

Units and Measurements

SI Base Quantities and Units

Introduction to SI Units

The International System of Units (SI) is the modern form of the metric system and is the most widely used system of measurement. It was established to provide a standard for consistent measurement across different fields and countries. SI units are based on seven fundamental base quantities from which all other units can be derived.

SI Base Quantities

The seven base quantities in the SI system are:

1. **Length**
2. **Mass**
3. **Time**
4. **Electric Current**
5. **Thermodynamic Temperature**
6. **Amount of Substance**
7. **Luminous Intensity**

SI Base Units

Each base quantity is associated with a specific unit and symbol as follows:

1. Length

- **Unit:** metre
- **Symbol:** m
- **Definition:** The metre is defined by taking the fixed numerical value of the speed of light in vacuum c to be 299792458 when expressed in the unit m/s.

2. Mass

- **Unit:** kilogram
- **Symbol:** kg
- **Definition:** The kilogram is defined by taking the fixed numerical value of the Planck constant h to be $6.62607015 \times 10^{-34}$ when expressed in the unit J·s.

3. Time

- **Unit:** second
- **Symbol:** s

- **Definition:** The second is defined by taking the fixed numerical value of the caesium frequency $\Delta\nu_{Cs}$, the unperturbed ground-state hyperfine transition frequency of the caesium-133 atom, to be 9192631770 when expressed in the unit Hz.

4. Electric Current

- **Unit:** ampere
- **Symbol:** A
- **Definition:** The ampere is defined by taking the fixed numerical value of the elementary charge e to be $1.602176634 \times 10^{-19}$ when expressed in the unit C, which is equal to A·s.

5. Thermodynamic Temperature

- **Unit:** kelvin
- **Symbol:** K
- **Definition:** The kelvin is defined by taking the fixed numerical value of the Boltzmann constant k to be 1.380649×10^{-23} when expressed in the unit J/K.

6. Amount of Substance

- **Unit:** mole
- **Symbol:** mol
- **Definition:** The mole is defined by taking the fixed numerical value of the Avogadro constant N_A to be $6.02214076 \times 10^{23}$ when expressed in the unit mol⁻¹.

7. Luminous Intensity

- **Unit:** candela
- **Symbol:** cd
- **Definition:** The candela is defined by taking the fixed numerical value of the luminous efficacy of monochromatic radiation of frequency 540×10^{12} Hz, K_{cd} , to be 683 when expressed in the unit lm/W.

Additional Units for Plane and Solid Angles

Besides the seven base units, two more units are defined for plane angles and solid angles:

1. Plane Angle

- **Unit:** radian
- **Symbol:** rad
- **Definition:** Plane angle is the ratio of the length of an arc to its radius.

2. Solid Angle

- **Unit:** steradian
- **Symbol:** sr
- **Definition:** Solid angle is the ratio of the intercepted area of a spherical surface to the square of its radius.

Importance of SI Units

- **Consistency:** Provides a consistent framework for measurement worldwide.
- **Simplicity:** Based on the decimal system, making conversions straightforward.
- **Universality:** Accepted and used internationally in scientific, technical, industrial, and commercial fields.

Understanding and using SI units is crucial for accurate and reliable measurements in various domains.