Larbi Ben M'hidi University

Faculty of Exact Sciences, Natural and Life Sciences

1st year LMD (2024-2025)

Exams in physics I

Name:	**Section:**	**Date:** 05-01-2025
Surname:	**Group:**	**Duration:** 01h30

Exercise 1: (3 points)

The gravitational force between two objets the erarth and the moon of the masses M=5.97 × 10^{24}Kg and m =7.35× 10^{22}Kg is 1.98× 10^{20}N. Calculate the distance between the centers of the earth and moon. The gravitational constant G =(6.67 × 10^{-11} N m^2/kg^2).

$F = G\cdot \frac{M\cdot m}{r^2} \Rightarrow r = \sqrt{6{,}67\cdot 10^{-11}\cdot \frac{5{,}97\times 10^{24}\times 7{,}35\times 10^{22}}{1{,}98\cdot 10^{20}}}$ 1,5

☐ $r = 1.47\times 10^{17}$m ☐ $r = 3.84\times 10^{8}$cm ☒ $r = 3.84\times 10^{8}$m ☐ $r = 1.47\times 10^{17}$cm

Exercise 2: (7 points)

The movement of a point M is described in polar coordinates by: $\begin{cases} r = b \\ \varphi = \frac{1}{3}t^3 \end{cases}$

Where **b** is positive constant.

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

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

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

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

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

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

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

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

☐ $\vec{a} = b\,t^4\vec{U}_r + 2bt\vec{U}_\varphi$ ☐ $\vec{a} = 2bt\,\vec{U}_\varphi$ ☒ $\vec{a} = -b\,t^4\vec{U}_r + 2bt\vec{U}_\varphi$ 1 ☐ $\vec{a} = b\ddot{\vec{U}_r}$

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

☒ $a = \sqrt{a_r{}^2 + a_\varphi{}^2}$ ☐ $a = \sqrt{4b^2t^2}$ ☐ $a = b$ ☐ $a = \sqrt{\ddot{x}^2 + \ddot{y}^2}$ ☒ $a = \sqrt{b^2t^{16} + 4b^2t^2}$

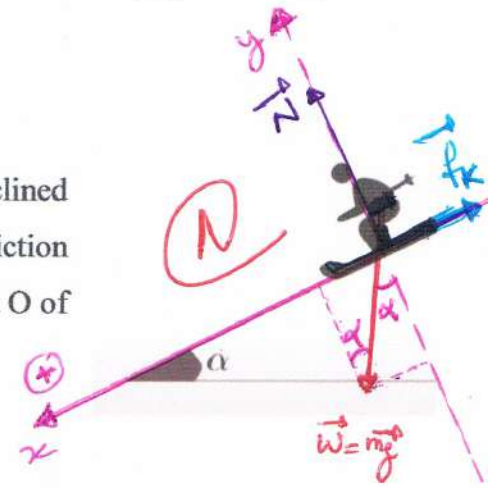
6. Find the Cartesian coordinates (x, y) of point M.

$x = r\cos\varphi$ $\quad y = r\sin\varphi$

☒ $x = b\cos\frac{1}{3}t^3$ ☐ $y = b\cos\frac{1}{3}t^3$ ☐ $x = b\sin\frac{1}{3}t^3$ ☒ $y = b\sin\frac{1}{3}t^3$

Exercise 3: (7 points)

A skier of mass m = 65 kg has a rectilinear movement on a slope inclined at an angle α = 15° with the horizontal. The skier is subjected to friction equivalent to a force of value f_k= 10 N. Initially, the skier is at point O of the frame (Ox, Oy) without initial velocity. g=9.81(m/s²).



1. Represent qualitatively the external forces exerted on the skier.

2. What is the intensities of the normal forces N for skier ?

$\sum \vec{F} = m\vec{a} \Rightarrow \vec{N} + \vec{w} + \vec{f}_k = m\vec{a}$

the projection on an axis (oy) $\Rightarrow N - mg\cos\alpha = 0 \Rightarrow N = 65 \cdot 9{,}81\cos$

☐ $N = 62N$ ☐ $N = 16.82N$ ☐ $N = 165{,}03N$ ☒ $N = 615{,}92\,N$

3. What is the acceleration of the skier ?

$\sum \vec{F}_{ext} = m\vec{a} \Rightarrow \vec{N} + \vec{w} + \vec{f}_k = m\vec{a} \Rightarrow$ the projection (ox) $\Rightarrow a = \frac{-f_k + mg\sin\alpha}{m}$

☐ $a = 2.69\ m/s^2$ ☐ $a = 2\ m/s^2$ ☒ $a = 2.38\ m/s^2$ ☐ $a = 1.2\,m/s^2$

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

$a = 2{,}38\ m/s^2 = C \Rightarrow$ Uniformly accelerated movement

5. In what is the time required for the skier in order to ke much time will the skier have travel 300 m at a velocity of value 26.72 (m/s)?

$a = \frac{dv}{dt} \Rightarrow \int_{v_0}^{v} dv = \int_{t_0}^{t} a\,dt \Rightarrow v - v_0 = 2{,}38t \Rightarrow t = \frac{26{,}72}{2{,}38}$

☐ $t = 13.36s$ ☐ $t = 9.93s$ ☐ $t = 22.26s$ ☒ $t = 11.22s$

6. Find the coefficient of kinetic friction μ_k for the skier ?

$f_k = \mu_k . N \Rightarrow \mu_k = \frac{f_k}{N} = \frac{10}{615,92}$ (N)

☐ $\mu_k = 0.59$ ☐ $\mu_k = 0.16N$ ☐ $\mu_k = 0,06$ ☒ $\mu_k = 0,01$ (0,5)

Exercise 4: (3 points)

Let a point M located in the (OXY) plane with the following parametric equations:

$$\begin{cases} x(t) = \frac{1}{2}t^2 + 4t - 1 & \cdots\cdots ① \\ y(t) = \frac{1}{2}t^2 + 4t - 2 & \cdots\cdots ② \end{cases}$$

1. Deduce the equation of the trajectory.

② - ① $\Rightarrow y - x = -2 + 1 \Rightarrow y = x - 1$ (1)

2. What is its nature and represent it graphically? (1) the nature is a straight line (rectilinear)