

System of Units

The principle aspects of the scientific method are accurate measurement, selective analysis, and mathematical formulation. Note that the first and most important is accurate measurements.

Measurement: *is the process by which one can convert physical parameters to meaningful number.*

Instrument: *may be defined as a device for determining the value or magnitude of a quantity or variable.*

The standard measure of each kind of physical quantity is the unit; the number of times the unit occurs in any given amount of the same quantity is the number of measure. With out the unit, the number of measure has no physical meaning.

Fundamental and Derived Units

To measure an unknown we must have acceptable unit standard for the property that is to be assessed. Since there are virtually hundreds of different quantities that man is called upon to measure, it would seem that hundreds of different standard units would be required. Fortunately, this is not the case. By choosing a small number of basic quantities as standards, we can define all the other in terms of these few.

The basic units are called *fundamentals*, while all the others which can be expressed in terms of fundamental units are called *derived* units, and formed by multiplying or dividing fundamental units. The *primary fundamental* units which most commonly used are *length, mass, and time*, while measurement of certain physical quantities in *thermal, electrical, and illumination* disciplines are also represented by fundamental units. These units are used only when these particular classes are involved, and they may therefore be defined as *auxiliary fundamental* units. Every derived unit originates from some physical law defining that unit. For example, the voltage [volt]:

$$\text{volt} = \frac{\text{workdone}}{\text{charge}} = \frac{\text{Joule}}{\text{coulomb}} = \frac{J}{C} = \frac{\text{Force} \times \text{distance}}{\text{current} \times \text{time}} = \frac{\text{Newton} \times \text{meter}}{\text{Amper} \times \text{second}} \Rightarrow$$

$$\text{volt} = \frac{\text{mass} \times \text{acceleration} \times \text{meter}}{\text{current} \times \text{time}} = \frac{\text{mass} \times \frac{\text{velocity}}{\text{time}} \times \text{meter}}{\text{current} \times \text{time}} = \frac{\text{mass} \times \frac{\text{distance}}{\text{time}^2} \times \text{meter}}{\text{current} \times \text{time}}$$

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A derived unit is recognized by its *dimensions*, which can be defined as the complete algebraic formula for the derived unit. The dimensional symbols for the fundamental units of length, mass, and time are L, M, and T, respectively. So the dimensional symbol for the derived unit of voltage

is
$$V = \frac{M \cdot L^2}{I \cdot T^3} = \left[M \cdot L^2 \cdot I^{-1} \cdot T^{-3} \right]$$

Table (1) shows the six basic *S.I* quantity and units of measurement, with their unit symbol:

Table (1):

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electrical current	Ampere	A
Thermodynamic temperature	Kelvin	K

Multiples and Submultiples of units

The units in actual use are divided into submultiples for the purpose of measuring quantities smaller than the unit itself. Furthermore, multiples of units are designated and named so that measurement of quantities much larger than the unit is facilitated. Table(2) lists the decimal multiples and submultiples of units.

Table(2):

<i>Name</i>	<i>Symbol</i>	<i>Equivalent</i>
tera	T	10^{12}
giga	G	10^9
mega	M	10^6
kilo	K	10^3
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

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