Dr/A.ElShabasy physics

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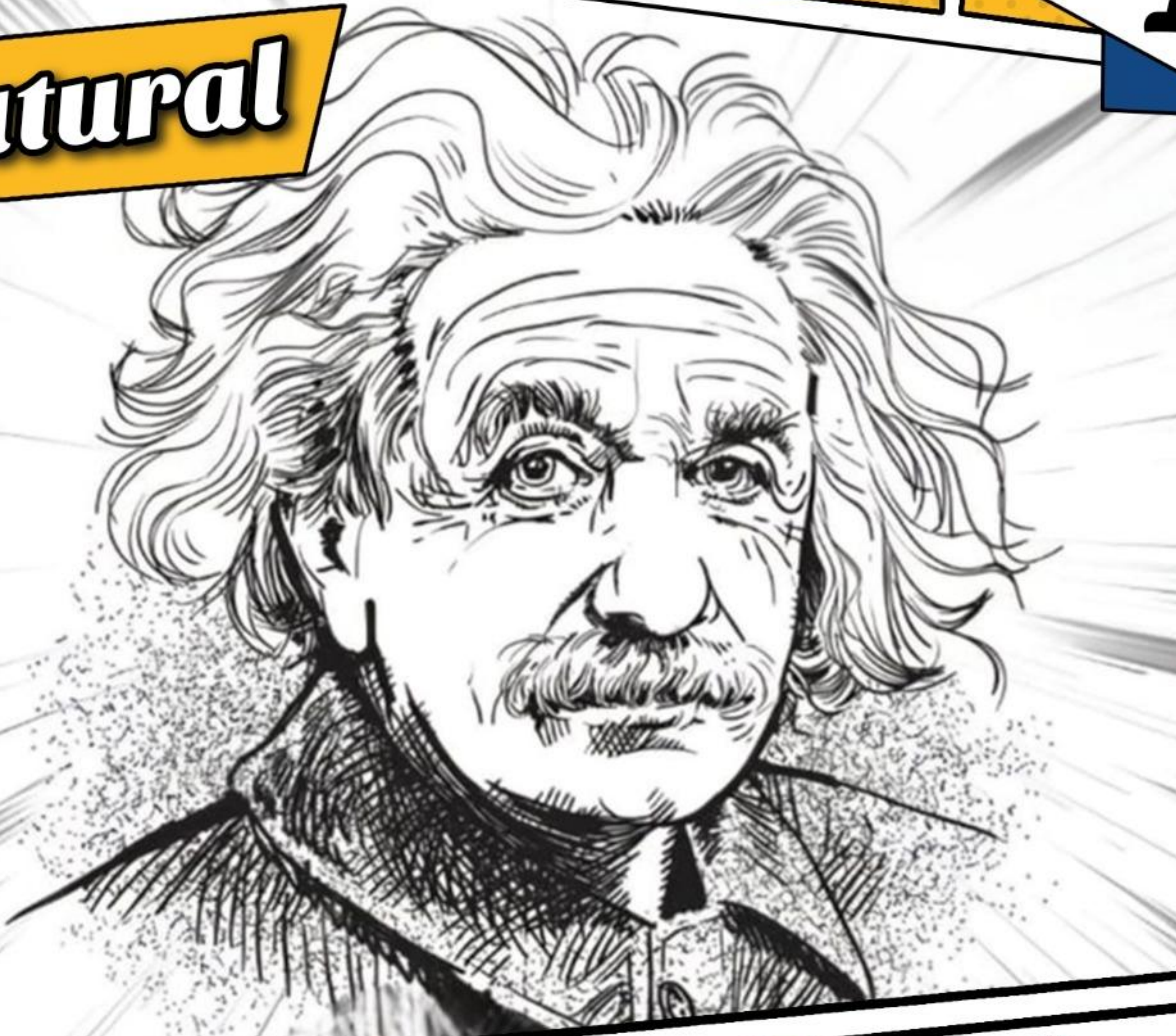
NO 1

Natural



Properties of Matter (Measurements & Dimensions)

Physics 1 Dr.Elsahbasy

WhatsApp group

Units and Physical Measurements

Physical quantity

- Any quantity that can be measured and consists of **magnitude** and **unit**

EX:

Mass = 50 kg	
Magnitude	unit

Systems of units

a) A standard international system (SI) (النظام العالمي)

b) CGS system (النظام الفرنسي أو نظام جاوس)

c) The English system (FPS) (النظام البريطاني)

Quantity	SI	CGS	FPS
Length (L)	Meter (m)	Centimeter (Cm)	Foot (ft)
Mass (M)	Kilogram (Kg)	Gram (g)	Pound (P)
Time (T)	Second (S)	Second (S)	Second (S)

Length Units and Conversions

Unit	Symbol	Conversion Formula
Mile	mi	1 mi = 1,609.34 m
Kilometer	km	1 km = 1,000 m
Meter	m	1 m = 1 m
Centimeter	cm	1 cm = 0.01 m
Millimeter	mm	1 mm = 0.001 m
Yard	yd	1 yd = 0.9144 m
Foot	ft	1 ft = 0.3048 m
Inch	in	1 in = 0.0254 m

Ex:

- **If 1 ft = 30.48 cm, how many feet are in 2 m?**
- **If 1 mile = 1.60934 km, how many kilometers are in 5 miles?**

Answer

The prefix multipliers

Name	equal	Name	equal
kilo (K)	10^3	*millie* (m)	10^{-3}
mega (M)	10^6	*micro* (μ)	10^{-6}
Giga (G)	10^9	*nano* (n)	10^{-9}
tera (T)	10^{12}	*pico* (p)	10^{-12}
peta (P)	10^{15}	*femto* (f)	10^{-15}

There are two types of quantities

a) Fundamental or basis quantities

- **quantities** that we cannot express them with other physical **quantities**

Ex:

1. **Mass (Kg)**
2. **Time (S)**
3. **Length (m)**
4. **Temperature (K)**
5. **Electric current (A)**
6. **Luminous intensity (candle)**
7. **Amount of substance (Mole)**

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b) derivative quantities

- **quantities** we can express them with other physical **quantities**.

Ex:

Area (A) - Volume (V) - Density (ρ) - Pressure (P) - Force (F)

The meter:

- Is defined as 10^7 the distance from the equator to the north pole

قاسوا المسافة بين خط الاستواء والقطب الشمالي وقسموها إلى 10 ملايين جزء، وكل جزء منها يُعتبر متر واحد.

- Is the distance between two scratches on a platinum bar put on display in Paris, France.

المسافة بين خطين محفورين على عمود من البلاتين

- the meter is defined as the distance a beam of light travels through vacuum in, $3.33564095 \times 10^{-9}$ second.

المسافة التي يقطعها شعاع من الضوء في الفراغ خلال $3.33564095 \times 10^{-9}$ ثانية

The kilogram:

- The base unit of the mass is kg
- Is defined by the mass of 0.001 cubic m (1 liter) of pure water

وزن 1 لتر من الماء النقي، والذي يعادل 0.001 متر مكعب

Note:

$$\textbf{Atomic mass unit } (Amu) = 1.6605387 \times 10^{-27}\ kg$$

The second:

- Is the Si unit of time $= \frac{1}{60}$ of a min
- Second $= \frac{1}{24} \times \frac{1}{60} \times \frac{1}{60} = \frac{1}{86400}$ of solar day
- 1 S is defined as the amount of time taken for a certain cesium atom to oscillate through $9.192631770 \times 10^{9}$ complete cycles.

تعريف الثانية

بأنها الزمن الذي تأخذه ذرة السيزيوم لتقوم بـ 9,192,631,770 اهتزازة أو دورة

The kelvins:

- How much heat exist that is relative to absolute zero

Note:

- $-273\ ℃ \rightarrow 0\ K$
- $373.15\ K \rightarrow 100\ ℃$ Boling point of H_2O

Candela:

- is the unit of luminous intensity
- It is equivalent to $\frac{1}{683}$ of a watt of radiant energy emitted at a frequency of $5.4\ x10^{14}$ hertz (cycles per second) in a solid angle of one steradian

تُعرف الكاندلا

بأنها تعادل $\frac{1}{683}$ من الواط عندما يُصدر مصدر الضوء طاقة ضوئية بتردد

$5.4\ x10^{14}$ هرتز

Ampere:

- The ampere (A) is the unit of electric current.
- A flow of approximately $6.241506\ \times\ 10^{18}$ electrons per second past a fixed point in an electrical conductor produces an electrical current of 1 ampere.

The mole:

- The standard unit of material quantity **(Amount of substance)**

✶ المول الواحد من المادة مهما كانت كتلتها = عدد افوجادرو

- Atomic mass is **Mass of one atom**

$$Atomic\ mass = \frac{Molar\ Mass}{Avogadro's\ Number}$$

Some rules you know

$$Molar\ mass = Number\ of\ atoms\ \chi\ Mass\ number\ (g)$$

$$Numer\ of\ moles = \frac{Mass\ of\ the\ substance}{Molar\ mass}$$

Ex:

- **If the mass number of Oxygen is 16, then the mass of 0.5 moles of O_2 is ……………………………………**

- **If one of Oxygen O_2 is 32 g, then the mass of one Oxygen atom is ……………………………………**

Dimensional Analysis

- It is used to indicate the physical quantity and type of unit used to identify it.

Quantity	Dimension
Mass	M
Length	L
Time	T

Very important Notes

① Adding and Subtracting Physical Quantities:

- You can only add or subtract physical quantities if they have the same type of dimensions, such as length with length or time with time.

يمكن جمع أو طرح الكميات الفيزيائية فقط إذا كانت لها أبعاد من نفس النوع

- Example: 5 meters + 3 meters = 8 meters. Both quantities are in the same units.
- As a Dimension

$$\boldsymbol{L + L = L}$$
$$\boldsymbol{M - M = M}$$

② Multiplying and Dividing Physical Quantities:

- You can multiply or divide quantities with different dimensions.

يمكن ضرب أو قسمة كميات بأبعاد مختلفة

- Example: To find speed, you divide distance by time

③ Constants with or without Dimensions:

- **Numbers** and Some constants, like π are **dimensionless**, meaning they don't have units.
- functions like $sin, cos, or\ tan$ they are **dimensionless**, meaning the result has **no units.**
- Other constants, like gravity g or the speed of light c, have dimensions and are measured in specific units.
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Uses of Dimensions Formula

① Find some physical quantities' dimensions and units.

إيجاد أبعاد ووحدات بعض الكميات الفيزيائية

Quantity	Law	dimensions	Base unit
Area (A)	$L \times L$	$[L^2]$	m^2
Volume (V)	$L \times L \times L$	$[L^3]$	m^3
Density (ρ)	$\frac{Mass}{Volume}$	$[M/L^3]$	Kg/m^3
Speed (v)	$\frac{Distance}{Time}$	$[L/T]$	m/sec
Acceleration (a)	$\frac{velocity}{Time}$	$[L/T^2]$	m/sec^2
Force (F)	$Mass \times acceleration$	$[ML/T^2]$	$Kg.m/s^2 \equiv Newton$
Pressure (P)	$\frac{Force}{Area}$	$[M/LT^2]$	$Kg/m.s^2 \equiv Pascal$
Work (W)or Energy (E)	$Force \times Distance$	$[ML^2/T^2]$	$Kg.m^2/s^2 \equiv Joul$
Momentum	$\boldsymbol{m \times v}$	$[1/T]$	$1/sec$
Surface Tension ($\boldsymbol{\gamma}$)	$\frac{Force}{Length} = \frac{Work}{Area}$	$[M/T^2]$	Kg/s^2
Potential Energy ($\boldsymbol{PE}$)	$Mass \times acceleration \times Height$	$[ML^2/T^2]$	$Kg.m^2/s^2 \equiv Joul$
Kinetic Energy (KE)	$\frac{1}{2}mv^2$	$[ML^2/T^2]$	$Kg.m^2/s^2 \equiv Joul$
Viscosity ($\boldsymbol{\eta}$)	$\frac{Force \text{ X distance}}{Velocity \text{ X area}}$		$pacal.sec$

② Check the correctness of some physical equations

التأكد من صحة المعادلات الفيزيائية

يجب أن تكون الأبعاد متساوية على طرفي المعادلة عشان تكون المعادلة صحيحة

$$L.H.S = R.H.S$$

Example 1

Check the validity of these equation $x = \frac{1}{2}vt^2$ where x is distance, v is velocity and t is time

Solution

$$x = \frac{1}{2}vt^2$$

$$LHS = [L]$$

$$RHS = \frac{[L]}{[T]} * [T^2] = [L][T]$$

$$RHS \neq LHS$$

Example 2

Check the validity of these equation $x = vt$

Solution

$$LHS = [L]$$

$$RHS = \frac{[L]}{[T]} * [T] = [L]$$

$$RHS = LHS$$

Example 3

Check the validity of these equation $x = \frac{1}{2}at^2$ where a is acceleration

Solution

$$x = \frac{1}{2}at^2$$
$$LHS = [L]$$
$$RHS = \frac{[L]}{[T^2]}[T^2] = [L]$$

Example 4

Check the correctness of physical equation $s = ut + ½\, at^2$. In the equation, s is the displacement, u is the initial velocity, v is the final velocity, a is the acceleration and t is the time in which change occurs.

Answer

Example 5

Check the correctness of physical equation $P = (\rho g h)^{½}$ where P is the pressure, ρ is the density, g is gravitational acceleration, h is the height.

Answer

③ determine the relationship between some of the physical quantities.

استنتاج بعض المعادلات الفيزيائية

Example 6

The displacement (x) of a particle moving under uniform acceleration (a) is some function of the elapsed time (t) and the acceleration. Suppose we write this displacement $x = k\, a^n t^m$, where k is a dimensionless constant. Find the values of m and n

Solution

$$LHS = RHS$$

$$LHS = L \rightarrow \boxed{1}$$

$$RHS = [L.T^{-2}]^n\, T^m$$

$$RHS = [L]^n[T]^{m-2n} \rightarrow \boxed{2}$$

From 1, 2

$$m - 2n = 0$$

$$n = 1\,, m = 2$$

$$x = kat^2$$

Example 7

Let the periodic time (T) of a simple pendulum is proportion to:

1) The mass of the pendulum (m)
2) The length of the pendulum (l)
3) The acceleration due to gravity (g)
   Find power of m, l and g

Solution

$$T \propto m^a$$

$$T \propto l^b$$

$$T \propto g^c$$

$$T = k\, m^a l^b\, g^c$$

$$RHS = LHS$$

$$LHS = T = [T] \rightarrow \boxed{1}$$

$$RHS = [M]^a [L]^b \left[\frac{[L]}{[T]^2}\right]^c$$

$$RHS = [M]^a [L]^{b+c} [T]^{-2c} \rightarrow \boxed{2}$$

$$1 = 2$$

$$a = 0\,, \qquad B + C = 0\,, \qquad -2C = 1$$

$$C = -\frac{1}{2}$$

$$B = \frac{1}{2}$$

$$\therefore T = km^0\, l^{\frac{1}{2}}\, g^{-\frac{1}{2}} = K\sqrt{\frac{l}{g}}$$

Example 8

The force F acting on a body depends on the mass m of the body and its velocity v. Suppose we write the force as $F = k\, m^a\, v^b$, where k is a dimensionless constant. Find the values of a and b using dimensional analysis.

Answer