The force perpendicular on a pendulum string is:

Where is the mass of the pendulum, is the gravitational acceleration constant, and is the current position (or the angle) of the pendulum. The negative sign is a matter of the direction, as the force on the pendulum is pointing down.

The equation of motion for simple harmonic motion:

And the general solution for it is:

Where , is the current time point, is the starting angle, and is the phase constant of the oscillation. In order to obtain the numerical solution for the pendulum, we need to convert the 2nd order differential equation of motion, into multiple 1st differential equations:

and:

We multiply both sides of the two equations by and apply Euler-Cromer method, and we obtain:

Converting to numerical form gives us:

From that we can obtain the energy of our oscillator:

But when we use small angle approximation, we get:

**Adding Damping and Driving Force:**

When adding damping and driving force to our oscillator, the equation of motion becomes:

Where is the dissipation constant, is the driving force, and is the imposed angular frequency. The general solution for that equation depend on the behavior of the pendulum:

(Underdamped)

(Overdamped)

(Critically Damped)

And the analytical solution is:

where:

**Numerical Solution of Damped Pendulum:**

We multiply both sides of the new two equations by and apply Euler-Cromer method, and we obtain:

Converting to numerical form gives us:

During calculation the position value will be increasing above or below , we must make sure the position stays for it to make sense. To deal with that problem, we add a condition that is evaluated at every time step:

If

If