Graphing Motion

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CONCEPT 1

Graphing Motion

Students will learn how to graph motion vs time. Specifically students will learn how to take the slope of a graph and relate that to the instantaneous velocity or acceleration for position or velocity graphs, respectively. Finally students will learn how to take the area of a velocity vs time graph in order to calculate the displacement.

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Key Equations

For a graph of position vs. time. The slope is the rise over the run, where the rise is the displacement and the run is the time. thus,

Slope = $v_{avg} = \frac{\Delta x}{\Delta t}$

Note: Slope of the tangent line for a particular point in time = the instantaneous velocity

For a graph of velocity vs. time. The slope is the rise over the run, where the rise is the change in velocity and the run is the time. thus,

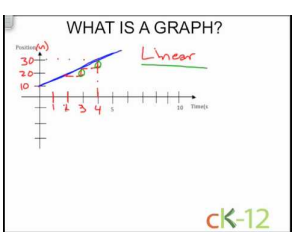
Slope = $a_{avg} = \frac{\Delta v}{\Delta t}$

Note: Slope of the tangent line for a particular point in time = the instantaneous acceleration

Guidance

- One must first read a graph correctly. For example on a position vs. time graph (thus the position is graphed on the y-axis and the time on the x-axis) for a given a data point, go straight down from it to get the time and straight across to get the position.
- If there is constant acceleration the graph x vs. t produces a parabola. The slope of the x vs. t graph equals the instantaneous velocity. The slope of a v vs. t graph equals the acceleration.
- The **slope** of the graph v vs. t can be used to find **acceleration;** the **area** of the graph v vs. t can be used to find **displacement.** Welcome to calculus!

What is a Graph



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Watch this Explanation

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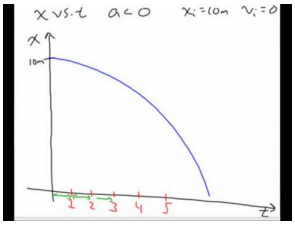

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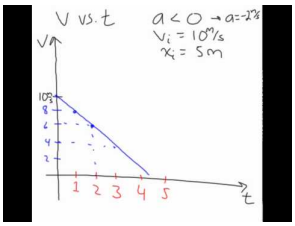

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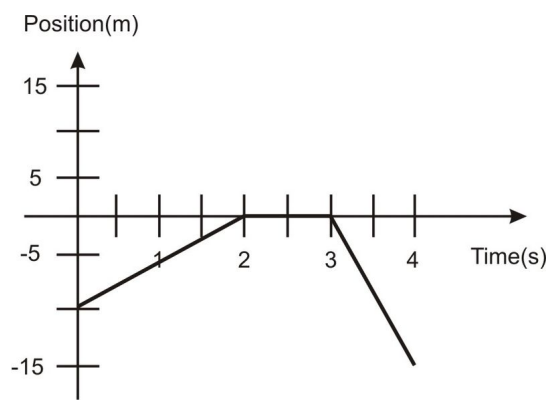
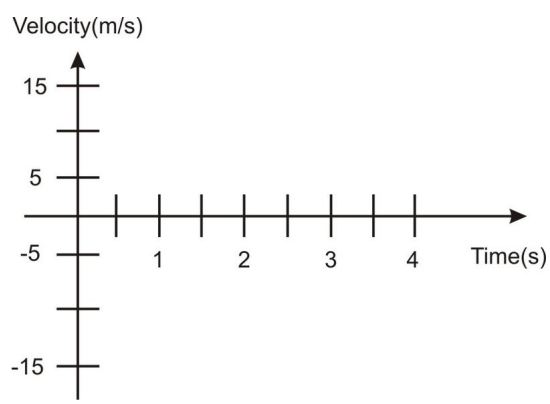
Time for Practice

1. The position graph below is of the movement of a fast turtle who can turn on a dime.

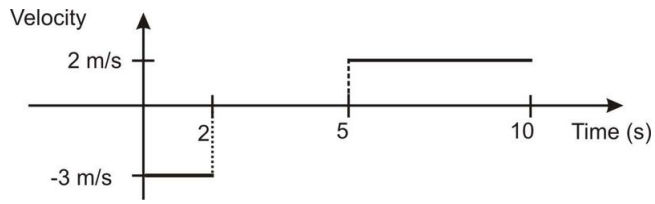


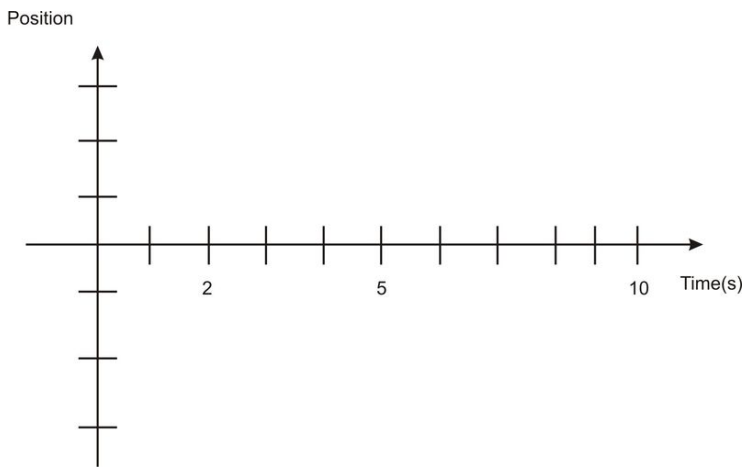
a. Sketch the velocity vs. time graph of the turtle below.



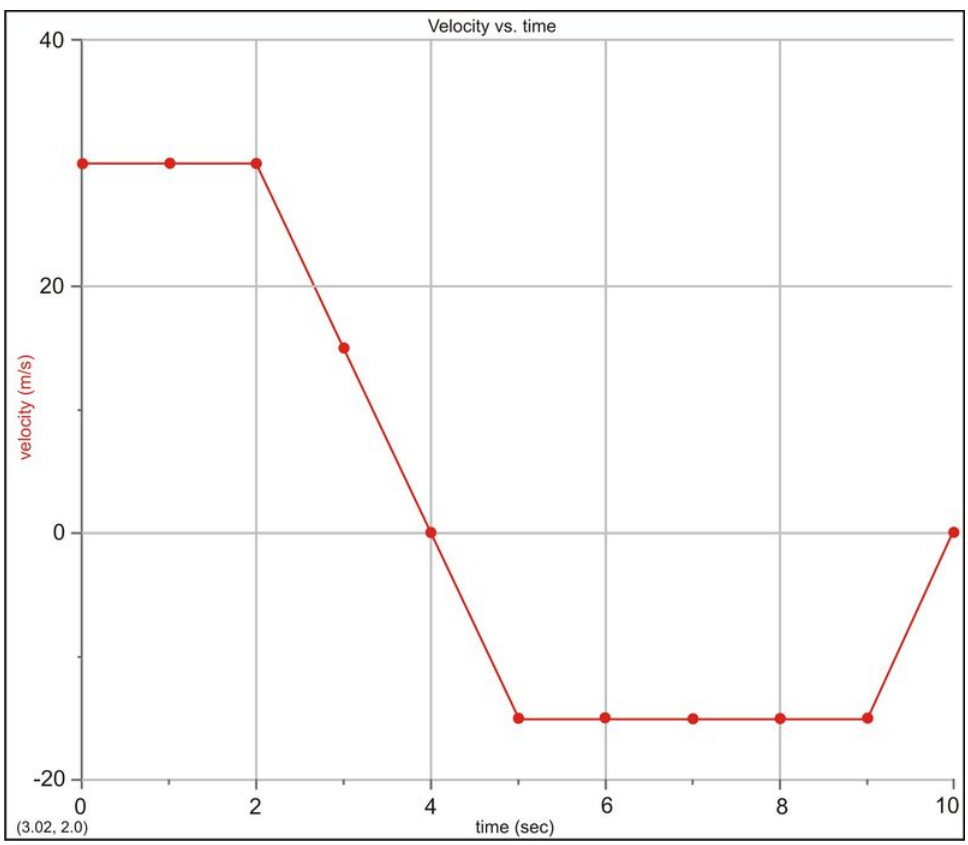
b. Explain what the turtle is doing (including both *speed* and *direction*) from: i) 0-2s. ii) 2-3s. iii) 3-4s. c. How much distance has the turtle covered after 4s? d. What is the turtle's displacement after 4s?

2. Draw the position vs. time graph that corresponds to the velocity vs. time graph below. You may assume a starting position $x_0 = 0$. Label the $y-$axis with appropriate values.





3. The following velocity-time graph represents 10 seconds of actress Halle Berry's drive to work (it's a rough morning).

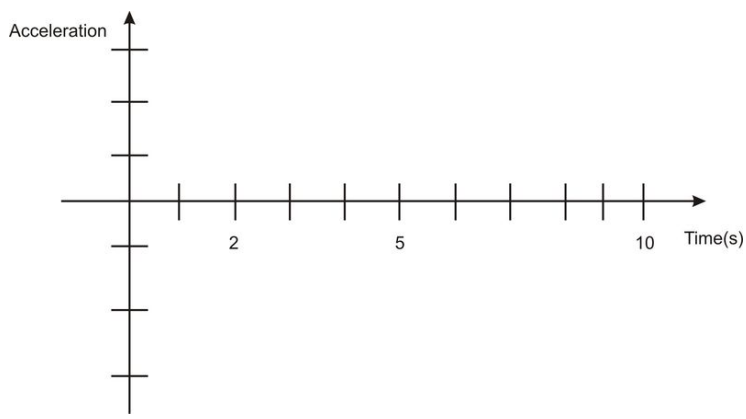


a. Fill in the tables below – remember that *displacement* and *position* are not the same thing!

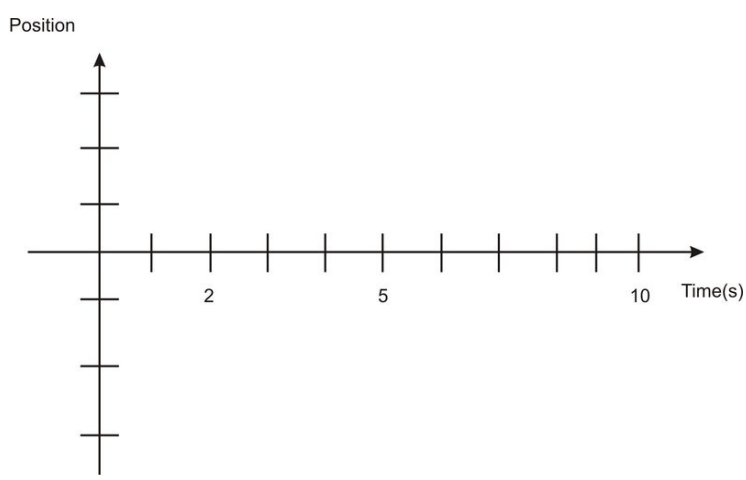
TABLE 1.1:

Interval (s)	Displacement (m)	Acceleration(m/s^2)	**Instantaneous Time (s)**	**Position (m)**
0-2 sec			0 sec	0 m
			2 sec	
2-4 sec				
			4 sec	
4-5 sec				
			5 sec	
5-9 sec				
			9 sec	
9-10 sec				
			10 sec	

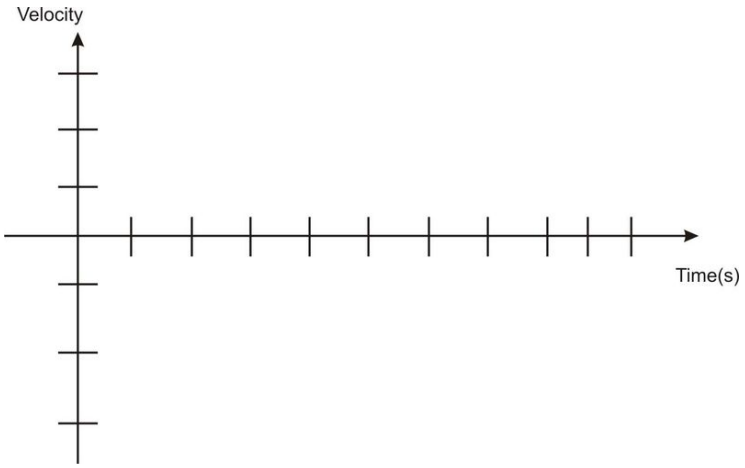
b. On the axes below, draw an *acceleration-time* graph for the car trip. Include numbers on your acceleration axis.



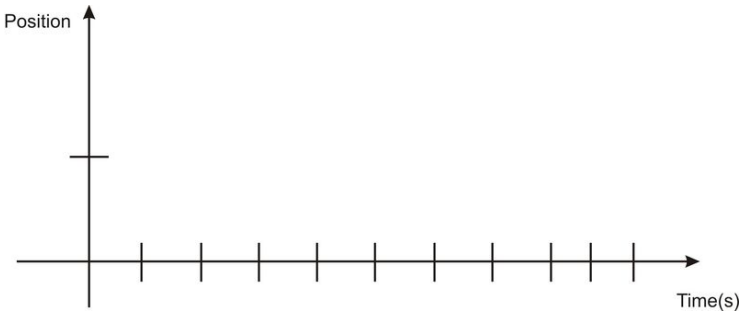
c. On the axes below, draw a *position-time* graph for the car trip. Include numbers on your position axis. Be sure to note that some sections of this graph are linear and some curve – why?



4. Two cars are drag racing down El Camino. At time $t = 0$, the yellow Maserati starts from rest and accelerates at 10 m/s^2. As it starts to move it's passed by a '63 Chevy Nova (cherry red) traveling at a constant velocity of 30 m/s. a. On the axes below, show a line for each car representing its speed as a function of time. Label each line.



b. At what time will the two cars have the same speed (use your graph)? c. On the axes below, draw a line (or curve) for each car representing its *position* as a function of time. Label each curve.



d. At what time would the two cars meet (other than at the start)?

Answers:

1c. 25 m

1d. -5 m

2. discuss in class

3. discuss in class

4b. 3 sec

4d. 6 sec