1

**(Dynamic)**

**Motion of a Projectile**

The free-flight motion of a projectile is often studied in terms of its rectangular components (x , y).

**Kinematic analysis:**

Projectile launched at point (xo, yo), with an initial velocity of vo.

Vo have components (vo)x and (vo)y as shown in Fig. 1 .



Figure 1

When air resistance is neglected, weight is only force acting on the projectile, causes the projectile to have a constant downward acceleration of approximately ac = g = 9.81 m/s2

**Horizontal Motion**: Apply constant acceleration equations:

ac= → Δv=ac t → v-vo= ac t → v=vo+ ac t

Horizontal component of velocity remains constant during motion.

**Vertical Motion**:

Positive y axis is directed upward, then ay = -g , we get:



Example 1:

The track for this racing event was designed so that riders jump off the slope at 30°, from a height of 1 m. During a race it was observed that the rider shown in Figure remained in midair for 1.5 s. Determine:

1. The speed of traveling off the ramp.
2. Horizontal distance before striking the ground.
3. Maximum height he attains.

Solution :

a) Vertical Motion



b) Horizontal Motion



c) (vc)y = 0

Example 2:

A ball is kicked from point A with the initial velocity v=10m/s. Determine :

(a) The maximum height h . (Ans. 1.28 m)  
(b) distance A point to C point . (Ans. 4.41 m)  
(c) The speed when the ball strikes the ground. (Ans. 8.66 m/s)

Solution :

Assume the ball is kicked at an angle θ to the horizontal, initial velocity components are:

vx​o=v cos(θ) =10 cos 30o= 8.66m/s

vy​o=v sin(θ)= 10 sin 30o = 5m/s

Maximum height (h) at point B , determine by using maximum time (tmax.):

y=yo+v0yt-gt2 ( y=h=maximum height) (t= tmax)

h=0+5 tmax - (9.81) (tmax)2……(1)

we find tmax. then substitute in eq. 1

vy=vyo+act (vy= 0 (في اعظم نقطة تكون المركبة العمودية = صفر

0=5-9.81 tmax → tmax=5/9.81≈0.51s substitute in eq. 1 → h=0+5\*(0.51)- (9.81) (0.51)2

h=1.28m

The distance A point to C point:  
xB=xA+vAx tAB → xBA= vAx tmax → xBA= 8.66m/s \* 0.51 ≈ 4.41m

The speed when the ball strikes the ground:  
The horizontal component of the velocity remains constant, and the speed when the ball strikes the ground is the same as the horizontal component of the initial velocity.

So, the speed = vAx≈8.66m