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INTERNATIONAL SYSTEM OF UNITS

The Système International d'Unités (SI) was adopted by the eleventh General Conference on Weights and Measures and endorsed by the International Organization for Standardization in 1960. The system is an extension and refinement of the traditional metric system and is superior to any other in being completely coherent, rational, and comprehensive. In the system there is one, and only one, unit for each physical quantity and the product or quotient of any two SI units yields the unit of the resulting quantity; no numerical factors are involved.

The seven basic and two supplementary units on which the SI is based are listed in Table 1.

TABLE 1

BASIC AND SUPPLEMENTARY SI UNITS

Quantity	Name of Unit	Unit Symbol
Length	metre	m
Mass	kilogramme	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	degree Kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol
Plane angle	radian	rad
Solid angle	steradian	sr

The basic units are defined as follows:

Metre: The metre is the length equal to 1 650 763·73 (exactly) wavelengths in a vacuum of the radiation corresponding to the transition between the energy levels $2p_{10}$ and $5d_5$ of the pure nuclide ^{86}Kr.

Kilogramme: The kilogramme is the mass of the International Prototype Kilogramme which is in the custody of the Bureau International des Poids et Mesures at Sèvres, France.

Second: The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels ($F = 4$, $M_F = 0$ and $F = 3$, $M_F = 0$) of the ground state of the atom of pure nuclide ^{133}Cs.

Ampere: The ampere is that constant current which, if maintained in two parallel rectilinear conductors, of infinite length and of negligible circular cross-section, at a distance apart of 1 metre in a vacuum, would produce a force between the conductors equal to 2×10^{-7} newton per metre of length.

Degree Kelvin: The degree Kelvin is completely defined by the decision of the 1954 Conférence Générale to assign the value 273·16 degrees Kelvin (exactly) to the thermodynamic temperature at the triple point of water.

Candela: The candela, the unit of luminous intensity, is such that the luminance of a black body at the freezing point of platinum is 6×10^5 candelas per square metre.

Mole: The mole is an amount of substance of a system which contains as many elementary units as there are carbon atoms in 0·012 kg (exactly) of the pure nuclide ^{12}C. The elementary unit must be specified and may be an atom, a molecule, an ion, an electron, a photon, etc., or a specified group of such entities.

All the other necessary units can be derived from these basic units. Tables 2 and 3 list some of the derived units.

TABLE 2

DERIVED SI UNITS WITH SPECIAL NAMES

Physical Quantity	Name of Unit	Symbol for Unit	Definition of Unit
Energy	joule	J	$kg\ m^2\ s^{-2}$
Force	newton	N	$kg\ m\ s^{-2} = J\ m^{-1}$
Power	watt	W	$kg\ m^2\ s^{-3} = J\ s^{-1}$
Electric charge	coulomb	C	A s
Electric potential difference	volt	V	$kg\ m^2\ s^{-3}\ A^{-1} = J\ A^{-1}\ s^{-1}$
Electric resistance	ohm	Ω	$kg\ m^2\ s^{-3}\ A^{-2} = V\ A^{-1}$
Electric capacitance	farad	F	$A^2\ s^4\ kg^{-1}\ m^{-2} = A\ s\ V^{-1}$
Magnetic flux	weber	Wb	$kg\ m^2\ s^{-2}\ A^{-1} = V\ s$
Inductance	henry	H	$kg\ m^2\ s^{-2}\ A^{-2} = V\ s\ A^{-1}$
Magnetic flux density	tesla	T	$kg\ s^{-2}\ A^{-1} = V\ s\ m^{-2}$
Luminous flux	lumen	lm	cd sr
Illumination	lux	lx	$cd\ sr\ m^{-2}$
Frequency	hertz	Hz	s^{-1}

TABLE 3

OTHER DERIVED SI UNITS

Physical Quantity	SI Unit	Symbol
Area	square metre	m^2
Volume	cubic metre	m^3
Density	kilogramme per cubic metre	$kg\ m^{-3}$
Velocity	metre per second	$m\ s^{-1}$
Angular velocity	radian per second	$rad\ s^{-1}$
Acceleration	metre per second squared	$m\ s^{-2}$
Pressure	newton per square metre	$N\ m^{-2}$
Kinematic viscosity, diffusion coefficient	square metre per second	$m^2\ s^{-1}$
Dynamic viscosity	newton second per square metre	$N\ s\ m^{-2}$
Electric field strength	volt per metre	$V\ m^{-1}$
Magnetic field strength	ampere per metre	$A\ m^{-1}$
Luminance	candela per square metre	$cd\ m^{-2}$
Heat capacity (specific)	joule per kilogramme degree Kelvin	$J\ kg^{-1}\ K^{-1}$
Thermal conductivity	watt per metre degree Kelvin	$W\ m^{-1}\ K^{-1}$
	joule per metre second degree Kelvin	$J\ m^{-1}\ s^{-1}\ K^{-1}$
Surface tension	newton per metre	$N\ m^{-1}$
	joule per square metre	$J\ m^{-2}$

Table 6 lists a number of other units which are not part of SI and defines them exactly in terms of the basic SI units. *Their use is to be progressively discouraged.*

TABLE 6

SOME COMMON UNITS DEFINED EXACTLY IN TERMS OF SI UNITS

Physical Quantity	Name	Symbol	Definition
Length	inch	in	$2\cdot54\times10^{-2}$ m
Area	acre	ac	$4046\cdot856\,422\,4$ m^2
Mass	pound (avoirdupois)	lb	0·453 592 37 kg
Force	kilogramme-force	kgf	9·806 65 N
Pressure	atmosphere	atm	101 325 N m^{-2}
Pressure	torr	Torr	(101 325/760) N m^{-2}
Pressure	conventional millimetre of mercury	mmHg	$13\cdot595\,1\times980\cdot665\times10^{-2}$ N m^{-2}
Energy	kilowatt-hour	kW h	$3\cdot6\times10^{6}$ J
Energy	thermo-chemical calorie	cal (thermochem.)	4·184 J
Energy	international table calorie	cal_{IT}	4·186 8 J

Some of the SI units are of inconvenient size, but the prefixes listed in Table 4 may be used to indicate fractions or multiples of the basic or derived units.

TABLE 4

PREFIXES FOR SI UNITS

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	μ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f			
10^{-18}	atto	a			

Also, there are a number of familiar units which differ from the corresponding SI units only by powers of ten. They are not part of SI but will probably continue in use for some time. The list of such units in Table 5 is not exhaustive.

TABLE 5

NAMED UNITS WHICH ARE DECIMAL FRACTIONS AND MULTIPLES OF SI UNITS

Physical Quantity	Name	Symbol	Definition
Length	ångström	Å	10^{-10} m
Length	micron	μm	10^{-6} m
Area	hectare	ha	10^{4} m^{2}
Volume	litre	l	10^{-3} m^{3}
Mass	tonne	t	10^{3} kg
Mass	gramme	g	10^{-3} kg
Force	dyne	dyn	10^{-5} N
Pressure	bar	bar	10^{5} N m^{-2}
Energy	erg	erg	10^{-7} J
Kinematic viscosity, diffusion coefficient	stokes	St	10^{-4} m^{2} s^{-1}
Dynamic viscosity	poise	P	10^{-1} kg m^{-1} s^{-1}
Magnetic flux	maxwell	Mx	10^{-8} Wb
Magnetic flux density (magnetic induction)	gauss	G	10^{-4} Wb m^{-2}