Ch-1 - Measurements and Experiments

⇒ "Measurement" is the process of comparison of the given physical quantity with the known standard quantity of the same nature.

⇒ "Unit" is the quantity of a constant magnitude, used to measure the given physical quantity of same Nature.

⇒ Relation between physical quantity, numerical value, and unit :-

Physical quantity = (Numerical value) X (unit)

Eg → mass of the given object = 6 kg
(Physical quantity) = (Num. Val.) x (units)

∴ mass of the object is 6 times the unit.

⇒ Choice of unit :-

→ should be of convenient size
→ define without ambiguity. (PUZZLE)
→ Reproducible.
→ Always remain constant Everywhere.

} Essential to be accepted Internationally.

⇒ Kinds of unit :-

① → Fundamental units (Basic)
which is Independent of any other unit, It can neither be changed nor can be related to any other fundamental unit. Eg → mass, length etc.

② → Derived units
Dependent on fundamental units.
Eg → Volume, Area, speed etc.

System of unit

- C.G.S (French)
  - centimetre
  - Gram
  - second
- F.P.S. (British)
  - Foot
  - Pound
  - second
- M.K.S (metric)
  - metre
  - Kilogram
  - second

⇒ modified version of metric system is S.I system:-

S.I (Systeme Internationale d'unites)

7 fundamental units

Length	metre (m)
mass	Kilogram (Kg)
Time	Second (S)
Temperature	Kelvin (K)
Luminous Intensity	candela (Cd)
Electric current	Ampere (A)
Amount of substance	mole (mol)

2 - complementary F.U.

Angle	Radian (rd)
Solid angle	Steradian (St-rd)

Smallest to Biggest unit

	Symbol	Value	
Yocto	y	10^{-24}	Smallest
zepto	z	10^{-21}	
atto	a	10^{-18}	
femto / fermi	f	10^{-15}	
Pico	p / (μμ)	10^{-12}	
nano	n	10^{-9}	
micro / micron	μ	10^{-6}	
milli	m	10^{-3}	
centi	c	10^{-2}	
deci	d	10^{-1}	
Hertz / metre / Litre / gram	m	10^{0}	
deca	da	10^{1}	
hecto	h	10^{2}	
Kilo	K	10^{3}	
mega	M	10^{6}	
giga	G	10^{9}	
tera	T	10^{12}	
peta	P	10^{15}	
Exa	E	10^{18}	
Zetta	Z	10^{21}	
Yotta	Y	10^{24}	↓ Biggest

Ex ⇒ 3 GHz ⇒ 3×10^{9} Hz

5.2 pF ⇒ 5.2×10^{-12} F (farad) →

6.0 MΩ ⇒ 6.0×10^{6} Ω

Units of length

⇒ **metre** (·) defined in 1889

(·) Distance between two marks drawn on a platinum-iridium (an alloy of 90% Pt and 10% iridium) rod at 0°C.

(·) At Serres near paris in International Bureau of weights and measures.

→ In 1983, It was re-defined in terms of speed of light,

1 metre = Dist. travelled by light in $\frac{1}{299,792,458}$ of a second in air / vaccum.

⇒ **Sub-units of metre**

(a) $cm = 10^{-2}\ m$

(b) $mm = 10^{-3}\ m$

(c) $\mu m = 10^{-6}\ m$

(d) $nm = 10^{-9}\ m$

(e) $Km = 10^{3}\ m$

⇒ **Non-metric units of length**

→ **Bigger units**

(a) Astronomical unit

• $1\ A.U. = 1.496 \times 10^{11}\ m$

Equal to mean dist. b/w Earth and Sun.

(b) Light year

Dist. travelled by light in one year, in vaccum

1 light year = spd. of light × time in '1' yr.

$= 3 \times 10^{8}\ m/s \times 365 \times 24 \times 60 \times 60 s$

$= 9.46 \times 10^{15}\ m$

$= 9.46 \times 10^{12}\ km$

Light minute $= 1.8 \times 10^{10}\ m$

Light second $= 3 \times 10^{8}\ m$

→ **Smaller units.**

(a) Angstrom (Å)

→ wavelength of light

→ size and separation b/w two molecoles.

→ Radius of orbit of e^-.

$1\ Å = 10^{-10}\ m = 10^{-8}\ cm$

$= 10^{-1}\ nm$

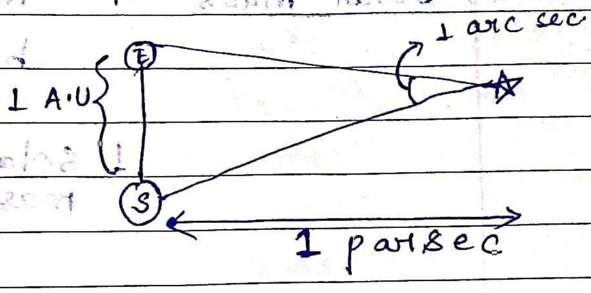
Å ⇒ is outdated.

Nowadays, 'nm' is used.

(b) Fermi (size of Nucleus)

$1\ f = 10^{-15}\ m$

(C) Parsec : is the distance from where the semi major axis of orbit of Earth subtends angles of 1 sec.



<table><tr><td>Angle = Arc / Rad.</td></tr></table>

$$1 \text{ Parsec} = \frac{1.496 \times 10^{11} \text{ m}}{(1/3600) \times (\pi/180)}$$

$$= 3.08 \times 10^{16} \text{ m}$$

$$= \frac{3.08 \times 10^{16}}{9.46 \times 10^{15}} \text{ ly} = 3.26 \text{ ly.}$$

Unit of Mass

⇒ Kilogram :⇒ In 1889 defined as mass of piece of pt-iridium alloy kept at IBWM at Sevres near paris.

→ 1 litre at 4°c is considered as 1 kg.

⇒ Subunits :-

(1) Gram $= 10^{-3}$ kg

(2) milligram $= 10^{-3}$ g / 10^{-6} kg

⇒ Bigger units :-

(1) Quintal = 100 kg

(2) metric Tonne = 1000 kg = 10 quintal.

Non-metric unit of mass

(1) A.M.U ⇒ mass of atomic particles (P, n, e^-)

↳ also known as unified A.M.U (U).

$$1 \text{ AMU} = \frac{1}{12} \times \text{mass of C-12 atom.}$$

$$= \frac{1}{12} \times \frac{12}{6.02 \times 10^{26}} \text{ kg} = 1.66 \times 10^{-27} \text{ kg.}$$

(2) Solar mass :- measures mass of large heavenly bodies.

$1 \text{ solar mass} = 2 \times 10^{30}$ kg

Units of time

⇒ Second = $\frac{1}{86400}$ x one mean solar day

i.e. one solar day is the time taken by Earth to complete one rotation on its own axis.

⇒ In 1964, Energy change in cesium-133 atom also defines second.

⇒ Smaller units

(a) 1 ms = 10^{-3} s
(b) 1 μs = 10^{-6} s
(c) 1 shake = 10^{-8} s
(d) 1 ns = 10^{-9} s

⇒ Bigger units

(a) mint. = 60 s
(b) HOUR = 3600 s
(c) Day = 86400 s
(d) 1 lunar month = 29.53 days
(e) month = 30 days } Approx.
(f) 1 Year = 365 days = 365 x 86400 = 3.1536×10^{7} s
↳ is defined as time which earth takes to complete one revolution around the sun.
(g). Leap Year = 366 day. (Divisible by four)
(h) Decade ⇒ 10 yrs = 3.1536×10^{8} s
(i) century ⇒ 100 yrs = 3.16×10^{9} s
(j) Millenium ⇒ 1000 Yrs = 3.16×10^{10} s

nly

Quantity	Unit
(1) Area	m^2
(2) Volume	m^3
(3) Density	$Kg\,m^{-3}$
(4) speed/velocity	$m s^{-1}$
(5) Acceleration	$m s^{-2}$
(6) Force	$Kg m s^{-2}$ / N
(7) work/Energy	$Kg m^2 s^{-2}$ / J
(8) Momentum	$Kg m s^{-1}$ / NS
(9) Torque	$Kg m^2 s^{-2}$ / Nm
(10) Power	$Kg m^2 s^{-3}$ / $J s^{-1}$ / W
(11) Pressure	$kg m^{-1} s^{-2}$ / $N m^{-2}$ / Pa
(12) Frequency	s^{-1} / Hz
(13) Electric charge	A·S / C
(14) Electric potential or (E.m.f)	$Kg m^2 A^{-1} s^{-3}$ / $J C^{-1}$ / V
(15) Electrical Resistance	$Kg m^2 A^{-2} s^{-3}$ / VA^{-1} / Ω
(16) Electrical power	VA / W

(#) Guidelines for writing the units :-

(i) Symbol not named after scientist, should be small.
Ex → metre → m.

(ii) Symbol named after scientist, the first letter of the symbol should be capital.
Ex → newton → N ; Pascal ⇒ Pa

(iii) Full name of the unit should be written with small letter, whether named after scientist or not.
Ex → newton, kilogram, metre etc.

(iv) compound unit can be written by putting dot, cross or leaving space between the two symbols.
Ex → N·m, or N×m or Nm.

(v) Negative power is used for compound units, formed by dividing one unit by other. Ex ⇒ J/C ⇒ $J C^{-1}$