Physics 151, HW #2

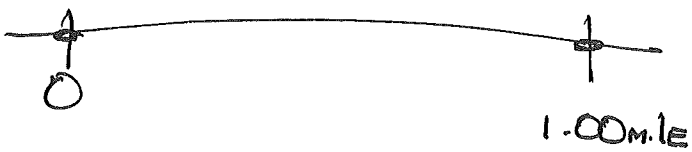
7 Mastering Physics from chapters 1 & 2

Written: 1.39, 1.44

52 SHANNON'S SPEED = 70 mph = 70 mi/h.

MILE MARKERS 1.00 mile APART IN 54 s.

IS SPEEDOMETER ACCURATE?



$$V = \frac{\Delta x}{\Delta t}$$

CALCULATE ACTUAL V USING $\Delta x = 1.00\,mi$

$$\Delta t = 54\,s \times \frac{1\,h}{3600\,s} = .015\,h$$

$$V_{ACTUAL} = \frac{1.00\,mi}{.015\,h} = 66.7\,mph \leftarrow$$ SPEEDOMETER READING TOO HIGH

56. E. Coli

$2\mu m$ long cylinder
$1\mu m$ diameter
$1\times10^{-12}g$ mass
DNA 700× longer than length
$20\mu m/s$ speed

Find in S.I. using proper sig-fig

a) Length: $1\mu m = 1\times10^{-6}m \Rightarrow 2\mu m \times \frac{1\times10^{-6}m}{1\mu m} = \underline{\underline{2\times10^{-6}m}}$

b) Diameter: $1\mu m = \underline{\underline{1\times10^{-6}m}}$

c) Mass: $1Kg = 1000g \Rightarrow 1\times10^{-12}g \times \frac{1Kg}{1000g} = \underline{\underline{1\times10^{-15}Kg}}$

d) DNA length in milimeters:

Length: $l = 700 \times 2\mu m = 1400\mu m \times \frac{1\times10^{-6}m}{1\mu m} = .0014m$

$1mm = .001m \Rightarrow .0014m \times \frac{1mm}{.001m} = 1.4mm = 1mm$ to 1 sig Fig

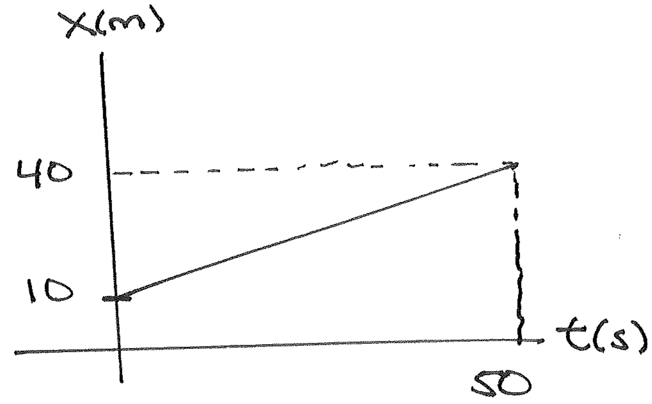
e) How many meters in a day: $V = \frac{\Delta x}{\Delta t}$. $V = \frac{20\mu m}{s} \times \frac{1\times10^{-6}m}{\mu m} = 2\times10^{-5}m/s$

$\Delta t = 1day \times \frac{24h}{day} \times \frac{3600s}{h} = 86400s \Rightarrow 2\times10^{-5}m/s = \frac{\Delta x}{86400s} \Rightarrow \Delta x = (2\times10^{-5}m/s)(86400s)$

$= 1.728m = \underline{\underline{2m}}$

1 sig Fig

WHAT X vs. t GRAPHS CAN Tell you:



a) WHAT IS TOTAL distance? $\Delta X = X_f - X_i$. JUST READ OFF VALUES

at $t_f = 50s$, $X_f = 40m$, at $t_i = 0$, $X_i = 10m$

$\Rightarrow \Delta X = 40m - 10m = 30m$

b) WHAT IS V_{av} FOR $\Delta t = 50s$? $V_{AV} = \frac{\Delta X}{\Delta t}$. Already have $\Delta X = 30m$

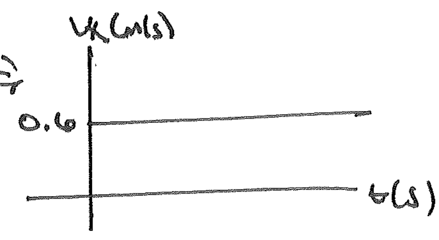
$\Rightarrow V_{AV} = \frac{30m}{50s} = 0.6 m/s$

c) WHAT IS V_x at $t = 10s$. XUST is straight LINE $\Rightarrow$ UNIFORM MOTION

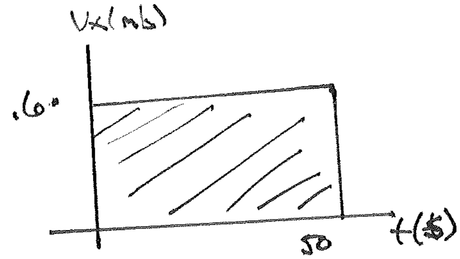
$\Rightarrow$ Constant velocity. So $V_{AV} = V_x$ at all times $\Rightarrow V_x = 0.6 m/s$ too

d) Correct V_x graph? $\rightarrow$ AGAIN, UNIFORM MOTION $\Rightarrow$ Constant V_x

$\Rightarrow$ HORIZONTAL V_x vs. t graph. $V_x = 0.6 m/s$ $\Rightarrow$



PartE. → e)



Area = .6m/s(50s)

= 30m

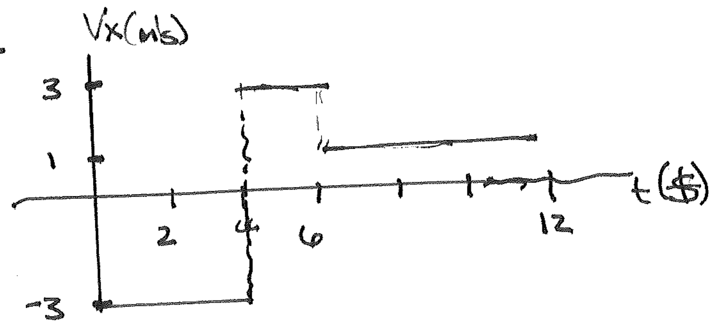
just verifying

That AREA UNDER

Vx PLOT IS EQUAL to

ΔX

2.8



DRAW Corresponding X vs t. Assume $X=0$ at $t=0$

First: Notice that V_x consists of 3 Horizontal Line segments

$\Rightarrow$ 3 Uniform Motions Combined together $\Rightarrow$ 3 Line segments

for X vs. t

To find distances traveled use $V_x = \frac{\Delta X}{\Delta t} \Rightarrow \Delta X = V_x \Delta t$ OR Equivalently

Find Area on graph. Then to find position use $\Delta X = X_F - X_i \Rightarrow X_F = X_i + \Delta X$

For $0<t<4s$ $\quad \Delta t = 4s - 0 = 4s$, $\overset{V_x = -3m/s}{\Rightarrow}$ $\Delta X = (-3m/s)(4s) = -12m$

At $t=0$, $X=0 \Rightarrow X_i = 0 \quad \Rightarrow X_F = \overset{0-12m}{\cancel{\quad}} = -12m$

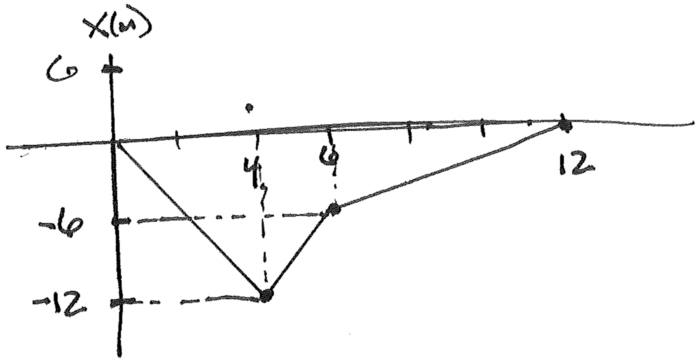
For $4s<t<6s$ $\quad \Delta t = 6s - 4s = 2s$, $V_x = +3m/s \Rightarrow \Delta X = (3m/s)(2s) = 6m$

but Now $t_i = 4s \Rightarrow X_i = X$ at $4s = -12m \Rightarrow X_F = -12m + 6m = -6m$

For $6s<t<12s$, $\quad \Delta t = 12s - 6s = 6s$, $V_x = +1m/s \Rightarrow \Delta X = (1m/s)(6s) = 6m$

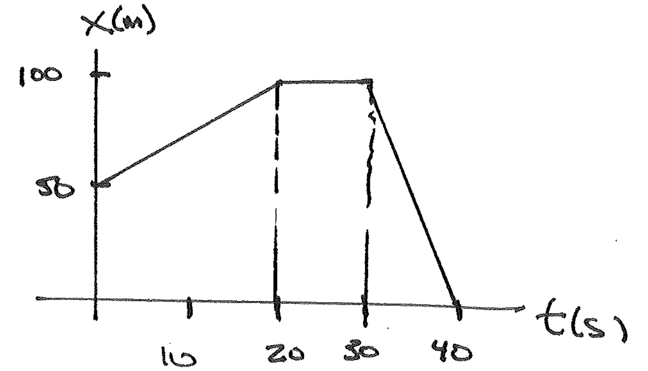
Here $t_i = 6s \Rightarrow X_i = -6m \quad \Rightarrow X_F = -6m + 6m = 0$

Putting this All together:



Part B: What is x at t=12s? x = 0m

2.9



Notice.. 3 straight line segments ⇒ 3 uniform motions

a) What is velocity at $t=10s$

This is x vs t ⇒ V_x = slope. $t=10s$ is during first line segment

⇒ use ~~x_0~~ $t_i=0$, $t_f=20s$, $x_i=50m$, $x_f=100m$

⇒ $V_x=\frac{\Delta x}{\Delta t}$ ← gives instantaneous velocity because this is uniform motion

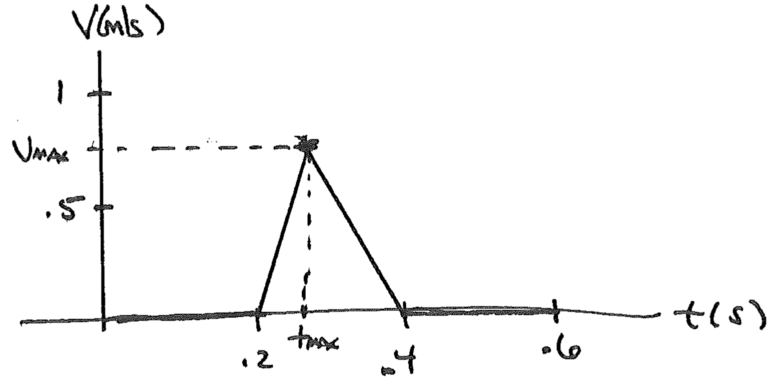
$$V_x=\frac{(100m-50m)}{(20s-0)}=\frac{50m}{20s}=2.5m/s$$

b) What is velocity at $t=25s$ ← during 2ND segment which is HORIZONTAL ⇒ $V_x=0$. OR, EQUIVALENTLY, $x_i=x_f=100m$ for 2ND segment ⇒ $\Delta x=0$ ⇒ $V_x=0$

c) V_x at $t=35s$? 3RD segment has $t_i=30s$, $t_f=40s$ ⇒ $x_i=100m$, $x_f=0$

$$\Rightarrow V_x=\frac{(0-100m)}{(40s-30s)}=\frac{-100m}{10s}=-10m/s$$

18.

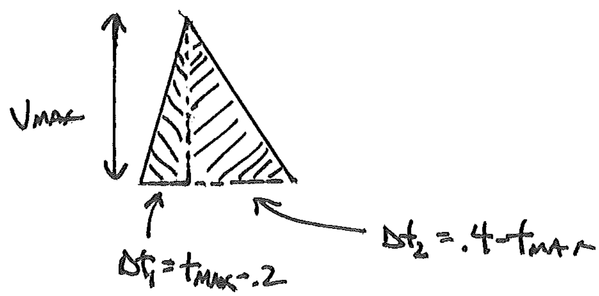


To me, I measure the max velocity to be halfway between .5 and 1 while t_{MAX} is about $\frac{1}{3}$ of the way between .2s and .4s.

You may have slightly different values.

a) Approximately how far does blood go during one beat.

How far ⇒ Area



$V_{MAX} = .75\,m/s$ ← halfway

$t_{MAX} = .2 + \frac{1}{3}(.4 - .2)$

$= .2 + \frac{1}{3}(.2) = .2667\,s$

$\Rightarrow \Delta t_1 = .0667\,s \quad \Delta t_2 = .1333\,s$

Two Triangles $\Rightarrow \Delta X = \frac{1}{2}\Delta t_1 V_{max} + \frac{1}{2}\Delta t_2 V_{MAX}$

$\Delta X = \frac{1}{2}(.0667s)(.75m/s) + \frac{1}{2}(.1333s)(.75m/s) = \frac{1}{2}(.2s)(.75m/s)$

$\Rightarrow \boxed{\Delta X = .075m \times \frac{100cm}{m} = 7.5cm}$

b) Estimate how many beats from heart to brain.

I (think) its about 1/4 meter from brain to heart

$1/4\,m = .25\,m = 25\,cm$

Blood travels $7.5\,cm/beat$

$\therefore \#\,beats = \dfrac{25\,cm}{7.5\,cm/beat} = 3.33 \approx 3\,beats$

Note: the original book problem had you estimate your own height. In mastering, they just tell you to use 30cm.

For 30cm, $\#\,beats = \dfrac{30\,cm}{7.5\,cm/beat} = 4$

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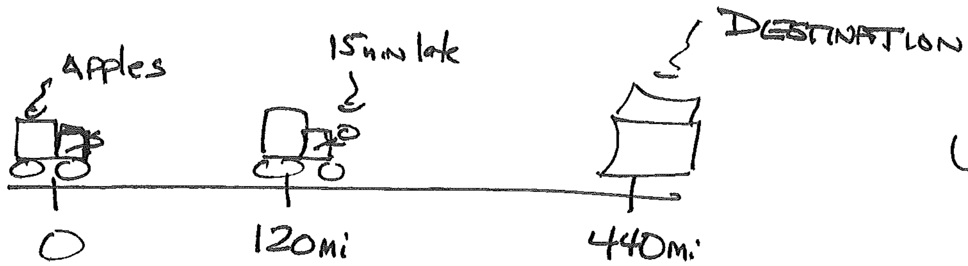


USUALLY TAKES 8 hours

WHAT SPEED FOR REMAINING DISTANCE to make up time.

SPLIT TRIP INTO TWO PIECES : ① AND ② → ① = First 120 mi
② = REST

$V_1 = \frac{\Delta x_1}{\Delta t_1}$. $\Delta x_1 = 120mi$, $\Delta t_1 = ?$, $V_1 = ?$

$V_2 = \frac{\Delta x_2}{\Delta t_2}$. $\Delta x_2 = 440mi - 120mi = 320mi$, $\Delta t_2 = ?$

$V_2 = ?$ AND V_2 IS FINAL ANSWER.

WE KNOW $\Delta t_1 + \Delta t_2 = 8h$ → IF WE FIND Δt_1, WE CAN SOLVE FOR Δt_2.

USE THE 15 min LATER THAN USUAL: $\Delta t_1 = \Delta t_{1,USUAL} + 15MIN$

$\Delta t_{1,USUAL}$ = USUAL time to travel $\Delta x_1 = 120mi$

$$V_{USUAL} = \frac{440\,mi}{8\,h} = 55\,mi/h$$

$$V_{USUAL} = \frac{\Delta X_1}{\Delta t_{1,USUAL}} \Rightarrow 55\,mi/h = \frac{120\,mi}{\Delta t_{1,USUAL}} \Rightarrow \Delta t_{1,USUAL} = \frac{120\,mi}{55\,mi/h}$$

$$= 2.181818\,h$$

UNIT: $mi \cdot \frac{h}{mi} = h$

$$\Delta t_1 = \Delta t_{1,USUAL} + 15\,min. \qquad 15\,min \times \frac{1\,h}{60\,min} = .25\,h$$

$$\Rightarrow \Delta t_1 = 2.431818\,h$$

$$\Delta t_1 + \Delta t_2 = 8\,h \Rightarrow \Delta t_2 = 8\,h - 2.431818\,h = 5.568181\,h$$

$$\therefore \quad V_2 = \frac{\Delta X_2}{\Delta t_2} = \frac{320\,mi}{5.568181\,h} = 57.469\,mi/h = 57.5\,mi/h$$

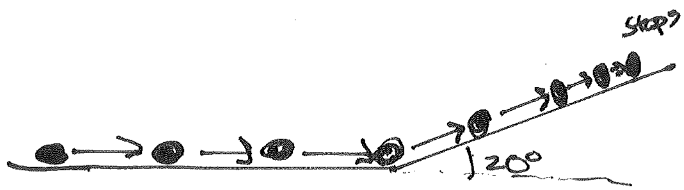
$$= 57\,mi/h \text{ to 2 sig Fig}$$

1.39 Draw Motion Diagram For Ball rolling on Smooth, Horizontal Floor which rolls up a 20° Ramp, and stops, (And then rolls back down)

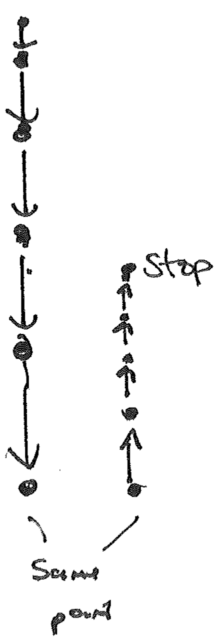
On ~~Sm~~ Floor ball has Constant speed (Hence the word smooth)

⇒ Equal spacing of dots.

Up Ramp, the ball is slowing down since its speed has changed for 10m/s to Zero ⇒ Dots getting closer together.



1.44.



Be Creative!

Jack drops his Phone off the top of his roof of his Apartment building. (He was foolishly sunbathing up there) The phone falls with increasing speed. Luckily, Jack has the new "protect-a-phone" App that inflates A small balloon Around the phone just before impact. This allows it to bounce back up (but with smaller upward speed). It flys into the air with decreasing speed and is caught by his Roommate Sally, just at the top of its motion