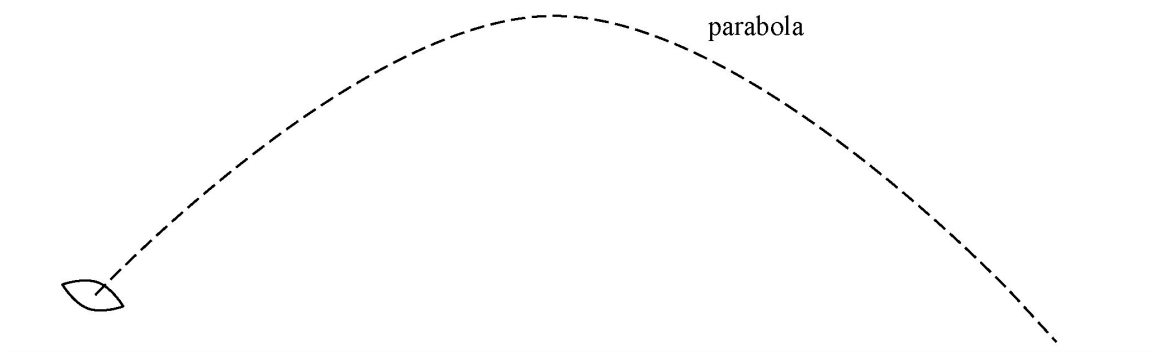


## PROJECTILE MOTION

The curved path of an airborne object is called a parabola.

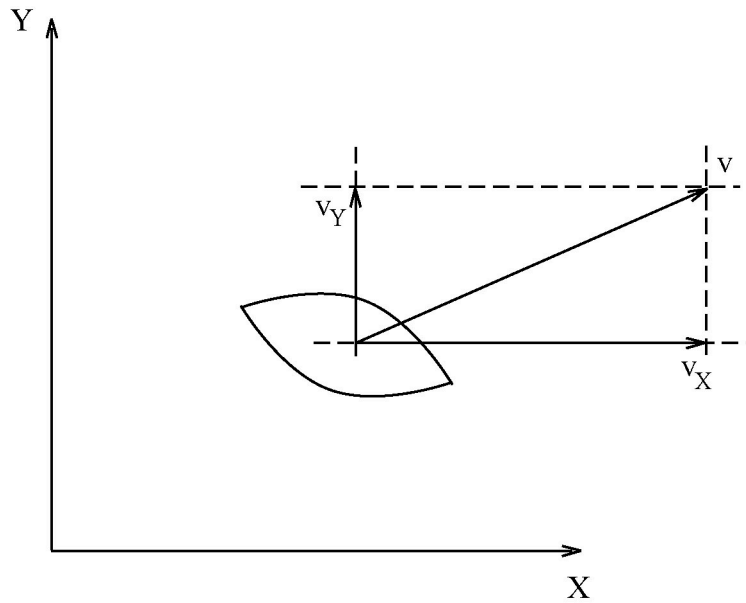


Need to study separately:

- the horizontal aspects of the projectile's motion
- the vertical aspects of the projectile's motion

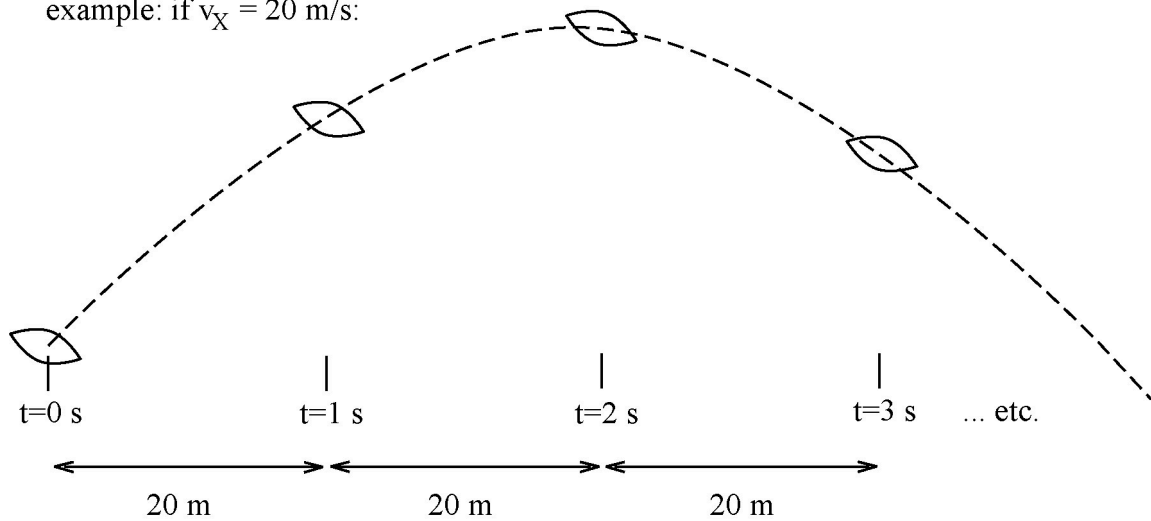
and then put the information together.

Break the initial resultant velocity vector into horizontal and vertical components:



Horizontal component of projectile motion: uniform motion (constant velocity)

example: if  $v_x = 20$  m/s:



Formula for horizontal location of a projectile at any time  $t$ :

$$S_X = S_{0X} + v_X \cdot t$$

where  $S_{0X}$  is the initial horizontal location

Vertical component of projectile motion: uniformly accelerated motion (constant acceleration of  $-9.81 \text{ m/s}^2$ )

$-9.81 \text{ m/s}^2$  = “gravitational acceleration”, or “g”

$$\text{time to peak} = \frac{v_Y \text{ at takeoff}}{9.81}$$

If landing height = takeoff height, then time to peak = time from peak to landing, and total time in the air =  $2 \cdot$  time to peak.

“Range” is how far a projectile lands from the takeoff point

$$\text{Range} = v_X \cdot \text{time in the air}$$

Formula for vertical location of a projectile at any time t:

$$S_Y = S_{0Y} + v_{0Y} \cdot t - 1/2 \cdot 9.81 \cdot t^2$$

where:

$S_{0Y}$  is the initial vertical location

and

$v_{0Y}$  is the initial vertical velocity

Some important conclusions about airborne motion:

- The path of a projectile is determined by its location and velocity at release.

There is no way to change the path after release.

- The larger the vertical velocity at release, the longer the time that the projectile will be in the air.

- The larger the vertical velocity at release, the higher the projectile will go.

- The larger the horizontal and vertical velocities at release, the larger the range of the projectile.

- The horizontal velocity at release has no influence on the time in the air nor on the height of the path.