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Faculty of sciences
Field : Sciences of matter (SM)
1st year LMD Semester 01.

جامعـة محمد بوضياف ـالمسيلـة
كليـة العلـوم
ميدان : علوم المادة
السنة الأولى ل م د - السداسي 01

Physics 01: Mechanics of point particle.

University Year 2024-2025

Series N° 01: Mathematical background

EXERCISE 01:

1- Which of the following quantities are vector or scalar quantities?

(a) Velocity (b) Displacement (c) Kinetic Energy (d) Momentum (e) Acceleration (f) Work (g) Weight (h) Power.

EXERCISE 02:

1- What are the dimensions of the following quantities?

- Velocity ($\boldsymbol{v}$), Acceleration (**a**), Force (**F**), Density (ρ, which is mass per unit volume), Pressure (**P**, which is force per unit area).

2- For a fluid with constant density ρ, the velocity $\boldsymbol{v}$, pressure **P** and height **h** are related by Bernoulli's equation:

$$\boldsymbol{P + \frac{1}{2}\rho v^2 + \rho g h = Constant}$$

g is the acceleration due to gravity.

Show that the left side of the Bernoulli's equation is dimensionally consistent.

3- Use dimensional analysis to determine which of the following equation is certainly wrong?

$$\boldsymbol{\lambda = vt} \quad , \quad \boldsymbol{F = \frac{m}{a}} \quad , \quad \boldsymbol{F = \frac{mv}{t}} \quad , \quad \boldsymbol{h = \frac{v^2}{2g}}$$ (λ and h are lengths)

EXERCISE 03 (home work):

The speed of sound, v, in a gas might plausibly depend on the pressure, p, the density, ρ, and the volume, V , of the gas. Use dimensional analysis to determine the formula of v

EXERCISE 04:

1- The magnitude of the centripetal force F_c acting on an object is a function of mass *m* of the object, its velocity υ, and the radius *r* of the circular path. By the method of dimensional analysis, find an expression for the centripetal force.

2- The frequency of vibration *f* of a mass *m* at the end of spring that has a stiffness constant *k* is related to *m* and *k* by a relation of the form $f = (constant)m^a k^b$.

Use dimensional analysis to find *a* and *b*. it is known that $[f]=[T]^{-1}$ and $[k] = [M][T]^{-2}$.

EXERCISE 05:

1- Newton's law of universal gravitation is given by $F_G = \boldsymbol{G}\,\frac{\boldsymbol{m_1 m_2}}{\boldsymbol{r^2}}$, where F_G is the force of attraction of one mass m_1 upon another mass m_2 at a distance $\boldsymbol{r}$. Find the SI units of the constant G.

2- Find the exponents n and m in the formula : $\boldsymbol{x} = \frac{1}{2}\,\boldsymbol{a^n t^m}$

Where x: distance, a: acceleration and t: time.

EXERCISE 06:

1- Represent the following points in the Cartesian referential: $M_1(3,1,-2)$, $M_2(1,2,1)$, $M_3(-3,2,1)$, $M_4(-1,1,2)$ and find the vectors $\vec{A} = \overrightarrow{M_1M_2}$ **and** $\vec{B} = \overrightarrow{M_3M_4}$

2- Calculate: (a) $\vec{A} + \vec{B}$, (b) $\vec{A} - \vec{B}$, (c) $\|\vec{A}\|$, $\|\vec{B}\|$, (d) $(\vec{A} + \vec{B})^2$, (e) $A^2 + B^2$, (f) $\vec{A}\,.\vec{B}$, (g) the angle between $\vec{A}$ and $\vec{B}$, (h) $\vec{A} \wedge \vec{B}$, (i) the directional cosines of $\vec{A}$ and $\vec{B}$, (j) the unit vector of $\vec{A}$ and $\vec{B}$**.**

3- Given the vector $\vec{C} = x\vec{i} + \vec{j} + z\vec{k}$; find x and z for each case: (a) $\vec{C}$ parallel to $\vec{A}$, (b) $\vec{C}$ is perpendicular to ($\vec{A}$ and $\vec{B}$) at the same time.

EXERCISE 07 (home work):

Relative to a fixed origin *O*, the respective position of three points *A* , *B* and *C* are:

A(3,2, 9), B(-5,11,6), C(4, 0, -8)

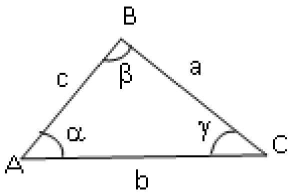
1- Determine, in component form, the vectors $\overrightarrow{AB}$ and $\overrightarrow{AC}$

2- Find the angle BÂC .

3- Calculate the area of the triangle BAC.

EXERCISE 08:

1- By using the properties of the vector product, show that the following equation is satisfied in triangle ABC (see figure 1): $\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$



2- Prove that:

$$\cos\alpha = \frac{b^2 + c^2 - a^2}{2bc}$$

EXERCISE 09:

1- Given $\vec{A} = 3t\vec{i} - (t^2 + t)\vec{j} + (t^3 - 2t^2)\vec{k}$. Calculate $\frac{d\vec{A}(t)}{dt}$ and $\frac{d^2\vec{A}(t)}{dt^2}$. Apply for t=2 s.

2- Given $\vec{B} = e^{-wt}\vec{i} + \sin wt\vec{j} + \cos wt\vec{k}$ (w is constant). Calculate $\frac{d\vec{B}(t)}{dt}$ and $\frac{d^2\vec{B}(t)}{dt^2}$

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