



The NIST Reference on Constants, Units, and Uncertainty

International System of Units (SI)

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SI base units

The SI is founded on seven SI base units for seven base quantities assumed to be mutually independent, as given in Table 1.

Table 1. SI base units

Base quantity	Name	Symbol
SI base unit		
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

For detailed information on the SI base units, see [Definitions of the SI base units](#) and their [Historical context](#).

SI derived units

Other quantities, called derived quantities, are defined in terms of the seven base quantities via a system of quantity equations. The SI derived units for these derived quantities are obtained from these equations and the seven SI base units. Examples of such SI derived units are given in Table 2, where it should be noted that the symbol 1 for quantities of dimension 1 such as mass fraction is generally omitted.

Derived quantity	Name	Symbol
Table 2. Examples of SI derived units		
SI derived unit		
area	square meter	m ²
volume	cubic meter	m ³
speed, velocity	meter per second	m/s
acceleration	meter per second squared	m/s ²
wave number	reciprocal meter	m ⁻¹
mass density	kilogram per cubic meter	kg/m ³
specific volume	cubic meter per kilogram	m ³ /kg
current density	ampere per square meter	A/m ²
magnetic field strength	ampere per meter	A/m
amount-of-substance concentration	mole per cubic meter	mol/m ³
luminance	candela per square meter	cd/m ²
mass fraction	kilogram per kilogram, which may be represented by the number 1	kg/kg = 1

For ease of understanding and convenience, 22 SI derived units have been given special names and symbols, as shown in Table 3.

Derived quantity	Name	Symbol	Expression in terms of other SI units	Expression in terms of SI base units
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Table 3. SI derived units with special names and symbols

SI derived unit				
plane angle	radian ^(a)	rad	-	$\text{m} \cdot \text{m}^{-1} = 1$ ^(b)
solid angle	steradian ^(a)	sr ^(c)	-	$\text{m}^2 \cdot \text{m}^{-2} = 1$ ^(b)
frequency	hertz	Hz	-	s^{-1}
force	newton	N	-	$\text{m} \cdot \text{kg} \cdot \text{s}^{-2}$
pressure, stress	pascal	Pa	N/m^2	$\text{m}^{-1} \cdot \text{kg} \cdot \text{s}^{-2}$
energy, work, quantity of heat	joule	J	$\text{N} \cdot \text{m}$	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2}$
power, radiant flux	watt	W	J/s	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-3}$
electric charge, quantity of electricity	coulomb	C	-	$\text{s} \cdot \text{A}$
electric potential difference, electromotive force	volt	V	W/A	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-3} \cdot \text{A}^{-1}$
capacitance	farad	F	C/V	$\text{m}^{-2} \cdot \text{kg}^{-1} \cdot \text{s}^4 \cdot \text{A}^2$
electric resistance	ohm	Ω	V/A	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-3} \cdot \text{A}^{-2}$
electric conductance	siemens	S	A/V	$\text{m}^{-2} \cdot \text{kg}^{-1} \cdot \text{s}^3 \cdot \text{A}^2$
magnetic flux	weber	Wb	$\text{V} \cdot \text{s}$	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2} \cdot \text{A}^{-1}$
magnetic flux density	tesla	T	Wb/m^2	$\text{kg} \cdot \text{s}^{-2} \cdot \text{A}^{-1}$
inductance	henry	H	Wb/A	$\text{m}^2 \cdot \text{kg} \cdot \text{s}^{-2} \cdot \text{A}^{-2}$
Celsius temperature	degree Celsius	$^{\circ}\text{C}$	-	K
luminous flux	lumen	lm	$\text{cd} \cdot \text{sr}$ ^(c)	$\text{m}^2 \cdot \text{m}^{-2} \cdot \text{cd} = \text{cd}$
illuminance	lux	lx	lm/m^2	$\text{m}^2 \cdot \text{m}^{-4} \cdot \text{cd} = \text{m}^{-2} \cdot \text{cd}$
activity (of a radionuclide)	becquerel	Bq	-	s^{-1}
absorbed dose, specific energy (imparted), kerma	gray	Gy	J/kg	$\text{m}^2 \cdot \text{s}^{-2}$
dose equivalent ^(d)	sievert	Sv	J/kg	$\text{m}^2 \cdot \text{s}^{-2}$
catalytic activity	katal	kat		$\text{s}^{-1} \cdot \text{mol}$

^(a) The radian and steradian may be used advantageously in expressions for derived units to distinguish between quantities of a different nature but of the same dimension; some examples are given in Table 4.

^(b) In practice, the symbols rad and sr are used where appropriate, but the derived unit "1" is generally omitted.

^(c) In photometry, the unit name steradian and the unit symbol sr are usually retained in expressions for derived units.

^(d) Other quantities expressed in sieverts are ambient dose equivalent, directional dose equivalent, personal dose equivalent, and organ dose equivalent.

For a graphical illustration of how the 22 derived units with special names and symbols given in Table 3 are related to the seven SI base units, see [relationships among SI units](#).

Note on degree Celsius. The derived unit in Table 3 with the special name degree Celsius and special symbol $^{\circ}\text{C}$ deserves comment. Because of the way temperature scales used to be defined, it remains common practice to express a thermodynamic temperature, symbol T, in terms of its difference from the reference temperature $T_0 = 273.15 \text{ K}$, the ice point. This temperature difference is called a Celsius temperature, symbol t, and is defined by the quantity equation

$$t = T - T_0.$$

The unit of Celsius temperature is the degree Celsius, symbol $^{\circ}\text{C}$. The numerical value of a Celsius temperature t expressed in degrees Celsius is given by

$$t/^{\circ}\text{C} = T/\text{K} - 273.15.$$

It follows from the definition of t that the degree Celsius is equal in magnitude to the kelvin, which in turn implies that the numerical value of a given temperature difference or temperature interval whose value is expressed in the unit degree Celsius ($^{\circ}\text{C}$) is equal to the numerical value of the same difference or interval when its value is expressed in the unit kelvin (K). Thus, temperature differences or temperature intervals may be expressed in either the degree Celsius or the kelvin using the same numerical value. For example, the Celsius temperature difference Δt and the thermodynamic temperature difference ΔT between the melting point of gallium and the triple point of water may be written as $\Delta t = 29.7546\text{ }^{\circ}\text{C} = \Delta T = 29.7546\text{ K}$.

The special names and symbols of the 22 SI derived units with special names and symbols given in Table 3 may themselves be included in the names and symbols of other SI derived units, as shown in Table 4.

Derived quantity	Name	Symbol
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Table 4. Examples of SI derived units whose names and symbols include SI derived units with special names and symbols

	SI derived unit	
dynamic viscosity	pascal second	$\text{Pa}\cdot\text{s}$
moment of force	newton meter	$\text{N}\cdot\text{m}$
surface tension	newton per meter	N/m
angular velocity	radian per second	rad/s
angular acceleration	radian per second squared	rad/s^2
heat flux density, irradiance	watt per square meter	W/m^2
heat capacity, entropy	joule per kelvin	J/K
specific heat capacity, specific entropy	joule per kilogram kelvin	$\text{J}/(\text{kg}\cdot\text{K})$
specific energy	joule per kilogram	J/kg
thermal conductivity	watt per meter kelvin	$\text{W}/(\text{m}\cdot\text{K})$
energy density	joule per cubic meter	J/m^3
electric field strength	volt per meter	V/m
electric charge density	coulomb per cubic meter	C/m^3
electric flux density	coulomb per square meter	C/m^2
permittivity	farad per meter	F/m
permeability	henry per meter	H/m
molar energy	joule per mole	J/mol
molar entropy, molar heat capacity	joule per mole kelvin	$\text{J}/(\text{mol}\cdot\text{K})$
exposure (x and γ rays)	coulomb per kilogram	C/kg
absorbed dose rate	gray per second	Gy/s
radiant intensity	watt per steradian	W/sr
radiance	watt per square meter steradian	$\text{W}/(\text{m}^2\cdot\text{sr})$
catalytic (activity) concentration	katal per cubic meter	kat/m^3

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