Physics 01: Mechanics of point particle.   **University Year 2023-2024**

Series N° 03: Relative motion

EXERCISE 01

The position vector of a particle is: $\vec{r} = 4\,t\,\vec{\imath} - 2\,t^2\vec{\jmath} + \vec{k}$ (m) with respect to a frame of origin at rest O.

The position vector of the same particle with respect to another frame of origin O' moving at constant

velocity with respect to O is: $\vec{r'} = 8\,t\,\vec{\imath} - 2\,t^2\vec{\jmath} + \vec{k}$ (m).

Calculate:

1- The velocity vector of O' with respect to O.

2- The acceleration of the particle with respect to both frames of reference.

EXERCISE 02

A plane flies at 11 km/h on a bearing of 30°.
The wind appears to be coming from 80° at
20 km/h (See fig.1).
What is the real velocity of the wind? Determine
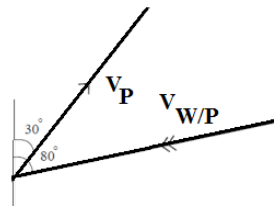its direction with respect to Y axis.

Fig.1

EXERCISE 03

A 400 m wide river is flowing at a rate of 2 m/s. A boat is sailing with a velocity of 10 m/s with

respect to the water, in a perpendicular to the river.

1- Find the time taken by the boat to reach the opposite bank.

2- How far from the point directly opposite to the starting point does the boat reach the opposite bank?

3- In what direction does the boat actually move, with river flow?

EXERCISE 04 (homework)

A man moving with 5 m/s observes rain falling vertically at the rate of 10 m/s. Find the velocity and

direction of the rain with respect to ground.

EXERCISE 05 (homework)

You are riding in a boat with a velocity relative to the water of $V_{b/w} = 6.1$ m/s. The boat points at an angle of $\theta = 25°$ upstream on a river flowing at 1.4 m/s.
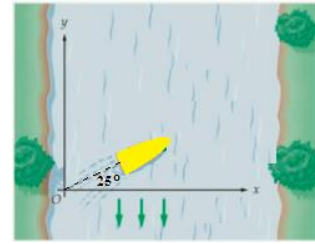
1- What is your velocity $V_{b/g}$ and angle $\theta_{b/g}$ relative to the ground?

EXERCISE 06

Boat A is travelling forward (in positive y) with a velocity of 25 m/s and an acceleration of 4 m/s^2. The person in dingy B is travelling in a circle (as they only have one oar). They have a forward (in positive y) velocity of 5 m/s and acceleration of -1 m/s^2 (as they have lost focus while watching boat A). The radius of dingy B's path is r = 20 m, and the distance between the vessels is d = 10 m.

1- Find the velocity and acceleration of boat A as seen by the occupants of dingy B.
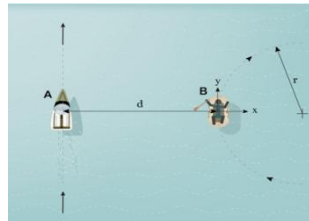
EXERCISE 07

In the xOy plane, a disc of radius R rolls without slipping about the Oz axis at a constant angular velocity w. The center of the disc is moving in a straight line with a constant velocity V_0. An object M moves from point A along the diagonal in a uniform rectilinear motion with the velocity V' in negative y (see figure). At time t=0, A is on axis oy.

1. Determine the relationship between V_0 and W.

2. Determine the absolute velocity by:

a- Derivation of the position vector.

b- Using the law of addition.

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