25.1: SI Units

"SI" is the French abbreviation for the International System of Units, the system used universally in science. See http://physics.nist.gov/cuu/Units/ for the last word on this subject. This treatment is derived from the National Institute of Science and Technology (NIST) website.

The most fundamental units of measure are length (meters; m), mass (kilograms; kg), time (seconds; s), electric current (ampere; A), temperature (kelvin; K), amount of a substance (mole; mol), and the luminous intensity (candela; cd). The candela is a rather specialized unit related to the perceived brightness of a light source by a "standard" human eye. As such, it is rather anthropocentric and hardly seems to merit the designation "fundamental". The mole is also less fundamental than the other units, as it is simply a convenient way to refer to a multiple of Avogadro's number of atoms or molecules.

Fundamental units can be combined to form derived units with special names. Some of these derived units are listed below.

Fundamental and derived SI units can have multipliers expressed as prefixes, e. g., 1 km = 1000 m. The NIST website points out a minor irregularity with the fundamental unit of mass, the kilogram. This already has the multiplier "kilo" prefixed to the unit "gram". In this case 1000 kg is written 1 Mg, not 1 kkg, etc. SI multipliers are listed below as well.

Derived Units

Name	Abbrev.	Units	Meaning
hertz	Hz	s^{-1}	frequency (cycles/sec)
(unnamed)		s^{-1}	angular frequency (radians/sec)
newton	N	kg m s^{-2}	force
pascal	Pa	N m^{-2}	pressure
joule	J	N m	energy
watt	W	J s^{-1}	power
coulomb	C	A s	electric charge
volt	V	N m C^{-1}	scalar potential
(unnamed)		N s C^{-1}	vector potential
(unnamed)		V m^{-1}	electric field
tesla	T	N s C^{-1} m^{-1}	magnetic field
(unnamed)		V m	electric flux
weber	Wb	T m^2	magnetic flux
volt	V	V	electric circulation (EMF)
(unnamed)		T m	magnetic circulation
farad	F	C V^{-1}	capacitance
ohm	Ω	V A^{-1}	resistance
henry	H	V s^2 C^{-1}	inductance

Multipliers

Multiplier	Name	Prefix
10^{24}	yotta	Y

Multiplier	Name	Prefix
10^{21}	zetta	Z
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a
10^{-21}	zepto	z
10^{-24}	yocto	y

Centimeter-Gram-Second Units

An older system of scientific units is the CGS system. This system is still used widely in certain areas of physics. The fundamental units of length, mass, and time are as implied by the title given above. The most common CGS derived units are those for force (1 dyne = 10^{-5} N) and energy (1 erg = 10^{-7} J).

Electromagnetism is expressed in several different ways in CGS units. Electromagnetic quantities in CGS not only have different units than in SI, they also have different physical dimensions, with different versions differing among themselves. The most common variant of CGS electromagnetic units is called “Gaussian” units. This variant is advocated by some physicists, though many others consider the whole subject of CGS electromagnetic units to be a terrible mess! SI units for electromagnetism are used in this text and CGS units will not be discussed further here.

Miscellaneous Conversions

1 lb = 4.448 N
1 ft = 0.3048 m
1 mph = 0.4470 m s^{-1}
1 eV = 1.60×10^{-19} J
1 mol = 6.022×10^{23} molecules
(One mole of carbon-12 atoms has a mass of 12 g.)
1 gauss = 10^{-4} T (CGS unit of magnetic field)

1 millibar = 1 mb = 100 Pa (Old unit of pressure)
