Unit 1: Measurements

A. PHYSICAL QUANTITY

All physical quantities in Physics can be classified into:

- base (or fundamental) quantities
- derived quantities

1. Base Quantities

Base quantities are **quantities that can be accurately and easily reproduced** and **are unchanging with time**.

All other physical quantities in Physics can be defined in terms of these base quantities.

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

Any physical quantity must be quoted with its **numerical value** and its **unit**.

2. Derived Quantities

All other quantities in Physics can be obtained from the multiplication or division of base quantities. No numerical factors are involved. Some derived units are given special names due to their complexity when expressed in terms of the base units.

Derived Quantity	Base Unit	SI Unit
density $\rho = m/V$	kg m^{-3}	--

momentum *p* = *mv*	kg m s^{-1}	--
force *F* = *ma*	kg m s^{-2}	newton, N
pressure *P* = *F/A*	kg m^{-1} s^{-2}	pascal, Pa
work *W* = *Fs*	kg m^2 s^{-2}	joule, J
power *P* = *W/t*	kg m^2 s^{-3}	watt, W
electric charge *Q* = *It*	As	coulomb, C

3. Homogeneity of a Physical Equation

Addition and subtraction of quantities are only meaningful if the quantities have the same units. The same is true for equality and inequality. A physical equation is said to be homogeneous if **each of the terms, separated by plus, minus, equality or inequality signs has the same base units.**

A correct physical equation must be homogeneous. The method of homogeneity enables us to weed out wrong equations since equations which are not homogeneous are *definitely* not correct.

4. Prefixes and Their Symbols

A prefix added to a unit means that the unit is multiplied by a numerical value represented by the prefix.

Value	Name	Symbol	Example
10^{-12}	pico	p	10 pF (capacitance)
10^{-9}	nano	n	400 – 700 nm (wavelength of light)
10^{-6}	micro	μ	μm (thickness of hair, fibre optics)
10^{-3}	milli	m	mA (current that kills)
10^{-2}	centi	c	2 cm (wavelength of microwave)
10^{-1}	deci	d	40 dB (intensity level of quiet conversation)
10^{3}	kilo	k	50 kg (mass of a person)
10^{6}	mega	M	98.7 MHz (Perfect 10 station)
10^{9}	giga	G	40 GBytes (Pentium 4 Computer)
10^{12}	tera	T	Tm (radius of solar system)

B. UNCERTAINTY OF MEASUREMENT

1. Absolute uncertainty

When a measurement is made using a measuring instrument, the value obtained will always carry an uncertainty. The actual value can be greater or smaller then the measured value by as much as the uncertainty. The **graduation of the scale** of an instrument determines the uncertainty of the measurement obtained. In general,

a) If the separation between scale markings on an instrument is **small**, readings are taken to the nearest **half** of the smallest graduation. In this case, the uncertainty is half the smallest graduation.

b) If the separation between scale markings is **large**, readings may be taken to the nearest **fifth** of the smallest graduation. In this case, the uncertainty is then one fifth of the smallest graduation.