INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

SCAN 1st

Mechanics test 1

Friday, 4th March 2022 – Duration: 1h

1-page personal formula sheet authorised.

Exercise 1:

The aircraft in Figure 1 is diving at an angle α from the vertical at a speed v_0. The flight path is directed towards the target at A.

1 - If the aircraft drops a package at an altitude h, determine the time t^* when the package hits the ground ($y = 0$)

2 – Deduce the distance d between the point of impact and the target at A.

3 – Numerical application for $\alpha = 30°$; $h = 1200\,\text{m}$; $v_0 = 200\,\text{m/s}$

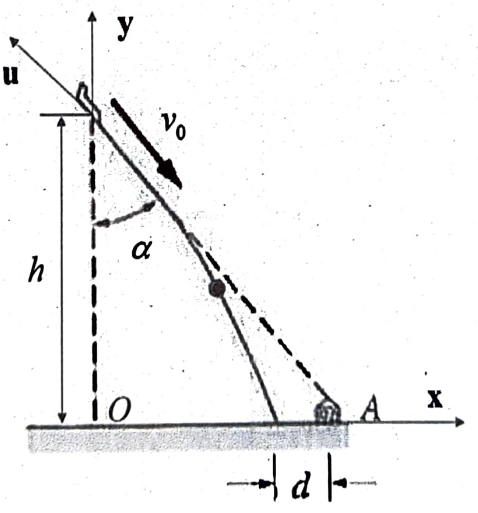

Figure 1.

Exercise 2:

A ball of mass m is suspended from the accelerating frame by two strings A and B (Figure 2). Considering that the frame and ball experience the same acceleration $\mathbf{a} = a\,\mathbf{x}$,

1 – Determine the tensions in strings A and B in terms of m, a and g (acceleration of the gravity field).

Ma. h

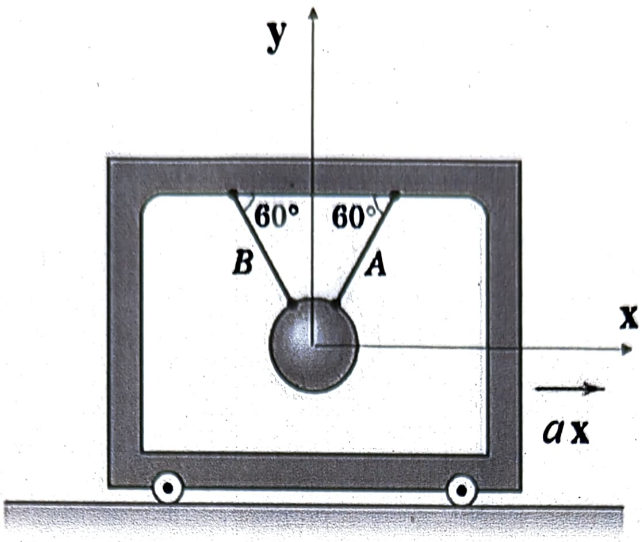

Figure 2.

Exercise 3:

The rocket in Figure 2 is tracked by radar, which measures $r, \dot{r}, \ddot{r}$ and θ.

1 – Using the fact that the trajectory is a vertical line in the $\mathbf{y}$-direction, express the angular speed $\dot{\theta}$ in terms of the measured variables. Deduce the speed (magnitude of velocity vector) when $r = 5\,\text{km}$, $\dot{r} = 350\,\text{m/s}$, $\ddot{r} = 100\,\text{m/s}^2$ and $\theta = 40°$

Bonus question – Same question for the acceleration.

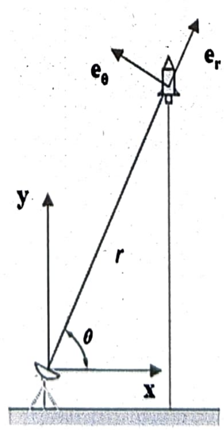

Figure 3.