University Aboubekr-Belkaid-Tlemcen,

Faculty of Sciences ST-2023/24

**Series of problems N°1 Dimensional analysis**

**Problem 1**

Consider the Table below and complete columns.

|  |  |  |  |
| --- | --- | --- | --- |
| **Physical quantities and symbols** | **Equation** | **Dimensional equation** | **Unit in MKSA** |
| Frequency, f |  |  |  |
| Wavelength, λ |  |  |  |
| Potential energy, Ep |  |  |  |
| Electric charge, q |  |  |  |
| Centripetal force, Fr |  |  |  |
| Electric energy, W |  |  |  |

**Problem 2**

Let us consider the force F which is expressed by the following relationship:

F = αmv + βv2

where m and v represent the mass and velocity of a particle, respectively.

Find the dimensions of the parameters α and β and their units.

**Problem 3**

Consider a spherical object of radius *a*, mass *m* and density *ρ0*. This object moves under such conditions, the object undergoes a friction force with a velocity *v* in a liquid of density *ρ1* and viscosity *η*. In such condition, the force *F* inducing the displacement of the particle in the solution has the form:

*F = λv*

Where the velocity is given by

*g* being the constant of gravity.

Find dimensional equations of the parameters *λ* and *η*.

**Problem 4**

Experimentally, it is verified that the velocity *v* of sound in a gas depends only on the density *ρ* and compressibility coefficient *χ* of the gas. We recall that the dimension of *χ* is inverse of dimension of pressure.

Using the dimensional analysis method, find the expression of the velocity *v*.

**Problem 5**

Consider a cylindrical object of diameter *d*, height *h* and mass *m*. Its density *ρ* is given by the relationship:

Using the dimensional analysis, deduce the exponents α and β.

**Problem 6**

A mobile point moves with the instantaneous velocity *v(t)* given by the relationship:

*v(t) = At2 – Bt +* , where *t* is time.

Find the dimensional equation and unit of the parameters *A, B* and *C*.

**Problem 7**

A) Consider the following cases of dynamical equations representing the position a particle during its motion:

(a) 𝑥 = 𝑣

(b) 𝑥 = 𝑣𝑡 +

(c) 𝑥 = 𝑣𝑡 + 2𝑎

Where *x, v, a*, and *t* are displacement, velocity, acceleration and time, respectively. Check the homogeneity of these previous equations.

B) Consider three relations of the motion periodicity of a satellite that turns around the earth:

(a)

(b)

(c)

Where *G* is the gravitational constant. We recall that dim(G)= .

Use the method of dimensional analysis to select the correct expression of the period *T*.