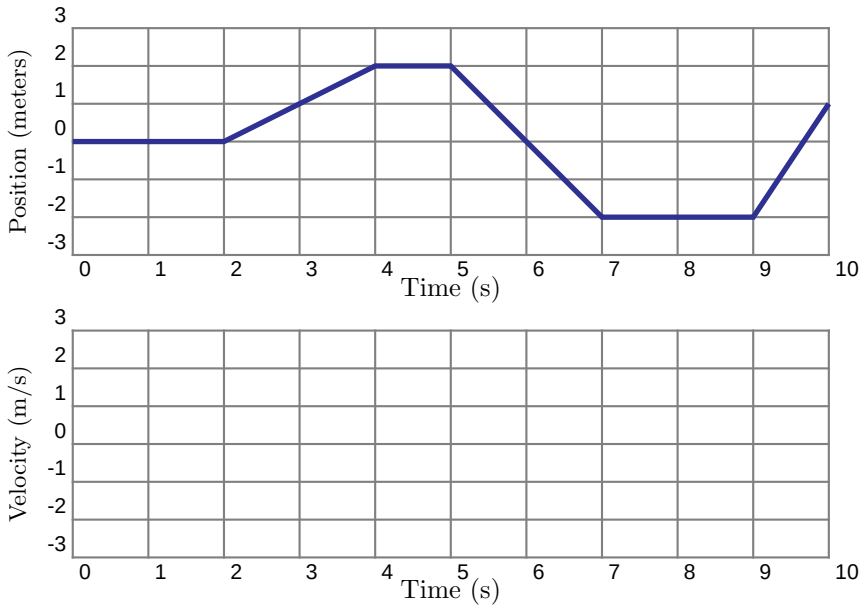


Question 2.4 *A kayaker paddles in a straight line at a speed of* 1 m/s *for four seconds, and then at a speed of* 3 m/s *for one second. What is the average speed for the five second interval?*

Question 2.5 *On the graph below, the positive direction represents north and the negative direction is south. The solid curve shows the motion of cart A. A second cart B starts from an initial position which is two meters farther to the south. The velocity of cart B is twice the velocity of cart A. Draw the position versus time for cart B on the same graph.*



Question 2.6 *The figure below shows a plot of position versus time. On the empty graph below make a plot the velocity as a function of time.*



Question 2.7 *For the graph above, what is the average velocity between two and six seconds?*

Question 2.8 *For the graph above, compute the average velocity for the one second interval that has the largest average velocity.*

Question 2.9 *What is the average velocity for the entire trip?*