Estimation by orders of magnitude

The order of magnitude of a physical quantity is its magnitude in powers of ten when that physical quantity is expressed in powers of ten with one digit to the left of decimal

Physical quantity = $M \times 10^n$

Where M is a number greater than 1 , but less than 10 , and n is a positive or negative integer. The power of 10 is called the order of magnitude of the physical quantity and M is called its numerical value

If M = 3.2 , it can be written as $10^{0.5}$ which when rounded becomes 10^{1} .Hence if M < 3.2 , its power of 10 will be less than 0.5, i.e, M = 10^{0} , so order of magnitude becomes 10^{n} . But if M >3.2 , its power of 10 will be more than or equal to 0.5,i.e, M = 10^{1} , so the order of magnitude becomes 10^{n+1} .

Some Examples of Order of Magnitude

Mass of electron = 9.1×10^{-31} kg

$= 10^{1} \times 10^{-31} = 10^{-30}$ kg

Radius of earth = 6.378×10^{6} m

$= 10^{1} \times 10^{6} = 10^{7}$ m

Kinds of units

Fundamental Units : These are the units of the physical quantity which are independent of any other units. The units of length, mass , time, temperature, luminous intensity and current are the fundamental units.

Derived Units : These are the units of the physical quantity which are dependent on the fundamental units. The units of area, volume, force, pressure, momentum etc. are the derived units.

Systems of unit

Systems of Units

(i) CGS : (Centimetre Gram Second)

(ii) MKS : (Metre Kilogram Second)

(iii) SI : (Standard International)

Base quantity	Name	Symbol
length	metre	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Prefixes used for big measurements

Prefix	Symbol	Exponent
yotta	Y	10^{24}
zetta	Z	10^{21}
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deca	da	10^{1}

Prefixes used for small measurements

Prefix	Symbol	Exponent
yocto	y	10^{-24}
zepto	z	10^{-21}
atto	a	10^{-18}
femto	f	10^{-15}
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
centi	c	10^{-2}
deci	d	10^{-1}

Derived units of some physical quantities

Derived Quantities	Equation	Derived Units
Area (A)	$A = L^2$	m^2
Volume (V)	$V = L^3$	m^3
Density (ρ)	$\rho = m / V$	$kg\ m^{-3}$
Velocity (v)	$v = L / t$	ms^{-1}
Acceleration (a)	$a = \Delta v / t$	$ms^{-1} / s = ms^{-2}$
Momentum (p)	$p = m \times v$	$(kg)(m^{s-1}) = kg\ m\ s^{-1}$

Bigger and smaller units of mass

Smaller units	Value in kg	Bigger units	Value in kg
Gramme(g)	10^{-3}kg	qunital	100kg
Milligramme(mg)	10^{-6}kg	Metric tonne	1000kg
Atomic mass unit(a.m.u)	1.655×10^{-27}kg	Solar mass	2×10^{30}kg

Bigger units of time

Bigger units	Value in seconds	Bigger units	Value in seconds
Minutes	60 s	Year	3.1536×10^7 s
Hour	3600 s	Decade	3.1536×10^8 s
Day	86400s	Century	3.16×10^9 s
Month	2.592×10^6s	Millennium	3.16×10^{10} s

Derived units of some physical quantities

Derived Quantities	Equation	Derived Unit		Derived Units
		Special Name	Symbol	
Force (F)	$F = \Delta p / t$	Newton	N	$[(kg\ m\ s^{-1}) / s = kg\ m\ s^{-2}$
Pressure (p)	$p = F / A$	Pascal	Pa	$(kg\ m\ s^{-2}) / m^2 = kg\ m^{-1}\ s^{-2}$
Energy (E)	$E = F \times d$	joule	J	$(kg\ m\ s^{-2})(m) = kg\ m^2\ s^{-2}$
Power (P)	$P = E / t$	watt	W	$(kg\ m^2\ s^{-2}) / s = kg\ m^2\ s^{-3}$
Frequency (f)	$f = 1 / t$	hertz	Hz	$1 / s = s^{-1}$
Charge (Q)	$Q = I \times t$	coulomb	C	A s
Potential Difference (V)	$V = E / Q$	volt	V	$(kg\ m^2\ s^{-2}) / A\ s = kg\ m^2\ s^{-3}\ A^{-1}$
Resistance (R)	$R = V / I$	ohm	Ω	$(kg\ m^2\ s^{-3}\ A^{-1}) / A = kg\ m^2\ s^{-3}\ A^{-2}$

Smaller and bigger units of length

Smaller units	Value in metre	Bigger units	Value in metre
Centimetre (cm)	10^{-2} m	Kilometre (km)	10^{3}m
Millimetre (mm)	10^{-3}m	Astronomical unit(A.U)	1.496 x 10^{11} m
Micron (µm)	10^{-6}m	Light year (ly)	9.46 x 10^{15}m
Nanometer(nm)	10^{-9}m	Parsec	3.08 x 10^{16}m
Angstrom	10^{-10}m		
Fermi(f)	10^{-15}m		