Partiel n°1 - PHYSICS

Calculators and documents are not allowed.
Answers must be written exclusively on the subject

Exercise 1 Kinematics (7 points)

Part A :

It is asked to retrieve the velocity and the acceleration expressions in the Frenet's basis.
The curvilinear abscissa in this basis is $ds = R\,d\theta$ where R is the radius of curvature at any point M of the trajectory.

1- Express the velocity vector $\vec{V}$ in the basis $(\vec{T}, \vec{N})$.

2- Deduce the acceleration's components (a_T, a_N) of the acceleration vector $\vec{a}$.

Part B

A material point describes, at constant angular velocity ω, a spiral curve whose equation is in polar coordinates: $\rho(t) = a.\exp(\omega t)$, a and ω are constant and $\theta(t) = \omega t$.

1- Give the position vector $\overrightarrow{OM}$ in polar coordinates.

2 – Determine the velocity vector of that movement knowing that in polar coordinates
$\vec{V} = \dot{\rho}.\vec{u}_\rho + \rho\,\dot{\theta}\,\vec{u}_\theta$

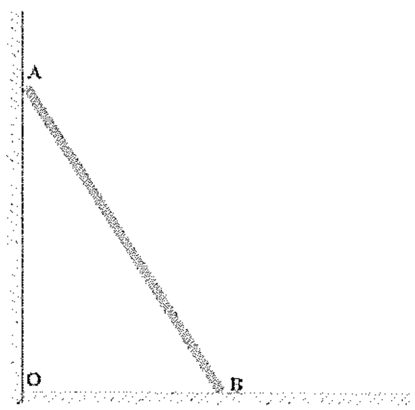
3- Deduce the components of the acceleration vector $\vec{a}$ of this movement, knowing that in polar coordinates $\vec{a} = (\ddot{\rho} - \rho\,\dot{\theta}^2)\,\vec{u}_\rho + (2\,\dot{\rho}\,\dot{\theta} + \rho\,\ddot{\theta})\,\vec{u}_\theta$

Exercise 2 **System at equilibrium** (7 points)

Give the litteral expression before doing the numerical calculus.

A homogeneous beam AB of length L = 2 m is at equilibrium as shown on the diagram hereunder. Points O, A, B are in the same vertical plane. The beam makes an angle $\alpha = 30°$ with the vertical wall.
The mass of the beam is m = 10 kg and $g = 10 m.s^{-2}$.

1- List all the forces that act on the beam. Represent them. Knowing that there are only frictions at point B, explain and argue the direction taken by the reaction at point B



2- It is supposed that the beam could rotate around an axis at B, perpendicular to the sheet of paper. Use the condition of rotational equilibrium to calculate the magnitude of the force exerted in A by the wall on the beam.

Data given : $\tan(30°) = \frac{1}{\sqrt{3}}$

3- a) Use the condition of translational equilibrium to express the components R_{Bx} and R_{By} of the reaction $\vec{R}_B$ at point B. Do the numerical application with the given data.

b) Calculate the norm of the reaction $\vec{R}_B$.

c) Deduce the value of the static friction coefficient μ_s at point B.

Exercise 3 **Kinematics (6 points)**

The coordinates (x, y, z) of a material point of mass M in a fixed referential (Oxyz) are such that:

$x(t) = R\cos(\omega t)$
$y(t) = R\sin(\omega t)$
$z(t) = H\omega.t$ where ω, R et H are positive constants.

1- Precise the equation and the nature of the trajectory in the xOy plane. What is the movement on the axis (Oz) ? Deduce the nature of the movement in the space (Oxyz).

2- Express the position vector $\overrightarrow{OM}$ in the cylindrical coordinates system $(\vec{u}_\rho, \vec{u}_\theta, \vec{u}_z)$.

3- Express the velocity vector $\vec{V}$ in the cylindrical coordinates system $(\vec{u}_\rho, \vec{u}_\theta, \vec{u}_z)$, deduce its norm.

4- Express the acceleration vector $\vec{a}$ in the cylindrical coordinates system $(\vec{u}_\rho, \vec{u}_\theta, \vec{u}_z)$, deduce its norm.