Exercise 01:

The position vector expressions for a particle moving with respect to a fixed reference R and a reference moving horizontally with a constant velocity V_0 are given as follows:

$\overrightarrow{OM} = t\,\vec{\imath} + t^2\vec{\jmath} + (2t+3)\,\vec{k}$; $\overrightarrow{O'M} = t\,\vec{i'} + t^2\vec{j'} + (4t+3)\,\vec{k'}$

- Write the expression the position vector $\overrightarrow{OO'}$

- Write the expression of the absolute velocity and relative velocity of M.

- Deduce the entrained velocity and the nature of the movement of R' in relation to R.

- Determine the absolute acceleration, entrained acceleration, and relative acceleration of M

Exercise 02:

The motion of a mobile is defined by the position vector in a mobile frame R':

$$\overrightarrow{O'M} = 5t\,\vec{i'} + (2t^2 - t)\vec{j'} - 2t\,\vec{k'}$$

This frame undergoes rectilinear translational motion with respect to a fixed reference R, characterized by a velocity vector $\overrightarrow{V_e} = 2t\,\vec{\imath} + \vec{\jmath} + \vec{k}$

- *Determine the expression for the absolute velocity of M concerning the reference R.*
- *Calculate both the relative and absolute acceleration of the mobile M. Deduce the coriolis acceleration*

Exercise 03:

A swimmer is crossing a river with a width of L = 1 km, moving from one bank to the other perpendicular to the current at a constant velocity v = 0.5 km/h. The current velocity is = 2 km/h.

- *What do these two velocities represent?, Write their analytical expressions in the Cartesian coordinate system (xoy).*
- *Calculate the angle at which the swimmer deviates.*
- *Determine the swimmer's trajectory, velocity, and the time required to reach the opposite bank.*
- *If the swimmer intends to reach a point directly opposite the starting bank, what should be the initial direction? Calculate the time needed to reach the opposite bank under these conditions.*

Exercise 04:

A ball falls without initial velocity from a building of height H, and its descent follows uniformly accelerated motion with acceleration g.

- *Determine the trajectory of the ball in a reference frame linked to a car moving at a constant velocity, passing through the vertical drop point at the moment of release.*
- *Identify the trajectory of the ball in a reference frame tied to a car moving along a uniformly accelerated straight path with acceleration g, passing vertically under the point of descent at the moment of departure.*

Exercise 05:

While driving in the rain at 100 km/h on a flat road, a driver notices that raindrops, seen through the side windows of the car, follow trajectories making an angle of $(\frac{\pi}{6} rad)$ *with the vertical. Upon stopping the car, the driver observes that the rain is actually falling vertically. Calculate the velocity of the rain relative to the stationary car and relative to the car moving at 100 km/h.*

Exercise 06:

In the coordinate system $R'(O', \vec{i'}, \vec{j'}, \vec{k'})$*, the Cartesian coordinates of a material object M are expressed as functions of time:* $' = t^2 + 3t$, $y' = t$, $z' = -t^3$*. The coordinate system R' movesin a uniform rectilinear translation with a velocity vector* $\overrightarrow{V_e} = -3\vec{\imath} + 5\vec{k}$ *relative to an absolute coordinate system R.*

1. *Determine the expression for the velocity vector of M relative to coordinate system R.*
2. *Infer the coordinates of M in coordinate system R, given that att=0, in coordinate system R, M is located at the point (0, 1, 0).*
3. *Calculate the relative and absolute accelerations of M.*