University of Oum El Bouaghi

Faculty of Exact Sciences, Natural and Life Sciences

1st year LMD (2025-2026)

Exams in physics I

Name:	Group:	Date:18/01/2026
Surname:		Duration: 01h30

Exercise 1 (08)

The motion of a point M is described In polar coordinates by:

$\begin{cases} r = b \\ \varphi = k\omega t^2 \end{cases}$ Where b, k and ω are positive constants.

1. Write the position vector of point M in polar coordinates.

$\vec{OM} = r\vec{U}_r$ 0,5

☐ $\overline{OM} = x\vec{\imath} + y\vec{\jmath}$ ☐ $\overline{OM} = b\,(sin\varphi\,\vec{\imath} + cos\varphi\,\vec{\jmath})$ ☒ $\overline{OM} = b\,(cos\varphi\,\vec{\imath} + sin\varphi\,\vec{\jmath})$ 0,5 ☒ $\overline{OM} = b\,\vec{U}_r$ 0,5

2. Calculate the velocity vector of point M in polar coordinates.

$\vec{V} = \dot{r}\vec{U}_r + r\dot{\varphi}\vec{U}_\varphi$ 0,5 0

☐ $\vec{v} = \dot{x}\vec{\imath} + \dot{y}\vec{\jmath}$ ☒ $\vec{v} = b\dot{\varphi}\,\vec{U}_\varphi$ 0,5 ☐ $\vec{v} = b\dot{\varphi}\vec{U}_r$ ☒ $\vec{v} = 2bk\omega t\vec{U}_\varphi$ 0,5

3. Calculate the magnitude of the velocity vector of point M in polar coordinates.

☒ $v = \sqrt{v_\varphi{}^2}$ 0,5 ☒ $v = 2bk\omega t$ 0,5 ☐ $v = b\dot{\varphi}$ ☐ $v = \sqrt{\dot{x}^2 + \dot{y}^2}$

4. Calculate the acceleration vector of point M in polar coordinates.

$\vec{a} = (\ddot{r} - r\dot{\varphi}^2)\vec{U}_r + (2\dot{r}\dot{\varphi} + r\ddot{\varphi})\vec{U}_\varphi$ 0,5 0 0

☐ $\vec{a} = b\,t^4\vec{U}_r + 2bt\vec{U}_\varphi$ ☐ $\vec{a} = 2bk\omega\,\vec{U}_\varphi$ ☒ $\vec{a} = -4bk^2\,\omega^2t^2\vec{U}_r + 2bk\omega\vec{U}_\varphi$ 0,5 ☐ $\vec{a} = b\ddot{\vec{U}_r}$

5. **Calculate the magnitude of the acceleration vector of point M in polar coordinates.**

0,75

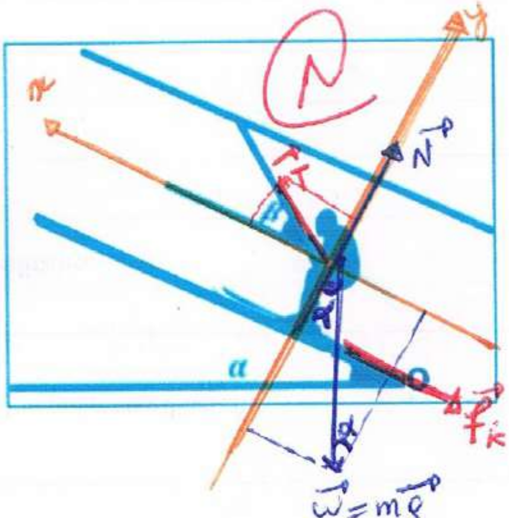
- [x] $a = \sqrt{a_r^2 + a_\varphi^2}$
- [x] $a = \sqrt{(-4bk^2\omega^2t^2)^2 + (2bk\omega)^2}$ 0,75
- [ ] $a = \sqrt{\ddot{x}^2 + \ddot{y}^2}$
- [ ] $a = \sqrt{(2bk\omega)^2}$

6. **Calculate the Cartesian coordinates (x, y) of point M.**

- [x] $x = b\cos k\omega t^2$ 0,75
- [ ] $y = r\cos k\omega t^2$
- [x] $y = b\sin k\omega t^2$ 0,75
- [ ] $x = b\sin k\omega t^2$

Exercise 2 (08)

Pulled by a ski lift, a skier of mass M = 60 kg has a rectilinear movement on a slope inclined at an angle $\alpha = 10°$ with the horizontal. The pole makes an angle $\beta = 25°$ with the slope and exerts on the skier a tension T= 300 N. The skier is subjected to friction equivalent to a force of value f_k= 50 N. Initially, the skier is at point O of the frame $(x_0 = 0\ m)$ **(Ox, Oy) without initial velocity ($v_0 = 0\ m/s$).**



1. **Represent the forces acting on the skier.**
2. **Find the normal force N applied to the skier.**

N

$\sum \vec{F}_{ext} = \vec{0} \Rightarrow \vec{w} + \vec{f}_k + \vec{N} + \vec{T} = \vec{0}$

the projection on an axis (oy) : $-w\cos\alpha + 0 + N + T\sin\beta = 0$

$N = 60.(9,81)\cos 10 + 300\sin 25 =$

- [ ] $N = 320N$
- [x] $N = 452.87N$ 0,5
- [ ] $N = 165.03N$
- [ ] $N = 505.92N$

3. **Find the coefficient of kinetic friction μ_k for the skier ?**

$f_k = \mu_k . N \Rightarrow \mu_k = \frac{f_k}{N} = \frac{50}{452,87}$ N

- [ ] $\mu_k = 0.09$
- [ ] $\mu_k = 0.15$
- [x] $\mu_k = 0.11$ 0,5
- [ ] $\mu_k = 0.3$

4. **What is the acceleration of the skier ?**

$\sum F_{ext} = m\vec{a} \Rightarrow \vec{w} + \vec{f_k} + \vec{N} + \vec{T} = m\vec{a}$

the projection on an axis (ox): $-w\sin\alpha - f_k + 0 + T\cos\beta = ma$

$a = (-60.(9,81)\sin 10 - 50 + 300\cos 25)/60$

☒ $a = 1.99\ m/s^2$ ☐ $a = 2\ m/s^2$ ☐ $a = 2.38\ m/s^2$ ☐ $a = 1.2\ m/s^2$

0.5

5. Show that the skier has a uniformly accelerated movement.

$a = 1,99\ (m/s^2) = \text{Constant} \Rightarrow$ Uniformly accelerated M^{vt}

6. In what is the time "t" required for the skier in order to ke much time will the skier have travel 300 m ?

$dv = a\,dt \Rightarrow \int_{v_0=0}^{v} dv = \int_{t_0=0}^{t} 1,99t \Rightarrow \boxed{v = 1,99t}$ ①

$dx = v.\,dt \Rightarrow \int_{x_0=0}^{x} dx = \int_{t=0}^{t} 1,99t.\,dt \Rightarrow \overset{300}{\overset{\shortparallel}{x}} = \frac{1,99}{2}t^2$

$\Rightarrow t = \sqrt{\frac{2\times 300}{1,99}}$

☐ $t = 20.04s$ ☐ $t = 9.93s$ ☒ $t = 17.36s$ ☐ $t = 11.22s$

0.1

Exercise 2 (04)

A material point M is moving along a trajectory in space R (O; $\vec{i}, \vec{j}, \vec{k}$). The Cartesian coordinates of M are:

- $x(t) = \sin\left(\frac{\pi}{2}t\right) + 2;$ $y(t) = 2\cos\left(\frac{\pi}{2}t\right) + 1;$ $z(t) = 0$

1. Determine the equation of the trajectory of point M. What is its nature?

$\begin{cases} x - 2 = \sin\left(\frac{\pi}{2}t\right) \\ y - 1 = 2\cos\left(\frac{\pi}{2}t\right) \end{cases} \Rightarrow \begin{cases} (x-2)^2 = \sin^2\left(\frac{\pi}{2}t\right) \text{ ---- ①} \\ \frac{(y-1)^2}{2^2} = \cos^2\left(\frac{\pi}{2}t\right) \text{ ---- ②} \end{cases}$

① + ② $\Rightarrow$

$$\frac{(x-2)^2}{1^2} + \frac{(y-1)^2}{2^2} = 1 \Rightarrow \text{ellipse trajectory}$$

2. Draw the trajectory of the mobile.

centre of ellipse is $(2, 1)$