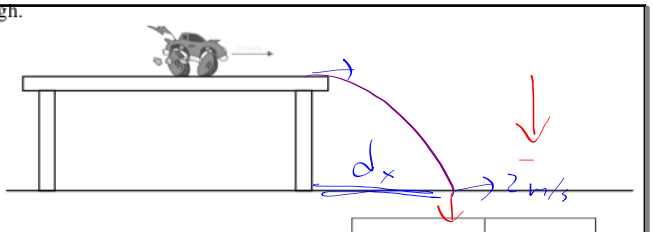
2. A toy car moving at 2.0 m/s runs off a table that is 1.3 m high.
Determine:

a) the time it takes for the car to hit the ground.



$$\vec{d}_y = \vec{v}_{0y}t + \frac{1}{2}\vec{a}_y t^2$$

$$t = \sqrt{\frac{2\vec{d}_y}{\vec{a}_y}} = \sqrt{\frac{2(-1.3\,m)}{(-9.8\,m/s^2)}} = 0.51\,s$$

	x	y
d	1.0 m	-1.3m
t	.51s	.51s
a	0	$-9.8\,m/s^2$
v_i	2 m/s	0
v_f	2 m/s	-5.0 m/s

b) how far from the table the toy car lands

$$\vec{d}_x = \vec{v}_{0x}t + \frac{1}{2}\vec{a}_x t^2$$

$$= (2.0\,m/s)(.51s) = 1.0\,m$$

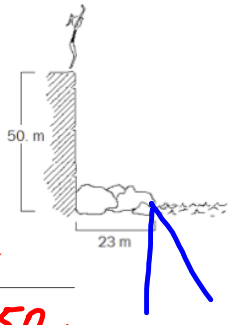
c) the impact speed of the car

$$\vec{v}_{fy} = \vec{v}_{0y} + \vec{a}t = -9.8\,m/s^2 \cdot 0.51s = -5.0\,m/s$$

$$v = \sqrt{v_{fx}^2 + v_{fy}^2} = \sqrt{(2\,m/s)^2 + (5.0\,m/s)^2} = 5.4\,m/s$$

3. Cliff divers jump from heights as high as 50 meters.
Suppose a diver wants to jump off a cliff that has rocks at the base that extend out for 23 m. Determine:

a) how long it will take to hit the water.



$$d_y = v_{0y}t + \frac{1}{2}at^2$$

$$t = \sqrt{2d_y/a_y} \quad 3.2s$$

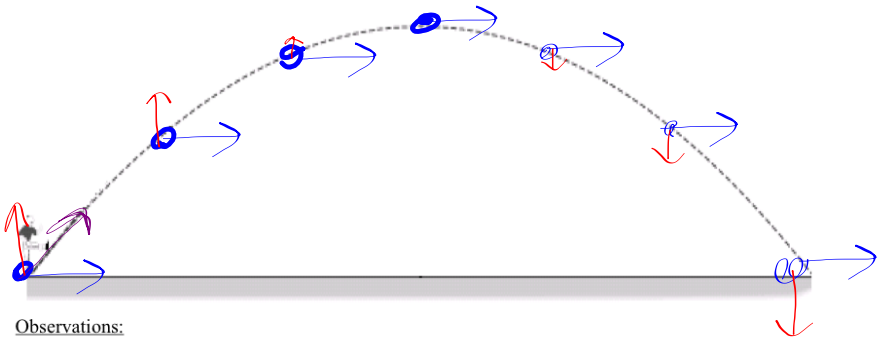
b) how fast the diver should run to clear the rocks below?

$$d_x = v_{0x}t + \frac{1}{2}a_x t^2 \quad 7.2\,m/s$$

	X	Y
d	23m	-50. m
V_0	.	0
V_f		
a	0	$-9.8\,m/s^2$
t		

Projectiles Launched at an Angle

The opening kick-off of a football game is shown below.

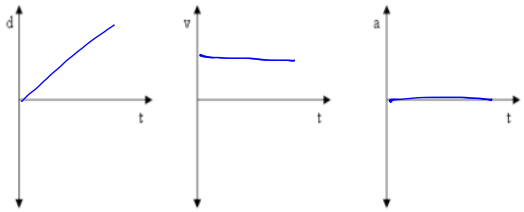


Observations:

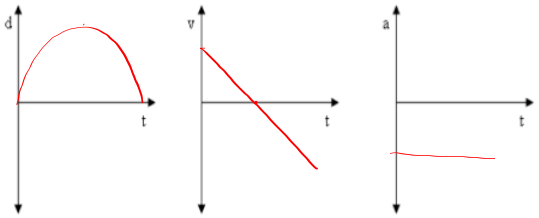
1. max height at $t_{1/2}$
2. range (d_x) at total time
3. break into X and Y components
4. const. velocity in X direction
5. const. accl in Y dir
6. at peak, $V_y = 0$

Sketch the graphs below for both the horizontal and the vertical component of the ball's motion.

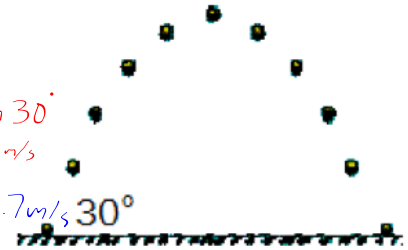
Horizontal Component



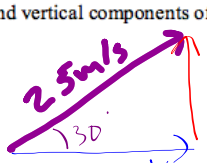
Vertical Component



1. A baseball was thrown with a speed of 25.0 m/s at an angle of 30.0°. Determine:



a) Horizontal and vertical components of the initial velocity



$V_{0y} = V_0 \sin\theta = 25\ m/s \cdot \sin 30^\circ = 12.5\ m/s$

$V_{0x} = V_0 \cos\theta = 25\ m/s \cdot \cos 30^\circ = 21.7\ m/s$

b) time taken to reach the top of its flight

at $t_{1/2}$ $V_{fy} = 0$ $\quad 2.54\ s / 2 = 1.27\ s$

	x	y
d		0
t	2.54 s	2.54 s
a	0	-9.8 m/s²
v_i	21.7 m/s	12.5 m/s
v_f	21.7 m/s	-12.5 m/s

c) total time before baseball lands

$d_y = v_{0y} t + \frac{1}{2} a_y t^2 \rightarrow 0 = v_{0y} + \frac{1}{2} a_y t$

$t = -v_0 / \frac{1}{2} a = \frac{-12.5\ m/s}{\frac{1}{2}(-9.8\ m/s)} = 2.54\ s$

d) how high the ball went

$t_{1/2}$ $\quad d_y = v_{0y} t + \frac{1}{2} a_y t^2 = 12.5\ m/s \cdot 1.27\ s + \frac{1}{2}(-9.8\ m/s^2)(1.27\ s)^2$

$= 7.91\ m$

e) how far away the ball landed

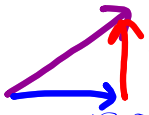
t

$d_x = v_{0x} t + \frac{1}{2} a_x t^2$

$= 21.7\ m/s \cdot 2.54\ s = 55.1\ m$

2. A cannon ball is shot at an angle of 65.0° with an initial speed of 330. m/s. Determine:

a) the components of its initial velocity



$V_{1y} = V_1 \sin\theta = 330\ m/s \cdot \sin 65^\circ$

$V_{0x} = V_0 \cos\theta = 330\ m/s \cdot \cos 65^\circ$

b) how long it took to land

(Y) $d = v_0 t + \frac{1}{2} a t^2$ $\quad 61\ s$

$(30.5\ s = t_{1/2})$

c) how far away it landed

(X) $d = v_0 t + \frac{1}{2} a t^2$ $\quad 8480\ m$

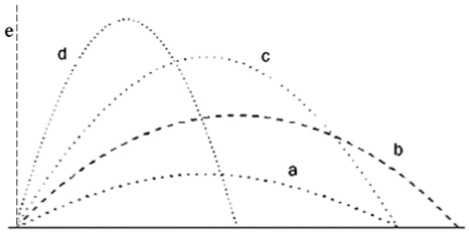
d) how high it went

(Y) $d = v_0 t + \frac{1}{2} a t^2$ $\quad 4560\ m$

$t_{1/2} = 30.5\ s$

	x	y
d		0
t		
a	0	-9.8 m/s²
V_0	139 m/s	299 m/s
V_f	139 m/s	-299 m/s

3. The diagram below shows the trajectories of five identical cannonballs all launched with the same speeds but at different launch angles measured from the horizontal.



Cannonball	Launch Angle
a	30^0
b	45^0
c	60^0
d	70^0
e	90^0

1. Which path shows the projectile having the
   a) largest angle of launch? e
   b) largest initial vertical component of velocity? e
   c) largest initial horizontal component of velocity? a

2. As the launch angle increases, what happens to the
   a) initial velocity? same
   b) the components of the initial velocity? x ↓ y ↑

3. At what launch angle will the components of the initial velocity be equal? 45°

4. What angle of launch will give the largest range? 45°

5. Which two projectiles have the same range? 30° 60°

6. What angle of launch will give the longest time in the air (flight time)? 90°

7. What angle of launch will make the cannonball go the highest? 90°