Falling Motion with Air Resistant and Surface Area

**Preliminary**

Concept of Regular Changed Straight Motion (GLBB)

The definition of GLBB is very diverse. Depends on the sources and thoughts of each person. Following are some of the GLBB meanings according to several sources:

* Straight, regularly changed motion (GLBB) is a straight motion of an object, where the speed changes with time due to a constant acceleration. Due to the acceleration of the formula the distance traveled is no longer linear but quadratic (source: id.wikipedia.org).
* Regular Changed Straight Motion (GLBB) is a straight motion in a horizontal direction with a velocity v that changes at any time due to a constant acceleration. In other words an object that moves from rest or starts with the initial speed will change its speed because there is acceleration (a = +) or deceleration (a = -) (source: Bebas.xlsm.org).
* GLBB is the motion of an object on a straight line path with fixed acceleration. The purpose of fixed acceleration is the acceleration of a large acceleration and its fixed direction (source: sidikpurnomo.net).

**Free Fall Motion**

Its characteristic is that objects fall without initial speed (vo = zero). The more downward motion of objects is faster. The acceleration experienced by each free falling object is always the same, which is equal to the gravitational acceleration of the earth (a = g) (g = 9.8 m / s2 and often rounded to 10 m / s2).

An object that is falling through the [atmosphere](https://www.grc.nasa.gov/www/k-12/airplane/atmos.html) is subjected to two external [forces.](https://www.grc.nasa.gov/www/k-12/airplane/newton.html) The first force is the gravitational force, expressed as the [weight](https://www.grc.nasa.gov/www/k-12/airplane/weight1.html) of the object, and the second force is the aerodynamic [drag](https://www.grc.nasa.gov/www/k-12/airplane/drag1.html) of the object. The [weight equation](https://www.grc.nasa.gov/www/k-12/airplane/wteq.html) defines the weight **W** to be equal to the mass **m** of the object times the gravitational acceleration **g**:

W = weight (newton)

W = m × g

m = mass (kg)

g = gravitation (9,8 m/s)

The motion of any moving object can be described by Newton's [second law](https://www.grc.nasa.gov/www/k-12/airplane/newton2.html) of motion, force **F** equals mass **m** times acceleration **a**:

F = force(newton)

F = m × a

m = mass(kg)

a = acceleration()

Then we have :

a =

Weight and drag are **forces** which are [vector quantities](https://www.grc.nasa.gov/www/k-12/airplane/vectors.html). The **net external force** is then equal to the [difference](https://www.grc.nasa.gov/www/k-12/airplane/vectadd.html) of the weight and the drag forces:

W = Weight(newton)

F = W - D

D = Drag(newton)

Since free fall motion that doesn’t have or affected by air resistant has zero drag (D=0) then we have the acceleration of the object then becomes:

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**Analytical Model**

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W = m × g

W = weight

m = mass

g = gravitation (9,8 m/s)

The gravitational acceleration decreases with the square of the distance from the center of the earth. But for most practical problems in the atmosphere, we can assume this factor is constant. If the object were falling in a vacuum, this would be the only [force](https://www.grc.nasa.gov/www/k-12/airplane/ffall.html) acting on the object. But in the atmosphere, the motion of a falling object is opposed by the aerodynamic [drag](https://www.grc.nasa.gov/www/k-12/airplane/drag1.html). The [drag equation](https://www.grc.nasa.gov/www/k-12/airplane/drageq.html) tells us that drag **D** is equal to a [drag coefficient](https://www.grc.nasa.gov/www/k-12/airplane/dragco.html) **Cd** times one half the air [density](https://www.grc.nasa.gov/www/k-12/airplane/density.html) **r** times the [velocity](https://www.grc.nasa.gov/www/k-12/airplane/vel.html) **V** squared times a reference [area](https://www.grc.nasa.gov/www/k-12/airplane/sized.html) **A** on which the drag coefficient is based:

D = drag (newton)

D = Cd ρ ½(V²A)

Cd = drag coefficient (sphere (0,47)

ρ = density ( m/ V) mass/Volume

V = velocity(m/s)

A = reference area (sphere ()

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F = m × a

Then we have :

a =

F = force(newtomn)

m = mass(kg)

a = acceleration()

Weight and drag are **forces** which are [vector quantities](https://www.grc.nasa.gov/www/k-12/airplane/vectors.html). The **net external force** is then equal to the [difference](https://www.grc.nasa.gov/www/k-12/airplane/vectadd.html) of the weight and the drag forces:

W = Weight(newton)

F = W - D

D = Drag(newton)

The acceleration of the object then becomes:

The **drag force** depends on the square of the velocity. So as the body accelerates its velocity and the drag increase. It quickly reaches a point where the drag is exactly equal to the weight. When drag is equal to weight, there is **no net external force** on the object, and the acceleration becomes zero. The object then falls at a constant velocity as described by Newton's [first law](https://www.grc.nasa.gov/www/k-12/airplane/newton1a.html) of motion. The constant velocity is called the [terminal velocity.](https://www.grc.nasa.gov/www/k-12/airplane/termv.html)

**Numerical Model**

* W = m × g
* F = m × a

Then we have :

a = F/m

* D = Cd ρ ½(V²A)

D = 0,47 (m/V) ½ (V²A)

D = 0,47 (m/V) ½ (V² )

* F = W – D

F = (m × g ) – (0,47 (m/V) ½ (V² )

(with air resistant)

* F = W – D

F = W ( without air resistant)

F = m × g



( with air resistant)

= g (without air resistant )

Suppose , there’s two ball with same mass = 20 kg , will be throw to the ground with falling motion, the first ball will be throwing without any air resistant and the second ball will be throwing with air resistant, where the air resistant is = 40m/s calculate the acceleration of the both ball and which ball is touch the ground faster ?

**a. ball without air resistant**

**b. ball with air resistant**

From the equation above we can conclude that the ball with the same massa and the in same gravity simulate with different falling motion where the first ball is without air resistant and the second ball with the air resistant will be generate different result where the ball that simulated without air resistant will me have bigger acceleration than the ball that simulated with air resistant.

**Algorithm Flowchart**

