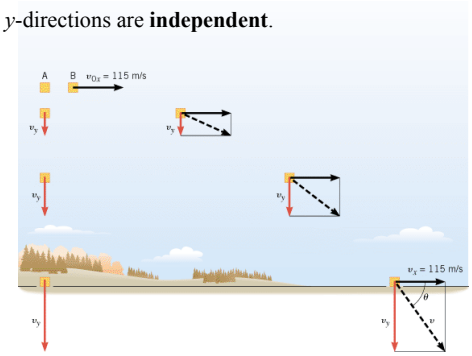
Galileo's observation:

"The distances traversed during equal intervals of time by a body falling from rest stand to one another in the same ratio as the odd numbers, beginning with unity."

In other words, for equal time intervals the distances travelled scale in the ratio 1:3:5:7 …

Projectile motion (motion in a 2D vertical plane)

Motion in *x* and *y*-directions are **independent**.



Simulation

www.physics.umanitoba.ca/~blunden/phys1050/Animations/TwoBallsGravity.html

Projectile motion (motion in a 2D vertical plane)

$$\vec{v} = \vec{v}_0 + \vec{a}t$$

$$\vec{r} - \vec{r}_0 = \vec{v}_0 t + \tfrac{1}{2}\vec{a}t^2$$

Here $\vec{a} = -g\hat{j}$, so

$$v_x = v_{0x}, \quad v_y = v_{0y} - gt$$

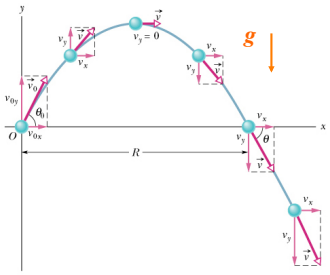
$$x - x_0 = v_{0x}t$$

$$y - y_0 = v_{0y}t - \tfrac{1}{2}gt^2$$

The projectile is launched with an initial velocity $\vec{v}_0$ at an angle θ_0.

$$v_{0x} = v_0 \cos\theta_0$$

$$v_{0y} = v_0 \sin\theta_0$$

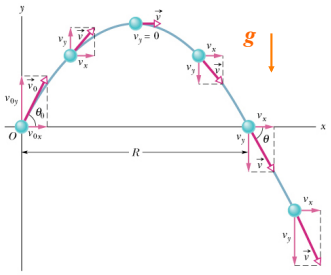


These describe the parametric equation of a parabola (common parameter is the time *t*).

To see this, eliminate *t* to get:

$$y = (\tan\theta_0)x - \frac{g}{2(v_0\cos\theta_0)^2}x^2$$

All projectiles follow some piece of a parabolic path.

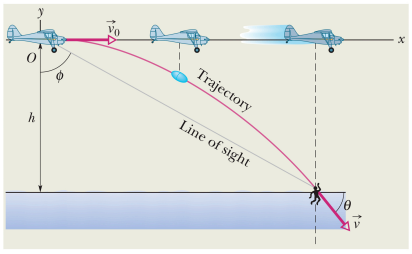


Example

A plane with a horizontal velocity v_0=430 km/h releases a rescue capsule from a height h=1200 m above water.

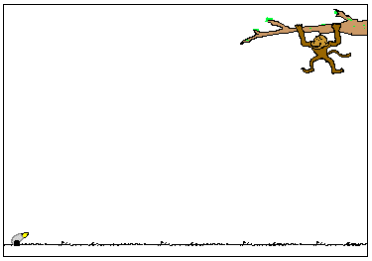
a) At what line of sight angle φ should the capsule be released to land near a survivor in the water?

b) What is the speed of the capsule when it hits the water?



Monkey and hunter example

A hunter aims his gun at a monkey hanging from a tree. To avoid being hit, the monkey let's go at the instant it sees the flash from the gun. Does the strategy work?



Simulation: www.physics.umanitoba.ca/~blunden/phys1050/Animations/MonkeyHunter.html

Video: https://youtu.be/cxvsHNRXLjw