PHYSICS TEST

Les calculatrices et les documents ne sont pas autorisés. Le barème est donné à titre indicatif.

Réponses exclusivement sur le sujet. Si vous manquez de place, vous pouvez utiliser le verso des pages.

Exercise 1. **Lecture questions [2.5 POINTS](No negative points)**

Select the correct answer

1. A motion is said uniform if

    a. Its trajectory is a straight line.

    b. Its acceleration is constant over time.

    c. Its velocity is constant over time.

    d. Its velocity and acceleration vary very few over time.

2. In polar coordinates, $(\overrightarrow{u}_\rho, \overrightarrow{u}_\theta)$, position vector $\vec{r}(t) = \overrightarrow{OM}(t)$ has for expression:

    a. $\vec{r}(t) = \rho\overrightarrow{u}_\rho + \theta\overrightarrow{u}_\theta$

    b. $\vec{r}(t) = \rho\overrightarrow{u}_\rho$

    c. $\vec{r}(t) = \theta\overrightarrow{u}_\rho + \rho\overrightarrow{u}_\theta$

    d. $\vec{r}(t) = \rho\overrightarrow{u}_\theta$

3. A moving particle has a rectilinear trajectory along the X-axis. Its trajectory equation is $x(t) = 10 - 2t^2$.

    a. The motion is uniform.

    b. The motion is uniformly circular.

    c. Le mouvement est decelerated.

    d. Acceleration magnitude is $2\ m/s^2$

4. Consider a moving particle whose position at each instant t is given by its position vector $\vec{r}(t) = \overrightarrow{OM}(t)$. Acceleration vector $\overrightarrow{a}(t)$ of this motion has for expression:

    a. $\overrightarrow{a}(t) = \dfrac{dr(t)}{dt^2}$

    b. $\overrightarrow{a}(t) = \dfrac{d^2\vec{r}(t)}{dt^2}$

    c. $\overrightarrow{a}(t) = \left[\dfrac{d\vec{r}(t)}{dt}\right]^2$

    d. $a(t) = \sqrt{r}(t)$

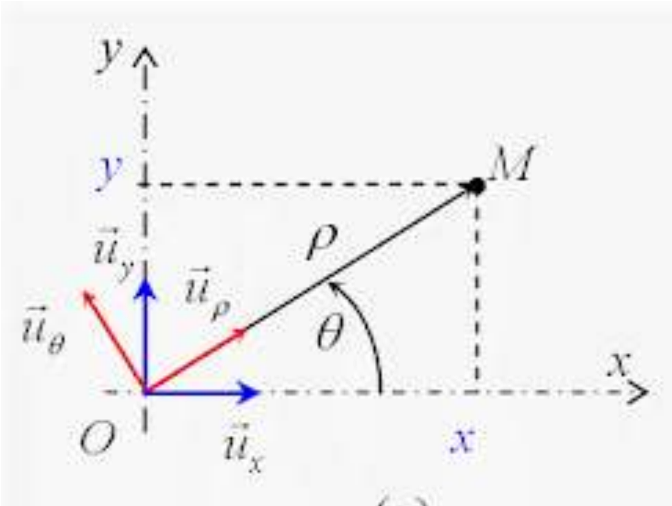
5. Two vectors are perpendicular if their scalar product is equal to zero.

    a. TRUE

    b. FALSE

EXERCISE 2 : **CARTESIAN AND POLAR COORDINATES [8 POINTS]**

Diagram below shows on the same plane, polar and cartesian coordinates representations.



(a)

1. Express $\vec{u}_\rho$ and $\vec{u}_\theta$, the unit vectors of the polar basis, as functions of θ and cartesian unit vectors $\vec{u}_x$ and $\vec{u}_y$.

2. a. Calculate $\frac{d\vec{u}_\rho}{d\theta}$, derivative of unit vector $\vec{u}_\rho$ with respect to θ angle.

b. Express $\frac{d\vec{u}_\rho}{d\theta}$ as a function of $\vec{u}_\theta$

3. a. Calculate $\frac{d\vec{u}_\theta}{d\theta}$, derivative of unit vector $\vec{u}_\theta$ with respect to θ.

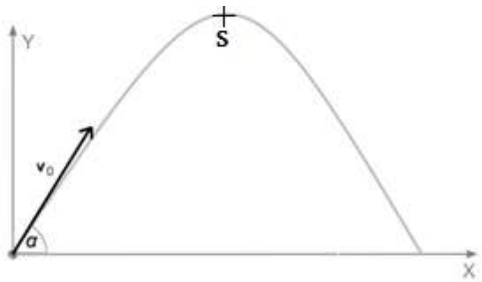
b. Express $\frac{d\vec{u}_\theta}{d\theta}$ as a function of $\vec{u}_\rho$

4. M point represents position of a moving particle. Express its position vector $\vec{r}(t) = \overrightarrow{OM}(t)$ in cartesian basis and in polar basis.

5. Give the general expression of velocity vector $\vec{v}(t)$ and then give its expression in polar basis. Detail your calculations.

EXERCISE 3 : MOTION OF A PROJECTILE [5,5 POINTS]

Consider a projectile launched from the origin point (0;0) of a cartesian frame at instant $t = 0$ s. It is launched by forming an angle α with the X-axis. S point, called the apex, corresponds to the top of the trajectory.



$\vec{r}(t) = \overrightarrow{OM}$, the position vector, is :

$$\overrightarrow{OM} = (v_0 \cos\alpha) \cdot t \ \vec{u}_x + \left[(v_0 \sin\alpha) \cdot t - 5t^2 \right] \vec{u}_y$$

1. a. Give the hourly equations, $x(t)$ and $y(t)$, of this motion.

b. Give the trajectory equation of this motion.

2. Give the expression of velocity vector $\overrightarrow{v}(t)$. Express its magnitude.

3. At the top of trajectory, V_y (the Y-axis component of velocity vector) is equal to zero. Calculate the maximal height reached by the projectile as a function of V_0 et α angle.

<u>EXERCISE 4</u> : ACCELERATION IN POLAR COORDINATES [4 POINTS]

For any motion, acceleration expression in polar coordinates is $\overrightarrow{a}(t) = (\ddot{\rho} - \rho\dot{\theta}^2)\overrightarrow{u}_\rho + (\rho\ddot{\theta} + 2\dot{\rho}\dot{\theta})\overrightarrow{u}_\theta$

1. What is the acceleration expression if the motion is circular ? Justify your answer.

2. What is the acceleration vector expression if the motion, in addition of being circular, is also uniform. Justify your answer.