Projectile Motion

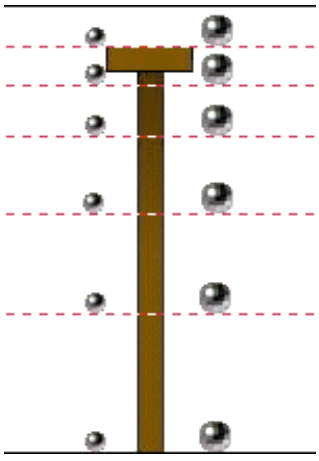
Independance of Motion in Two Dimensions

Projectile motion has motion in two dimensions (planes).

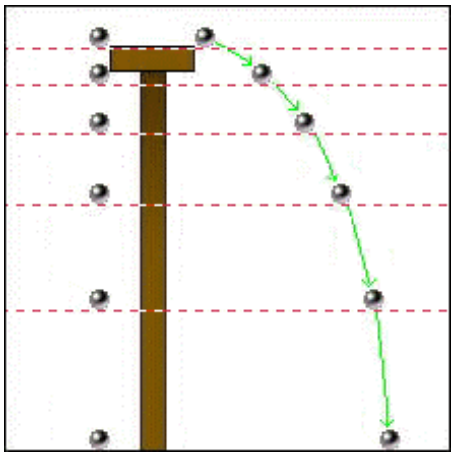
There is motion in the vertical and horizontal at the same time

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"

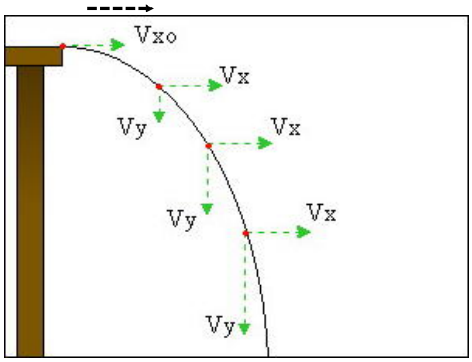


mass doesn't affect acceleration in the "y"

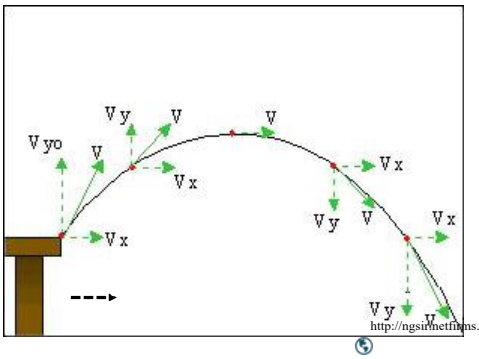


motion in the "x" axis doesn't affect acceleration in the "y"

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

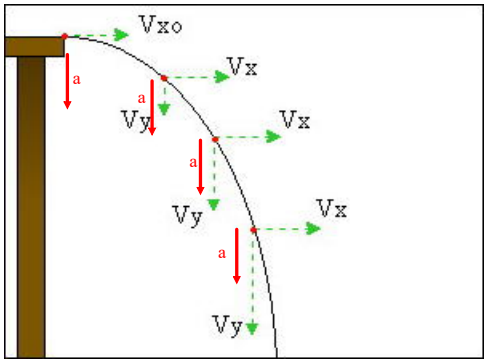


note that v_x is constant and v_y starts from rest and increases

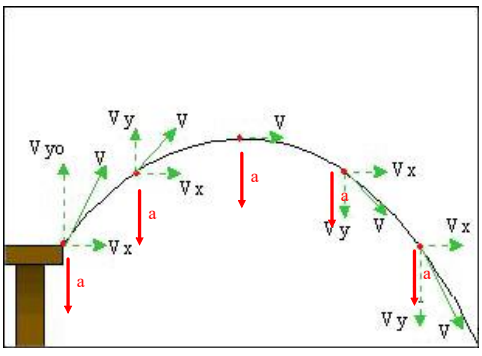


http://ngsir.netfirms.com/englishhtm/ThrowABall.htm

note that v_x is constant and v_y starts at max and decreases to zero and then increases to max



note that acceleration is constant (-9.8 m/s^2) in the "y" axis and "0" in the "x"



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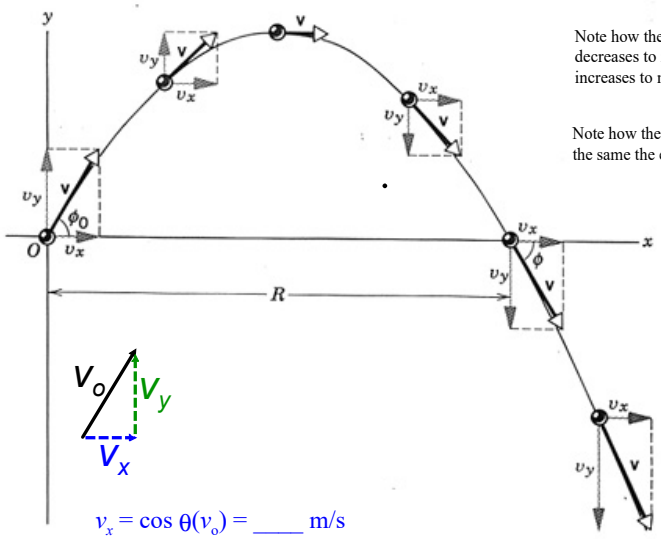
Really?

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

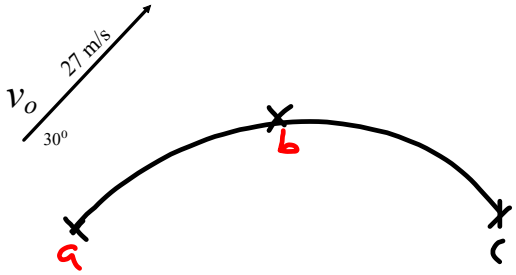
Note how the "x" vector (velocity) stays the same the entire path (v_x)

v_x = cos θ(v_o) = ____ m/s

v_y = sin θ (v_o) = ____ m/s

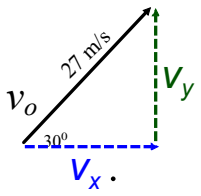
A 755 g soccer ball is kicked and leaves the foot at 27.0 m/s at 30.0^0 from the horizontal. a) How long is it in the air? b) How far does it go? c) How high does it go?

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.?

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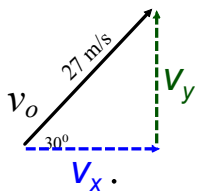


PM → X, Y

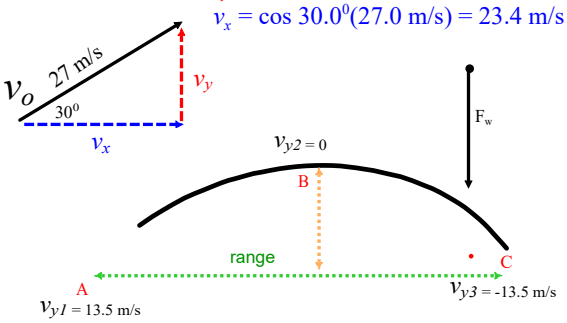
TM → X-v_c, Y-accel

Sys. ball

Env. earth -F_w

$v_o = 27.0$ 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

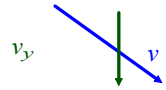
how high is A to B, ∴ 1/2 the time

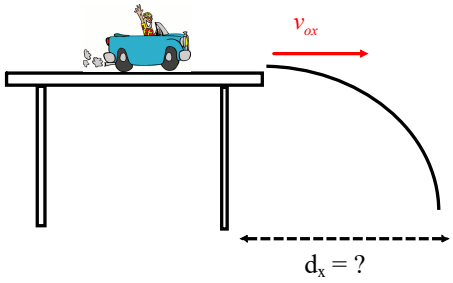
$y_1 = y_3$

ll (x)	⊥ (y)
no force $\Sigma F = 0$	gravity ∴ $\Sigma F = ma$
∴ 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	$t = ?$
	$t_t = v_{y3} - v_{y1}/a$
	$t = [-13.5 \text{ m/s} - (13.5 \text{ m/s})]/(-9.81 \text{ m/s}^2)$
	$t = 2.75$ s is total time in air

$d_y = v_{y2}^2 - v_{y1}^2/2a$
$d_y = [0 - (13.5 \text{ m/s})^2]/[2(-9.81 \text{ m/s}^2)]$
$d_y = 9.30$ m to the top of the arch

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





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TM?

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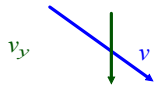

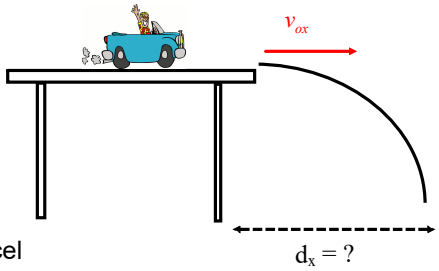

PM → X, Y

TM → X-v_c, Y-accel

Sys. ball

Env. earth -F_w

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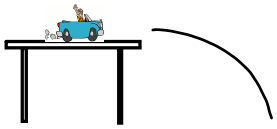


X

const. vel
ΣF = 0
v_{ox} =1.3 m/s

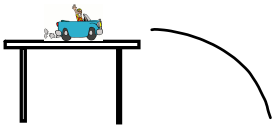
d_x = ?
$v_c = d_x/t$
$d_x = v_c(t)$
d_x = 1.3 m/s(.43 s)
d_x = .56 m

Y

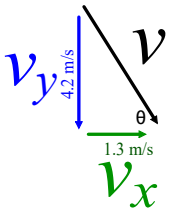
accel
force of gravity ∴ ΣF = ma

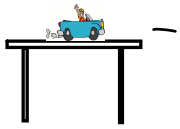
v_{y1} = 0
d_y = -92 cm
a_y = -9.8 m/s^2
t = ?
$d = 1/2\ at^2$
$t = \sqrt{2d/a}$ *time in air*
$t = \sqrt{[2(-.92m)]/-9.8\ m/s^2}$
t = .43 s

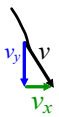
v_{ox} =1.3 m/s
b) d_y = 92 cm
c) d_x = ?



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