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Series N°1: Fundamental concepts (Mathematical review)

Exercice 1

1. Using the dimensional analysis, give the dimension and the unity of speed (V), acceleration (γ), force (f), and work (W).
2. In the first assumption, we consider the period of a pendulum is proportional to its mass (to the power of α) and to its length (to the power of β), and to gravitational constant g. Find α and β discuss the result.
3. Suppose that the acceleration γ of a particle moving with uniform speed v in a circle of radius r is proportional to some power of r (r^{α}) and some power of v (v^{α}). Determine the values of α and β and write the simplest form of an equation for the acceleration.
4. Newton's law of universal gravitation is given by the relation $f = G\frac{m_1 \times m_2}{r^2}$, (G is the constant of gravity, $m_1 and\ m_2$ are the masses of the bodies, and r is the distance between them). Based on the results above (the unit of force), give the Si unit to G.

Exercise 2

- In the Cartesian system, represent the vectors $\vec{V}_1 = 3\vec{\imath} - 4\vec{\jmath} + 4\vec{k}$, $\vec{V}_2 = 2\vec{\imath} + 3\vec{\jmath} - 4\vec{k}$,

$\vec{V}_3 = 5\vec{\imath} - \vec{\jmath} + 3\vec{k}$, $\vec{V}_2 - \vec{V}_1$, $\vec{V}_3 + \vec{V}_2$

- The magnitude of $\vec{V}_1$, $\vec{V}_2$, $\vec{V}_3$ and $\vec{V} = 2\vec{V}_1 + \vec{V}_2 - \vec{V}_1$.
- Determine the vector unity of $\vec{V} = \vec{V}_1 + \vec{V}_2$.
- Calculate the scalar product of $\overrightarrow{V_1} \cdot \vec{V}_2$, and $\overrightarrow{V_1} \cdot \vec{V}_1$, deduce the angle between them.
- Calculate the cross product of $\vec{V} = \overrightarrow{V_1} \times \vec{V}_2$, deduce the angle between them.

Exercise 3

Calculate the area of the parallelogram constructed by

$\vec{V}_1 = 3\vec{\imath} - 4\vec{\jmath} + 4\vec{k}$ and $\vec{V}_1 = -3\vec{\imath} + 2\vec{\jmath} + 3\vec{k}$.

Exercise 4

- Represent the triangle constructed by the points M_1(4, 2, -1), M_2(2, 3 5) and M_3(2, 2, 2) in the Cartesian system and calculate its area.

Exercise 5

- Calculate the volume of the parallelepiped constructed by $\vec{V}_1 = -3\vec{\imath} - 4\vec{\jmath} + 4\vec{k}$, $\vec{V}_2 = 2\vec{\imath} + 3\vec{\jmath} - 4\vec{k}$, and $\vec{V}_3 = 3\vec{\imath} - 2\vec{\jmath} + 3\vec{k}$.

Exercise 6: For $\vec{V} = (t^2 + 2t)\vec{\imath} - 4\sin(2t)\vec{\jmath} + 4e^t\vec{k}$, calculate $\frac{d\vec{V}}{dt}$.

For $\vec{V}_1 = t^3\vec{\imath} - 3t^2\vec{\jmath} + 3\vec{k}$ and $\vec{V}_2 = 2\cos(3t)\vec{\imath} - t\vec{\jmath} + 2t^2\vec{k}$

- Calculate $\frac{d\|\vec{V}_1\|}{dt}$, $\frac{d(\vec{V}_1.\vec{V}_2)}{dt}$ and $\frac{d(\vec{V}_1\wedge\vec{V}_2)}{dt}$