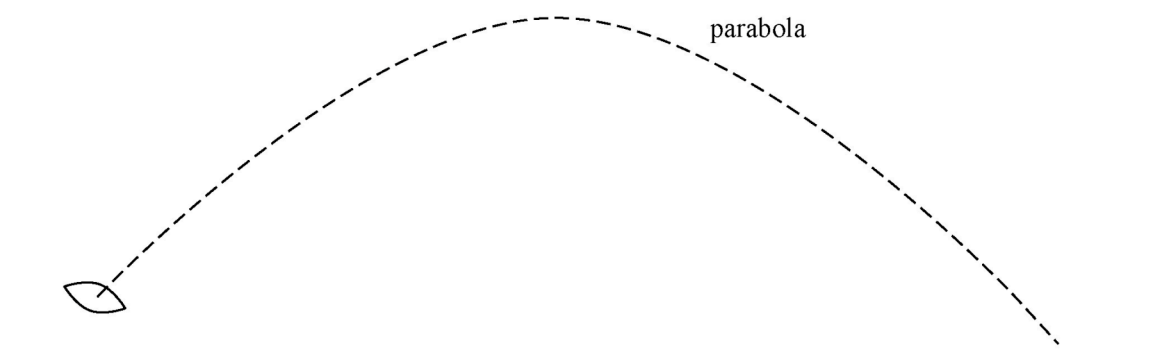


PROJECTILE MOTION

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

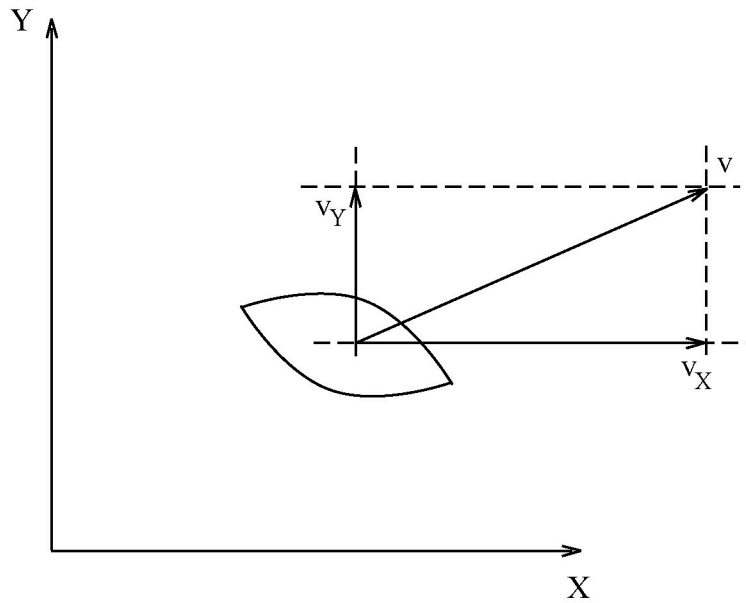


Need to study separately:

- 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)

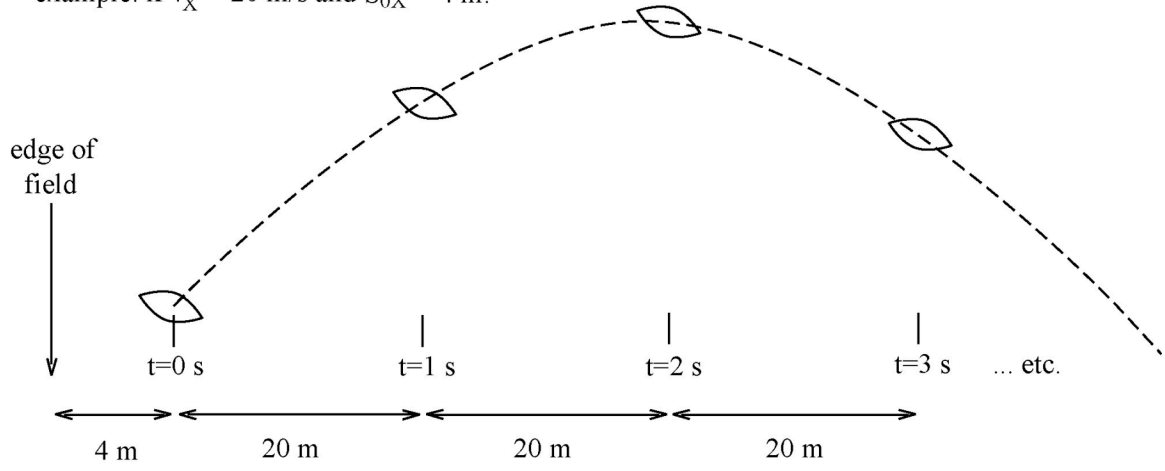
Equations:

$$S_x = S_{0x} + v_x \cdot t \quad [1]$$

$$v_x = \text{constant} \quad [2]$$

$$a_x = \text{zero} \quad [3]$$

example: if $v_x = 20$ m/s and $S_{0X} = 4$ m:



Vertical component of projectile motion:

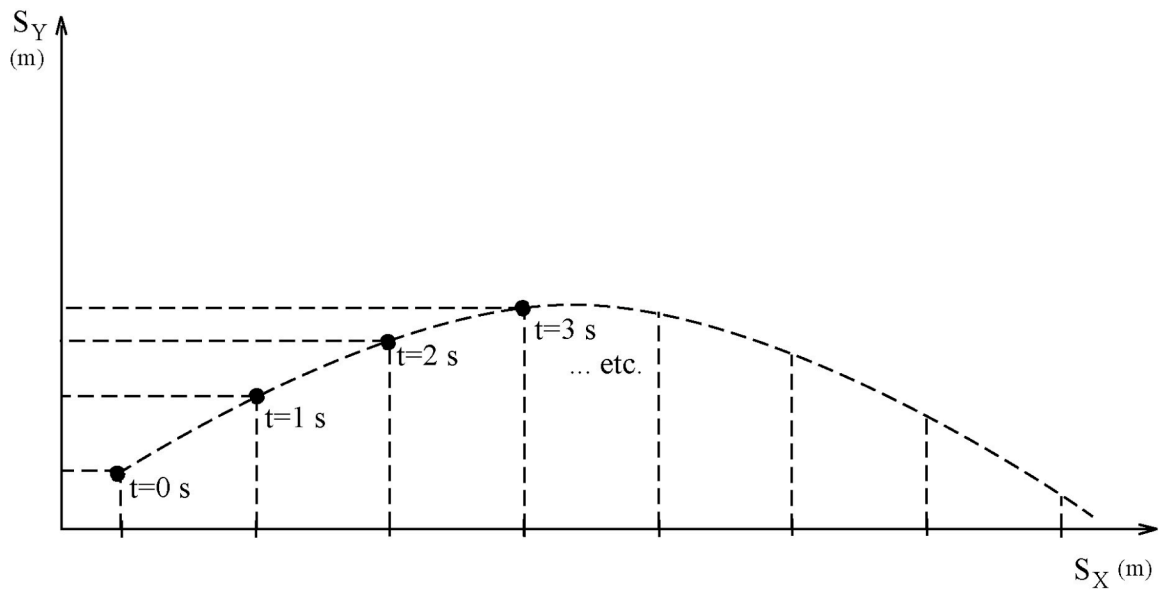
uniformly accelerated motion (constant acceleration)

Equations:

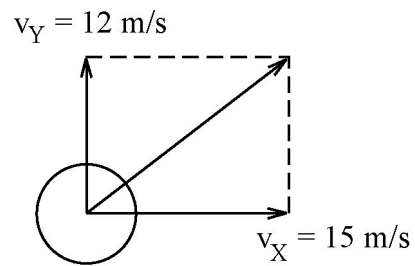
$$S_Y = S_{0Y} + v_{0Y} \cdot t - \frac{1}{2} \cdot 9.81 \cdot t^2 \quad [4]$$

$$v_Y = v_{0Y} - 9.81 \cdot t \quad [5]$$

$$v_Y^2 = v_{0Y}^2 - 2 \cdot 9.81 \cdot (S_Y - S_{0Y}) \quad [6]$$



Problem: Calculate the range of a soccer kick.



How far will the ball land?

If we knew how long the ball will be in the air, the solution would be easy.

Steps to follow:

- (1) Calculate how long it will take the ball to reach its peak height.

(2) Calculate the peak height reached by the ball.

(3) Calculate how long it takes the ball to come down from the peak.

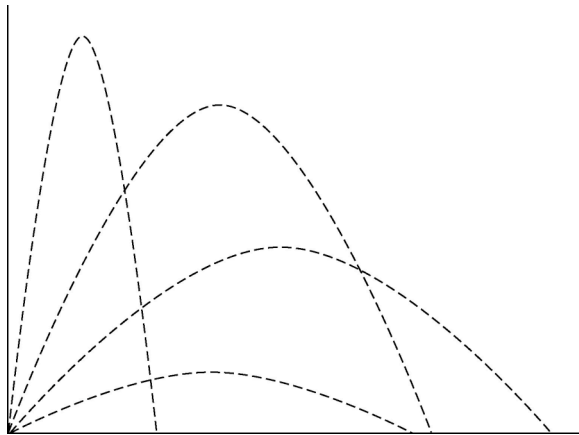
(3) Calculate total time in the air, and then the range of the projectile.

Important conclusions about airborne motion:

- 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.

Initial angle of projectile path



Summary for projectile motion:

- Study horizontal and vertical motions separately.
- Vertical motion: constant acceleration = -9.81 m/s^2 .
- Horizontal motion = constant velocity.
- All the translation motion is determined at takeoff.
- Time to the peak is proportional to vertical velocity at takeoff.
- Time to the peak = time from peak back to ground, if takeoff and landing are at the same height.
- The larger the vertical velocity at takeoff, the higher the peak height.
- For a given magnitude of the resultant velocity at takeoff, greatest range is produced with an initial 45° angle.
 - Only true if takeoff and landing are at same level.
 - Often max range produced with larger resultant and shallower angle.