



## Final Exam of Mechanics

(Authorized calculator)

### Course questions: (05 pts)

- 1- Which laws are used to study the motion of a system subject to frictional forces?
- 2- Demonstrate and state the fundamental principle of dynamics (Newton's 2nd law).
- 3- To lift a car with a mass of one and a half tons, a force  $F$  of 15,000N vertical to the car is required. Calculate the work done by this force to move the car from a height (AB) of 3 meters.
- 4- What does the modulus of the vector product and the mixed product represent?

### Exercise 1: (07 Pts)

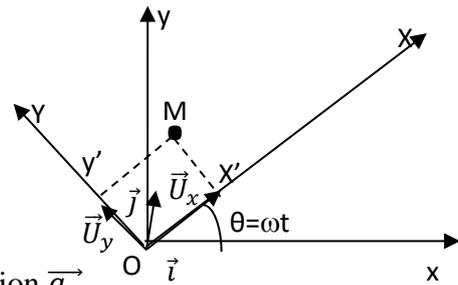
In the Oxy plane, consider a system of moving axes (OXY) such that Ox makes a variable angle  $\theta$  with OX (rotation around (oz) with a **constant angular** velocity  $\omega$ ). The coordinates of a moving object M in the moving frame of reference are given by:  $X'=t^2$  and  $Y'=t$ .

At time  $t=0$ , the axis (O'X) coincides with (Ox).

Calculate in the moving reference frame :

1- The relative speed  $\vec{v}_r$  and training speed  $\vec{v}_e$ , deduce the absolute speed  $\vec{v}_a$ .

2- Relative acceleration  $\vec{a}_r$ , training acceleration  $\vec{a}_e$ , Coriolis acceleration  $\vec{a}_c$ , deduce the absolute acceleration  $\vec{a}_a$ .



### Exercise 2: (08 Pts)

A ball B of mass  $m$ , attached to an inextensible wire of length  $l$ , is moved away from its equilibrium position by an angle  $\alpha$ . It is dropped without initial velocity.

Passing through the vertical position, the ball strikes (touches) a body A of the same mass and stops, body A passes from point O to point C ( $OC=d$ ) on a rough horizontal plane of friction coefficient  $\mu$ .

1- Express the velocity of ball B just before touching body A.

2- Represent the forces exerted on body A.

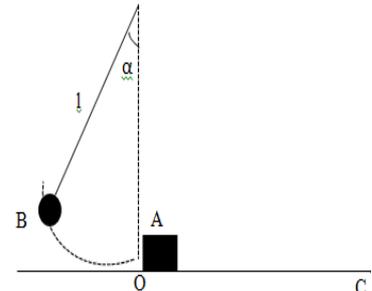
3- What is the nature of the motion on the horizontal plane (OC)?

4- Using the principle of conservation of momentum of the system, determine the velocity of body A after the interaction.

5- If  $v_A=v_B$  at point O, give **the expression** for the velocity of body A at point C as a function of  **$g, l, d, \alpha$  and  $\mu$** .

6- By what angle must ball B be moved away for body A to arrive at point C with zero velocity?

Given:  $l=30$  cm,  $g=10\text{m/s}^2$ ,  $\alpha=30^\circ$ ,  $\mu=0.1$ ,  $d=3\text{m}$  and  $m=0.5\text{kg}$ .



**Good luck**