University Of Oran - 2 **Academic year 2023-2024**
Faculty of Earth and Universe Sciences
Department of Earth Sciences - Level L1

DIMENSIONAL EQUATIONS, UNITS AND UNCERTAINTIES

Exercise 1

1- Establish the dimensions and units of the following quantities:
Angular velocity ($\dot{\alpha}$), angular acceleration ($\ddot{\alpha}$), work(w), kinetic energy(Ec), power(P), gravity constant (g), pressure(p_r), amount of movement(P_Q).

2- Give the dimensions as well as the SI units
a- The permittivity of the vacuum, ε which appears in the expression of the electrical interaction force (Coulomb's law),

$$\mathbf{F} = \frac{\mathbf{1}}{\mathbf{4\pi\varepsilon_0}} \cdot \frac{\mathbf{qq'}}{\mathbf{r^2}}$$

b- The dimension of G which appears in the this expression. Two point masses m and m' attract each other according to Newton's law of attraction,

$$\mathbf{F} = \mathbf{G}.\frac{\mathbf{mm'}}{\mathbf{r^2}}$$

c- of α,β and γ in the following relation:

$$\left(\mathbf{A} + \frac{\boldsymbol{\alpha}}{\mathbf{V^2}}\right)(\mathbf{V} - \boldsymbol{\beta}) = \boldsymbol{\gamma}\mathbf{T}$$

The unit of A is $\left(dyne/cm^2\right)$, V is the volume and T is the temperature

Exercise 2

A sphere of radius R and density ρ Progressing in a liquid of Viscosity coefficient η with a speed V, $V = \frac{2}{9} R^2 g\left(\frac{\rho-\alpha}{\eta}\right)$, g being the Earth's acceleration

- **a-** Determine the dimensions of η and α.
- **b-** What is the unit of η and α in CGSA and MKSA.

Exercise 3

The period T of a pendulum, formed by a ball of radius R, attached by a wire of length L, is given by the relation: $T = \frac{KR^2}{\eta}$.
Where K is dimensionless constant,
Ƞ: air viscosity coefficient whose unit is ($kg.m^{-1}\ s^{-1}$) and b: density of the ball. Find the dimension of T.

1- What is its unit in the international system (MKSA)?
The period T of a simple pendulum of mass m and length L can be put in the form: ($T = A.g^x.L^y.m^z$), g being the acceleration of gravity and has a dimensionless constant.

2- Deduce the expression of T.

Exercise 4

Check the homogeneity of the following expressions:
Here are three hourly equations describing the movement of an object in which: x designates the distance traveled, v the speed, a the acceleration, t the time

$$x = v\sqrt{t} \qquad x = vt + \frac{1}{2}at^2 \qquad x = vt + 2at^2$$

Here are three expressions for the period of revolution of a satellite orbiting the planet Mercury where m represents the mass of mercury and r the radius of the circular orbit of the satellite

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$$T = 2\pi\sqrt{\frac{r}{Gm}} \qquad T = 2\pi\sqrt{\frac{Gm}{r^3}} \qquad T = 2\pi\sqrt{\frac{r^{\ 3}}{Gm}}$$

Determine by the dimensional analysis method the correct expression for the period, knowing that G has the dimension $L^3\ M^{-1}\ T^{-2}$.

Exercise 5 (Work home)

Experience has shown that the speed v of sound in a gas is a function only of the density of the gas ρ and of its compressibility coefficient χ. It is given by $= k\rho^x\ \chi^y$. It is recalled that χ is homogeneous on the inverse of a pressure; k is a dimensionless constant. Determine the relationship of the speed of sound v.

Exercise 6

The moment of inertia I (its unit in the international system Kg .m^2) of a homogeneous tube with respect to its axis is given by the following relation

$$\boldsymbol{I = \frac{1}{12}\rho^{\alpha}.x.y^{\beta}.z.[x^2 + y^{\gamma}]}$$

x represents the length of the tube, y its width, z its thickness and ρ its density
Determine the value of the exponents α,β and γ and give the final expression of the moment of inertia
What is the accuracy on I if $\frac{\Delta x}{x} = \frac{\Delta y}{y} = \frac{\Delta z}{z} = \boldsymbol{10^{-3}}\ \ \boldsymbol{et}\ \ \frac{\Delta\rho}{\rho} = \boldsymbol{10^{-2}}$

Exercise 7

In order to find the average speed of a mobile on an air cushion table, a student measures the distance d traveled during a time interval t. he finds d = (5.10±0.01) m et t = (6.02±0.02) s. the uncertainties are independent.

1. What is the value of the velocity V as well as its absolute uncertainty ΔV ?
2. What is the real value of the momentum of the mobile (p = m.V), knowing that its mass is : m = (0.711 ± 0.002) kg.

Exercise 8

The torsion constant C of a metal wire of circular cross section (its unit in SI is kg.m^2/s^2) is expressed as a function of its length l and its diameter d by the relation :$\mathbf{C = Y^a\frac{d^b}{l}}$

Où Y is the torsion modulus (or Coulomb coefficient) characterizing the nature of the wire. Knowing that Y is homogeneous at a pressure.

1. Calculate the exponents a and b.et give the final expression of C.
2. Literally calculate the accuracy on C.

Exercise 9

The height H of a liquid of mass M contained in a cylinder of radius R is given by the relation: $H = \frac{2\sigma cos\alpha}{\rho.gR}$

Where α is the liquid-cylinder contact angle and ρ represents the density of the liquid and g the acceleration of gravity.
1. Find the dimension of the quantity σ.
2. Find the expression for the relative uncertainty on σ as a function of ΔR; Δg; ΔM et $\Delta\alpha$.