Projectile Motion

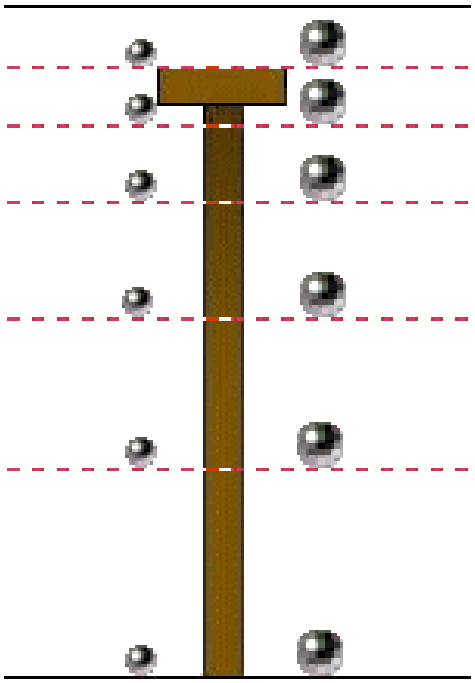
Independance of Motion in Two Dimensions

Projectile motion has motion in two dimensions (planes).

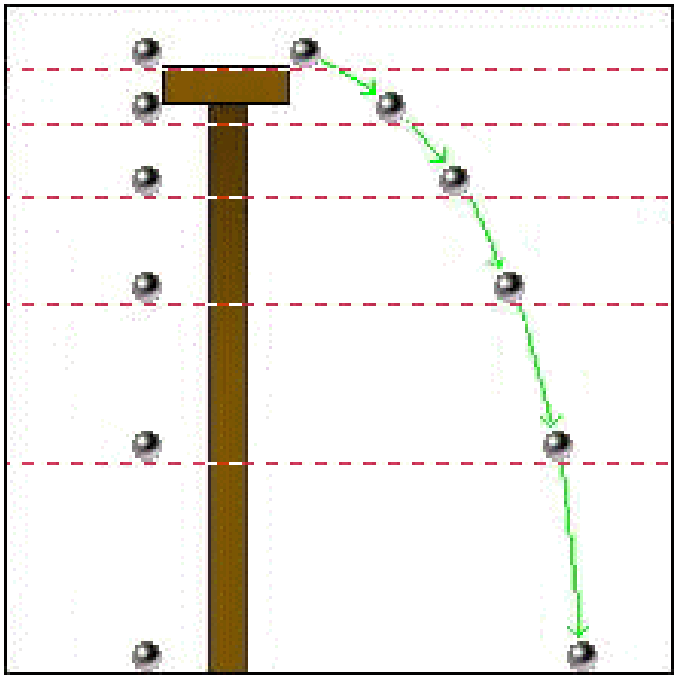
There is motion in the vertical and horizontal at the same time

Because the planes are perpendicular to each other they have ***no effect*** of each other.

Motion in the "x" does not effect motion in the "y"



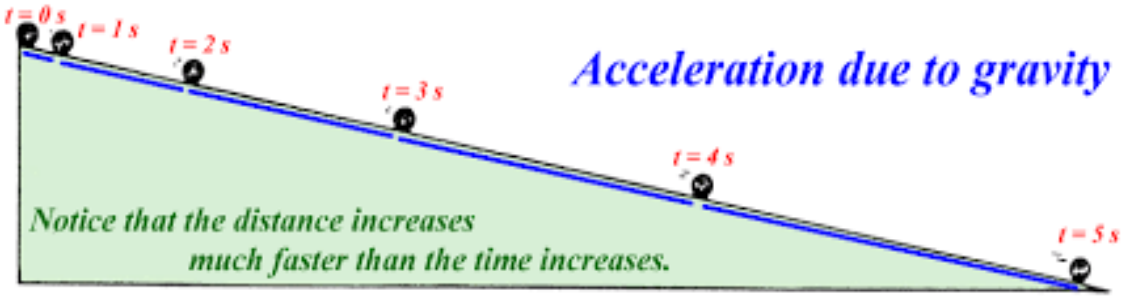
mass doesn't affect acceleration in the "y"



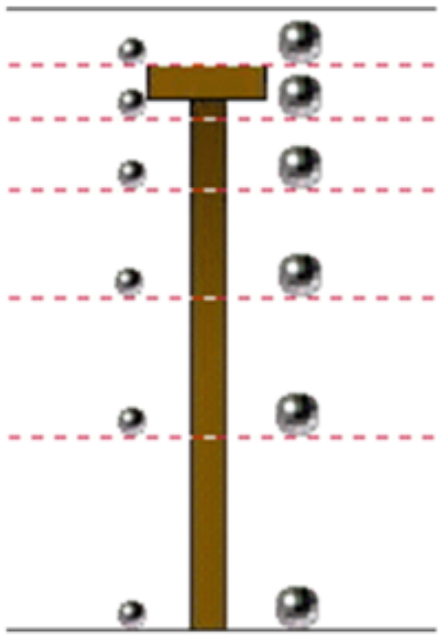
motion in the "x" axis doesn't affect acceleration in the "y"

how is the ramp the same/different?

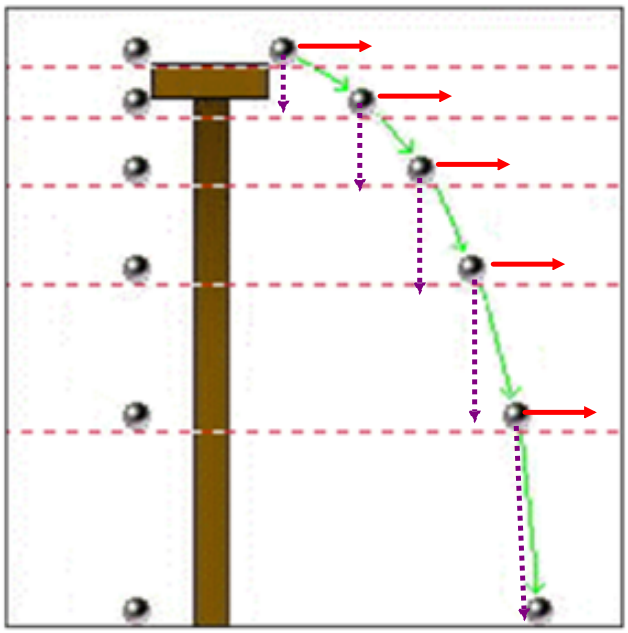
http://library.thinkquest.org/2779/



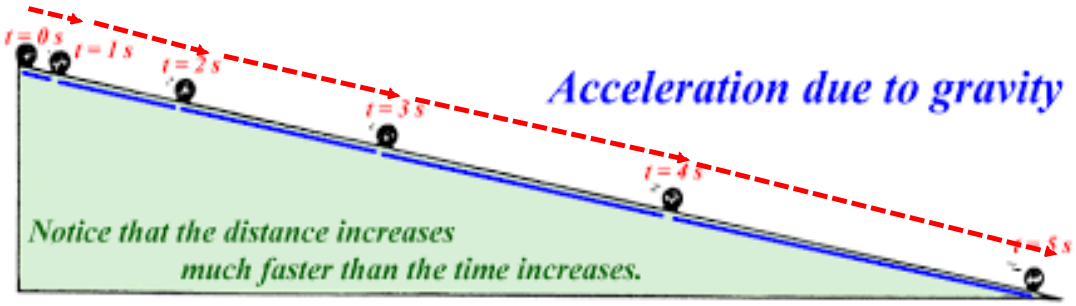
note that v_x is constant and v_y starts from rest and increases

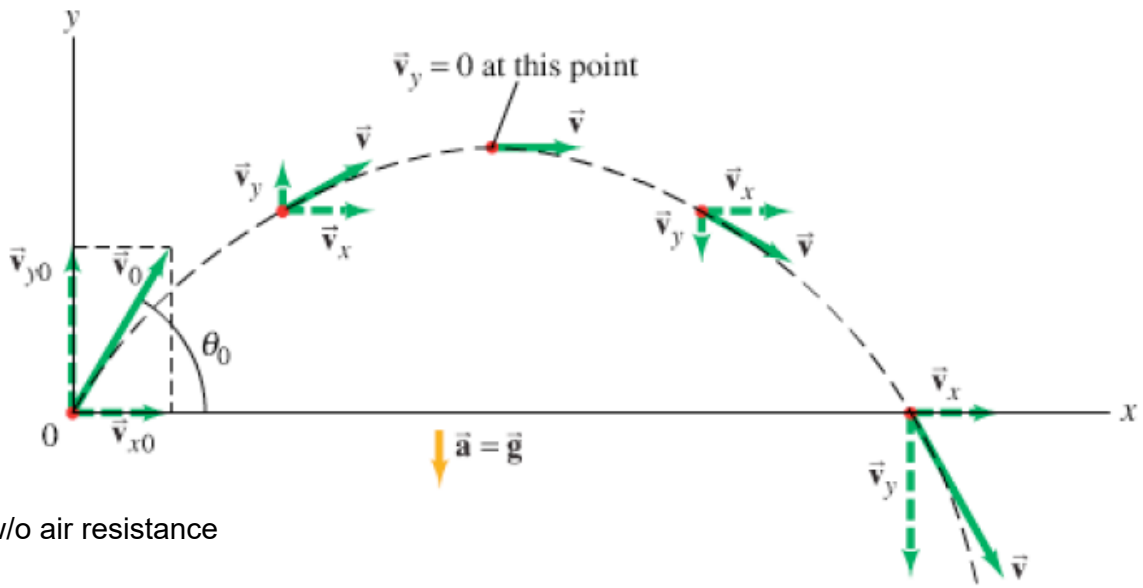


mass doesn't affect acceleration in the "y"



motion in the "x" axis doesn't affect acceleration in the "y"





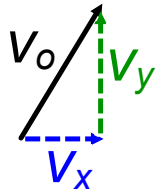
w/o air resistance

Really?

https://www.youtube.com/watch?v=0G7083ezHOQ

Note how the "y" vector (acceleration) decreases to zero as it goes up and then increases to max as it goes down

Note how the "x" vector (velocity) stays the same the entire path (v_c)



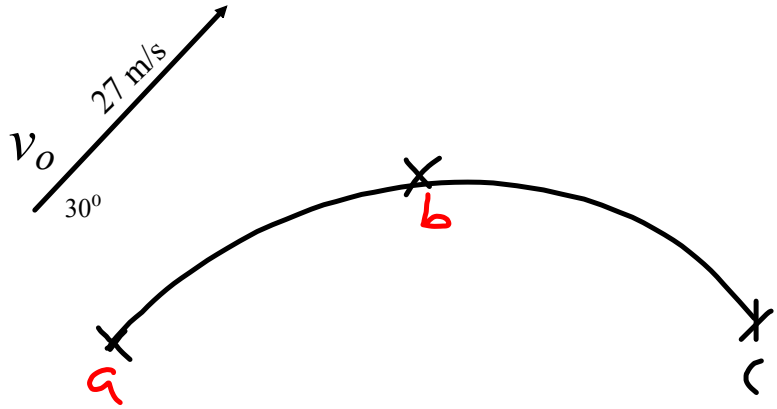
$v_x = \cos\theta(v_o) =$ _____ m/s

$v_y = \sin\theta\ (v_o) =$ _____ m/s

.

A 755 g soccer ball is kicked and leaves the foot at 27.0 m/s at 30.0^0 from the horizontal. a) How long is it in the air? b) How far does it go? c) How high does it go?

data?



A 755 g soccer ball is kicked and leaves the foot at 27.0 m/s at 30.0^0 from the horizontal. a) How long is it in the air? b) How far does it go? c) How high does it go?

$m = 0.755$ kg

-7.41 N

$a_y = -9.81$ m/s^2

$a_x = 0$

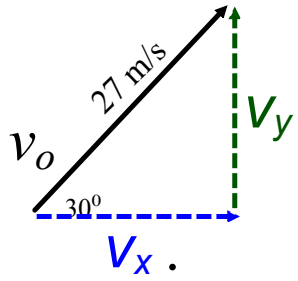
$v_o = 27.0$ m/s

$\theta = 30.0^0$

a) $t = ?$

b) $d_x = ?$

c) $d_y = ?$



PM?

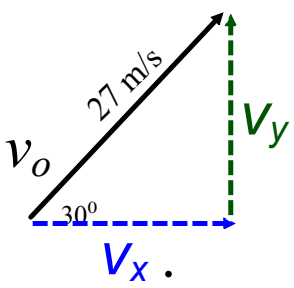
TM?

Sys.?

Env.?

A 755 g soccer ball is kicked and leaves the foot at 27.0 m/s at 30.0^0 from the horizontal. a) How long is it in the air? b) How far does it go? c) How high does it go?

$m = 0.755$ kg
$a_y = -9.81$ m/s^2
$a_x = 0$
$v_o = 27.0$ m/s
$\theta = 30.0^0$
a) t = ?
b) d_x = ?
c) d_y = ?



PM → X, Y

TM → X-v_c, Y-accel

Sys. ball

Env. earth -F_w

∴ only force in "Y"

$v_o = 27.0$ m/s

$\theta = 30.0^0$

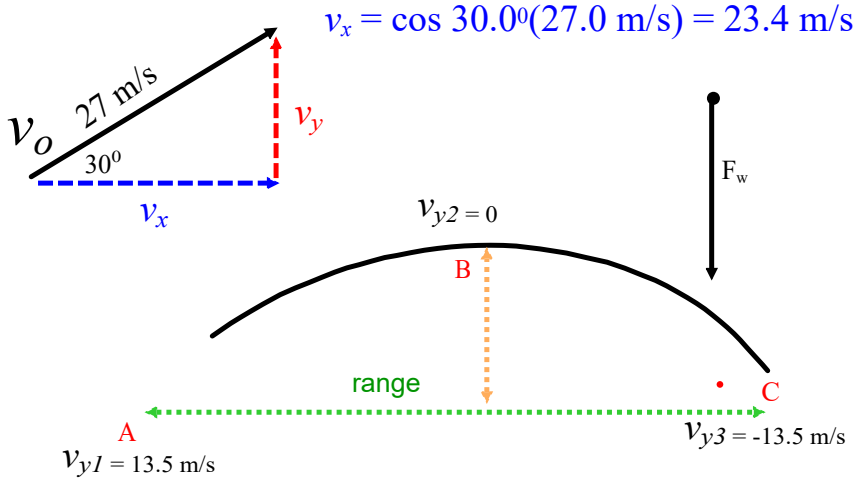
a) t = ?

b) d_x = ?

c) d_y = ?

$v_y = \sin 30.0^0(27.0 \text{ m/s}) = 13.5$ m/s

$v_x = \cos 30.0^0(27.0 \text{ m/s}) = 23.4$ m/s



time in air is from A to C

how high is A to B, ∴ 1/2 the time

$y_1 = y_3$

ll (x)	⊥ (y)
no force ΣF = 0	gravity ∴ ΣF = ma
∴ v_c	∴ a
$v_x = 23.4$ m/s	$v_{y1} = 13.5$ m/s
d_x = ?	a = g = -9.81 m/s^2
$v_x = d_x/t$	$v_{y2} = 0$ (top)
$d_x = v_c t$	$v_{y3} = -13.5$ m/s (end)
$d_x = 23.4$ m/s (t)	*could solve for "t" or "d"*
$d_x = 23.4$ m/s x 2.75 s	d_y = ?
$d_x = 64.4$ m	t = ?
	$t_t = v_{y3} - v_{y1}/a$

∴ a

ΣF = ma

vad

vat

dvt

dat

$d_y = v_{y2}^2 - v_{y1}^2/2a$

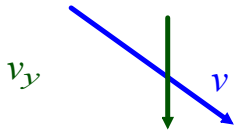
$d_y = [0 - (13.5 \text{ m/s})^2]/[2(-9.81 \text{ m/s}^2)]$

$d_y = 9.30$ m to the top of the arch

$t = [-13.5 \text{ m/s} - (13.5 \text{ m/s})]/(-9.81 \text{ m/s}^2)$

t = 2.75 s is total time in air

v_{ox} =1.3 m/s
b) d_y = 92 cm
c) d_x = ?

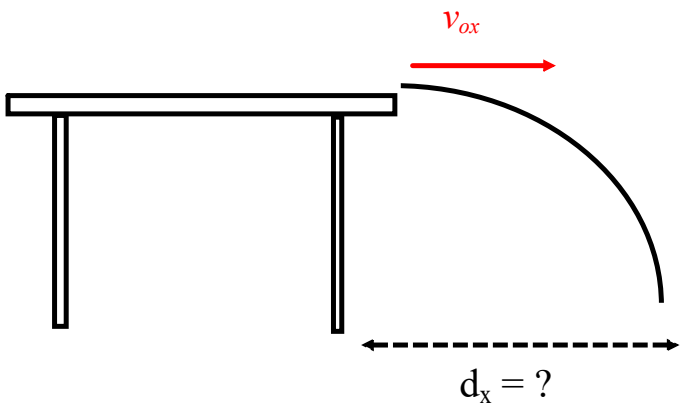


PM?

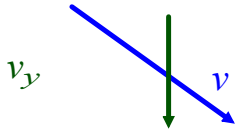
TM?

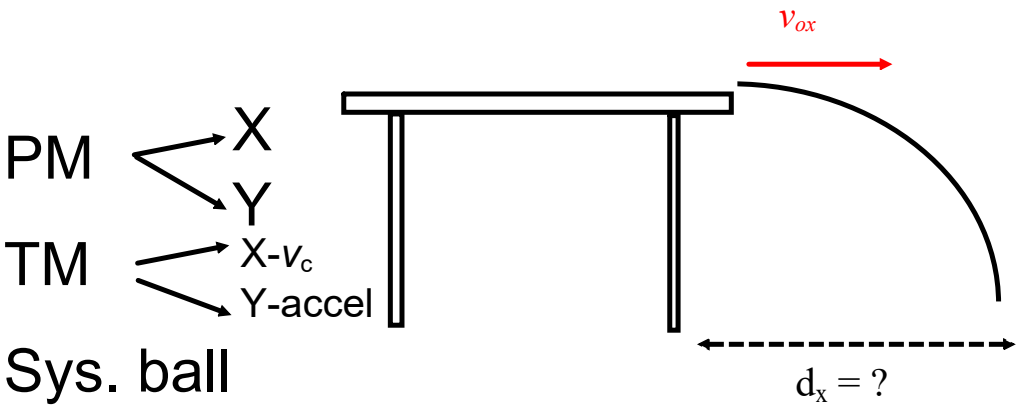
Sys.?

Env.?



v_{ox} =1.3 m/s
b) d_y = 92 cm
c) d_x = ?





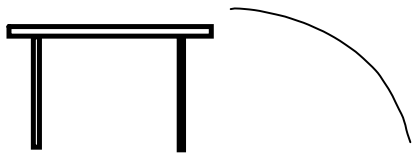
PM → X, Y

TM → X-v_c, Y-accel

Sys. ball

Env. earth -F_w

v_{ox} =1.3 m/s
b) d_y = 92 cm
c) d_x = ?



X

const. vel
$\Sigma F = 0$
v_{ox} =1.3 m/s

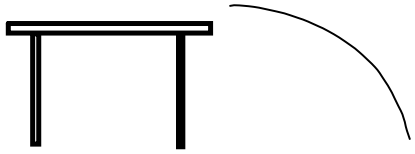
d_x = ?
$v_c = d_x/t$
$d_x = v_c(t)$
d_x = 1.3 m/s(.43 s)
d_x = .56 m

Y

accel
force of gravity ∴ $\Sigma F = ma$

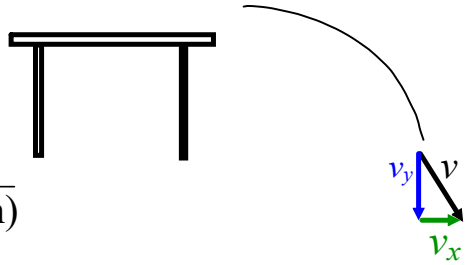
$v_{y1} = 0$
d_y = -92 cm
a_y = -9.8 m/s^2
t = ?
$d = 1/2\ at^2$
$t = \sqrt{2d/a}$ *time in air*
$t = \sqrt{[2(-.92m)]/-9.8\ m/s^2}$
t = .43 s

v_{ox} =1.3 m/s
b) d_y = 92 cm
c) d_x = ?

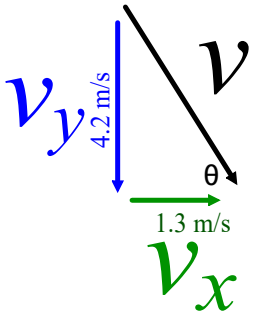


What angle did the little car hit the ground at? .... what velocity?

v_{y1} = 0
v_{y2} = ?
a = -9.8 m/s^2
d = -0.92 m



$v_{y2} = \sqrt{2(-9.8\ m/s^2)(-0.92\ m)}$
v_{y2} = -4.2 m/s



Tan θ = (4.2 m/s)/1.3 m/s
θ = 73^0 above the horizontal

$v_o = \sqrt{(4.2\ m/s)^2 + (1.3\ m/s)^2}$
v_o = 4.4 m/s at 73^0 above the horizontal

- Junior's car is traveling at 65 mph and he drops a test object from 1.7 m above the ground. How far from the drop point does the test object hit the ground?

$v_x = 65$ mph
$\hookrightarrow 29$ m/s
$d_y = -1.7$ m
d_x ?

PM?

TM?

Sys.?

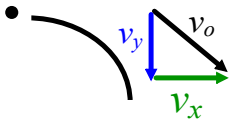
Env.?

- Junior's car is traveling at 65 mph and he drops a test object from 1.7 m above the ground. How far from the drop point does the test object hit the ground?

$v_x = 65$ mph
↳ 29 m/s
$d_y = -1.7$ m
d_x ?

PM → X, Y
TM → X-v_c, Y-accel
Sys. ball
Env. earth -F_w

Junior's car is traveling at 65 mph and he drops a test object from 1.7 m above the ground. How far from the drop point does the test object hit the ground?



- $v_x = 65$ mph
  $\hookrightarrow 29$ m/s
  $d_y = -1.7$ m
  d_x ?

X

const. vel

$\Sigma F = 0$

$v_{ox} = 1.3$ m/s

$d_x = ?$

$v_c = d_x/t$

$d_x = v_c(t)$

$d_x = 29$ m/s(.59 s)

$d_x = 17$ m

Y

accel

force of gravity $\therefore \Sigma F = ma$

$d_y = -1.7$ cm

$a_y = -9.8$ m/s^2

$t = ?$

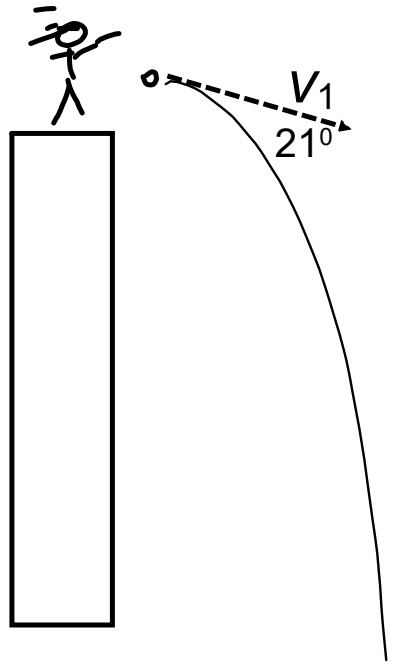
$d = 1/2\ at^2$

$t = \sqrt{2d/a}$

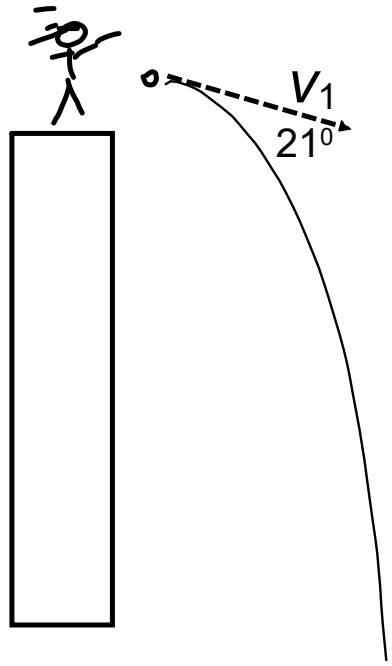
$t = \sqrt{[2(-1.7\text{m})]/-9.8\ \text{m/s}^2}$

$t = .59$ s

A 65 g rock is *thrown downward* at 35 m/s at an angle of 21^0 below the horizontal. How far does it travel if it is thrown from a 20. m cliff?



A 65 g rock is *thrown downward* at 35 m/s at an angle of 21^0 below the horizontal. How far does it travel if it is thrown from a 20. m cliff?



m_o = 65 g

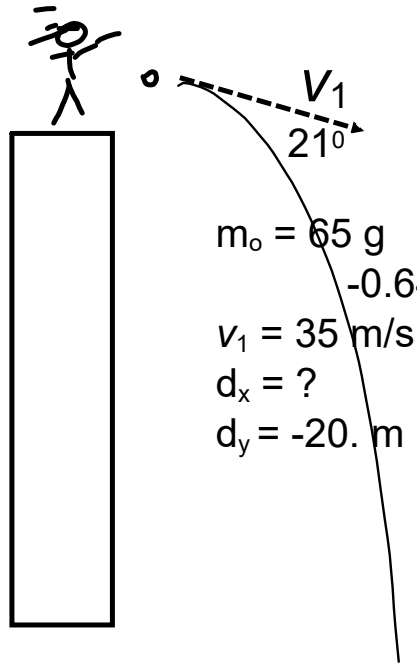
-0.64 N

v_1 = 35 m/s at 21^0 downward

d_x = ?

d_y = -20. m

A 65 g rock is *thrown downward* at 35 m/s at an angle of 21^0 below the horizontal. How far does it travel if it is thrown from a 20. m cliff?



m_o = 65 g
-0.64 N
v_1 = 35 m/s at 21^0 downward
d_x = ?
d_y = -20. m

PM → X, Y
TM → X-v_c, Y-accel
Sys. ball
Env. earth -F_w

A 65 g rock is thrown downward at 35 m/s at an angle of 21^0 below the horizontal. How far does it travel if it is thrown from a 20. m cliff?

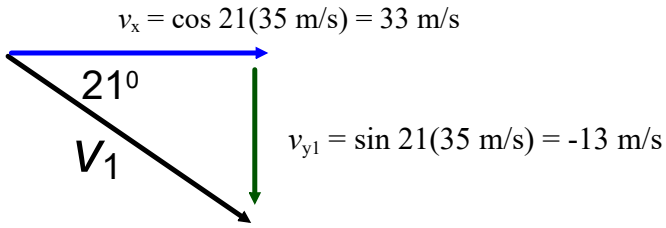
m_o = 65 g

-0.64 N

v_1 = 35 m/s at 21^0 downward

d_x = ?

d_y = -20. m



X

const. vel

ΣF = 0

v_{ox} =33 m/s

d_x = ?

$v_c = d_x/t$

$d_x = v_c(t)$

d_x = 33(t)

d_x = 33 m/s(.59 s)

d_x = 36 m

Y

accel

force of gravity ∴ $\Sigma F = ma$

d_y = -20. m

v_1 = -13 m/s

a_y = -9.8 m/s²

t = ?

would have the quadratic equation with "dat" so solve for v_2

v_2 ?

vad

$v_{y2} = \sqrt{(-13 \text{ m/s})^2 + 2(-9.8 \text{ m/s}^2)(-20 \text{ m})} = -24$ m/s

now "time"

$t = (v_{y2} - v_{y1})/a = [(-24 \text{ m/s} - (-13 \text{ m/s})]/-9.8 \text{ m/s}^2 = 1.1$ s

$d_x = v_x t = 33$ m/s(1.1 s) = 36. m