National School
of Autonomous Systems
Academic year 2023/2024

Test N°1 : Classical Mechanics, Physics 1

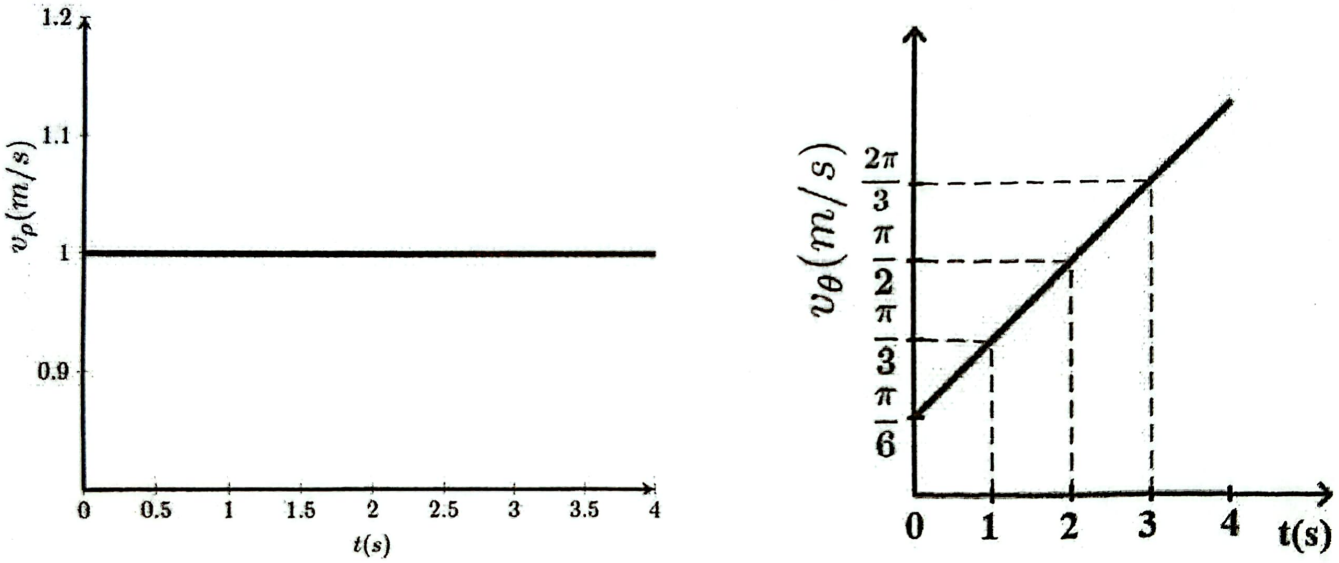
Due Wednesday, November 29, 2023 at 9h40mn am

This problem will give you a chance to practice some math skills (including coordinate systems) and also begin to work on basic kinematics.

Recommendations

- ✔ You must explain your reasoning to receive credit.
- ✔ All smart-phones and other communication devices must be turned off and stored out of sight.

Exercise 1 – Consider a point-like object P moving in the xy plane in such a way that its velocity in the polar coordinate system (ρ, θ) at any instant is given by the velocity-time graph of its components $\overrightarrow{v_\rho}$ (radial velocity) and $\overrightarrow{v_\theta}$ (transverse or circumferential velocity) as shown in figure 1, where v_ρ and v_θ are expressed in meters per second and t is in seconds.



(a) (b)

FIGURE 1 – Velocity-time graph components. (a) Radial velocity v_ρ. (b) Transverse velocity v_θ.

① Determine the parametric equations $\rho(t)$ and $\theta(t)$ called polar coordinates of P knowing that at time $t = 0$, $\rho(t = 0) = 1\ m$ and $\theta(t = 0) = 0$.

② Complete the table 1 and plot the trajectory (path) of the object.

t(s)	0	1	2	3	4	5	6	7
ρ								
θ								

TABLE 1

③ Determine the radial acceleration $\overrightarrow{a_\rho} = (\ddot{\rho} - \rho\dot{\theta}^2)\overrightarrow{u_\rho}$ and the transverse acceleration $\overrightarrow{a_\theta} = (\rho\ddot{\theta} + 2\dot{\rho}\dot{\theta})\overrightarrow{u_\theta}$ components, then find the magnitude of the vector acceleration.

④ Use a convenient scale to draw the velocity and acceleration vectors at time $t_1 = 2\ s$.

⑤ Determine the tangential $\overrightarrow{a_T}$ and normal $\overrightarrow{a_N}$ components of acceleration.