

# INTERNATIONAL SYSTEM OF UNITS

## DEFINITION

A complete set of units, both base and derived, for all kinds of physical quantities is called as system of units.

## EXPLANATION

Several systems of units have been in use in different countries for specifying a particular physical quantity. They are:

- i. Meter-Kilogram-Second (MKS)
- ii. Centimeter-gram-second or Gaussian system (CGS)
- iii. Foot-Pound-Second or British Engineering system (FPS)

For the sake of uniformity in trade and universalization of science and technology, a set of definitions and standard was defined by an international committee in 1960's. This system was named as system international (SI). The units included in international system of units are termed as SI units. SI units are of three types:

- i. Base units

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- ii. Derived units
- iii. Supplementary units

### BASE UNITS

The unit of the base quantities are called as base units. They are given in the following table.

S.No	Base Quantity	Symbol	Unit	Symbol
1	Length	L	Meter	m
2	Mass	m	Kilogram	kg
3	Time	t	Second	S
4	Temperature	T	Kelvin	K
5	Electric current	i	Ampere	A
6	Luminous Intensity	I	Candela	cd
7	Amount of substance	N	Mole	mol

### DERIVED UNITS

The Unit of derived quantity is called as derived unit.

Derived units are defined in terms of the base units. For example, a unit length (1 m) multiplied by a unit length (1 m) is a unit of area (1 m<sup>2</sup>). Similarly a unit length (1 m) divided by unit of time (1 s) is a unit of speed (1 m/s).

### DEGREE

A degree, OR "A degree of arc" usually denoted by ° (the degree symbol), is a measurement of plane angle, representing 1/360 of a full rotation.

One degree is also equivalent to  $\pi/180$  radians. It is not an SI unit, as the SI unit for angles is radian, but it is mentioned in the SI brochure as an accepted unit.

### SUBDIVISIONS

One degree is divided into 60 minutes (of arc), and one minute into 60 seconds (of arc). These units, also called the arc minute and arc second, are respectively represented as a single and double prime:

Mathematically:

$$1 \text{ degree} = 60 \text{ minutes} = 3600 \text{ seconds}$$

$$1^\circ = 60' = 3600''$$

For example,  $40.1875^\circ = 40^\circ 11' 15''$ .

### SUPPLEMENTARY UNITS

The general conference on weight and measures has not yet classified certain units of SI under either base units or derived units. These SI units are called as supplementary units.

Till now this class contains only two units of purely geometrical quantities.

They are:

- i. Plane angle (two dimensional angle)
- ii. Solid angle (three dimensional angle)

Physical Quantity	SI unit	Symbol
Plane angle ( $\theta$ )	Radian	Rad
Solid angle ( $\Omega$ )	Steradian	Sr

**NOTE**

Radian and steradian were formerly SI supplementary units, but this category was abolished from the SI in 1995 and they are now considered as SI derived units.

**RADIAN** =  $57.3^\circ$

**DEFINITION**

"One radian is the angle between two radii of the same circle subtended by an arc equal in length to the radius of the circle".

**SYMBOL** It is denoted by rad.

**EXPLANATION**

Radian is the unit of plane angle.

If "r" is the radius of the circle and arc length is AC, then  $\angle AOC = 1$  radian. Consider fig. 1.1. Let  $\angle AOB = \theta$  and length of arc AB = S.

From trigonometry, we know that the ratio of angles subtended by arc "S" is equal to the ratio of the length of arcs i.e.

$$\frac{\angle AOB}{\angle AOC} = \frac{\text{Length of arc AB}}{\text{Length of arc AC}}$$

$$\Rightarrow \frac{\theta}{1 \text{ rad}} = \frac{S}{r}$$

$$\Rightarrow S = r \theta \tag{1}$$

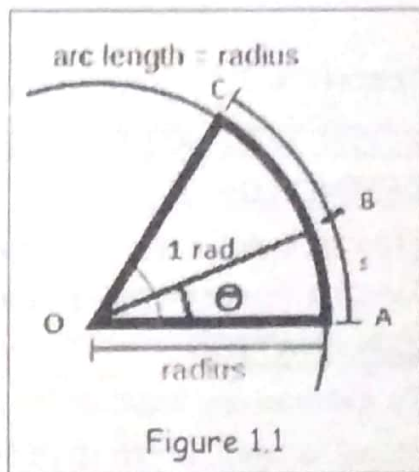


Figure 1.1

**STERADIAN**

**DEFINITION**

"One Steradian is the angle subtended at the centre of a sphere by an area of its surface equal to the square of radius of the sphere".

**EXPLANATION**

A graphical representation of one steradian is shown in figure 1.2. The sphere has radius r, and in this case the area of the patch on the surface is  $A = r^2$ . The solid angle "Omega" is:

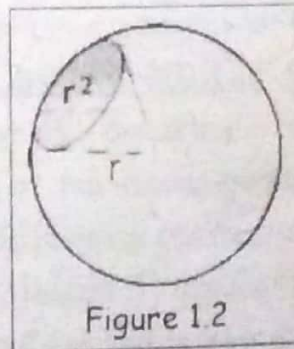


Figure 1.2

$$\Omega = A/r^2 = r^2/r^2 = 1 \text{ sr}$$

## Chapter 1

## Measurement

A steradian can also be called a squared radian.

Because the surface area of a closed sphere is  $4\pi r^2$ , the entire sphere has a solid angle of:

$$\Omega = A/r^2 = 4\pi r^2/r^2 = 4\pi \text{ sr} \approx 12.56637$$

Hence, the maximum solid angle that can be subtended at any point is  $4\pi \text{ sr}$ .

### THE NUMBER " $\pi$ "

The number  $\pi$  is defined as the circumference of a circle divided by the diameter of the same circle. Thus the length of the circumference is  $2\pi r$ . According to equation  $S = r\theta$  the angle subtended by the circumference at the centre of a circle is  $2\pi$  radians or  $360^\circ$  or one revolution, i.e.

$$2\pi \text{ radians} = 360^\circ = \text{one revolution}$$

Therefore

$$1 \text{ rad} = \frac{360^\circ}{2\pi} = 57.32^\circ$$