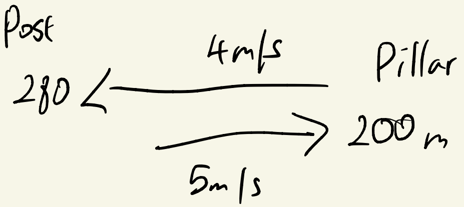
tutorial 1

#1



a) avg speed from pillar to post

$$\frac{200}{5} = 40s$$

$$\frac{280}{4} = 70s$$

$$\frac{480}{110} = 4.36 \, m/s$$

$$\approx 4.4 \, m/s$$

b) avg velocity from pillar to post

$$\frac{-80}{110} = -0.73 \, m/s$$

to the left/west

2

distance : $x(t) = 3t^2 - 0.11t^3$

a)

$$x(10) = 3(10)^2 - 0.11(10)^3$$

$$= 190$$

$$\frac{190}{10} = 19 \text{ m/s}$$

b)

velocity : $x'(t) = 6t - 0.33t^2$

at $t=0$, $v = 0$

at $t=5$, $v = 21.75$ m/s

≈ 22 m/s

at $t=10$, $v = 27$ m/s

c when $v=0$

$$6t - 0.33t^2 = 0$$

$$t(6 - 0.33t) = 0$$

$$t = 0 \quad \text{or} \quad t = 18.2s$$

#3

a) $x - x_0 = \frac{1}{2}(v_0 + v)t$

$66 = \frac{1}{2}(v_0 + 14.4)(6.7)$

$v_0 = 5.3 m/s$

b) $14.4 = 5.3 + a(6.7)$

$a = 1.36 m/s^2$

#4

a) $v = v_0 + at$

$73.14 = 0 + a(29 \times 10^{-3})$

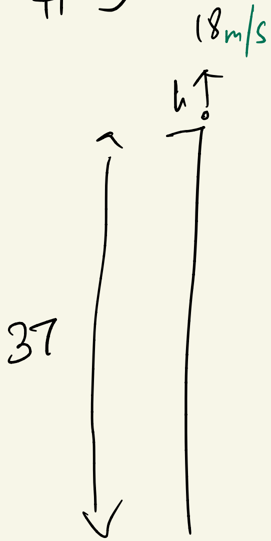
$a = 2522 m/s^2$

b) $v^2 = v_0^2 + 2a(x - x_0)$

$73.14^2 = 0 + 2(2522)(x)$

$x = 1.06 m$

#5



a) $v^2 = v_0^2 + 2a(x - x_0)$

$$18^2 = 2(9.81)(h)$$

$$h = 16.51$$

$$h_{total} = 37 + 16.51$$

$$= 53.51$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$v = \sqrt{0 + 2(9.81)(-53.51)}$$

$$= -32.4 \, m/s$$

b)

$$-53.51 = \frac{1}{2}(0 + (-32.4))t$$

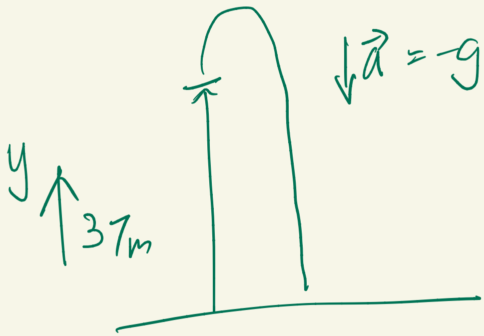
$$t_{down} = 3.3$$

$$18 = 0 + (9.81)(t)$$

$$t_{upwards} = 1.83$$

$$t_{total} \approx 5.14 s$$

#5



$\downarrow \vec{a} = -g\hat{j}$

Defining y-axis to point up

$$v^2 = v_0^2 + 2a(y - y_0)$$

$v_0 = 18\text{ m/s}$

$v = ?$

initial $y_0 = 37$

final $y_0 = 0$

$a = -g = -9.8$

$$v^2 = 18^2 + 2(-9.8)(-37)$$

$$v = -32.4\text{ m/s}$$

32.4 m/s downwards

negtive $\Rightarrow$ downwards

$$v = v_0 + at$$

$$-32.4 = 18 + (-9.81)(t)$$

$$t \approx 5.14\text{s}$$

#6 a) Acceleration due to gravity of Mars : $g_m = 0.379$

Total time taken : 7.5s

time taken to reach highest point , $\frac{7.5}{2} = 3.75$

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$

$$x = 0 + 0 + \frac{1}{2}(0.379)(9.81)(3.75)^2$$

$$x_{height} = 26.1m$$

b)

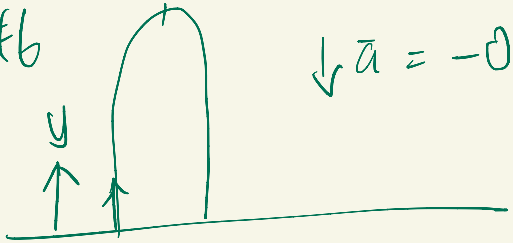
$$x - x_0 = \frac{1}{2}(v_0 + v)t$$

$$26.1 = \frac{1}{2}(0 + v)(3.75)$$

$$v = 13.92$$

$$\approx 13.9 m/s$$

#6



$\downarrow \bar{a} = -0.379 g \hat{j}$

At max point, $v=0$

Total time $= 7.5s \Rightarrow$ time to reach max height,

$$t = \frac{7.5}{2}$$

$$v_0 = ?$$

$$v = v_0 + at$$

$$v_0 = -at = 0.379 \times 9.8 \times \frac{7.5}{2}$$

b) $v_0 = 13.9 m/s$

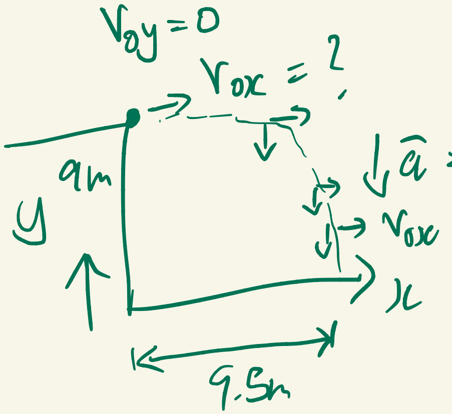
a) at the max point

$$y = y_0 + v_0 t + \frac{1}{2}at^2$$

$$= 0 + (13.9 \times 3.75 + \frac{1}{2}(-0.379 \times 9.81) \times (3.75)^2$$

$$= 26$$

7



$\hat{a} = -9.81\hat{j}$

$y_0 = 9m$

$y = 0m$

$V_{0y} = 0$

$V_{0x} = ?$

first find total time

$$y = y_0 + V_{0y}t + \frac{1}{2}at^2$$

$$0 = 9 + 0 + \frac{1}{2}(-9.8)t^2$$

$$t = 1.355s$$

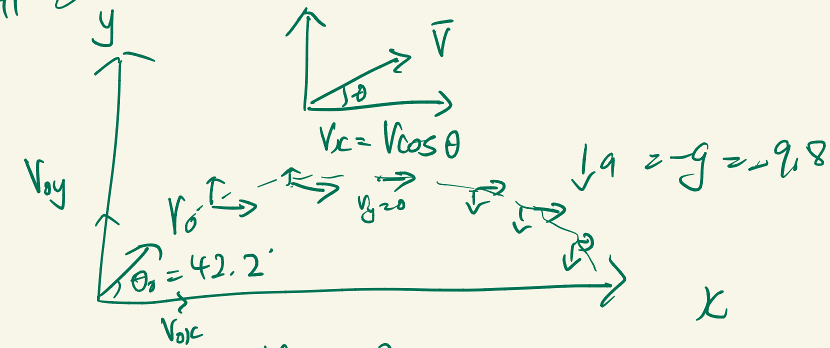
Using the time of height

$$V_{0x} = \frac{\text{distance in } x}{\text{time of flight}} = \frac{9.5}{1.355}$$

$$= 7m/s$$

$= v\cos(90 - \theta)$

#8



$$V_{0x} = V_0 \cos\theta_0$$

$$V_{0y} = V_0 \sin\theta_0$$

a) max height $\quad V_y = 0$

$$V_y^2 = V_{y0}^2 = 2a_y(y - y_0)$$

$$0 = V_0^2 \sin^2\theta_0 + 2(-g)(y_{max})$$

$$y_{max} = \frac{V_0^2 \sin^2\theta_0}{2g} = 50m$$

b) Total time :
or
time of flight

$$y = y_0 + V_{y0} t + \frac{1}{2} a_y t^2$$

$$0 = 0 + V_0 \sin\theta_0 t - \frac{1}{2} g t^2$$

$$\Rightarrow t = 0 \text{ or } 6.39s$$

c) horizontal range

$$v_{0x} \times t = v_0 \cos\theta_0 \times 6.39$$

$$= 221 m$$

horizontal range : $v_{0x} (t_{end} - t_{start})$

d) At $t = 1.5s$ $v_x = v_{0x} = v_0 \cos\theta_0$

$v_y = ?$ $v_y = v_{0y} + a_y t$

$$= v_0 \sin\theta_0 - gt$$

$$v = \sqrt{v_x^2 + v_y^2}$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$

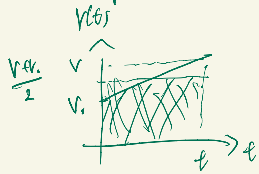
Notes

$$v = v_0 + at$$

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$x - x_0 = \frac{1}{2}(v_0 + v)t$$

$$v^2 = v_0^2 + 2a(x - x_0)$$



$$v = \frac{dx}{dt}$$

$$x = \int_{t=0}^{t} v(t)\, dt$$

$$= \text{area} = \frac{1}{2}(v + v_0 t)$$