Badji Mokhtar University -Annaba
Computer Sciences
Electronic Department

Mechanics of the material point

Chapter 1

Part one

Mathematicals reminders

Dimensional analysis

* General informations on physical quantities

* * Systems of units

* ** Dimensional equation

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* General in information on physical quantities

We have two kind of physical quantities, like fundamental quantities and derived quantityies.
* Fundamental quantities: the value of physical quantity is measurables. That is to say it can increase or decrease, the seven basic quantity are given by the following table:

Fundamental quantity	**Symbol**
Length	L (x, d)
Mass	M
Time	T
Electrical intensity	I
Temperature	T
Luminous intensity	J (Iv)
Amount of substance (quantity of matter)	N

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* General in information on physical quantities

- Derived quantities : these quantities are expressed as a combination of the seven fundamental quantitys like velocity, acceleration, power, force……

Derived quantity	**symbol**	**Laws of physics**	**Derived unit**
Force	F	$F = m\times a$	Newton (N)
Velocity	V	$V = \frac{l}{t}$	m/s
Pression	P	$P = \frac{F}{S}$	Pascal (Pa)
Resistance	R	$R = \frac{V}{I}$	Ohm (Ω)

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* * Systems of units

- A physiqual quantity can be defined by a numerical value and also its unit, which specifies the nature oh this quantity .

for general scientific and engineering purpose we mostly use:

1- The International System of **SI (MKSA)**
(Metre**, K**ilogram**, S**econd**, A**mpere**) = (** the fundamental unit)

2- System **CGS**
(**C**entimeters, **G**rams, **S**econd)

* ** Dimensional equation

Dimension:

In experimental physics, every measured quantity must be described primarily in a qualitative manner: length, time, mass, etc. This qualitative aspect is the dimension of the measured quantity. It is symbolized by the symbol **[G]**

Pyhsical quantity	**SI unit**	**Symbol**	**Dimension**
Time	Second	S	**[T]**
Mass	Kilogram	Kg	**[M]**
Length	metre	m	**[L]**
Electric current	ampere	A	**[I]**
Temperature	Kilvin	K	**[Q] or [θ]**
Amount of substance (quantity of matter)	mole	mol	**[n]**
Luminous intensity	candela	cd	$[I]_L$

Chapter 1

* ** Dimensional equation

When we use dimensional anlysis it allows to:

- Check the validity of dimensional equation.
- Research into the nature of physical quantities.
- Research the homogeneity of physical laws.
- Determine the unit of physical quantities based on essential units (lenght, time, mass).

* ** Dimensional equation

The dimensional equation for any physical quantity is given by:

$$\dim G = [G] = L^{\alpha}\, M^{\beta}\, T^{\gamma}\, I^{\delta}$$

This product called dimensional equation.

[G] →Dimension with quantity.

M→ $Mass$, L→ Lenght, T→ Time, I→Electric current .

$\alpha\ , \beta\ , \gamma\ , \delta\ real\ numbers$.

Example 1: Determine the dimension of velocity v .

Solution:

We have: v = $\frac{x}{t}$; [v] = $[\frac{x}{t}] = \frac{[x]}{[t]} = \frac{L}{T}$.

dimention [v] = LT^{-1}

unit in SI : m s^{-1}.

Example 2: Determine the dimension of acceleration .

Solution:

We have: a = $\frac{v}{t}$; [a] = $[\frac{v}{t}] = \frac{[v]}{[t]} = \frac{L\,T^{-1}}{T}$ = LT^{-2}.

dimention [a] = LT^{-2}

unit in SI : m s^{-2}.

The characteristics of dimensional equation

$$G = A + B \longrightarrow [G] = [A] = [B] \,.$$

$$G = A - B \longrightarrow [G] = [A] = [B] \,.$$

$$G = \frac{A}{B} \longrightarrow [G] = \frac{[A]}{[B]} \,.$$

Example 3: we have: $v = at$

- Prove that this equation is dimensionaly correct.

Solution:

$$[\mathrm{v}] = [\frac{x}{t}] = \frac{[x]}{[t]} = \frac{L}{T} = LT^{-1}$$

$$[\mathrm{a}] = [\frac{v}{t}] = \frac{[v]}{[t]} = \frac{L\,T^{-1}}{T} = \mathrm{L}T^{-2}.$$

$$\frac{L}{T} = \frac{L}{T^2} * \mathrm{T} = \frac{L}{T}$$

So the equation (*) is dimensionaly correct.

Example 4: we have: $v^2 = u^2 + 2as$

* u is the initial velocity, s is displacement

\- Prove that this equation is dimensionaly correct.

Solution:

$[s] = L$

$[v] = [\frac{x}{t}] = \frac{[x]}{[t]} = \frac{L}{T} = LT^{-1}$

$[a] = [\frac{v}{t}] = \frac{[v]}{[t]} = \frac{L\,T^{-1}}{T} = LT^{-2}.$

$\frac{L^2}{T^2} = \frac{L^2}{T^2} + 2\,\frac{L}{T^2}\,L$

$\frac{L^2}{T^2} = 3\frac{L^2}{T^2}$

So the equation (*) is dimensionaly correct.

End