Trajectory Calculator

Created by **Hanna Pamuła**, PhD candidate

Reviewed by **Bogna Szyk**

Last updated: Mar 21, 2022

Table of contents:

Use this trajectory calculator to find the flight path of a [projectile](#). Type in three values: velocity, angle and initial height, and in no time you'll find the trajectory formula and its shape. Keep reading if you want to check the trajectory definition as well as a simple example of calculations.

AD

Trajectory definition

Trajectory, also called a flight path, is **the path followed by a moving object under the action of gravity**. Usually, the term is used when we're talking about projectiles or satellites (where the regularly repeating trajectory is called an orbit). In an object is thrown for short distances, then a parabola is a good approximation of trajectory shape.

Some examples of projectile motion are:
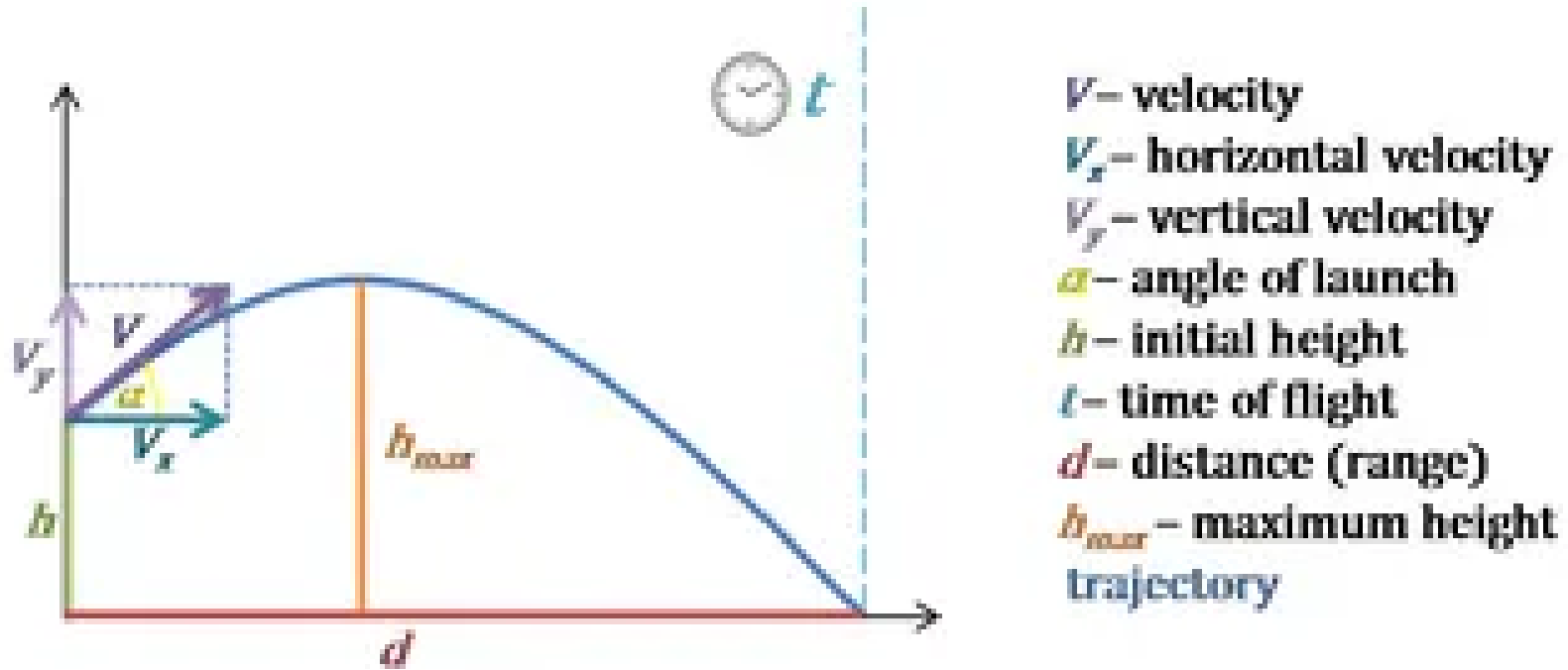
ice hockey puck, baseball or golf ball in flight ⛳

a bullet fired from a weapon 🔫

a jet of water from a fountain ⛲

object thrown from a table / plane / building / bridge ✈

Trajectory formula

Now as you know the trajectory definition, let's check how trajectory formula looks like.
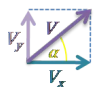
1. Let's start from equations of motion:

$x = V_x * t$

$y = h + V_y * t - g * t^2 / 2$

2. As we know that three vectors - V_o, V_x and V_y - form a [right triangle](), we can write that:

The horizontal velocity component V_x is equal to $V_o * cos(α)$.

The vertical velocity component $V_y = V_o * sin(α)$.

3. Then, we combine the equations of motion and [velocity]() components into one formula:

$$x = V_x * t \Rightarrow t = x / V_x$$

$$y = h + V_y * t - g * t^2 / 2$$

$$y = h + V_y * (x / V_x) - g * (x / V_x)^2 / 2$$

$$y = h + x * (V_0 * \sin(\alpha)) / (V_0 * \cos(\alpha)) - g * (x / V_0 * \cos(\alpha))^2 / 2$$

And as we know, <u>sine</u> over <u>cosine</u> is a definition of <u>tangent</u>. So, the final trajectory formula may be expressed as:

$$y = h + x * \tan(\alpha) - g * x^2 / (2 * V_0^2 * \cos^2(\alpha))$$

If you're interested in different aspects of projectile motion, check out our other dedicated tools to calculate:

<u>time of flight</u>;

<u>maximum height</u>;

<u>projectile range</u>;

<u>horizontal projectile motion</u>.

Trajectory calculator: how to use

Let's check out the trajectory of water from a water fountain:

1. **Type in the velocity**. Assume that it's equal to 5 ft/s.
2. **Enter the angle**. For example, 60°.
3. **Choose initial height**. Let's pick 5 inches.
4. Here you are! **Trajectory calculator displays the formula and the flight path!**

The critical thing to notice is the possible difference in axes scaling, so the angle may not look like on the chart as it should. Remember that in all calculations, air resistance is neglected.