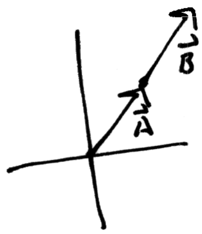
Homework Solutions to HW Set # 3 , due 9 / 28 / 03

By Tommy Willis
On 9 / 12 / 03

1. $\vec{A} + \vec{B} = \vec{C}$

a) when does $|\vec{C}|$ (magnitude of $\vec{C}$) equal $|\vec{A}| + |\vec{B}|$?

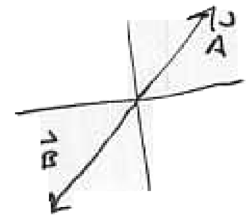
$\vec{A}$ and $\vec{B}$ in the same direction



then $|\vec{C}| = |\vec{A}| + |\vec{B}|$

b) when is $|\vec{C}| = 0$?

$\vec{A} = -\vec{B}$ we have

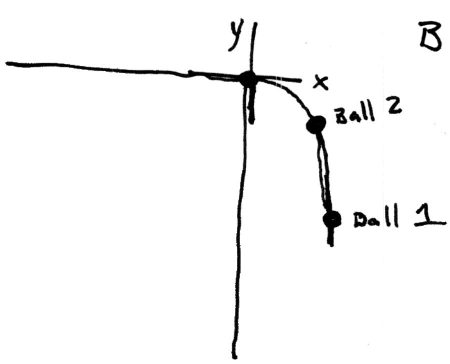


$\vec{A} + \vec{B} = \vec{A} - \vec{A} = 0 = \vec{C}$

so $|\vec{C}| = 0$

2.

a)



Both balls follow the same path but ball 2 is 1s behind.

So the equations for ball one are $x_1 = V_0 t \quad y_1 = -\frac{1}{2} g t^2$

And after 1 second for Ball 2

$x_2 = V_0 (t - 1s) \quad y_2 = -\frac{1}{2} g (t - 1s)^2$

Note: these equations only work for $t \geq 1s$

2) a) continued

the magnitude of the separation is

$$d = \sqrt{(x_1-x_2)^2+(y_1-y_2)^2}$$ so just plug in for the x's and y's

$$d = \sqrt{(v_0t - v_0(t-1s))^2 + (-\tfrac{1}{2}gt^2 - \tfrac{-1}{2}g(t-1s)^2)^2}$$

$$d = \sqrt{[v_0(1s)]^2 + (-2t(1s)+1s)^2}$$

In this last expression we see that the seperation increases as time gets bigger. So the closest they ever are is right as ball 2 is thrown.

You could get this without doing any math by realizing that the y component for the velocity of ball 2 is always bigger then that of Ball 1. So the distance between them has to grow in time.

b) We've already seen that the answer is yes

c) Because the balls are thrown with exactly the same initial condions (i.e. v_0, x_0 the same) then ball 2 is exactly where ball 1 was one second later. So ball 1 hits the ground second before ball 2.

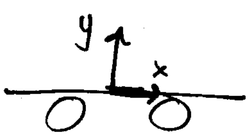
By
On / /

(2) continued

d) The answer is <u>no</u>. The y component of the position of the balls is completely determind by the initial velocity in the y direction. so the time it takes to hit the ground does not depend on the initial velocity in the x direction.

(3) a) <u>On the train:</u> The passenger see's the ball go straight up and down.

To see this we put our axis fixed on the train car.

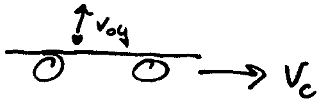


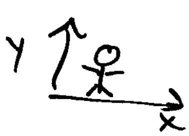
so $V_{ox} = 0 \Rightarrow$ $x(t) = 0$

V_{oy} s just how fast he throws the ball up

so $y = V_{oy} t - \frac{1}{2} g t^2$

b) For an outside observer, we fix the axis on the ground out side.

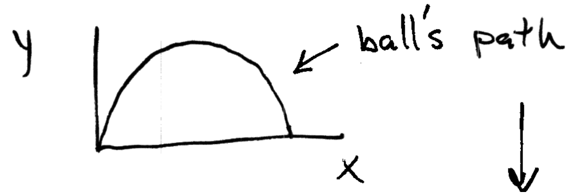




and for x we get $x = V_c t$

" y " " $y = V_{oy} t - \frac{1}{2} g t^2$

thus the outside observer see's



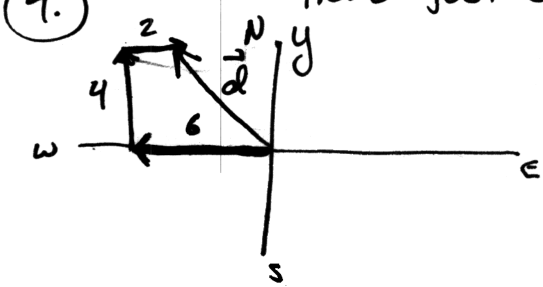
Homework Solutions to HW Set # 3, **due** 9 / 28 / 03

By	
On	/ /

(3) c) If the car is accelerating the outside observer sees the ball move in a parabola but he won't see the guy on the car catch it.

The train passenger would throw the ball upward and see it drift towards the back of the car before landing.

(4.) Here just add three vectors



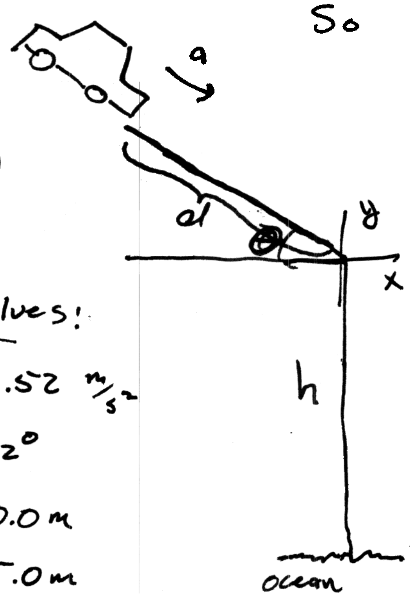
$d_x = (-6 + 2)$ blocks

$d_x = -4$ blocks

$d_y = 4$ blocks

So $|\vec{d}| = \sqrt{16+16} = \sqrt{32} = \sqrt{16 \cdot 2} = 4\sqrt{2}$ blocks

(5.)



My values:

$a = 3.52\ m/s^2$

$\theta = 22^\circ$

$d = 60.0\,m$

$h = 35.0\,m$

Here, do the problem in 2 parts

First find V_{ox}, V_{oy} at the instant the car leaves the cliff.

To find the magnitude of V when it falls

use $V_f^2 - \cancel{V_i^2}^{\,0} = 2a(\Delta x)$ $\quad \Delta x = d$

so $V_f = \sqrt{2ad} = \sqrt{2(3.52\ m/s^2)(60.0\ m)}$

$= 20.6\ m/s$

Use trig $\quad V_{ox} = V_f \cos\theta \quad V_{oy} = -V_f \sin\theta$

$= 9.1\ m/s \quad = -7.72\ m/s$

By	
On	/ /

(5) cont Now we know V_{ox} and V_{oy} so do the second part

for x: $x = V_{ox} t$

$$y = V_{oy} t - \frac{1}{2} g t^2$$

when it hits the water

$$y = -h = V_{oy} t - \frac{1}{2} g t^2 \Rightarrow \frac{1}{2} g t^2 - V_{oy} t - h = 0$$

Here we have to solve a quadratic.

$$\frac{9.8}{2} \frac{m}{s^2} t^2 + 7.72 \frac{m}{s} t - 35.0\,m = 0$$

of form $ax^2 + bx + c = 0$ with solutions

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

So $t = \left(\frac{-7.72 \pm \sqrt{(7.72)^2 - 4(4.9)(-35.0)}}{9.8} \right) s$

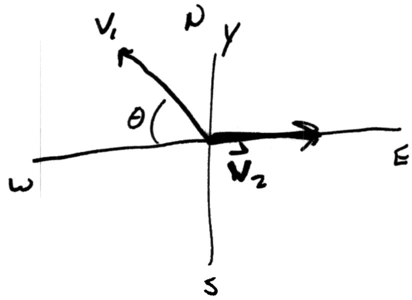
$$t = \frac{-7.72 \pm 27.3}{9.8} s = 2.00\,s$$

here I only pick the + sign from ± because I know time must be positive.

Now for the distance from the cliff that the car lands

$$x = V_{ox} t = (19.1 \tfrac{m}{s})(2.00)s = 38.2\,m \checkmark$$

(6.)



Here we've got 2 velocities

$V_{1x} = -V_1 \cos\theta$, $V_{2x} = V_2$

$V_{1y} = V_1 \sin\theta$, $V_{2y} = 0$

my values

$V_1 = 3.86 \frac{mi}{h}$

$V_2 = 1.25 \frac{mi}{h}$

$\theta = 62.5°$

$w = .560 \, mi$

w is width of river

To get the total velocity V , $\vec{V} = \vec{V}_1 + \vec{V}_2$

So $V_x = V_2 - V_1 \cos\theta = -.532 \frac{mi}{h}$

$V_y = V_1 \sin\theta = 3.42 \frac{mi}{h}$

In the y direction when you hit the bank

$w = V_y t \Rightarrow t = \frac{w}{V_y}$

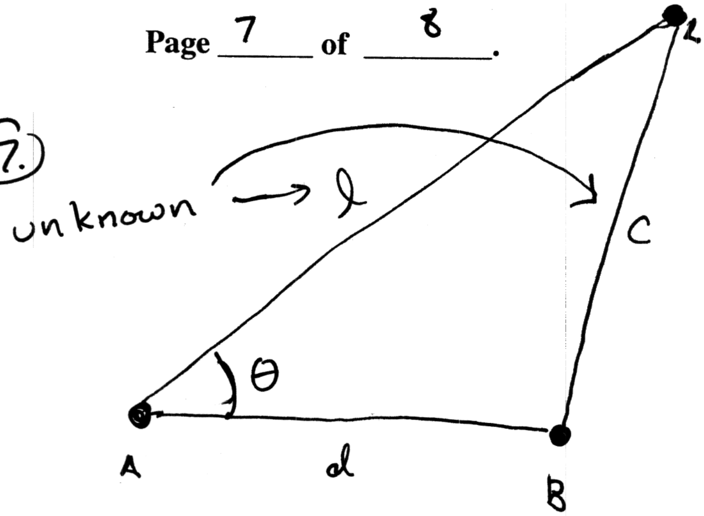
in x: $x = V_x t = V_x \frac{w}{V_y} = \frac{-532 \frac{mi}{h}}{3.42 \frac{mi}{h}} (.560 \, mi) = -8.71 \times 10^{-2} \, mi$

Now just convert to ft

$x = -8.71 \times 10^{-2} \, mi \cdot \frac{5280 \, ft}{mi} = -460 \, ft$

So 460 ft upstream

(7.)



givens are

$V_a = 90.0\ km/h$

$V_b = ?$

$d = 80.0\ km$

$t = 2.5\ h$

$\theta = 40.0°$

We can find ℓ

from $V_a \cdot t = \ell$

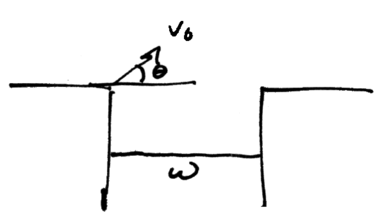
$\ell = 225\ km$

to find the length of c use law of cosines

$c^2 = d^2 + \ell^2 - 2d\ell\cos\theta \Rightarrow \quad c = 172\ km$

So $c = V_b t \Rightarrow V_b = \frac{c}{t} = \frac{172\ km}{2.5\ h} = 68.8\ \frac{km}{h}$

(8.)



$V_{oy} = V_o \sin\theta$

$V_{ox} = V_o \cos\theta$

givens:

$w = 12\ m$

$\theta = 17°$

$y = V_{oy}t - \frac{1}{2}gt^2 \; ; \; V_y = V_{oy} - gt$

$x = V_{ox}t$

Find for a given V_{oy}, how long the guy is in the air.

$y = 0 = V_{oy}t - \frac{1}{2}gt^2 = t\left(V_{oy} - \frac{g}{2}t\right) = 0$

$t = \frac{2V_{oy}}{g}$ Now for x we want it to be at least w, at the time $y = 0$

so $x = w = V_{ox}t = \frac{2V_{ox}V_{oy}}{g} = \frac{2\sin\theta\cos\theta\, V_0^2}{g}$

Homework Solutions to HW Set # 3 due 9 / 28 / 03

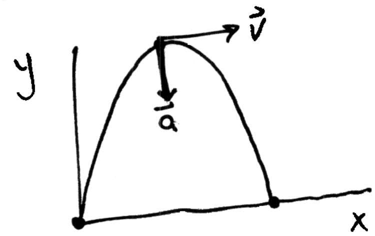
Page 8 of 8.

By
On / /

(8) cont.

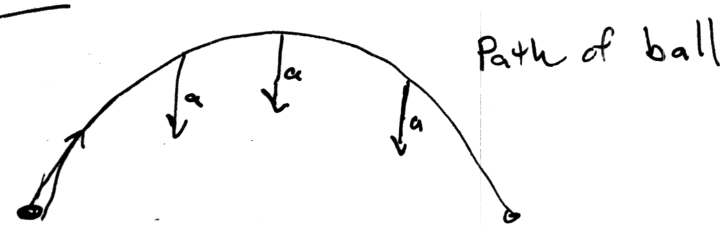
Have $w = \frac{2\sin\theta\cos\theta\, V_0^2}{g} \Rightarrow V_0 = \sqrt{\frac{wg}{2\sin\theta\cos\theta}} = 14.5\ \frac{m}{s}$

(9.) Look at a plot of the position in y vs. x



Notice $\vec{a}$ always points down. At the peak of the path the velocity is solely in the x direction so they are perpendicular.

(10.)



The acceleration is only in the $-y$ direction at all times. The magnitude is constant, at $+9.8\ m/s$.