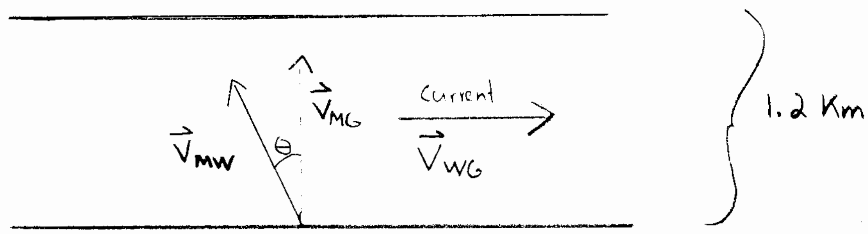
Phys 100 Assignment #4.

Question 1.



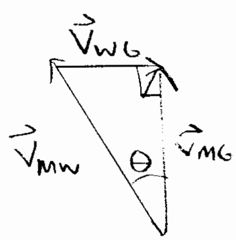
$\vec{V}_{MW}$ = velocity of man w.r.t. water = 5 Km/hr

$\vec{V}_{MG}$ = velocity of man w.r.t. ground

$\vec{V}_{WG}$ = velocity of current = 3 Km/hr.

a) Determine angle θ:

$$\vec{V}_{MG} = \vec{V}_{MW} + \vec{V}_{WG}$$



$$\sin\theta = \frac{V_{WG}}{V_{MW}}$$

$$\theta = \sin^{-1}\left(\frac{V_{WG}}{V_{MW}}\right)$$

$$\theta = \sin^{-1}\left(\frac{3}{5}\right)$$

$$\boxed{\theta = 36.9^\circ}$$

b) time to cross river:

need to calculate $\vec{V}_{MG}$, the velocity of the man w.r.t the ground.

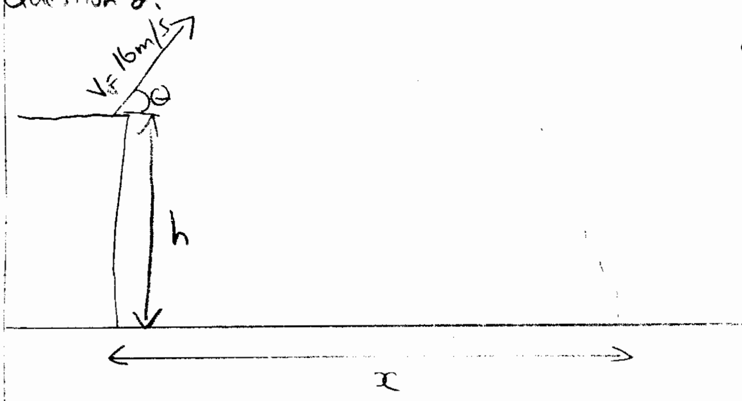
using pythagorous: $V_{MG} = \sqrt{V_{MW}^2 - V_{WG}^2} = \sqrt{5^2 - 3^2}$

$$V_{MG} = 4 \text{ Km/hr.}$$

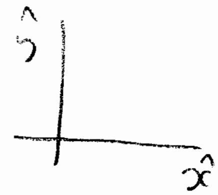
time to cross $= t = \frac{d}{v} = \frac{1.2 \text{ km}}{4 \text{ Km/hr}} = 0.3 \text{ hr.}$ $\boxed{t = 0.3 \text{ hr}}$

Assignment # 4.

Question 2.

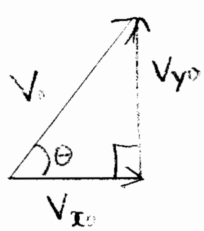


$\theta = 60^\circ$



time for ball to hit ground is 5s.

Breaking initial velocity into $\hat{x}$ & $\hat{y}$ components:



$V_{xo} = 16\cos 60^\circ = 8m/s$
$V_{yo} = 16\sin 60^\circ = 13.9m/s$

a) Determine the height of the building (h).

let the ground be $y = 0m$. $\therefore$ $y_i = h$, $y_f = 0$

$a = -g$ for the $\hat{y}$ component

$\Delta y = \frac{1}{2}at^2 + V_o t$

$t = 5s$.

$V_o = V_{yo} = 13.9m/s$

$\cancel{y_f}^{\,0} - y_i = -\frac{1}{2}gt^2 + V_{oy}t$

$-y_i = -\frac{1}{2}(9.8m/s^2)(5s)^2 + (13.9m/s)(5s)$

$y_i = 53m$

The height of the building is 53m

b) Find the horizontal distance x (range)

$\Delta x = \frac{1}{2} a_x t^2 + V_{0x} t$

$a_x = 0$
$V_{0x} = 8 m/s$

$x_f =$ range
$x_0 = 0 m.$

$x_f - x_0 = V_{0x} t$

$x_f = (8 m/s)(5 s)$

$x_f = 40 m$

The range (horizontal distance) is 40m.

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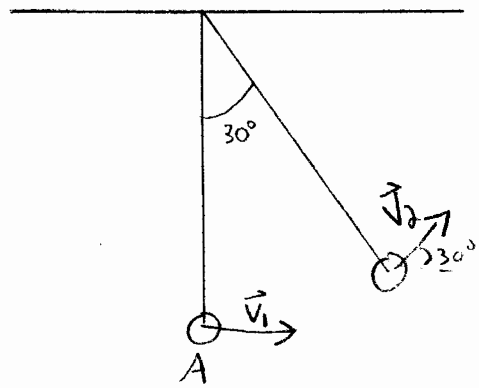
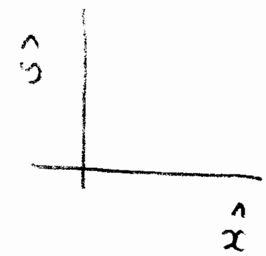
Question 3.

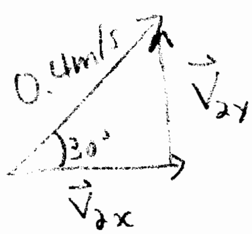
$\vec{V}_1 = 2\,m/s$

$\vec{V}_2 = 0.4\,m/s$ 30°





a) Find the horizontal component of the velocity @ B.



$$V_{2x} = (0.4\,m/s)(\cos 30^\circ) = 0.35\,m/s$$

$$V_{2y} = (0.4\,m/s)(\sin 30^\circ) = 0.2\,m/s$$

The horizontal velocity component @ B is 0.35 m/s

b) Find average acceleration:

$$\vec{a}_{av} = \frac{\Delta \vec{V}}{\Delta t}$$

Since acceleration is a vector we can deal with both components $\hat{x}$ & $\hat{y}$ seperately.

$$\vec{V}_1 = 2\,m/s\,\hat{x} + 0\hat{y}$$
$$\vec{V}_2 = 0.35\,m/s\,\hat{x} + 0.2\,m/s\,\hat{y}$$

$$\Delta V_x = V_{2x} - V_{1x}$$
$$= 0.35 - 2$$
$$\Delta V_x = -1.65\,m/s$$

$$a_{avx} = \frac{\Delta V_x}{\Delta t}$$

$$\Delta t = 0.5\,s$$

$$a_{avx} = \frac{-1.65\,m/s}{0.5\,s}$$

$$a_{avx} = -3.3\,m/s^2$$

now the y component.

$$\Delta V_y = V_{2y} - V_{1y}$$
$$= 0.2 - 0$$
$$\Delta V_y = 0.2\,m/s$$

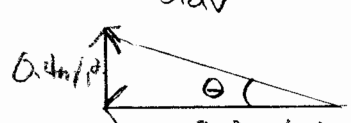
$$a_{avy} = \frac{\Delta V_y}{\Delta t}$$
$$= \frac{0.2\,m/s}{0.5\,s}$$

$$a_{avy} = 0.4\,m/s^2$$

summary:

$$a_{avx} = -3.3\,m/s^2$$
$$a_{avy} = 0.4\,m/s^2$$

$\vec{a}_{av}$



$$a_{av} = \sqrt{(0.4)^2 + (3.3)^2}$$

$$a_{av} = 3.32\,m/s^2$$

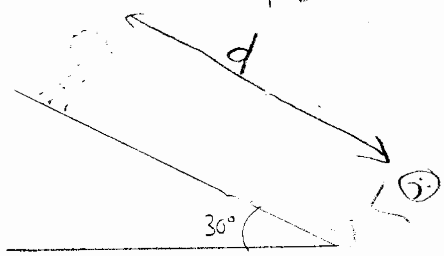
$$\theta = \tan^{-1}\left(\frac{0.4}{-3.3}\right)$$

$$\theta = 6.9^\circ$$

The average acceleration is $3.32\,m/s^2$ with a direction

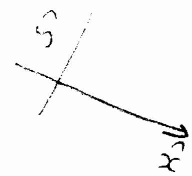
$\theta = 6.9^\circ$.

Question 4. Knight page 100 question 18



$d = 10\,m$

set up coordinate system:



given:

$d = 10m$
$V_0 = 0\,m/s$
$a = g\sin 30° = 4.9\,m/s^2$

want V_f.

$$V_f^2 = V_0^2 + 2ad$$

$$V_f = \sqrt{2ad}$$

$$V_f = \sqrt{2(4.9\,m/s^2)(10m)}$$

$$V_f = 9.9\,m/s$$

Santa's speed is 9.9 m/s as he leaves the roof.

Question 5. Knight page 101, question 34.

An old LP record rotates $33\frac{1}{3}$ rpm (rotations per minute).

a) find frequency in rev/s $\left(\frac{\text{revolutions}}{\text{second}}\right)$

$$\left(\frac{33\frac{1}{3}\text{ rot}}{1\text{ min}}\right)\left(\frac{1\text{ min}}{60\text{ s}}\right) = 0.55\text{ rev/s}$$

$$\boxed{f = 0.55\text{ rev/s}}$$

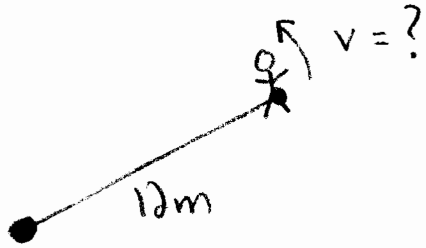
b) Find the period (T) in seconds.

$$T = 1/f$$

$$T = 1/0.55$$

$$\boxed{T = 1.8\text{ s}}$$

Question 6. Knight page 101 # 36.



$10g = 98 m/s^2$

What is the speed v in order to obtain a centripetal acceleration of 10g?

$$a = \frac{v^2}{r}$$

$$v = \sqrt{ar}$$

$$v = \sqrt{(98 m/s^2)(12 m)}$$

$$\boxed{v = 34.3 m/s}$$

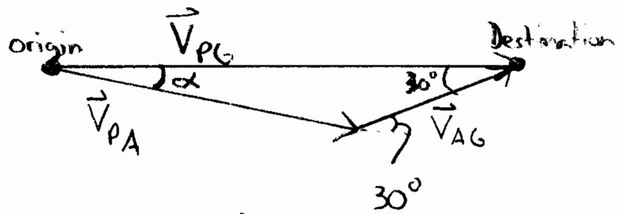
The speed of the rider has to be 34.3 m/s.

Question 7. Knight page 103 #60.

Plane has airspeed of 200mph, wind is blowing @ 50mph 30° north of east.

The pilot's destination is 600 miles east.

$V_{PA} = 200$ mph
$V_{AG} = 50$ mph



$\vec{V}_{PA}$ = plane's velocity w.r.t. air
$\vec{V}_{AG}$ = wind velocity
$\vec{V}_{PG}$ = plane's velocity w.r.t ground

$$\vec{V}_{PG} = \vec{V}_{PA} + \vec{V}_{AG}$$

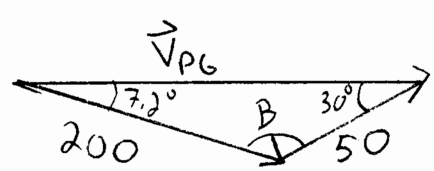
a) find plane's direction (α)

using sine law: $\dfrac{\sin(30°)}{V_{PA}} = \dfrac{\sin(\alpha)}{V_{AG}}$

$$\alpha = \sin^{-1}\left(\frac{V_{AG}}{V_{PA}}\sin 30°\right) = \sin^{-1}\left(\frac{50}{200}\sin 30°\right)$$

$\alpha = 7.2°$. Therefore the pilot has to fly 7.2° South of east.

b) trip duration?



$\beta = 180 - 30 - 7.2°$
$\beta = 142.8°$

V_{PG} using sine law.

$$\frac{\sin(142.8°)}{V_{PG}} = \frac{\sin(30)}{200}$$

$$V_{PG} = \frac{200 \sin(142.8°)}{\sin 30} = 241.8\text{mph}$$

now obtaining the trip time:

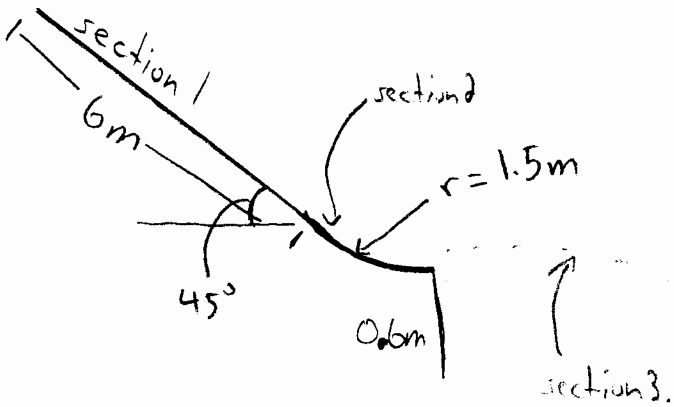
$$t = \frac{d}{v}$$

$$t = \frac{600\text{ miles}}{241.8\text{ mph}}$$

$t = 2.48$ hrs.

The trip takes 2.46 hrs.

Question 8. Knight page 104.



75) speed @ the end of section 1:

$V_0 = 0$
$V_f = ?$
$a = g\sin 45°$
$a = 6.93 m/s^2$
$d = 6m$

$$V_f^2 = V_0^2 + 2ad$$

$$V_f = \sqrt{2(6.93 m/s^2)(6m)}$$

$$V_f = 9.12 m/s^2$$

$V_f = 9 m/s^2$ Answer C.

76) the acceleration is section 2 is a centripetal acceleration.

$$a_c = \frac{v^2}{r}$$

Therefore increasing the radius of the circular segment is the only ~~given~~ option to reduce the acceleration.

Answer B

77)

This is a straight ahead parabolic motion problem. Looking @ the $\hat{y}$ component only:

$V_i = 0$ No vertical initial velocity.

$V_f = ?$

$a = -9.8 m/s^2$

$d = \Delta y = -0.6m$

$$V_f^2 = V_0^2 + 2ad$$

$$V_f = \sqrt{2(-9.8m/s^2)(-0.6m)}$$

$$\boxed{V_f = 3.4 \ m/s}$$

Answer B.

78) Re design the slide so that one lands twice as far from the slide. What is the new h?

i) old range:

time to hit ground from y component.

$$a_{av} = \frac{\Delta V}{\Delta t}$$

$$\Delta t = \frac{\Delta V}{a_{av}} = \frac{3.4m/s}{9.8m/s^2}$$

$$\Delta t = 0.35 \ s$$

D

In order to get twice the range the fall time has to be doubled.

New time:

$$2(0.35s) = 0.7s.$$

The new height therefore is:

$$\Delta y = \tfrac{1}{2}at^2 + V_0t$$

y comp $V_0 = 0$
$a = -9.81\,m/s^2$
$t = 0.7s.$

$$\Delta y = -\tfrac{1}{2}(9.8\,m/s^2)(0.7)^2$$

$$\Delta y = -2.4\,m$$

∴ the height would have to be changed to 2.4 m Answer C

79) What section has largest acceleration?

section 1: $6.93\,m/s^2$ $(g \sin 45^\circ)$

section 2: $a_c = \frac{v^2}{r} = \frac{9^2}{1.5} = 60.7\,m/s^2$

section 3: $9.8\,m/s^2$.

Therefore section 2 has the largest acceleration

Answer B.