Constant Acceleration WS#2 | Payton Physics

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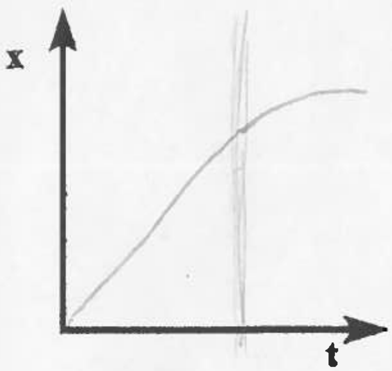
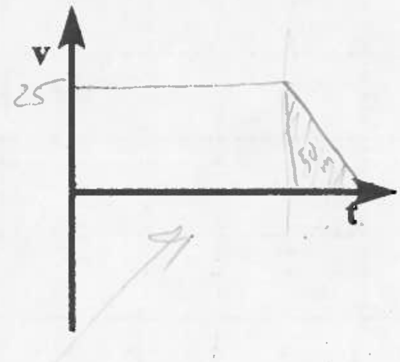
3. A stunt car driver drives a car at a constant speed of 25 m/s for a total of 100. m. He applies his brakes and accelerates uniformly to a stop just as he reaches a wall 50. m away.

$\Delta X = 150\,m$

a. Sketch **qualitative** position vs. time and velocity vs time graphs.





b. How long does it take for the car to travel the first 100.m?

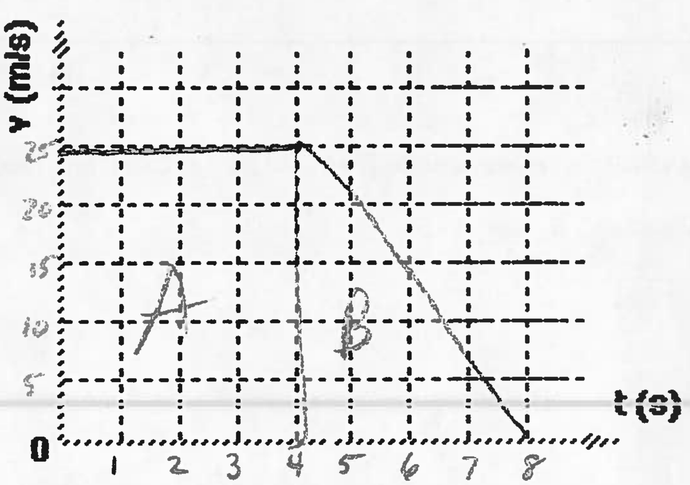
Constant velocity $\quad \Delta X = v\Delta t \quad 100\,m = 25\,m/s\,\Delta t \quad \Delta t = \frac{100\,m}{25\,m/s} = 4\,s$

c. Remember that the area under a velocity vs time graph equals the displacement of the car. How long must the brakes be applied for the car to come to a stop in 50 m?

$\Delta X = \frac{1}{2}bh = \frac{1}{2}\Delta t \cdot V$

$50\,m = \frac{1}{2}\Delta t\,(25) \Rightarrow \frac{50\,m}{25\,m/s} = \frac{1}{2}\Delta t \qquad 2(2) = \Delta t \qquad \boxed{\Delta t = 4\,s}$

d. Now that you know the total time of travel, sketch a **quantitative** velocity vs time graph.



$\Delta X_A = 4 \times 25 = 100$

$\Delta X_B = \frac{1}{2}(4 \times 25) = 50$

$\Delta X = 150\,m$

e. What acceleration is provided by the brakes? How do you know?

$$a = \frac{\Delta v}{\Delta t} = \frac{0\,m/s - 25\,m/s}{8\,s - 4\,s} = \frac{-25\,m/s}{4\,s} = -6.25\,m/s^2$$

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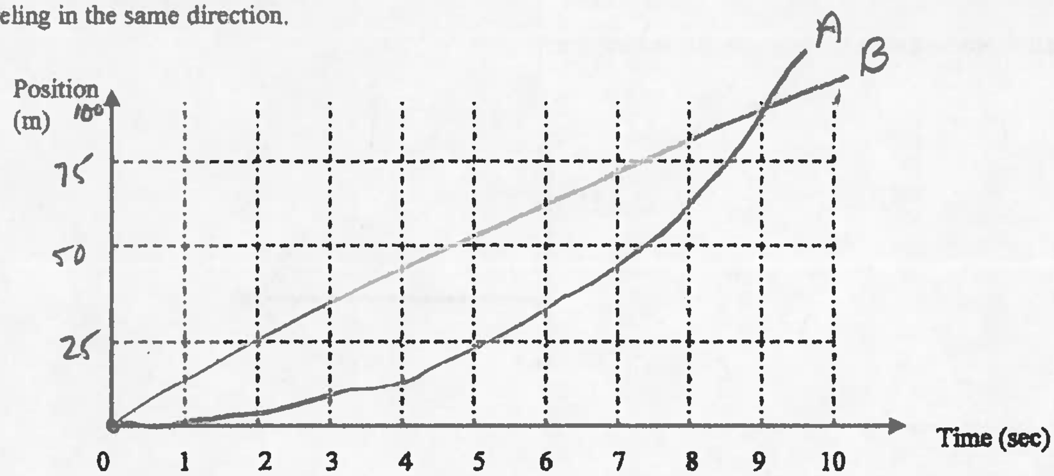
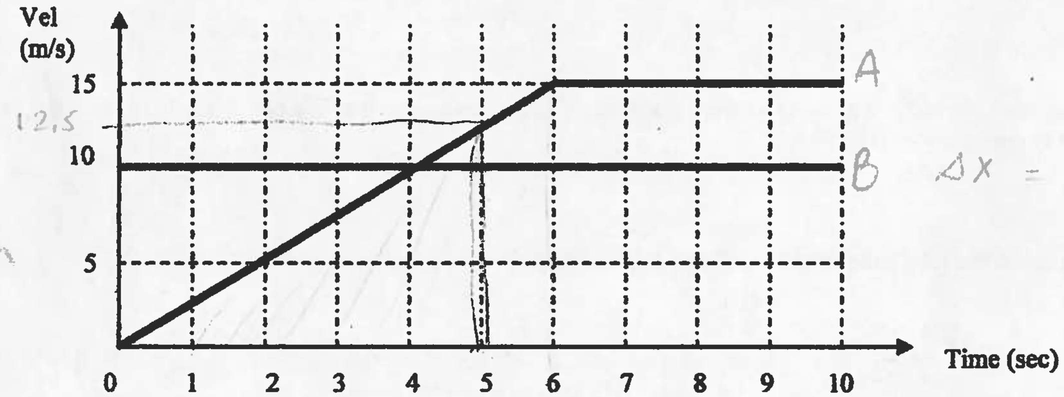
2. The following graph shows the velocity vs. time for two cars traveling on Chicago Ave. One car is stopped at Wells Ave. when the light turns green. Just as the resting car (Car A) begins to move (t = 0 seconds), it is passed by Car B which is traveling in the same direction.





$\Delta x = \frac{1}{2}bh$ $\Delta x = bh$

(a) Determine which lines in the velocity graph above correspond to which car. Label these lines.

(b) Which car is ahead at t = 5.0 seconds? By how much?

$a = \frac{\Delta v}{\Delta t}$

A ~~$\Delta x = \frac{1}{2}bh$~~

To find v @ t = 5 s
$V_f = a\Delta t + v_i$
need a $a = \frac{\Delta v}{\Delta t} = \frac{15}{6} = 2.5\,m/s^2 \Rightarrow V_f = (2.5\,m/s^2)(5\,s) + 0\,m/s = 12.5\,m/s$

Plug into $\frac{1}{2}bh$ $\Delta x = \frac{1}{2}bh = \frac{1}{2}(5s)(12.5\,m/s) = \frac{1}{2}(62.5\,m)$ $\Delta x_A = 31.25\,m$

B $\Delta x = 10\,m/s \cdot 5\,s$ $\Delta x_B = 50\,m$

B is ahead

(c) Does Car A ever pass Car B? (Show how you know)

$\Delta x_B = bh = 10(10) = 100\,m$

$\Delta x_A = \frac{1}{2}bh + bh = \frac{1}{2}(6s)(15\,m/s) + 4s(15\,m/s) = 45\,m + 60\,m = 105\,m$

Yes – A has larger displacement

(d) Construct a position vs. time graphs for both cars on the empty graph above.

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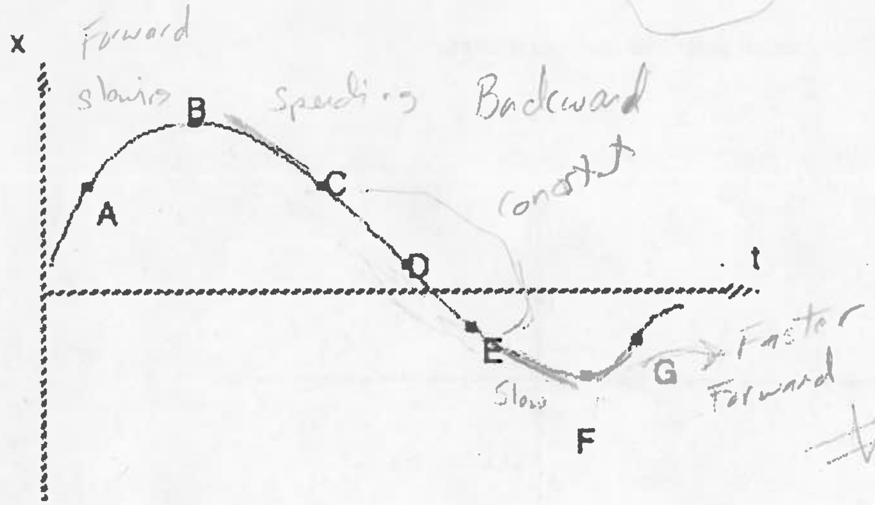
Introduction to problem-solving when velocity is not constant Part 2

1. The graph below represents the motion of an object.

Check Slope



Something dragged hypothetical

a. **At what point(s) on the graph above is the object moving most slowly? (How do you know?)**

B, F ~~change in~~ slope is flat (=0)

b. **Over what intervals on the graph above is the object speeding up? (How do you know?)**

B - E B-C F-G > slope is steepest

c. **Over what intervals on the graph above is the object slowing down? (How do you know?)**

A - B E-F Slope the least steep

d. **At what point(s) on the graph above is the object changing direction? (How do you know?)**

B, F

forward up

backward down then forward up

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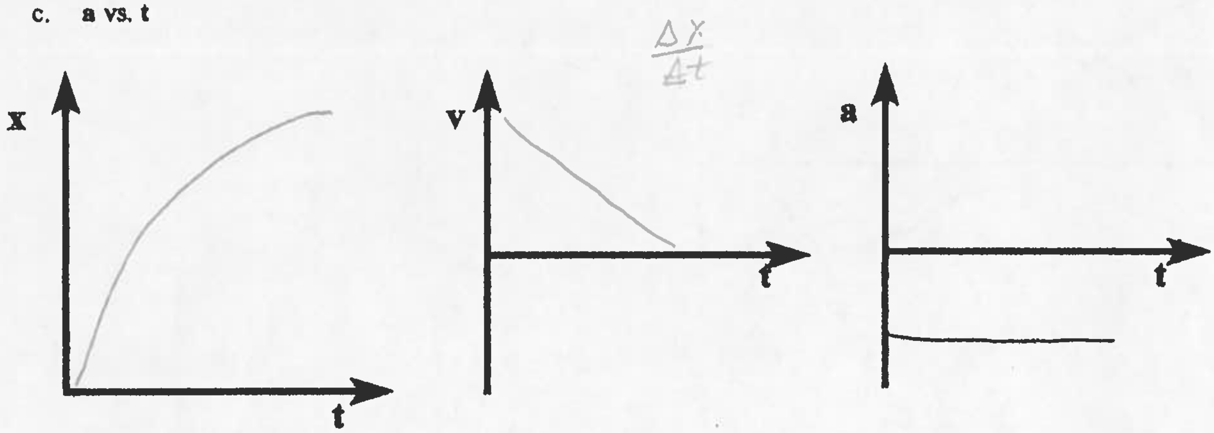
Introduction to problem-solving when velocity is not constant Part 1

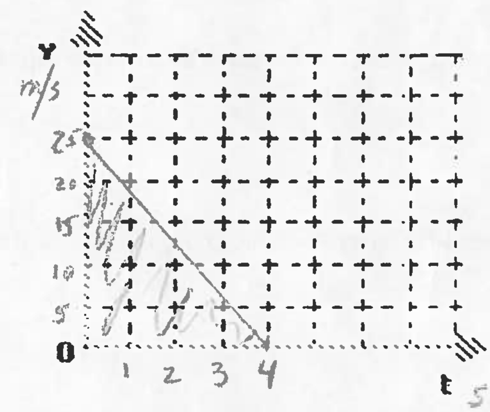
While cruising along a dark stretch of highway with the cruise control set at 25 m/s (≈55 mph), you see, at the fringes of y our headlights, that a bridge has been washed out. You apply the brakes and come to a stop in 4.0s. *Assume the clock starts the instant you hit the brakes.*

1. Construct **qualitative** graphical representations of the situation described above to illustrate:
   a. x vs. t
   b. v vs. t
   c. a vs. t



2. Construct a **quantitatively accurate** v vs t graph to describe the situation.

3. On the v vs. t graph at right, graphically represent the car's displacement during braking.



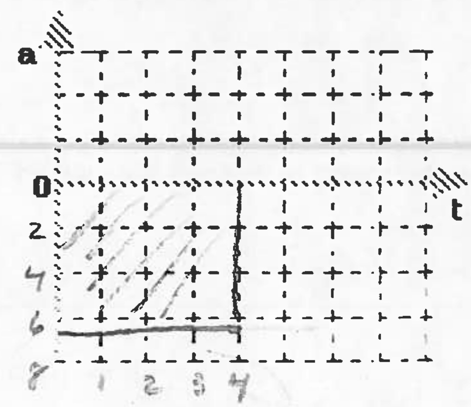
4. Utilizing the **graphical representation**, determine how far the car traveled during braking. (Please explain your problem solving method.)

area under v-t graph

$\Delta x = \frac{1}{2} bh = \frac{1}{2}(4\,s)(25\,\frac{m}{s}) = 50\,m$

5. In order to draw the **a** vs t graph, you need to determine the car's acceleration. Please do this, then sketch a **quantitatively accurate** a vs t graph

$a = \frac{\Delta v}{\Delta t} = \frac{0 - 25\,m/s}{4\,s} = \frac{-25\,m/s}{4\,s} = -6.25\,\frac{m/s}{s}$



6. Using the equation you developed for displacement of an accelerating object determine how far the car traveled during braking. (Please show your work.)

$x_f = \frac{1}{2} a \Delta t^2 + v_i \Delta t + x_i$

$= \frac{1}{2}(-6.25\,\frac{m}{s^2})(4\,s)^2 + (25\,\frac{m}{s})(4\,s) + 0$

$= 50\,m$

7. Compare your answers to 4 and 6.

Same