(SI) International system of units

International system of units

In 1960, an international committee agreed on a set of definitions and standards to describe the physical quantities. The system that was established is called the system international (SI).

Due to simplicity and convenience this system of units is being used by the world's scientific community and by most nations.

The SI units are build-up from three kinds of units:

1. Base units
2. Supplementary units
3. Derived units

Base units

"The units defined arbitrarily for the measurement of seven base quantities in comparison with them are called base units." The names of base units along with respective physical quantities and symbols are given below:

Sr. No.	Physical Quantity	SI - Unit	Symbol
1	Length	meter	m
2	Mass	kilogram	kg
3	Time	second	s
4	Electric Current	ampere	A
5	Temperature	kelvin	K
6	Intensity of Light	candela	cd
7	Amount of Substance	mole	mol

The standard definitions of base units are given below:

1. **Meter:** The unit of length is meter. Before 1960, it was defined as:

a. **Definition 1:** "The distance between two lines marked on the bar of an alloy of platinum (90%) and iridium (10%) kept under controlled conditions at the international bureau of weights and measures in France".
The 11^{th} general conference on weights and measures (1960) redefined the standard as follows:

b. **Definition 2:** "One meter is a length equal to 1,650,763.73 wavelength in vacuum of the orange red radiation emitted by the krypton-86 atom".

In 1983, the meter was redefined as:

c. **Definition 3:** "It is the distance travelled by light in vacuum during a time of 1/299,792,458 second".

A few sub-multiple and multiples of meter are:

i	1 micrometre = 10^{-6} m
ii	1 millimetre = 10^{-3} m
iii	1 centimetre = 10^{-2} m
iv	1 decimetre = 10^{-1} m
v	1 decametre = 10^{1} m
vi	1 hectometre = 10^{2} m
vii	1 kilometre = 10^{3} m
viii	1 megametre = 10^{6} m

i	10 mm = 1cm
ii	10 cm = 1 decimetre
iii	1000 mm = 1 m
iv	1000 m = 1 km

2. **Kilogram:** The unit of mass is kilogram. It is defined as: "the mass of a platinum (90%) and iridium (10%) alloy cylinder, 3.9cm in diameter and 3.9cm in height, kept at the international bureau of weights and measures in France".

This mass standard was established in 1901.

A few conversion relations of kg are:

i	1000 milligram = 1 gram
ii	1000 gram = 1 kilogram
iii	100 kilogram = 1 quintal
iv	1000 kilogram = 1 metric tone

3. **Second:** The unit of time is termed as second.

a. **Definition 1:** "One second is equal to 1/86400 part of an average day of the year 1900 A.D".

In 1967, an international committee redefined second as

b. **Definition 2:** "One second is equal to the duration in which the outer most electron of the cesium-133 atom makes 9,192,631,770 vibrations".
A few sub-multiples and multiples of second are as given below:

i	1 nanosecond = 10^{-9} s
ii	1 microsecond = 10^{-6} s
iii	1 millisecond = 10^{-3} s

i	60 s = 1 min
ii	60 min = 1 hour
iii	24 hour = 1 day
iv	365 days = 1 year
v	10 years = 1 decade
vi	100 years = 1 century
vii	1000 years = 1 millenium

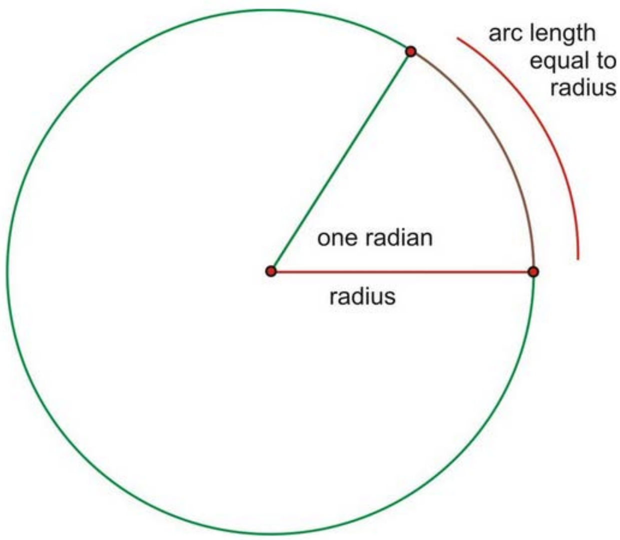
4. **Kelvin:** The unit of temperature is Kelvin.
Definition: "It is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water".
The triple point of a substance means the temperature at which solid, liquid and water vapour phases are in equilibrium. The triple point of water is taken as 273.16K. This standard was adopted in 1967.
5. **Ampere:** The unit of electric current is ampere.
Definition: "One ampere is that constant current which if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section and placed a meter apart in vacuum, would produce between those conductors a force equal to 2x10-7 Newton per meter of length".
This unit was established in 1971.
6. **Candela:** The unit of light intensity (or luminous intensity) is candela, which is defined as:
Definition: "One candela is the luminous intensity in the perpendicular direction of a surface of 1/600,000 square meter of a black body radiator at the solidification temperature of platinum under standard atmospheric pressure".
This definition was adopted in 1967.
7. **Mole:** The unit of amount of substance is mole.
Definition: "One mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kg of carbon-12". This standard was adopted in 1971. When the unit mole is used, the element entities must be specified. There may be atoms, molecules, ions, electrons, other particles or specified groups of such particles. One mole of any substance contain $6.0225\text{x}10^{23}$ entities.

Supplementary units

Those SI units which are not included either in base units or in derived units are called supplementary units. These are two in number as given below:

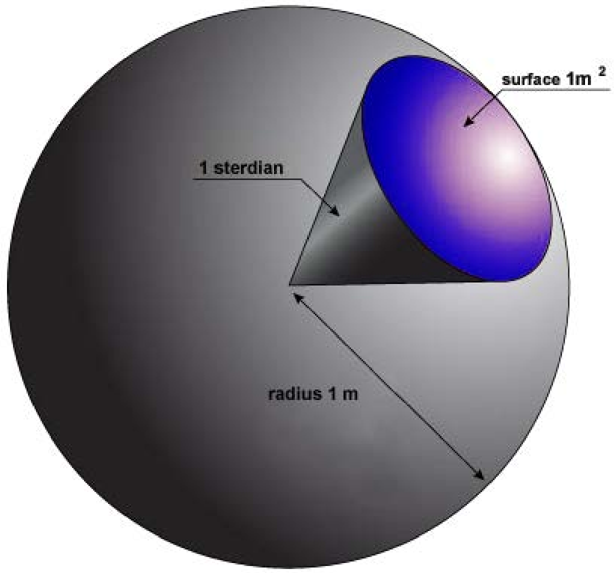
Sr. No.	Physical Quantity	SI - Unit	Symbol
1	Plane angle	Radian	rad
2	Solid angle	Steradian	sr

Radian: The radian is the plane angle between two radii of a circle which cut off on the circumference on arc, equal in length to the radius of the circle (see Figure).



Total angle of the circumference = 2 π rad

Steradian: The steradian is the solid angle (three dimensional angle) subtended at the centre of a sphere by an area of its surface equal to the square of radius of the sphere (see Figure)



Derived units

SI-units for measuring all other physical quantities are derived from the base and supplementary units. These are called derived units. Some of the derived units are given as under:

Sr. No.	Physical Quantity	Unit	Symbol	In terms of base units
1	Force	Newton	N	Kg m S^{-2}
2	Work	Joule	J	N m = Kg m^2 s^{-2}
3	Power	Watt	W	J S^{-1} = Kg m^2 s^{-3}
4	Pressure	Pascal	Pa	N m^{-2} = Kg m^{-1} s^{-2}
5	Electric charge	Coulomb	C	A s

Scientific notation

"When the numbers are expressed in standard form, it is called scientific notation, which employs power of ten".

Rule: whiles writing the numbers in scientific notation, there should be only one non-zero digit to the left of decimal.
Examples:

Sr. No.	Simple Notation	Scientific notation
1	134.7	1.347×10^2
2	0.0023	2.3×10^{-3}
3	1225	1.225×10^3

Conventions for indicating units

Following points should be kept in mind while using units:

1. Full name of the units does not begin with a capital letter even if named after a scientist. e.g. newton.
2. The symbol of unit named after a scientist has initial capital letter, such as 'N' for newton.
3. The prefix should be written before the unit without any space, such as 1×10^{-3} m = 1 mm
4. A combination of units is written each with one space apart. e.g. newton meter = N m
5. Compound prefixes are not allowed. e.g. 1µµF may be written as 1pF
6. A number such as 5.0×10^4 cm may be expressed in scientific notation as 5.0×10^2 m
7. When a multiple of a base unit is raised to a power, the power applies to the whole multiple and not the base unit alone. e.g. 1 km^2 = 1 (km)^2 = 1×10^6 m^2
8. Measurement in practical work should be recorded immediately in the most convenient unit. e.g. reading of screw gauge in 'mm' mass in 'grams'. But before calculation for the result, all measurements must be converted into SI-units.

Factor	Prefix	Symbol	
10^{-18}	atto	a	0.000000000000000001
10^{-15}	femto	f	0.000000000000001
10^{-12}	pico	p	0.000000000001
10^{-9}	nano	n	0.000000001
10^{-6}	micro	µ	0.000001
10^{-3}	milli	m	0.001
10^{-2}	centi	c	0.01
10^{-1}	deci	d	0.1
10^{0}			1
10^{1}	deca	da	10
10^{3}	kilo	k	1,000
10^{6}	mega	M	1,000,000
10^{9}	giga	G	1,000,000,000
10^{12}	tera	T	1,000,000,000,000
10^{15}	peta	P	1,000,000,000,000,000
10^{18}	exa	E	1,000,000,000,000,000,000

Posted by Sir Hayat
http://lectures-and-notes.blogspot.ca/2014/12/chapter-1-measurements-international.html