

Projectile Motion

Projectiles

A *projectile* is any object that is given an initial velocity and then follows a path determined entirely by the effects of gravitational acceleration and air resistance.

(In this class, we will assume no air resistance.)

2D-Motion

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Equations of Motion for Projectiles

For projectiles (cannon balls, footballs, baseballs, soccer balls) *the motion of the object in the horizontal and vertical direction are independent of one another.*

Therefore, the motion of projectile can be described by separate equations of motion for the x and y directions.

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2D-Motion

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Projectile Motion in Two Dimensions (2D)

Vertical Motion (y -direction)

There is gravitational acceleration in the y -direction so the equations of motion are those for uniform acceleration.

$$\Delta y = -\frac{1}{2}gt^2 + v_{y_i}t \quad (\text{y - displacement})$$

$$v_y = -gt + v_{y_i} \quad (\text{y - velocity})$$

$$\text{On Earth: } g = 9.8 \frac{\text{m}}{\text{s}^2}$$

2D-Motion

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Projectile Motion in Two Dimensions (2D)

Horizontal Motion (x -direction)

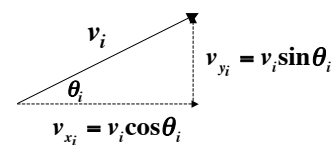
No acceleration in the x -direction so there is constant velocity and the equations of motion are

$$\Delta x = v_x t \quad (\text{x - displacement})$$

$$v_x = v_{x_i} \quad (\text{x - velocity})$$

Determining Initial Velocity Components

The initial velocities in the x and y directions are found from the initial velocity of the object and the angle at which the object is launched.



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More Equations for Projectiles

Because projectiles are uniformly accelerating in the y -direction:

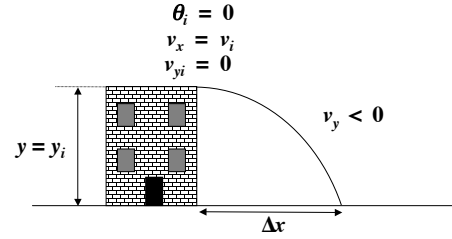
$$\Delta y = \left(\frac{v_{y_i} + v_y}{2} \right) t$$

$$v_y^2 = v_{y_i}^2 - 2g\Delta y$$

2D-Motion

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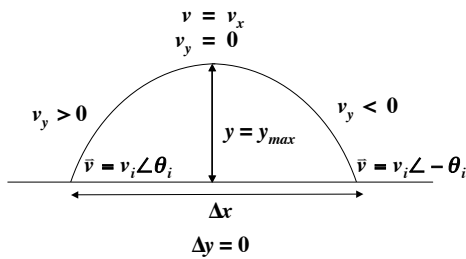
Horizontally Launched Projectile



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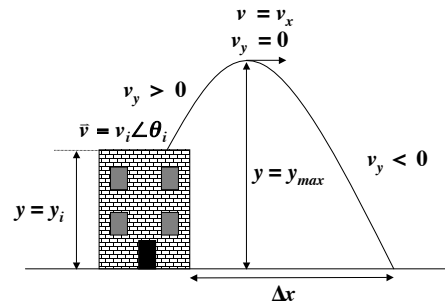
Ground-to-Ground Projectile



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Projectile Launched From a Height at an Angle

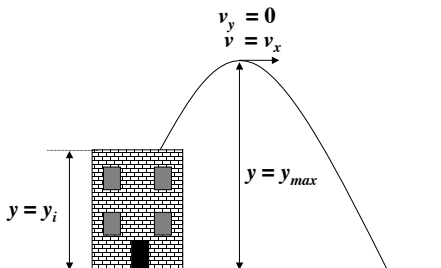


2D-Motion

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Maximum Height of a Projectile

When a projectile reaches its maximum height, the y -component of the velocity is zero and the speed is equal to the x -component of the initial velocity.



2D-Motion

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