KHEMIS MILIANA University

Faculty of Science and Technology
Department of Science of Matter - L1 ST-SM
Exercise Series of GW of Physics 1, 2023-2024
Exercise Series Number 1. Part II. Dimensional Analysis and Units of Measure

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In the course physics 1 you may need :

Quantity	Symbol	Dimension	(MKSA) unit	(CGS) unit	The ratio of MKSA to CGS
Length	ℓ	L	meter (m)	centimetre (cm)	10^2
Masse	m	M	kilogramme (kg)	gramme (g)	10^3
Time	t	T	second (s)	second (s)	1
Current Intensity	I	I	Ampere (A)	Electro static unit (e.s.u.)	3×10^9
Temperature	T	θ	degree Kelvin ($^\circ K$)	Kelvin degree ($^\circ K$)	1
luminous intensity	I_v	J	candela (cd)	candela (cd)	1
Quantity of matter	n	N	mole (mol)	?	?

Table 1: Dimensions and units of physics quantities

*Exercise 1:

Write the dimensional formula of any physics quantity in its most general mathematical form, depending on any other quantity from the table above.

Exercise 2:

From the simplest fundamental equations, write the corresponding dimensional formula for:

1. the velocity of a mobile in rectilinear motion.
2. the acceleration of a mobile in rectilinear motion.
3. the weight of an object subject to Earth's gravitational force.
4. the area of a triangle, a square, and a rectangle.
5. the volume of a sphere.

6. the momentum of a force.
7. the kinetic energy of a particle.

*Exercice 3:

Consider a simple pendulum whose period is solely determined by its length and the gravitational acceleration. Commence by deriving the dimensional formula for the period of this pendulum. Subsequently, formulate an expression for the period in terms of these two fundamental quantities.

Exercise 4:

A particle with charge q and velocity $\overrightarrow{v}$ immersed in a magnetic field $\overrightarrow{B}$ experiences a force known as the Lorentz force, given by $\overrightarrow{F} = q\overrightarrow{v} \times \overrightarrow{B}$. By conducting a dimensional analysis, determine the dimension of the magnetic field. What are its units in both the MKSA and CGS systems.

Exercice 5:

The speed as a function of time of a particle moving in a viscous fluid is given in the (SI) system by the expression $v = \dfrac{F}{K\eta}\left(1 - e^{-(K\eta/m)t}\right)$, where F is a frictional force, K is a constant with dimensions of length, η is the viscosity of the fluid, m is the mass of the particle, and t is the time. What is the dimension and unit of the parameter η.

Exercice 6:

Through dimensional analysis, determine the constants α and β in the expression for velocity $v = \sqrt{g^{\alpha}\ell^{\beta}}$, where g is an acceleration and ℓ is a length.

Exercice 7:

A wooden ball falls vertically through the air at a speed v. The air resistance force takes the form $f = \rho_0 S C_x v^2$ (with ρ_0 as the air density, S as the cross-sectional area of the ball, and C_x as the coefficient of air penetration). What is the unit of the air penetration coefficient C_x.

References