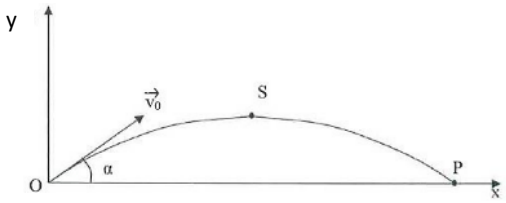
Exercise Set 1 (TD1) - Mechanics

Kinematics in cartesian coordinates

Exercise 1 : Parabolic motion

We study the free fall of a projectile that was launched from point O(0,0) at $t = 0$ with an initial velocity $\vec{v}_0$ at an angle a with the horizontal plane.



The equations of motion are:

$$\begin{cases} x(t) = v_0 \cos(\alpha)\, t \\ y(t) = v_0 \sin(\alpha)\, t - \frac{1}{2} g\, t^2 \end{cases}$$

1. Describe the study framework (reference frame, system under study, coordinate system).
2. Write the expression for the position vector in cartesian coordinates.
3. Establish the equation for the trajectory $y(x)$.
4. Give the expression for the velocity vector and its norm.
5. Give the expression for the acceleration vector and its norm.
6. Name the nature of motion on each axis (accelerated, deaccelerated or uniform). Name the orientation as well (positive or negative with respect to the axis).
7. Calculate the (horizontal) range of motion x_{max}.
8. Find the coordinates x_s and y_s of point S, the point of the trajectory with maximum height.

Exercise 2 : Circular motion

We study the motion of a particle M for which

$$\begin{cases} x(t) = R \cos(\omega t) \\ y(t) = R \sin(\omega t) \end{cases}$$

1. Describe the study framework (reference frame, system under study, coordinate system).
2. Write the expression for the position vector in cartesian coordinates.
3. Establish the equation for the trajectory.
4. Give the expression for the velocity vector and its norm.
5. Give the expression for the acceleration vector and its norm.

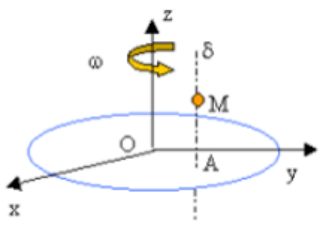
Exercise Set 2 (TD2) - Mechanics

Kinematics in polar coordinates

Exercise 1 : Polar coordinates

1. Which exercise of TD1 would be easier to solve using polar coordinates?
2. Repeat the exercise in polar coordinates.

Exercice 2 : Cylindrical coordinates



A carousel consists of a disk with center O and radius R rotating around the Oz axis with a constant angular velocity $\dot{\theta} = \omega$. The angle θ is measured from the Oy axis. A horse in the carousel, depicted here as point M, moves linearly along the vertical axis δ, with amplitude a and frequency φ according to the equation $z(t) = a(1 + \sin(\varphi t))$.

1. Give the study framework (reference frame, system under study, coordinate system).
2. Give the expression for the position vector in the cartesian basis knowing that $x(0) = R$.
3. Give the expression for the velocity vector.
4. Give the expression for the acceleration vector.