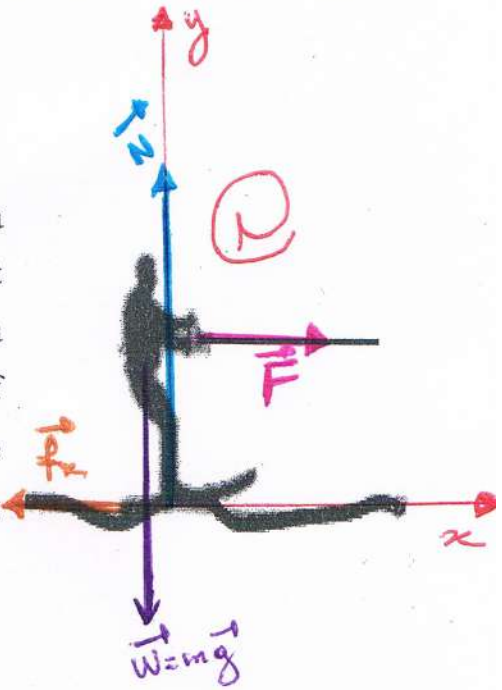
Larbi Ben M'hidi University
Faculty of Exact Sciences, Natural and Life Sciences
1st year LMD (2024-2025)

Exams in physics I

Name:		Section:	Date:11/01/2025
Surname:		Group:	Duration: 01h30

Exercise 1:(7 points)



A man his weight of W=686.7N, slides on a sea surface which is a rectilinear horizontal track with the help of a traction cable. At instant t_0 = 0s without initial velocity, the man starts from rest in a uniformly accelerated motion, under the action of a force of traction $\vec{F}$(exerted by the cable) horizontal and of magnitude F=187.67N. The man travels during this phase 500m during 25swith the presence of a frictional forcef_k = 68.67N.

The value of gravity g=9.81(m/s²).

1. Represent the forces acting on the man.

2. Calculate the mass of the man

$W = mg \Rightarrow m = \frac{W}{g} = \frac{686,7}{9,81} = 70kg \Rightarrow \boxed{m = 70kg}$ (0,25) (0,5)

3. Find the normal force N applied to the man.

$\sum \vec{F}_{ext} = m\vec{a} \Rightarrow \vec{W} + \vec{N} + \vec{f}_k + \vec{F} = m\vec{a}$ (0,5)

$N - W = 0 \Rightarrow N = W = 686,7N$ (0,5) (0,5)

4. Determine the coefficient of kinetic frictionμ_k.

$f_k = \mu_k \cdot N \Rightarrow \mu_k = \frac{f_k}{N} = \frac{68,67}{686,7} = 0,1 \Rightarrow \boxed{\mu_k = 0,1}$ (0,5) (0,5)

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

$\sum \vec{F}_{ext} = m\vec{a} \Rightarrow \vec{W} + \vec{N} + \vec{f}_k + \vec{F} = m\vec{a}$

$-f_k + F = ma$ (0,5) $\Rightarrow a = \frac{-68,67 + 187,67}{70} = 1,7(m/s^2)$

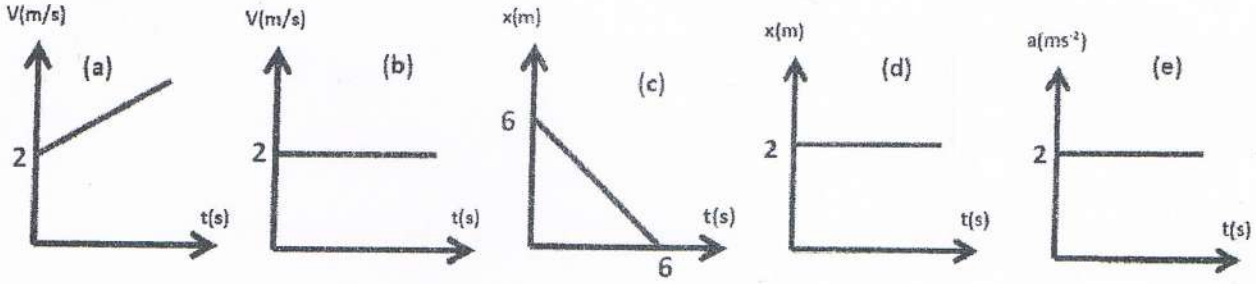
$\boxed{a = 1,7(m/s^2) = C}$ (1)

6. What will be his velocity be at the time 25s?

$a = \frac{dv}{dt} \Rightarrow \int_{v_0}^{v} dv = \int_{t_0}^{t} a\,dt \Rightarrow v - v_0 = 1,7t$ (at $t=0s$, $v_0 = 0(m/s)$)

$v = 1,7t = 1,7(25) = 42,5\ (m/s)$ 0,5

Exercise 2: (3 points)



1. Which graph represents no motion(see figure) Why?

☐ (a) ☐ (b) ☐ (c) ☒ (d) ☐ (e) 0,5

Since its position doesn't change 0,5

2. Graph (a) doesn't represent uniform rectilinear motion. Why?

Since the graph of its velocity is a straight line not parallel to t_axis 1

3. Which graphs represent uniform rectilinear motion?

☐ (a) ☒ (b) 0,5 ☒ (c) 0,5 ☐ (d) ☐ (e)

Exercise 3: (7 points)

The time equations of motion of a material point M with relative to $R(O, \vec{i}, \vec{j}, \vec{k})$ are given by:

$$x(t) = 2bt\cos\omega t, \quad y(t) = 2bt\sin\omega t$$

In these equations b and ω are constants.

1. Calculate the polar coordinates(r and φ) of M as a function of t.

$r = \sqrt{x^2 + y^2}$ 0,5 $\Rightarrow r = \sqrt{(2bt)^2[\cos^2\omega t + \sin^2\omega t]}$

$\cos^2\omega t + \sin^2\omega t = 1$

$r = 2bt$

$\operatorname{tg}\varphi = \frac{y}{x} = \frac{2bt \sin \omega t}{2bt \cos \omega t} = \operatorname{tg} \omega t$

$\Rightarrow \operatorname{tg}\varphi = \operatorname{tg} \omega t$

$\Rightarrow \boxed{\varphi = \omega t}$

- [x] $\begin{cases} r = 2bt \\ \varphi = \omega t \end{cases}$
- [ ] $\begin{cases} r = 4b^2t^2 \\ \varphi = \omega \end{cases}$
- [ ] $\begin{cases} r = 2bt \\ \varphi = \omega \end{cases}$
- [ ] $\begin{cases} r = \sqrt{2bt} \\ \varphi = \omega t \end{cases}$

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

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

- [ ] $\overrightarrow{OM} = 2bt\overrightarrow{U_\varphi}$
- [ ] $\overrightarrow{OM} = \sqrt{2bt}\overrightarrow{U_\rho}$
- [ ] $\overrightarrow{OM} = 2bt\,\overrightarrow{U_\rho}$
- [x] $\overrightarrow{OM} = 2bt\vec{U}_r$

3. Calculate thevelocity vectorof point M in polar coordinates.

- [x] $\vec{V} = 2b\,\vec{U}_r + 2bt\omega\,\vec{U}_\varphi$
- [ ] $\vec{V} = 2b\,\vec{U}_\varphi$
- [ ] $\vec{V} = 2b\,\vec{U}_r$
- [ ] $\vec{V} = 2b\,\vec{U}_\rho$

4. Determine the polar components (V_r and V_φ) of the vector velocity $\vec{V}$.

- [ ] $\begin{cases} V_r = 2b\vec{U}_r \\ V_\varphi = 2bt\omega\vec{U}_\varphi \end{cases}$
- [ ] $\begin{cases} V_r = 0 \\ V_\varphi = 2b \end{cases}$
- [x] $\begin{cases} V_r = 2b \\ V_\varphi = 2bt\omega \end{cases}$
- [ ] $\begin{cases} V_r = 2b \\ V_\varphi = 0 \end{cases}$

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

- [ ] $\vec{a} = 2b\omega\,\vec{U}_\varphi$
- [ ] $\vec{a} = 2bt\vec{U}_\varphi$
- [x] $\vec{a} = -2bt\omega^2\vec{U}_r + 4b\omega\vec{U}_\varphi$
- [ ] $\vec{a} = b\ddot{\vec{U}}_r$

6. Find the cylindrical components (a_r and a_φ) of the vectoracceleration $\vec{a}$.

- [x] $\begin{cases} a_r = -2bt\omega^2 \\ a_\varphi = 4b\omega \end{cases}$
- [ ] $\begin{cases} a_r = 0 \\ a_\varphi = 2b\omega \end{cases}$
- [ ] $\begin{cases} a_r = 0 \\ a_\varphi = 2bt \end{cases}$
- [ ] $\begin{cases} a_r = -2bt\omega^2\,\vec{U}_r \\ a_\varphi = 4b\omega\,\vec{U}_\varphi \end{cases}$

Exercise 4: (3 points)

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

$$\begin{cases} x(t) = \frac{1}{4}t^2 + 3t - 1 & \text{---- (1)} \\ y(t) = \frac{1}{4}t^2 + 3t - 2 & \text{---- (2)} \end{cases}$$

1. Deduce the equation of the trajectory.

(2) − (1) ⇒ $y - x = -2 - (-1) = -1$

⇒ $\boxed{y = x - 1}$ (2)

2. What is its nature and represent it graphically?

the nature is a straight line (rectilinear) (2)