DW 2 : mechanics of the material point

Exercice 1

A material point moves in a straight line following the following time equation:

$$X(t) = -6t^2 + 16t$$

1/ What is the position of this body at t=1s.
2/ At what time t, it passes through position O (origin).
3/ What is the average speed in the time interval between 0s and 2s.
4/ Give the expression for the instantaneous speed, deduce its value at t=0s.
5/ What is the average acceleration in the time interval between 0s and 2s.
6/ Give the expression for the instantaneous acceleration.

Exercise 2

We know the location of a point M in the reference frame $R(O,\vec{i},\vec{j})$ at the moment t with the following coordinates:

$$X(t) = t^2 - 1 \quad \text{and} \quad y(t) = 2t$$

1/ provide the path equation of the point M.
2/ provide the velocity (speed) expression of the point M.
3/ provide the acceleration expression of the point M.

Exercise 3

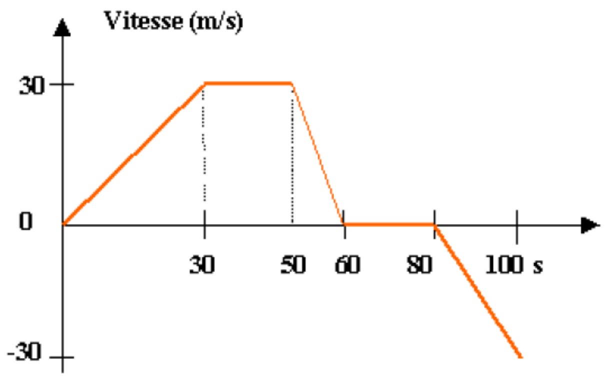
Let, in a plane, (P), be an orthonormal reference frame xOy and a mobile M moving in this plane. At the moment t ,its coordinates are defined by:

$$x = \sqrt{2}\cos\frac{t}{2}; \qquad y = 2\sqrt{2}\sin\frac{t}{2}$$

a. What is the trajectory?
b. Calculate the coordinates at time t of the velocity $\vec{v}$vector and the acceleration vector $\vec{\gamma}$of this mobile. What is the relationship between $\overrightarrow{OM}$and $\vec{\gamma}$?
c. Between the instants $t_1 = 0$and $t_2 = 4\pi$, determine the positions of the mobile and the coordinates of $\vec{v}$to have an acceleration vector of length$\frac{\sqrt{5}}{4}$

Exercice 4

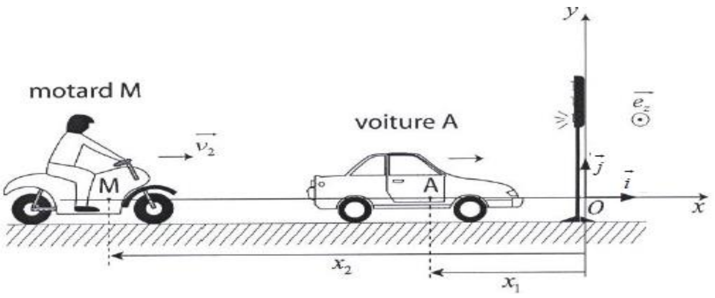
A vehicle travels $x_0 = 0$ on a straight path. Its speed is characterized by the following diagram.



1. Indicate over the 5 time intervals: the algebraic value of the acceleration and the displacement.
2. Determine at the end of the movement at t=100 s; the final position *x* and the path traveled in absolute value.

Exercise 5

A car A is stopped on a straight horizontal road at a distance $d_1 = 3\ m$ from a red light. When the light turns green, the car immediately $t = 0$ starts with constant acceleration $a_1 = 3\ {}^{m}/{}_{s^2}$. At the same time a motorcyclist M traveling at a constant speed $v_2 = 54\ Km/h$is at a distance $d_2 = 24\ m$ from the car. The car and the biker considered as material points are located at the moment $t$using their respective position vectors $\overrightarrow{OA} = x_1\vec{\imath}$ and $\overrightarrow{OM} = x_2\vec{\imath}$. We will choose as the origin O of the abscissa the position of the traffic light.



1. Determine the time equations $x_1(t)$ and $x_2(t)$ of the car and the biker respectively.
2. Determine the times of overtaking as well as the positions of the car and the biker at these times.
3. If the biker was going at speed $v_2 = 36\ Km/h$ could he catch up with the car?
4. A- calculate, in this case, the moment for which the distance which separates the biker from the car is minimum
   B- deduce this distance.

Exercice 6

Bottles of snow fall vertically with a speed of $8m/s$. How quickly do these bottles hit the windshield of a car traveling with a speed of $50\ Km/h$.

Exercise 7

The unit of length is the centimeter and the unit of time is the second.

A car is moving in a straight line and its acceleration is given by $a = -\frac{\pi^2}{4}x$,

So that at the moment t=1s, the interval x=4cm $v = 2\pi$ and the speed iscm/s.

1/ Determine the nature of motion and write its time equation

2/Calculate all the constants that characterize movement

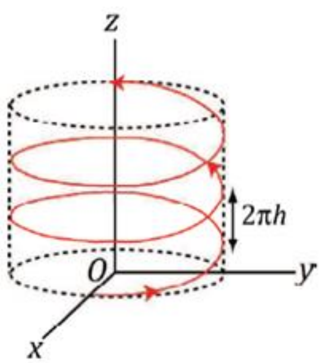
3/Show that x can be written in the form: $x = X_m \cos(\omega t + \varphi)$.

Exercise 8

The study reference ($\mathfrak{R}$) is associated to the orthonormal space reference $(O, \overrightarrow{e_x}, \overrightarrow{e_y}, \overrightarrow{e_z})$. Let the right helix be defined in cylindrical coordinates in ($\mathfrak{R}$) by:

$$\begin{cases} r = R_0 \\ z = h\theta \end{cases} \qquad (h \text{ est une constante positive})$$

We are interested in a material point M which describes this helix in the direction of the θcrescents



1. Calculate the velocity and acceleration vectors of *M* in ($\mathfrak{R}$) by cylindrical coordinates.
2. Calculate the speed $v$of *M* in ($\mathfrak{R}$)
3. M travels the propeller at constant V_0speed . Deduce the velocity and acceleration vectors of *M* as a function of V_0, $R_0$and h.