Answer on Question #42712, Physics, Mechanics | Kinematics | Dynamics

Two objects are thrown simultaneously from the same height at 45° angles to the vertical with a speed of 20 m per second; one up, the other one down. Find the difference between the heights the objects will be at two seconds later. How are these objects moving in regards to one another?

Solution:

Given:

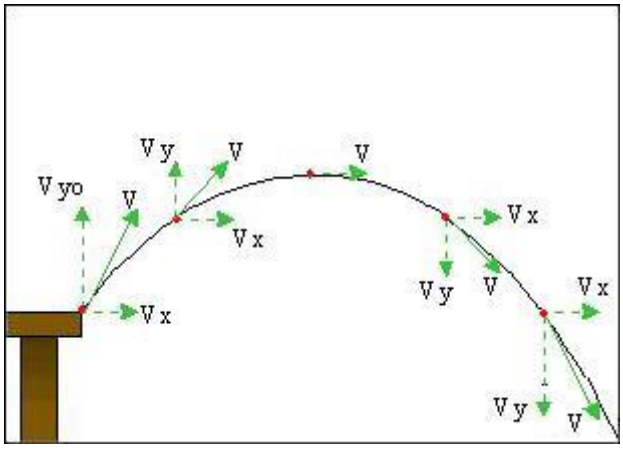
$\theta = 45°,$

$v_0 = 20\ \text{m/s},$

$t = 2\ \text{s},$

$y_1 - y_2 = ?$

Projectile motion is a form of motion in which an object or particle (called a projectile) is thrown near the earth's surface, and it moves along a curved path under the action of gravity only.



In projectile motion, the horizontal motion and the vertical motion are independent of each other; that is, neither motion affects the other.

The horizontal component of the velocity of the object remains unchanged throughout the motion. The vertical component of the velocity increases linearly, because the acceleration due to gravity is constant (g=9.81 m/s^2).

Equations related to trajectory motion are given by

$$\text{Horizontal distance,}\quad x = v_{0x}t$$

$$\text{Vertical distance,}\quad y = y_0 + v_{0y}t - \frac{1}{2}gt^2$$

For the first object the equation for vertical movement is:

$$y_1 = y_0 + v_{0y}t - \frac{1}{2}gt^2$$

For the second object the equation for vertical movement is:

$$y_2 = y_0 - v_{0y}t - \frac{1}{2}gt^2$$

Thus,

$$y_1 - y_2 = y_0 + v_{0y}t - \frac{1}{2}gt^2 - y_0 + v_{0y}t + \frac{1}{2}gt^2 = 2v_{0y}t$$

Here

$$v_{0y} = v_0 \cos 45°$$

So,

$$y_1 - y_2 = 2tv_0 \cos 45° = 2 \cdot 2 \cdot 20 \cdot \cos 45° = 56.57 \text{ m}$$

Answer. $y_1 - y_2 = 56.57$ m.

In the horizontal direction objects are moving with the same speed

$$v_{0x} = v_0 \sin 45° = 14.14 \text{ m/s},$$

and in vertical direction objects are moving away from each other with speed

$$2v_{0y} = 2 \cdot 20 \cdot \cos 45° = 28.28 \text{ m/s}.$$