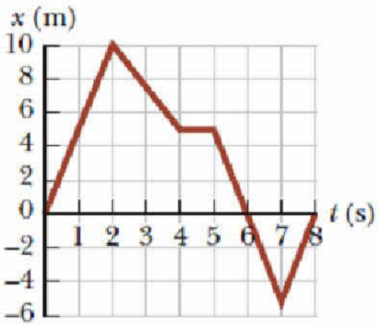
Homework 2

Note Title 1/27/2013

1. 0/5 points SerPSE8 2.P.001.WI. [1390657]

The position versus time for a certain particle moving along the *x* axis is shown in the figure below. Find the average velocity in the following time intervals.



The equation for the average velocity is:

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

(a) 0 to 2 s

$\Delta x = 10\,m - 0\,m = 10\,m$ and $\Delta t = 2s - 0s = 2s$

Hence, $v_{avg} = \frac{10\,m}{2\,s} = 5\,m/s$

(b) 0 to 3 s

$\Delta x = 7.5m - 0m = 7.5\,m$, $\Delta t = 3s$

$$v_{avg} = \frac{7.5m}{3s} = 2.5\,m/s$$

(c) 3 to 6 s

$$v_{avg} = \frac{0m - 7.5m}{3s} = -2.5\,m/s$$

(d) 4 to 7 s

$$v_{avg} = \frac{-5\,m - 5m}{3s} = -3.33\,m/s$$

(e) 0 to 7 s

$$v_{avg} = \frac{-5m - 0m}{7s} = -0.714\,m/s$$

2. 0/2 points SerPSE8 2.P.003.MI. [1265250]

A person walks first at a constant speed of 5.20 m/s along a straight line from point Ⓐ to point Ⓑ and then back along the line from Ⓑ to Ⓐ at a constant speed of 2.95 m/s.

(a) What is her average speed over the entire trip?

The average speed over the entire trip is : $v_{avg} = \dfrac{d_{AB} + d_{BA}}{\Delta t_{AB} + \Delta t_{BA}}$ (1)

where $d_{AB} = d_{BA}$.

We know that:

$$v_{AB} = \frac{d_{AB}}{\Delta t_{AB}} \longrightarrow 5.20\ m/s = \frac{d_{AB}}{\Delta t_{AB}} \longrightarrow \Delta t_{AB} = \frac{d_{AB}}{5.20\ m/s} \quad (2)$$

and

$$v_{BA} = \frac{d_{BA}}{\Delta t_{BA}} \longrightarrow \Delta t_{BA} = \frac{d_{BA}}{2.95\ m/s} \quad (3)$$

We can now replace eqs. (2) and (3) into (1):

$$v_{avg} = \frac{d_{AB} + d_{BA}}{\left(\frac{d_{AB}}{5.20\ m/s}\right) + \left(\frac{d_{BA}}{2.95\ m/s}\right)} = \frac{2\cancel{d_{AB}}}{\cancel{d_{AB}}\left(\frac{2.95\ m/s + 5.20\ m/s}{5.20 \cdot 2.95\ m^2/s^2}\right)}$$

$$= \frac{2\,(5.20 \cdot 2.95)\, m^{\cancel{2}}/s^{\cancel{2}}}{8.15\ \cancel{m}/\cancel{s}} = 3.76\ m/s$$

(b) What is her average velocity over the entire trip?

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_A - x_A}{\Delta t} = \frac{0\ m}{\Delta t\ s} = 0\ m/s$$

3. 0/2 points SerPSE8 2.P.004.WI. [1265265]

A particle moves according to the equation $x = 9t^2$, where x is in meters and t is in seconds.

(a) Find the average velocity for the time interval from 2.05 s to 3.15 s.

The position at $t = 2.05\,s$ is: $x_i = 9 \cdot (2.05)^2\ m = 37.82\ m$

The position at $t = 3.15$ is: $x_f = 9 \cdot (3.15)^2\ m = 89.30\ m$

$$v_{avg} = \frac{89.30\ m - 37.82\ m}{3.15\,s - 2.05\,s} = 46.8\ m/s$$

(b) Find the average velocity for the time interval from 2.05 s to 2.25 s.

$$v_{avg} = 38.7\ m/s$$

4. 0/1 points SerPSE8 2.P.012.WI. [1265255]

A 54.0-g Super Ball traveling at 28.0 m/s bounces off a brick wall and rebounds at 18.0 m/s. A high-speed camera records this event. If the ball is in contact with the wall for 4.55 ms, what is the magnitude of the average acceleration of the ball during this time interval?

The velocity of the ball before it reaches the wall is $v_i = 28 \, m/s$.

After it bounces off the wall: $v_f = -18 \, m/s$

The average acceleration of the ball that produces this change in velocity is:

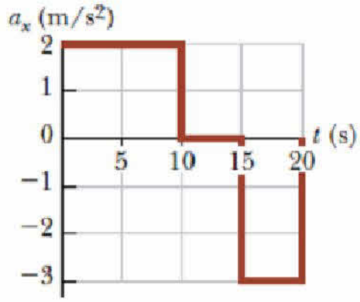
$$a_{avg} = \frac{v_f - v_i}{\Delta t} = \frac{-18 \, m/s - 28 \, m/s}{4.55 \times 10^{-3} \, s} = -10.10 \times 10^3 \, m/s^2$$

$$= -10100 \, m/s^2$$

The magnitude of the acceleration is:

$$|\overrightarrow{a_{avg}}| = 10100 \, m/s^2$$

A particle starts from rest and accelerates as shown in the figure below.



(a) Determine the particle's speed at t = 10.0 s.

$v_f = v_i + at$

but $v_i = 0_{m/s}$ and $a = 2\ m/s^2$.

Thus,

$v_f = 2\ m/s^2 \times 10\ s = 20\ m/s$

Determine the particle's speed at t = 20.0 s?

The speed of the particle at $t = 15.0\ s$ is $\rightarrow v_i = 20\ m/s$

$v_f = v_i + at$, where $a = -3\ m/s^2$

$v_f = 20\ m/s - 3\ m/s^2 \times 5\ s = 20\ m/s - 15\ m/s = 5\ m/s$

(b) Determine the distance traveled in the first 20.0 s. (Enter your answer to one decimal places.)

- The first 10 s.

$\Delta x = \frac{1}{2} a t^2 = \frac{1}{2}\ 2\ m/s^2 \times 10^2\ s^2 = 100\ m$

- From $t = 10\ s$ to $t = 15\ s$

$\Delta x = v \cdot \Delta t = 20\ m/s \times 5\ s = 100\ m$

- From $t = 15\ s$ to $t = 20\ s$

$\Delta x = v_i t + \frac{1}{2} a t^2 = 20\ m/s \times 5\ s + \frac{1}{2}\left(-3\ m/s^2\right) \times 5^2\ s^2$

$= 100\ m - \frac{75}{2}\ m = 62.5\ m$

- Hence the total distance traveled is:

$d = 262.5\ m$

6. 0/3 points SerPSE8 2.P.017.MI. [1265231]

A particle moves along the x axis according to the equation $x = \underbrace{2.02}_{x_i} + \underbrace{3.08}_{v_i}t - \underbrace{1.00}_{\frac{a}{2}}t^2$, where x is in meters and t is in seconds.

(a) Find the position of the particle at t = 3.10 s.

$x = 1.96\ m$

(b) Find its velocity at t = 3.10 s.

$v = 3.08 - 1.00\,t$

Thus, $v = -3.12\ m/s$

(c) Find its acceleration at t = 3.10 s.

$\frac{a}{2} = -1\ m/s^2 \longrightarrow a = -2\ m/s^2$

7. 0/2 points SerPSE8 2.P.022.WI. [1265238]

A truck covers 31.0 m in 8.60 s while smoothly slowing down to final speed of 2.90 m/s.

(a) Find its original speed.

$$\Delta x = \frac{1}{2}(v_i + v_f)\,\Delta t$$

where $\Delta x = 31\text{ m}$, $\Delta t = 8.6\text{ s}$, and $v_f = 2.90\text{ m/s}$

$$2\frac{\Delta x}{\Delta t} = v_i + v_f \rightarrow v_i = 2\frac{\Delta x}{\Delta t} - v_f = \frac{62\text{ m}}{8.6\text{ s}} - 2.90\text{ m/s}$$

$$v_i = 4.31\text{ m/s}$$

(b) Find its acceleration. (Indicate the direction of the acceleration with the sign of your answer.)

Use, for example, $v_f = v_i + at \rightarrow a = \dfrac{v_f - v_i}{\Delta t}$

$$a = -0.164\text{ m/s}^2$$

A car traveling at a constant speed of 59.5 m/s passes a trooper on a motorcycle hidden behind a billboard. One second after the speeding car passes the billboard, the trooper sets out from the billboard to catch the car, accelerating at a constant rate of 2.00 m/s^2. How long does it take her to overtake the car? Solve this problem by a graphical method. On the same graph plot position versus time for the car and the police officer. (Do this on paper. Your instructor may ask you to turn in this work.)

From the intersection of the two curves read the time at which the trooper overtakes the car.

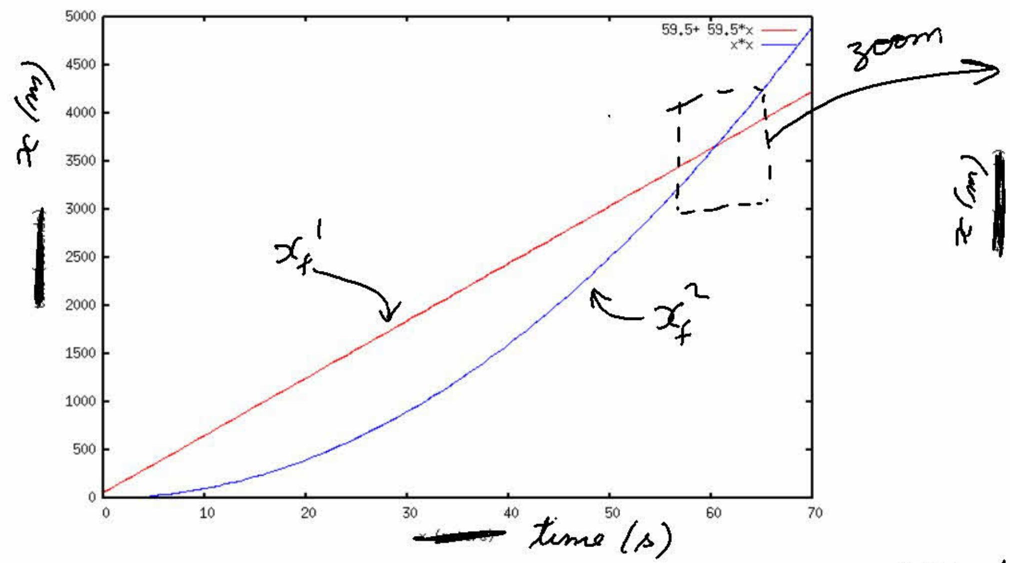
The equation for the position of the car is:

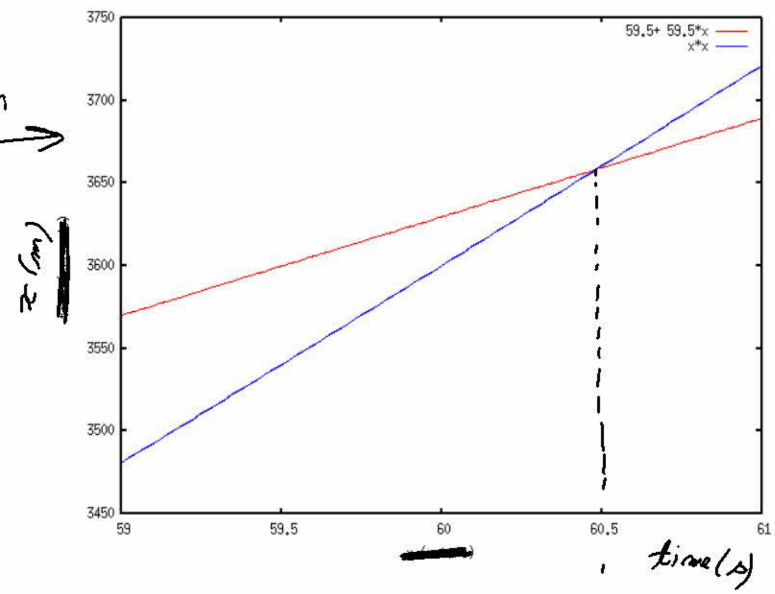
$$x_f^1 = 59.5\,m + 59.5\,m/s \times t$$

The equation for the trooper is:

$$x_f^2 = \frac{2.00\,m/s^2}{2} \times t$$

We can plot these two equations:





It takes 60.5 seconds

9. 0/4 points SerPSE8 2.P.037. [1231111]

A gymnast jumps straight up, with her center of mass moving at 3.31 m/s as she leaves the ground. How high above this point is her center of mass at the following times? (Ignore the effects of air resistance, and assume the initial height of her center of mass is at $y = 0$.)

$$x_f = 3,31\ m/s \times t - \frac{9.8\ m/s^2}{2} \times t^2$$

t (s)	x_f (m)
0,1	0,282
0,2	0,466
0,3	0,552
0,5	0,43

10. 0/2 points SerPSE8 2.P.040.WI. [1265264]

A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes 2.90 s for the ball to reach its maximum height.

(a) Find the ball's initial velocity.

$$v_f = v_i + at \longrightarrow 0\ m/s = v_i - 9.8\ m/s^2 \times 2.90\ s$$

$$v_i = 28.42\ m/s$$

(b) Find the height it reaches.

using: $\Delta x = v_i \times t + \dfrac{at^2}{2}$

we find that $\Delta x = 41.2\ m$

11. 0/1 points SerPSE8 2.P.041.WI. [1265235]

A ball is thrown directly downward with an initial speed of 7.65 m/s from a height of 29.4 m. After what time interval does it strike the ground?

$v_i = 7.65\,m/s$

$\Delta x = 29.4\,m$

We can use the following equation $\Delta x = v_i \times t + \frac{a t^2}{2}$ and solve it for t.

or, use $v_f^2 = v_i^2 + 2a\,\Delta x$ to obtain v_f.

and then use $v_f = v_i + at$ to obtain $t \Rightarrow t = \frac{v_f - v_i}{a}$

$t = 1.79\,s$