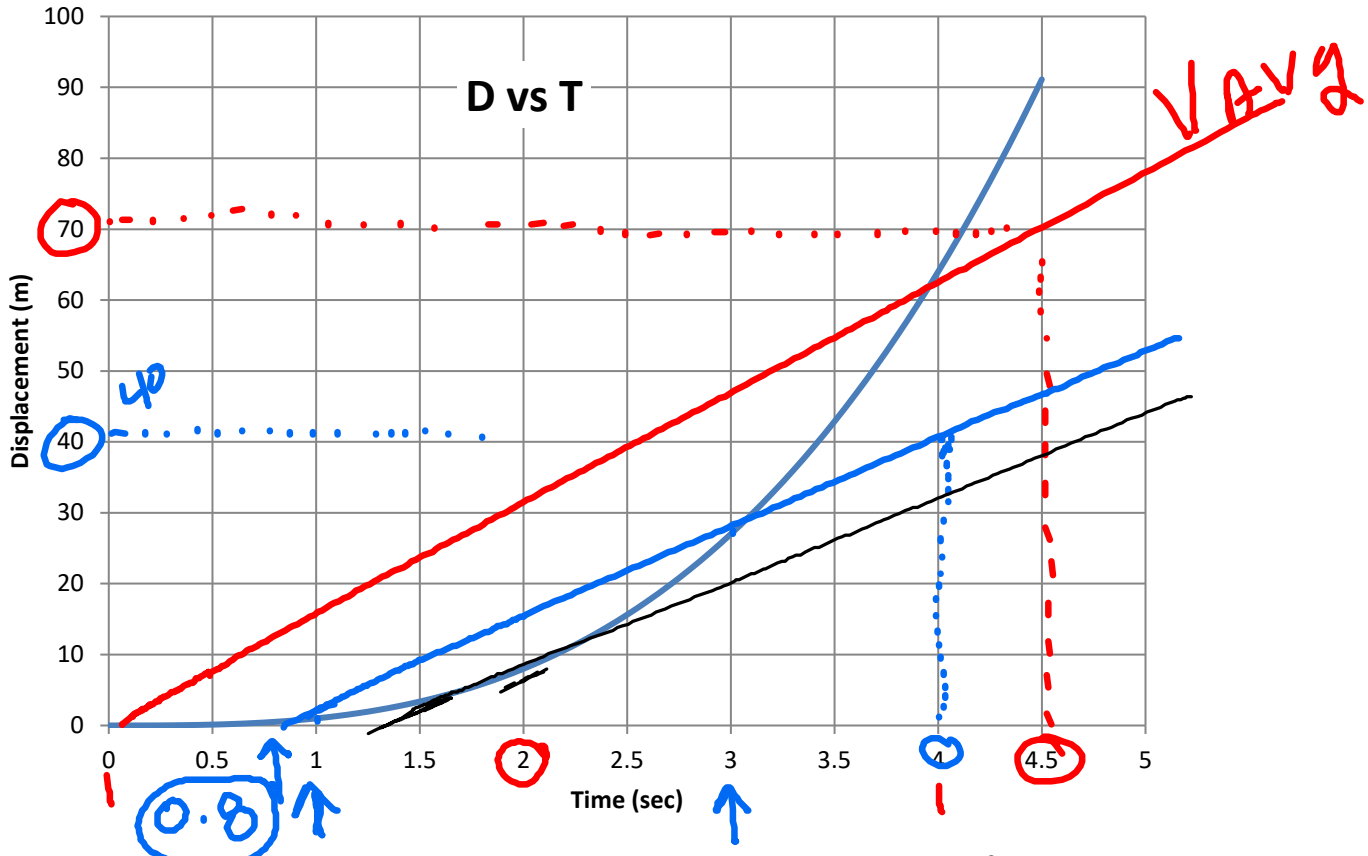
Linear Motion - Acceleration
Physics Honors

Name _____
Period _____

Up to this point we have worked with only constant velocity. In a Displacement-Time graph, we know when the velocity is constant when we have a constant slope (straight line). What does the graph below tell us about the velocity of this object?



In this lesson we use our knowledge in calculating average velocity in order to find the instantaneous velocity at 2.0 seconds.

1. Given a graph of Displacement vs. time, what mathematical procedure do you do to find velocity?

Find the Slope of a Straight Line

2. Let's start by estimating the velocity at 2 seconds by finding the average velocity from 2 seconds before and 2 seconds after our point in question. Otherwise, find the average velocity between 0 seconds and 4 seconds.

$$V = \frac{\Delta d}{\Delta t} = \frac{70-0}{4.5-0} = 15.6 \text{ m/s}$$

3. Now let's look at the average velocity for 2 seconds ± 1.0 second by finding the average velocity between 1 and 3 seconds?

$$V \quad \frac{\Delta d}{\Delta t} = \frac{40-0}{4-0.8} = 12.5 \text{ m/s}$$

4. Additionally, we can narrow down our range to 2 seconds ± 0.5 seconds by finding the average velocity between 1.5 and 2.5 seconds?

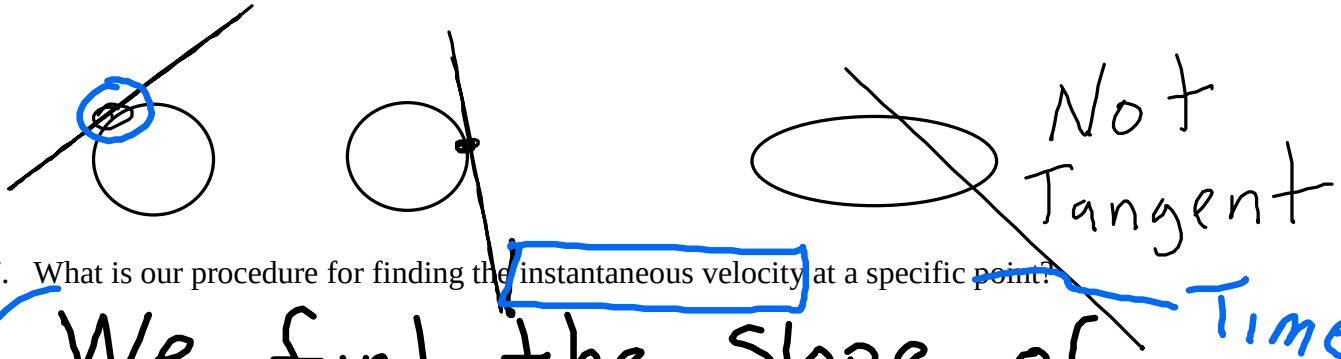
$V = 12.5\ m/s$

5. Look at the three average velocities, which is closer to the instantaneous velocity at 2.0 seconds, the ±2.0 seconds, ±1.0 seconds, or the ±0.5 seconds?

Best

Because the Range is smaller

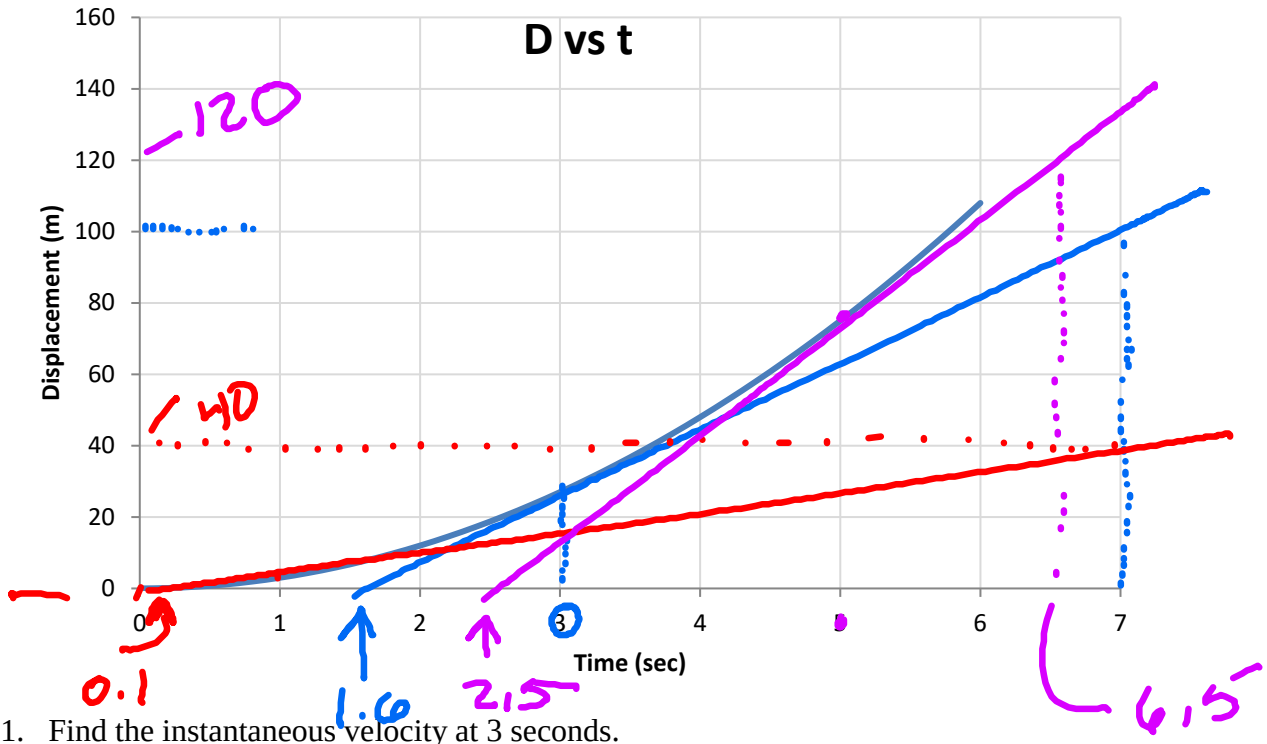
6. As we make the distance before and after 2.0 seconds gets even smaller so that it approaches 2.0 seconds ± 0.0 seconds, what type of line do we have?



7. What is our procedure for finding the instantaneous velocity at a specific point?

We find the Slope of a Line that is tangent @ the Point in Question.

Time



1. Find the instantaneous velocity at 3 seconds.

$$V_3 = \frac{\Delta d}{\Delta t} = \frac{100-0}{7-1.6} = \frac{100}{5.4} = 18.5 \text{ m/s}$$

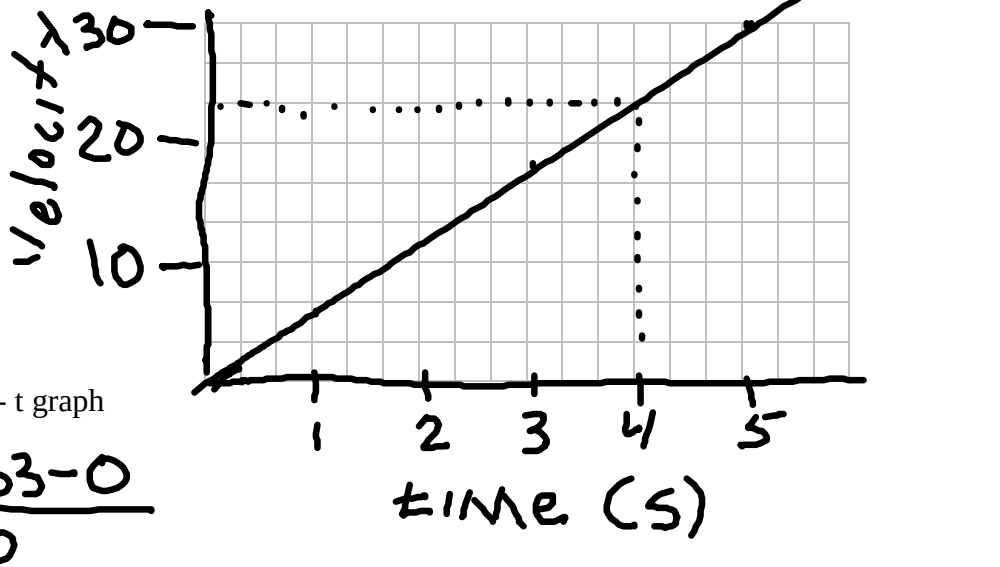
2. Find the instantaneous velocities at 1 second and 5 seconds

$$V_1 = \frac{\Delta d}{\Delta t} = \frac{40-0}{7-0.1} = \frac{40}{6.9} = 5.8 \text{ m/s}$$

$$V_5 = \frac{\Delta d}{\Delta t} = \frac{120-0}{6.5-2.5} = \frac{120}{4} = 30 \text{ m/s}$$

3. Plot a Velocity-Time graph for the three velocities that you calculated above.

Time (sec)	Velocity (m/s)
1	5.8
3	18.5
5	30



4. Calculate the slope of your V- t graph

$$a = \frac{\Delta V}{\Delta t} = \frac{23.33-0}{4-0} = 5.8 \frac{\text{m/s}}{\text{s}}$$