

Script Files

Projectile Motion Neglecting Air Resistance

The simplest model of projectile motion is that which neglects air resistance.

Assuming that the acceleration due to gravity is a constant $g = -9.80655m/sec^2$, directed downward,

$$\frac{dv}{dt} = -9.80655, \quad (1)$$

using elementary antidifferentiation, the velocity of the object as a function of time is

$$v(t) = -9.80655t + v_0, \quad (2)$$

where v_0 represents the object's initial velocity in m/sec . To calculate the height of the object at time t , we take the antiderivative of the velocity to get

$$h(t) = -\frac{9.80655}{2}t^2 + v_0t + h_0, \quad (3)$$

where h_0 is the initial height of the object.

The objective is to write the **R** script `projectile1.r` that prompts the user to enter the initial height h_0 and the initial velocity v_0 and calculates the following:

1. the object's maximum height,
2. the time the object stays in the air, and
3. the velocity of the object when it strikes the ground.

The function should display this information to the user. You will need to calculate t_f , the time it takes for the object to hit the ground. You can calculate this by setting Equation (3) equal to zero and solving for t using the quadratic formula. Although the quadratic formula returns two solutions to the quadratic equation, we know that the actual t_f is the larger of the two. You will also need to calculate t_{max} , the time it takes for the object to reach maximum height. You can calculate this by setting Equation (2) equal to zero and solving for t . You can assume that the initial velocity will be positive so that $t_{max} > 0$. Please use the quadratic formula. Although the quadratic formula returns two solutions to the quadratic equation, we know that the actual t_f is the larger of the two. Finally, if the initial velocity is negative, then the object is launched downward, and the maximum height is the initial height. Your script should have two “if...else” statements.

Here are several examples.

```
> source('~/Documents/R Folder/projectile1.r')
Please enter the initial height of the object 100
Please enter the initial velocity of the object 25
```

The maximum height of the object is 131.8665 meters.
The object is in the air 7.735215 seconds.
The velocity of the object when it hits the ground is -50.85578 meters/second.

```
> source('~/Documents/R Folder/projectile1.r')
Please enter the initial height of the object 25
Please enter the initial velocity of the object 15
```

The maximum height of the object is 36.47192 meters.
The object is in the air 4.256911 seconds.
The velocity of the object when it hits the ground is -26.74561 meters/second.

```
> source('~/Documents/R Folder/projectile1.r')
Please enter the initial height of the object 0
Please enter the initial velocity of the object 250
```

The maximum height of the object is 3186.646 meters.
The object is in the air 50.98633 seconds.
The velocity of the object when it hits the ground is -250 meters/second.

```
> source('~/Documents/R Folder/projectile1.r')
Please enter the initial height of the object 100
Please enter the initial velocity of the object -5
```

The maximum height of the object is 100 meters.
The object is in the air 4.034858 seconds.
The velocity of the object when it hits the ground is -44.56804 meters/second.