# TM HW5

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| Class | |
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| Materials | |
| Reviewed | ☐ |
| Type | |

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# Homework: HW5

# Task1

## Research Object:

- Bullet with a projectile motion
- Bullet has a mass (m=13.6g) and initial velocity $(v_0 = 870m/s)$
- Officer and sniper with distance in between(L = 1500m)
- Cargo ship in between with height (H=?)
- Constant for air friction(drag) (k=$1.3 * 10^{-5}$)

## Solution

- It is a basic projectile motion
- $\theta = \alpha$

### For the task without friction

$v_{x0} = vcos(\theta)$

$v_{y0} = vsin(\theta)$

$v_x = vcos(\theta)$

$v_y = vsin(\theta) - gt$

$a_x = 0,\ a_y = -g$

$H = \frac{v^2 sin^2(\theta)}{2g}$ (1)

$R = L = \frac{v^2 sin(2\theta)}{2g}$ (2)

Find $\theta$ from L from (2)

$\theta = \frac{arcsin(\frac{Lg}{v^2})}{2}$ = 0.556 degrees  (The first needed thing)

Then we can find the cargo ship maximum height from (1)

$H_{max} = 10771.825354043485$ m  (The second needed thing)

## For the task without drag

- $F_c = -kv^2$ and in the opposite direction of the movement

$v_{x0} = vcos(\theta)$

$v_{y0} = vsin(\theta)$

$v_x = vcos(\theta) - \frac{F_c * t}{m} = vcos(\theta) - \frac{kv_x^2 * t}{m}$

$v_y = vsin(\theta) - \frac{gt}{m} - \frac{kv_y^2}{m}$

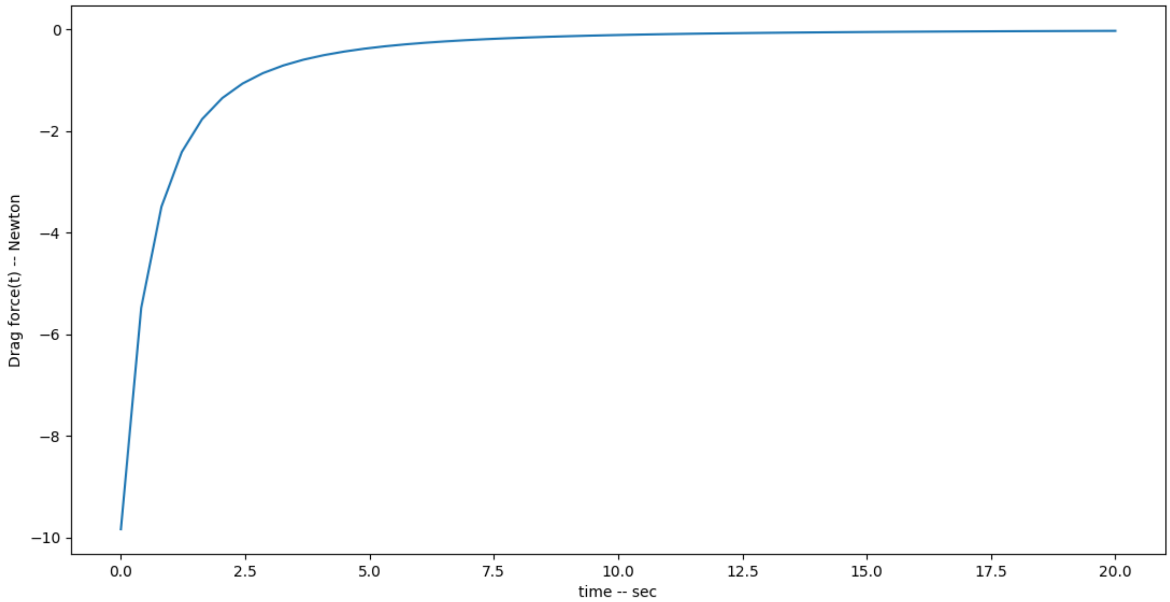
$a_x = \frac{kv_x^2}{m},\ a_y = -\frac{g}{m} - \frac{kv_y^2}{m}$

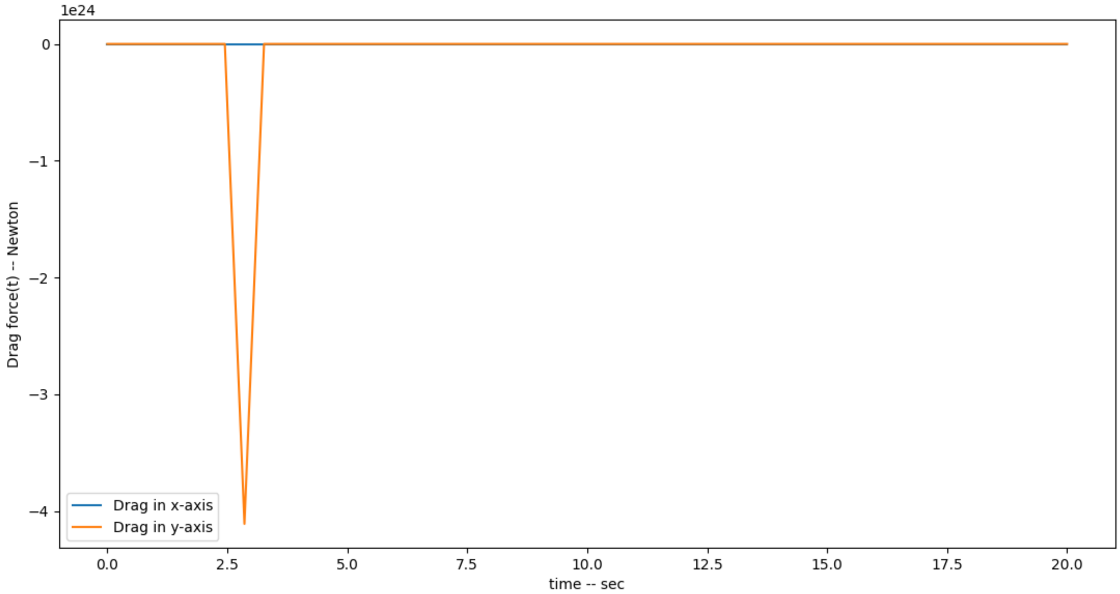
Finding the angle using equation (4) will not work as it is not valid as in x-axis the acceleration will not be constant and then simple motion equation will not work. Thus, we need to use numerical integration in order to find the velocity then integrate again in order to find the position in x-axis, and then we can substitute with the givens/initial conditions to get the constants and get $\theta$.

By numerical integration for the differential equation:

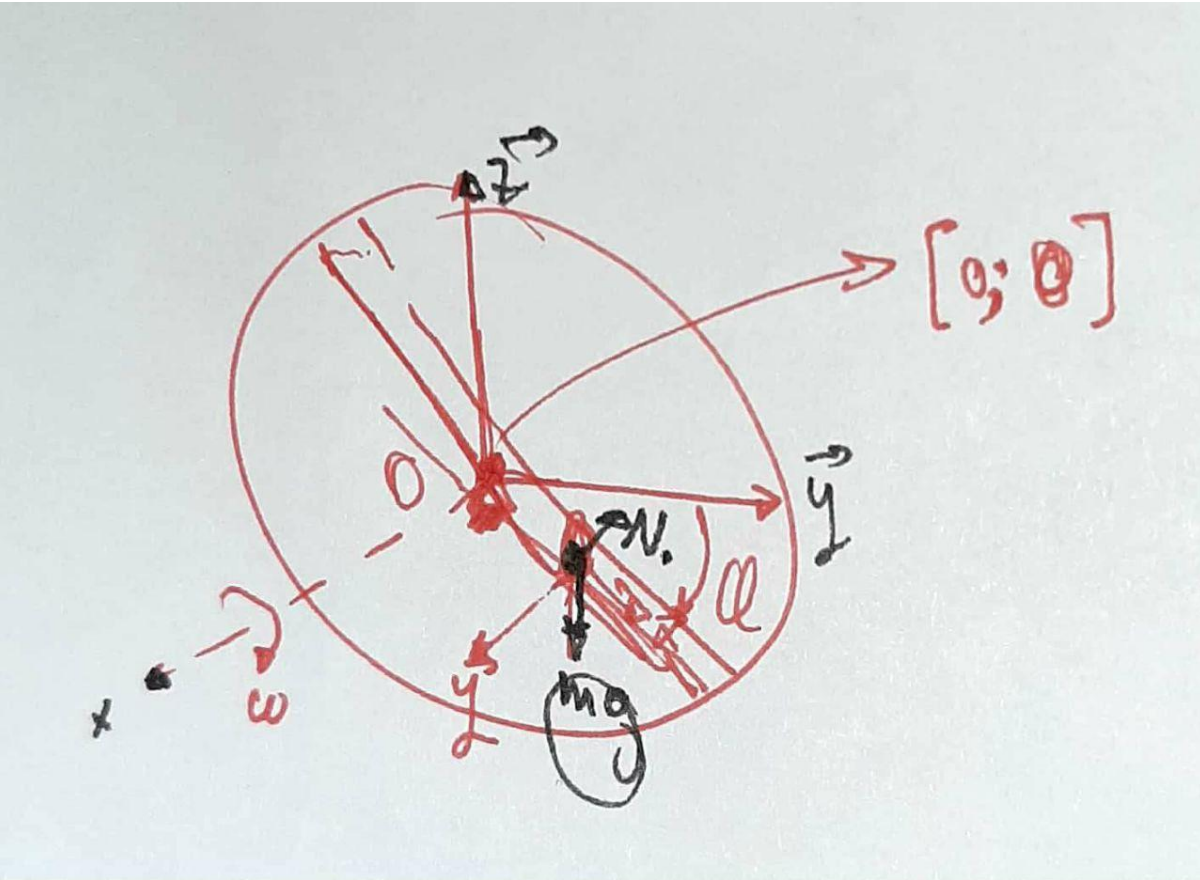
$\frac{dv_x}{dt} = \frac{-kv_x^2}{m}$ we can get v in x-axis at any time then we can get at any time and we can calculate the drag force according to the formula giving in the. and the same for y-axis

- Plotting the drag forces



# Task2





## Research objects:

- Particle M (translational motion in the tube and rotational motion due to be inside the tube in the moving object)
- Object A — a moving object rotational motion
- When the ball is moving it forces the object A to rotate

## Givens:

- m = 0.02kg
- w = pi rad/sec
- r = 0.5m

## Initial Conditions:

- $t_0 = 0$
- $x_0 = 0$
- $\dot{x}_0 = 0.4$ m/sec

## Forces analysis:

- There is weight from the particle.
- There is pressure of the particle to the wall == Normal forces on the particle from the wall
- Neglect friction of the ball and the walls of the tunnel

## Solution:

First we will solve to get how much it moves inside the tunnel according to the starting position O (origin 0,0) when $\phi = 0$ and the particle at the origin

$m\ddot{x} = \sum_i F_i + F_e$

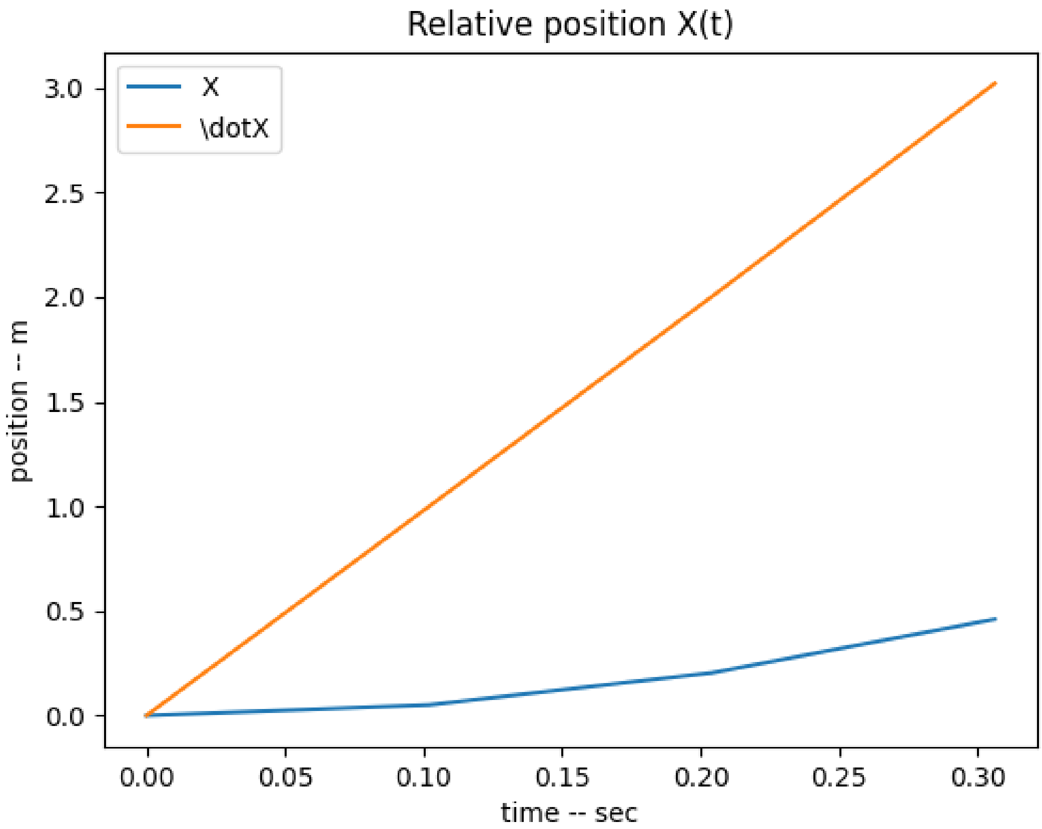
$F_e = mw^2x$

$m\ddot{x} = mgsin(wt) + mw^2x$

$\ddot{x} = gsin(wt) + w^2x$

And solve numerically this differential equation, and we can get x(t)

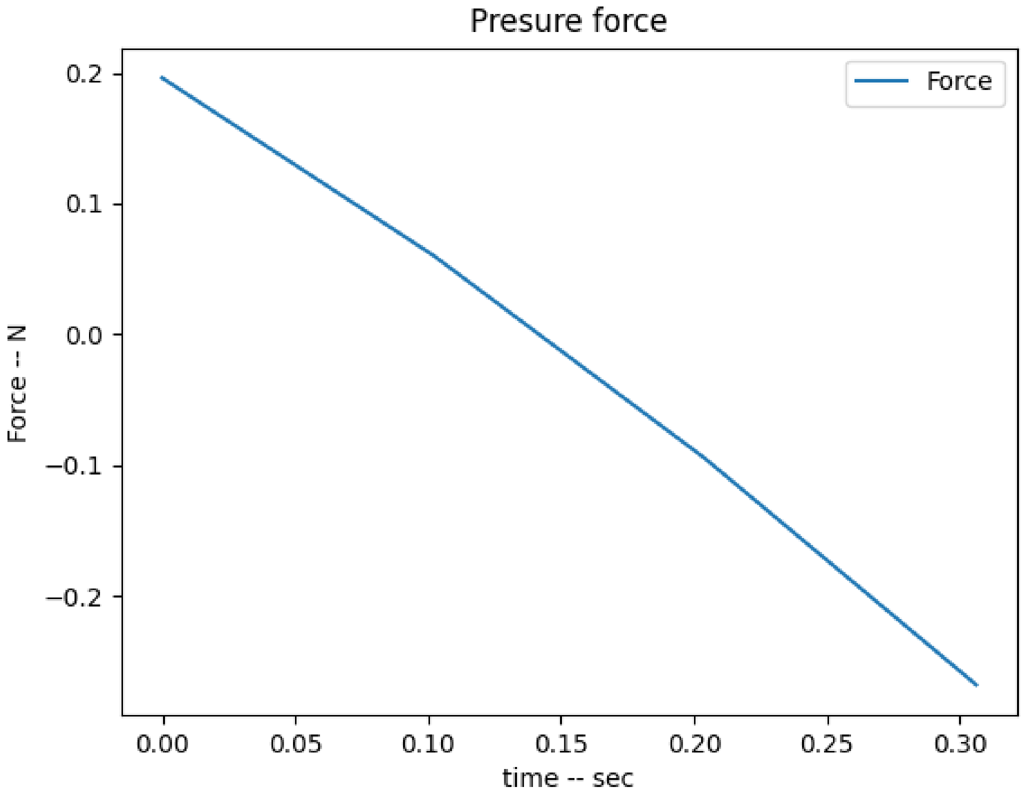
To plot till the time leave the tunnel (x = r) just run the loop for some time and with for loop to see when the partial satisfy this condition and then it is the time to leave = t = 0.3



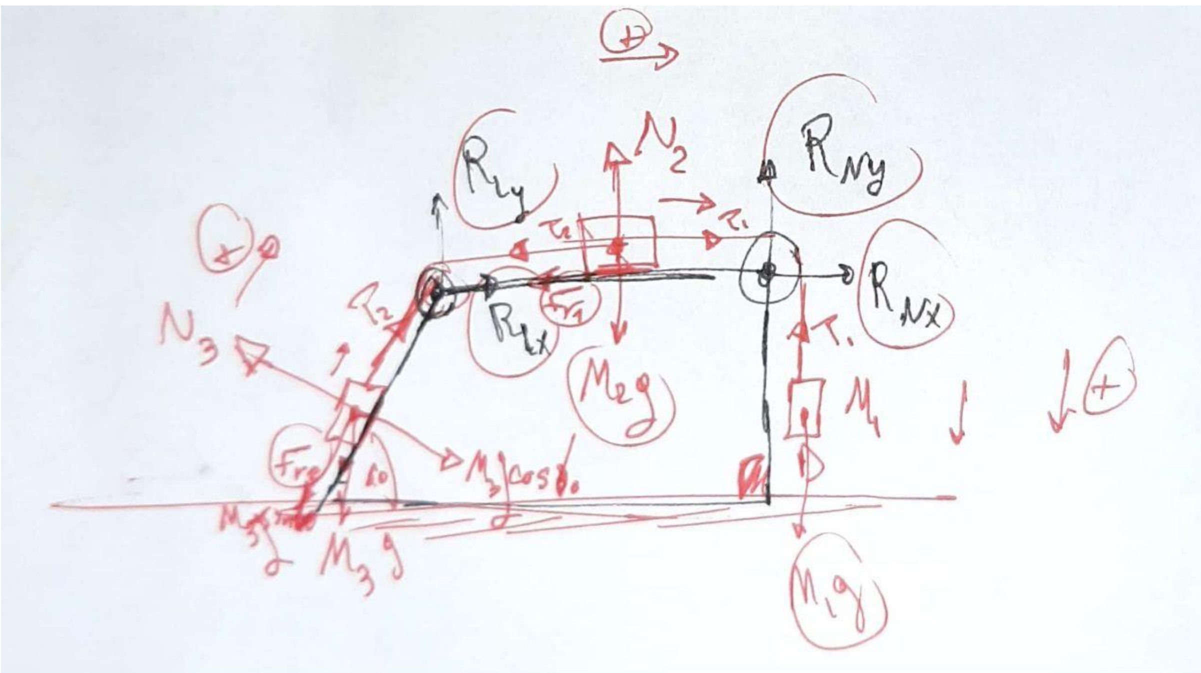

To find the pressure we need to investigate the other directions:

$N + F_c - mgcos(wt) = 0$ and $F_C = 2mwv_r$ and $v_r = \dot{x}$ and we already get it while solving the equation numercally

then $N = mgcos(wt) - 2mwv_r$


Presure force
Force
0.2
0.1
0.0
−0.1
−0.2
Force -- N
0.00
0.05
0.10
0.15
0.20
0.25
0.30
time -- sec

# Task3


N2
RNy
RNx
N3
M2g
M1
M1g
M3g

## Research objects:

- System of multiple objects:
  - 3 blocks of masses
  - 2 pulleys
  - Strings connect the pulleys with the blocks
  - Big block that can move

## Forces analysis:

- On each pulley there are equal tensions on both of the ends of the strings
- On each pulley there are reaction forces in the x and y directions
- Weights of the blocks
- Weight of the big block
- Normal forces that acts on M2 and M3 but not M1 normal to the surface
- Friction forces between M2, M3 with the main movable body (big block)

## Solution:

$(M_1 + M_2 + M_3)a = F_{r1} + F_{r2}cos(60)$ We can get the acceleration for the whole body according to the forces that really affect on it

As the moving in the directions of the normal forces are fixed, then

$N_2 = M2g,\ N_3 M_3 gcos60,\ F_{r1} = \mu N_2,\ F_{r2} = \mu N_3$ and such that $\mu$ is the current friction between the blocks and big body.

We can integrate acceleration with respect to time and get velocity and then integrate another time, and we can get position.

# Task4

## Research objects:

- Pulley
- Rope running over the pulley
- Man holds the rope from one side

- Load on the other side

## Force analysis:

- Reaction forces in x and y directions for the pulley
- Weight of the man
- Weight of the pulley
- Weight of the load

By intuition of the man starts to climb the rope, the load on the other side will start to go up too.

By using the principles of conservation of linear and angular momentum, we can deduce that the load will ascend (go up) with acceleration equal to $\frac{4}{9}a$