Medical Physics

Lecture 1

Ch1: Intro, measurements
Estimation

Ch2: Describing Motion:
Kinematics in One
Dimension

18/oct/2024

Medical Physics — Chapter 1+2

Introdution, measurements, Estimation

Ch1:

- The measurement of any quantity is made relative to a unit that must be with the numerical value of that quantity

ex: bought 1 Kg of sugar
(1 → numeric value; Kg → the unit of specefication)

* There are **Three** systems of units
  - They use the fundamental ~~units~~ quantities of measurement to express the units:
    - Length
    - Mass
    - Time

	Length	Mass	Time
① SI system (mks): uses	meters (m)	Kilogram (Kg)	Second (s)
② (cgs) system: uses	centimeter (cm)	gram (g)	Second (s)
③ British system: uses	foot (ft)	slug (slug)	Second (s)

The fundamental quantities are:
and [According to the SI system] units

Property	unit
① Length	meter (m)
② Mass	Kilogram (Kg)
③ Time	second (s)
④ Amount of substance	mole (mol)

Property	unit
⑤ Temperature	Kelvin (K)
⑥ Electric Current	ampere (amp)
⑦ Luminos Intensity	candella (cd)

* The rest of the physical quantities are derived from the fundamental units

ex: Velocity = $\frac{meter}{second}$ = $\frac{Length}{Time}$

- we also can convert units one to other by using a conversion factor

ex: 1 in (inch) = 2.45 cm

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* The fundamental Physical quantities, **Length**, **Mass** and **Time**

→ They are called **Dimensions**

→ and they are **abbreviated** (اختصرت) by:

- [L] (Length)
- [M] (Mass)
- [T] (Time)

So going back to the velocity, The Dimensions would be:

$$V = \frac{[L]}{[T]}$$

* For each dimension there is a family of units:

Ex: the dimension for Displacement is Length [L]

but we can use any unit from the units systems (3 systems) that describe length Like (meter, foot, Kilometer, mile...etc)

Dimensional Analysis :

Left Hand side ↰ ↱ Right Hand side

- A physical Equation has <u>two</u> sides [LHS = RHS]
  and **both** sides <u>must</u> use or have the **Same dimensions**

So → we can check if an equation is correct or not using that

Ex: Displacement is given by : $X = at$ (X → displacement, a → acceleration, t → time)

is it right?

using Dimensions :

LHS = RHS

$X = at$ (X → Dimension for Displacement)

$[L] \overset{??}{=} \frac{[L]}{[T]^2} \cdot [T]$

$[L] \neq \frac{[L]}{[T]}$ so it isn't right

The Correct Equation :

$X = \frac{1}{2} a t^2$

$[L] \overset{??}{=} \frac{1}{2} \frac{[L]}{[T]^2} \cdot [T]^2$

$[L] = \frac{1}{2} [L]$ ✓

($\frac{1}{2}$ →) numbers don't matter

Ch2: Describing Motion: Kinematics in one dimension

Kinematics: الحركة

in one dimension → الحركة في بعد واحد

* The study of the **Motion of an object** and the related concepts of:

- Force
- Energy
- Momentum

Form the field of **Mechanics**

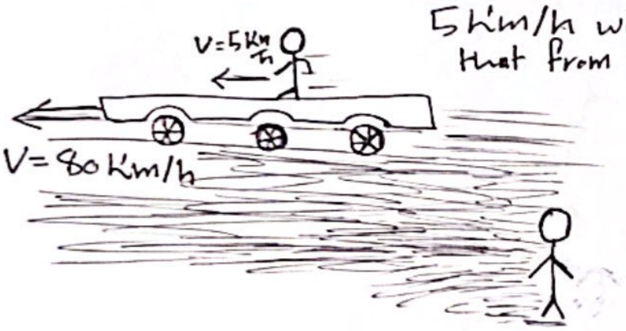
Mechanics — its divided into two Parts:

- **Kinematics** → The study of the motion of objects REGARDLESS of the cause of motion
- **Dynamics** → The study of the motion of objects WITH the cause of motion (Force)

* Reference frames and Displacement
الأطر المرجعية — الإزاحة

- Any measurement of <u>Position</u>, <u>Distance</u> [Displacement] or <u>speed</u> [Velocity] must be made with respect to a **referance frame**

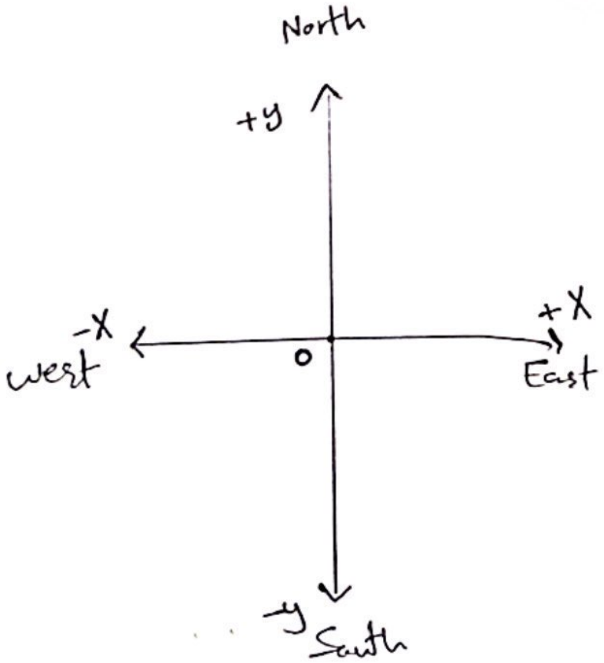
For example: A cart travelling at the speed of 80 Km/h with a person on top walking at a speed of 5 Km/h with the cart, and someone watching that from outside, <u>standing still</u>



* To the cart it self, the person on top has a speed of Just 5 Km/h [that is from the prespective of the cart]

* but to the person on the ground he sees the speed of the person on top to be 85 Km/h [from the person on the ground prespective]

* So to specify the motion of an object we use a reference frame which means a <u>constant</u> <u>Prespective</u> such as the coordinate system (x, y)



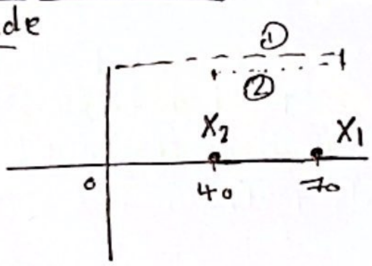
★ For one dimensional motion :

- the axis chosen to describe the ~~motion~~ Motion is the : **X-axis**
- The position of an object at any given moment is given by its : **X coordinate**

★ There is a difference between : Distance (المسافة) and Displacement (الإزاحة)

- Distance is a **Scalar quantity** (كمية قياسية) and its the actual total distance traveled Regardless of the direction
- Displacement is a **vector quantity** (كمية متجهة) and its the difference between initial and final **Position** and needs a direction along magnitude

ex: a Person walks 70 m East then 30 west



Distance is 100 m
but displacement is
$+70 - 30 = +40$ m
↳ Direction $-x$

$X_2 - X_1$ = Displacement

★ Same thing with Speed and Velocity

- Averge Speed = $\frac{\text{Total Distance}}{\text{time elapsed}}$
  ↳ scalar

while

- Average Velocity = $\frac{\text{Displacement}}{\text{time elapsed}}$
  ↳ Vector

Could be ← + or −
↳ because it resembles a direction not a quantity

symbol for averge velocity : $\bar{V}$

★ Solve some questions about it

* Instantaneous Velocity (V_{in})

- It is defined as the time rate of ~~change~~ the displacement change

$$V_{in} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

- when we say a uniform velocity that means:

(not changing)

$$\bar{V} = V_{in}$$

"The average velocity is equal to the instantaneous velocity at any moment given" → bc the rate of change = 0

- but if the velocity is changing during the motion then:

$$\bar{V} \neq V_{in}$$

"The average velocity isn't equal to the instant velocity at any moment" → bc the rate of change ≠ 0

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* Same thing goes for acceleration (a)

- Average acceleration is the chang of velocity divided by the change in time: $\bar{a} = \frac{\Delta V}{\Delta t} = \frac{V_2 - V_1}{t_2 - t_1}$

- The instantaneous acceleration is the Rate of change in velocity
  ↳ time

$$a_{in} = \lim_{\Delta t \to 0} \frac{\Delta V}{\Delta t} = \frac{dV}{dt}$$

* Solve some examples