

Physical Units Expression Language

PUEL Specification for SciNumTools v3

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Contents

1	PUEL Specification	2
1.1	Overview	2
1.2	Design Principles	2
1.2.1	Relationship to Existing Unit Standards	3
1.3	Unit Model	3
1.3.1	Base units	3
1.3.2	Scaling factors	3
1.3.3	Named Entities	4
1.3.4	Custom units	4
1.4	Unit expressions	4
1.4.1	General Form	4
1.4.2	Expression Parsing	5
1.4.3	Numerical arrays	5
1.4.4	Unit-system selection	5
1.4.5	Display notation	6
1.4.6	Canonical Representation and Serialization	6
1.5	Conversions	6
1.5.1	Logarithmic and temperature conversions	6
1.5.2	Conversion between unit systems	6
2	Scaling prefixes	7
3	Unit systems	7
3.1	Reading the tables	7
4	Shared unit definitions	8
4.1	Base-unit symbols	8
4.2	Fixed reference constants	8
5	SI: International System of Units	9
5.1	Derived units and aliases	9
5.2	System-specific constants	11
5.3	Quantity symbols and conversion factors	11
6	ESU: Electrostatic CGS units	13
6.1	Derived units and aliases	13
6.2	System-specific constants	14
6.3	Quantity symbols and conversion factors	14
7	EMU: Electromagnetic CGS units	15
7.1	Derived units and aliases	15
7.2	System-specific constants	15
7.3	Quantity symbols and conversion factors	16
8	GU: Gaussian CGS units	16
8.1	Derived units and aliases	16

8.2	System-specific constants	17
8.3	Quantity symbols and conversion factors	17
9	IU: Imperial units	18
9.1	Derived units and aliases	18
9.2	Quantity symbols and conversion factors	19
10	US: United States customary units	19
10.1	Derived units and aliases	19
10.2	Quantity symbols and conversion factors	21
11	AU: Atomic units	21
11.1	Derived units and aliases	21
11.2	System-specific constants	21
11.3	Quantity symbols and conversion factors	22
12	PU: Planck units	22
12.1	Derived units and aliases	22
12.2	System-specific constants	22
12.3	Quantity symbols and conversion factors	23
13	SRU: Units for special relativity	23
13.1	Derived units and aliases	23
13.2	System-specific constants	23
13.3	Quantity symbols and conversion factors	23
14	GRU: Units for general relativity	24
14.1	Derived units and aliases	24
14.2	System-specific constants	24
14.3	Quantity symbols and conversion factors	24
15	GEO: Geometrized units	25
15.1	Derived units and aliases	25
15.2	System-specific constants	25
15.3	Quantity symbols and conversion factors	25

1 PUEL Specification

1.1 Overview

PUEL (Physical Units Expression Language) is a domain-specific language for representing and manipulating physical units and dimensional expressions.

It defines the syntax and structure of unit expressions used in scientific computations within the SciNumTools3 framework. Evaluation, normalization, dimensional analysis, and unit conversion are performed by the underlying EXS and PUQ modules.

The language is designed for the following use cases: * As a component of DIPL for defining and validating unit-aware parameters. * As a standalone language for the concise and machine-readable representation of physical unit expressions. * As a backend for programmatic interfaces, such as Python bindings and other language integrations.

This chapter defines the language syntax and conversion rules. The following chapters provide reference tables for scaling prefixes, unit systems, and shared definitions, followed by the derived units, constants, and quantity scales of each supported system.

1.2 Design Principles

PUEL is designed to be:

- **Concise** — compact textual representation of units

- **Composable** — units can be combined using algebraic operations
- **Deterministic** — expressions resolve to a canonical dimensional form
- **Extensible** — supports custom units and prefixes
- **Solver-backed** — evaluation delegated to EXS

1.2.1 Relationship to Existing Unit Standards

PUEL is designed as a machine-readable language for representing physical quantities and unit expressions, rather than as a replacement for established unit coding systems. In particular, PUEL is intended to be interoperable with standards and vocabularies such as the International System of Units (SI), the Unified Code for Units of Measure (UCUM), UDUNITS, QUDT, and the OM ontology. PUEL extends the scope of conventional unit notations by providing a unified syntax for numerical values, units, uncertainties, physical constants, symbolic quantities, and algebraic expressions. Where applicable, PUEL unit expressions **SHOULD** be convertible to and from established unit representations, while the semantic interpretation of a PUEL expression remains independent of any particular serialization format. This design allows PUEL to serve as a compact interchange notation for scientific quantities while remaining compatible with existing unit standards and ontologies.

1.3 Unit Model

1.3.1 Base units

All unit expressions are ultimately represented in terms of a fixed set of base dimensions:

- Length in meters (**m**)
- Mass in grams (**g**)
- Time in seconds (**s**)
- Temperature in kelvins (**K**)
- Electric current in amperes (**A**)
- Luminous intensity in candelas (**cd**)
- Amount of substance in moles (**mol**)
- Angle in radians (**rad**)

Derived units are represented as combinations of these base dimensions together with an associated scaling factor.

The choice of base dimensions is driven by implementation considerations and does not exactly match the SI base-unit system.

- Mass is represented using grams (**g**) rather than kilograms (**kg**) to avoid embedding a prefix in a base unit.
- Electric current is represented using amperes (**A**); electric charge is a derived quantity (**C = A*s**).
- Angle is included as a base dimension to enable dimensional validation of mathematical functions that require angular arguments. However, angular units **MUST** remain convertible to dimensionless units, reflecting their dimensionless nature in the SI system.

1.3.2 Scaling factors

Scaling prefixes provide a compact way to represent decimal multiples and submultiples of units. A scaling prefix modifies a unit identifier by applying a fixed numerical factor while preserving the unit's dimensionality.

For example, the expressions **m**, **cm**, and **km** all represent units of length and differ only in their scaling factors relative to the base unit.

PUEL defines a standard set of scaling prefixes. Implementations **MUST** recognize and correctly apply these prefixes when parsing unit expressions. However, prefixes **SHOULD** only be permitted for units for which their use is conventional or widely accepted.

The complete list of supported scaling prefixes is provided in Scaling Prefixes.

1.3.3 Named Entities

Named entities in PUEL include all units (e.g., Joule J, degree Celsius `Ce1`, decibel `dB`), physical constants (e.g., proton mass `{m_p}`, Avogadro constant `{N_A}`, solar luminosity `{L_sol}`), physical quantities (e.g., energy `<E>`, electric flux `<Phi_E>`, radiation dose `<D_r>`), and unit-system scaling factors (e.g., `|E|`, `|Phi_E|`, `|D_r|`). The dimensionality of these entities is defined in terms of the base dimensions described in the previous section.

PUEL distinguishes between these categories using the following notation:

- Units are represented by their symbols: J, `Ce1`, `dB`
- Physical constants are enclosed in curly braces: `{m_p}`, `{N_A}`, `{L_sol}`
- Physical quantities are enclosed in angle brackets: `<E>`, `<Phi_E>`, `<D_r>`
- Unit-system scaling factors are enclosed in pipe symbols: `|E|`, `|Phi_E|`, `|D_r|`

Unit-system scaling factors represent the numerical coefficients required to convert a physical quantity between the SI system and another system of units. They are primarily intended to support conversions between systems with different dimensional conventions, such as SI and CGS.

Each implementation **MUST** define the numerical values and dimensional representations of all supported derived entities. These definitions **SHOULD** be precomputed and stored to avoid repeated evaluation and dimensional derivation during the processing of unit expressions.

Within a given implementation and unit system, all supported identifiers and scaling-prefix combinations **MUST** be unique. Consequently, every valid token in a PUEL expression **MUST** have exactly one interpretation.

1.3.4 Custom units

Custom units **MAY** be defined in the surrounding environment using existing unit expressions. Once registered in a unit system, a custom symbol can be used in expressions just like a built-in unit, including in products, quotients, and powers. For example, an environment may define `step` as `0.75*m` and then interpret `4*step` as `3*m`.

Custom definitions are scoped to their unit system. PUQ stores their numerical scale, uncertainty when present, and dimensions. Registration is performed by the host application; PUEL does not define assignment syntax. PUQ custom units do not accept scaling prefixes.

1.4 Unit expressions

1.4.1 General Form

A unit expression consists of an optional unit system identifier followed by a numerical value, unit factors, or both.

General form:

`[<system>_] [<value>*] [<unit-expression>]`

where:

- `<system>` is a unit system identifier.
- `<value>` is a numerical value, optionally including an uncertainty.
- `<unit-expression>` is a combination of unit identifiers and algebraic operators.

At least one of `<value>` or `<unit-expression>` **MUST** be present.

The `*` separator between the value and unit factors is present only when both are supplied. A value alone, such as `2.5`, represents a dimensionless quantity. The value **MAY** also be a numerical array, as described below.

Examples:

```
m
2.5*m
3.452(3)*kg*m/s2
US_lb*ft
SI_9.81*m/s2
```

The following rules apply in unit expressions:

Rule	Examples
Expressions MUST NOT contain whitespace except for spaces after array separators.	<code>kg*m/s2</code>
Unit identifiers MAY be combined using multiplication (*), division (/), and grouping parentheses ((,)).	<code>kg*mm/skg*m2/(sr*s2)</code>
Exponents are written directly after the corresponding unit identifier and do not use exponentiation operators such as ^ or **.	<code>m2</code>
Fractional exponents are written using the <code>numerator:denominator</code> notation.	<code>kg3:2</code>
Negative exponents are written using a leading minus sign.	<code>s-1</code>
A unit system MAY be specified. When present, it MUST appear at the beginning of the expression and MUST be separated from the remainder by an underscore (_).	<code>US_1b*ft</code>
Numerical values MAY be included in expressions.	<code>2.34e3*mol-9.81*m/s2</code>
The symbols + and - denote the sign of a numerical value or exponent; they do not represent addition or subtraction operators.	<code>+5*m-5*ms-2</code>
Uncertainties are written in parentheses immediately following the last decimal digit of a numerical value. The number of digits in the uncertainty corresponds to the same number of least significant digits in the value.	<code>3.45234(2)e3 → 3452.34 ±</code> <code>0.023.45234(12) → 3.45234 ±</code> <code>0.0001212.3(4)e-2 → 0.123 ±</code> <code>0.004120(5) → 120 ± 5</code>

1.4.2 Expression Parsing

Although numerical values are typically written at the beginning of an expression, they are not restricted to that position. Numerical factors MAY appear anywhere within a unit expression as multiplicative constants. For example, `2*kg*m/s2` and `kg*(2*m)/s2` are equivalent.

Implementations SHOULD accept numerical factors in any valid position within a unit expression. However, producers of unit expressions SHOULD place any numerical factor at the beginning of the expression, as this improves readability and simplifies parsing.

Unit expressions MAY use division operators and grouping parentheses for readability. For example, `kg*m2/(sr*s2)` and `kg*m2*sr-1*s-2` represent the same unit expression.

An exponent MAY follow a closing parenthesis and applies to the entire grouped expression, including numerical factors. Integer, negative, and fractional exponents use the same notation as unit exponents. For example, `(m/s)2` is equivalent to `m2*s-2`, and `kg/(m*s)-1:2` is equivalent to `kg*m1:2*s1:2`. Exponents also apply to named entities, as in `kg*<v>2`.

Expressions containing only numerical factors are supported. For example, `3*(2.0e1/5.0)` evaluates to the dimensionless value 12.

1.4.3 Numerical arrays

A numerical array is written as a comma-separated list of values in square brackets. All elements share the units specified outside the brackets. Elements MAY include scientific notation or parenthesized uncertainties. Spaces MAY follow commas.

```
[2,3.4,5e6]*km/s
[2.00(20), 3.00(30)]*m
```

Multiplication and division by a scalar apply to each element. Multiplication and division between arrays of the same shape are elementwise operations. For example, `[20,40.5]*2` evaluates to `[40,81]`, and `[20,40.5]*[2,3]` evaluates to `[40,121.5]`. Unit factors are combined using the ordinary expression rules.

1.4.4 Unit-system selection

The system identifier, when present, MUST appear only at the beginning of the expression, immediately followed by an underscore (_). It selects the interpretation of all unit factors in the expression. For example, `US_23*ft2` is valid; `US 23*ft2` and `23*US_ft2` are not valid PUEL expressions. PUQ supports SI and, when enabled, CGS variants (ESU, EMU, GU), English systems (IU, US), and natural systems (AU, PU, SRU, GRU, GEO).

When no identifier is supplied, PUQ uses the active unit system of the surrounding environment, initially SI. If both the expression and its environment explicitly select a system for that expression, the selections MUST

agree. Producers SHOULD include the system identifier when an expression must retain its interpretation outside its original environment.

1.4.5 Display notation

In addition to ASCII notation, PUQ can produce Unicode and HTML representations for display. When Unicode input preprocessing is enabled, it accepts superscript exponents, `*` for multiplication, `-` for a minus sign, and `*10` for scientific notation. For example, `6.23537*102 C3` corresponds to `6.23537e-2*C3`.

Unicode input conveniences are optional; ASCII notation remains the portable form. A system identifier MUST retain its leading position and underscore separator even when Unicode notation is used, as in `US_23 ft2`. HTML output is a display format, not an expression input format.

1.4.6 Canonical Representation and Serialization

Implementations SHOULD internally normalize unit expressions to a canonical form in which all unit factors appear in the numerator and division is represented using negative exponents. For example, the expression `kg*m2/(sr*s2)` is canonically represented as `kg*m2*sr-1*s-2`.

The canonical form provides a unique and deterministic textual representation of a unit expression. Because the original placement of division operators and grouping parentheses cannot, in general, be reconstructed from a normalized expression, implementations SHOULD use the canonical form when serializing unit expressions.

If a unit expression contains a numerical factor, serialized expressions MUST place the numerical factor at the beginning of the expression.

When representing base dimensions, only dimensions with non-zero exponents SHOULD be included. The order of the base dimensions MUST be preserved as specified in Section 3.1..

1.5 Conversions

PUEL supports conversion between units of identical dimensions:

`km` $\rightarrow$ `m`
`eV` $\rightarrow$ `J`
`dBW` $\rightarrow$ `W`

Special handling exists for:

- logarithmic units
- temperature units

These require custom conversion rules.

1.5.1 Logarithmic and temperature conversions

Logarithmic conversions distinguish ratios from levels with a defined reference. PUQ supports power ratios (`PR`), amplitude ratios (`AR`), and logarithmic units such as decibels (`dB`) and nepers (`Np`). Power levels such as `dBm` and `dBW` include their reference power: `0*dBm` corresponds to `1*mW`, while `0*dBW` corresponds to `1*W`. A bare `dB` value does not specify an absolute power.

Absolute temperature conversions can include an offset as well as a scale. For example, `23*Ce1` converts to `296.15*K`. PUQ supports Celsius (`Ce1`), Fahrenheit (`degF`), kelvin (`K`), and Rankine (`degR`). Such conversions cannot be described by a multiplicative scaling factor alone.

1.5.2 Conversion between unit systems

Conversions between systems with different dimensional conventions may require a physical-quantity context in addition to source and target units. For example, converting SI current in `A` to electrostatic CGS current in `statA` requires the current context `I`. Energy conversion between `J` and `erg` does not require an explicit context.

The context identifies the corresponding physical quantity in each system and enables the use of its unit-system scaling factors. It is supplied by the surrounding application, not appended as an additional operator in the expression. A system prefix selects a system; it does not by itself specify a conversion context.

2 Scaling prefixes

Prefix	Factor	Name
Y	1e24	yotta
Z	1e21	zetta
E	1e18	exa
P	1e15	peta
T	1e12	tera
G	1e9	giga
M	1e6	mega
k	1e3	kilo
h	1e2	hecto
da	1e1	deka
d	1e-1	deci
c	1e-2	centi
m	1e-3	milli
u	1e-6	micro
n	1e-9	nano
p	1e-12	pico
f	1e-15	femto
a	1e-18	atto
z	1e-21	zepto
y	1e-24	yocto

[!NOTE] The prefix u is used to represent micro () in ASCII-only unit expressions.

3 Unit systems

The following tables specify the built-in vocabulary provided by PUQ for PUEL expressions. A system identifier appears only at the beginning of an expression and is immediately followed by `_`, for example `SI_2*J` or `US_2*gal`. An identifier selects the entire expression; it cannot qualify an individual factor.

Identifier	System	Unit and quantity tables
SI	International System of Units	SI definitions
ESU	Electrostatic CGS units	ESU definitions
EMU	Electromagnetic CGS units	EMU definitions
GU	Gaussian CGS units	GU definitions
IU	Imperial units	IU definitions
US	United States customary units	US definitions
AU	Atomic units	AU definitions
PU	Planck units	PU definitions
SRU	Units for special relativity	SRU definitions
GRU	Units for general relativity	GRU definitions
GEO	Geometrized units	GEO definitions

3.1 Reading the tables

- Every system includes the shared base-unit symbols. Each system page lists its additional units and aliases, constants, and quantity scales. A unit available in SI is not automatically available in another system.
- Definitions describe one unprefix unit in terms of symbols from the same system. Prefix permissions apply to the symbol in that row; prefixes are not implicitly inherited through an alias.
- Numerical factors and constant values reproduce the PUQ definitions, including their stated precision. These tables describe the PUEL vocabulary and do not redefine external metrological standards.
- Temperature and logarithmic rows give reference units, not linear equalities. Use the special conversion rules; for example, `Ce1` is not equal to `K`.
- SI is always available in PUQ. Other system families, offset temperature units, and logarithmic units depend on enabled implementation features.

- Natural systems often use quantity scales such as <E> rather than a new named unit. Constants without # may be normalized to unity; fixed {#...} reference constants retain their reference values.

4 Shared unit definitions

These symbols are available in every listed system. Prefixes are case-sensitive: **All** means any prefix in the prefix table, **None** means no prefix, and an explicit list permits only those prefixes. An unprefix symbol is always permitted.

4.1 Base-unit symbols

Symbol	Meaning	Definition or reference	Prefixes
m	meter	m	All
g	gram	g	All
s	second	s	All
K	Kelvin	K	All
A	Ampere	A	All
cd	candela	cd	All
mol	mole	mol	All
rad	radian	rad	m

4.2 Fixed reference constants

The following constants are available in SI, AU, PU, SRU, GRU, and GEO. The # inside the braces distinguishes a fixed reference constant from a system-specific constant: for example, {#c} retains its reference value while {c} may be 1 in a natural system. Parenthesized digits denote uncertainty using the ordinary PUEL notation.

Symbol	Meaning	Definition or reference	Prefixes
{#alpha}	fine str. const.	7.2973525643(11)e-3	None
{#euler}	Euler's num.	2.718281828459	None
{#N_0}	Avogadro's num.	6.02214076e23	None
{#pi}	pi num.	3.1415926535	None
{#a_0}	Bohr radius	5.29177210544(82)e-11*m	None
{#c}	speed of light	299792458*m/s	None
{#e}	elem. charge	1.602176634e-19*A*s	None
{#eps_0}	permit. of vac.	8.8541878188(14)e-12*m-3*kg-1*s4*A2	None
{#G}	grav. const.	6.67430(15)e-11*m3*kg-1*s-2	None
{#g}	grav. accel.	9.80665*m/s2	None
{#h}	Planck const.	6.62607015e-34*m2*kg*s-1	None
{#hbar}	Reduced Pl. con.	1.054571817e-34*m2*kg*s-1	None
{#k_B}	Boltzmann const.	1.380649e-23*m2*kg*s-2*K-1	None
{#mu_0}	permeab. of vac.	1.25663706127(20)e-6*m*kg-1*s-2*A-2	None
{#mu_B}	Bohr magneton	9.2740100657(29)e-24*m2*A-1	None
{#m_e}	electron mass	9.1093837139(28)e-31*kg	None
{#m_p}	proton mass	1.67262192595(52)e-27*kg	None
{#m_n}	neutron mass	1.67492749804(95)e-27*kg	None
{#R_inf}	Rydberg constant	10973731.568157(12)*m-1	None
{#sigma}	Stef.Bolt. const.	5.670374419e-8*kg*s-3*K-4	None
{#N_A}	Avogadro's const.	6.02214076e23/mol	None
{#kap_0}	permittivity	1.11265005620e-13*m-3*g-1*s4*A2	None
{#k_e}	Coulomb const.	8.9875517923(14)e9*m3*kg-1*s-4*A-2	None
{#H_0}	Hubble const.	67.36(54)*3.24076e-20*s-1	None
{#L_sol}	Solar luminosity	3.828e26*m2*kg*s-3	None
{#M_sol}	Solar mass	1.988475(92)e30*kg	None
{#R_sol}	Solar radius	6.9566(14)e8*m	None

5 SI: International System of Units

Select this system with the leading `SI_` prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

The fixed reference constants are also available.

5.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
au	astr. unit	149597.870691*Mm	None
AU	astr. unit	au	None
ly	light-year	{c}*yr_j	k, M, G
pc	parsec	3.0857e16*m	k, M, G, T
Å	Angstrom	1e-10*m	m, k
u	atomic mass unit	g/{N_0}	None
amu	atomic mass unit	u	None
Da	Dalton	u	None
t	tonne	1e3*kg	k, m, G
ct	carat	200*mg	None
min	minute	60*s	None
h	hour	60*min	None
day	day	24*h	None
yr_t	tropical year	365.24219*day	k, m, G
yr_j	Julian year	365.25*day	k, m, G
yr_g	Gregorian year	365.2425*day	k, m, G
yr	year	yr_j	k, m, G
degR	degree Rankine	5/9*K	None
deg	angle degree	2*{pi}*rad/360	None
'	angle minute	deg/60	None
''	angle second	'/60	None
ar	are	100*m2	c, d, da, h
b	barn	1e-28*m2	M, k, m, u, n, p, f, a, z, y
l	liter	dm3	All
L	liter	l	All
J	Joule	N*m	All
eV	electronvolt	{e}*V	All
erg	erg	dyn*cm	None
cal	calorie	4.184*J	k, M
Cal	Calorie	kcal	None
Ha	Hartree	4.3597447222071e-18*J	k, M
E_h	Hartree	Ha	k, M
Pa	Pascal	N/m2	All
atm	atm. pressure	101325*Pa	None
bar	bar	100*kPa	M, k, d, c, m
Ba	Barye	0.1*Pa	None
N	Newton	kg*m/s2	All
dyn	dyne	g*cm/s2	All
Gy	Gray	J/kg	None
Sv	Sivert	J/kg	None
T	Tesla	Wb/m2	All
G	Gauss	1e-4*T	All
Hz	Hertz	s-1	All
Bq	Becquerel	s-1	None
W	Watt	J/s	All
hp	horse power	745.7*W	None
kph	kilometer p. hour	km/h	None
kn	knot	0.514444*m/s	None
Mx	Maxwell	1e-8*Wb	None

Symbol	Meaning	Definition or reference	Prefixes
Wb	Weber	$V \cdot s$	None
P	Poise	$g / (cm \cdot s)$	c
St	Stokes	cm^2 / s	c
Ka	Kayser	cm^{-1}	None
D	Debye	$3.33564e-30 \cdot C \cdot m$	All
Oe	Oersted	$1e3 \cdot A / (4 \cdot \{pi\} \cdot m)$	None
Gal	Gal	cm / s^2	None
Bi	Biot	$10 \cdot A$	None
Rad	radiation dose	$0.01 \cdot Gy$	None
sr	steradian	rad^2	None
lm	lumen	$cd \cdot sr$	None
C	coulomb	$A \cdot s$	All
H	Henry	Wb / A	All
Ohm	Ohm	V / A	All
V	Volt	J / C	All
lx	lux	lm / m^2	None
F	Farad	C / V	All
S	Siemens	Ohm^{-1}	All
kat	katal	mol / s	All
dpt	diopetre	$1 / m$	All
Mo	seismic moment	$N \cdot m$	All
%	percent	$1e-2$	None
permille	promile	$1e-3$	None
ppth	promile	$1e-3$	None
ppm	parts per million	$1e-6$	None
ppb	parts per billion	$1e-9$	None
Cel	degree Celsius	K (temperature reference; offset conversion)	None
degF	degree Fahrenheit	K (temperature reference; offset conversion)	None
PR	Power ratio	1	None
AR	Amplitude ratio	1	None
Np	Nepers	1 (logarithmic reference; special conversion)	c, d
B	Bel	1 (logarithmic reference; special conversion)	d
Bm	bel-milliwatt	mW (logarithmic reference; special conversion)	d
BmW	bel-milliwatt	mW (logarithmic reference; special conversion)	d
BW	bel-watt	W (logarithmic reference; special conversion)	d
BV	bel-volt	V (logarithmic reference; special conversion)	d
BuV	bel-microvolt	uV (logarithmic reference; special conversion)	d
BA	bel-amps	A (logarithmic reference; special conversion)	d
BuA	bel-microamps	uA (logarithmic reference; special conversion)	d
B0hm	bel-ohms	Ohm (logarithmic reference; special conversion)	d
BSPL	bel-SPL (Pa)	Pa (logarithmic reference; special conversion)	d
BSIL	bel-SIL (W/m2)	W/m2 (logarithmic reference; special conversion)	d

Symbol	Meaning	Definition or reference	Prefixes
BSWL	bel-SWL (W)	W (logarithmic reference; special conversion)	d
Mw	mom. magnitude	Mo (logarithmic reference; special conversion)	None

5.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{alpha}	fine str. const.	{#alpha}	None
{euler}	Euler's num.	{#euler}	None
{N_0}	Avogadro's num.	{#N_0}	None
{pi}	pi num.	{#pi}	None
{a_0}	Bohr radius	{#a_0}	None
{c}	speed of light	{#c}	None
{e}	elem. charge	{#e}	None
{eps_0}	permit. of vac.	{#eps_0}	None
{G}	grav. const.	{#G}	None
{g}	grav. accel.	{#g}	None
{h}	Planck const.	{#h}	None
{hbar}	Reduced Pl. con.	{#hbar}	None
{H_0}	Hubble const.	{#H_0}	None
{k_B}	Boltzmann const.	{#k_B}	None
{k_e}	Coulomb const.	{#k_e}	None
{L_sol}	Solar luminosity	{#L_sol}	None
{M_sol}	Solar mass	{#M_sol}	None
{mu_0}	permeab. of vac.	{#mu_0}	None
{mu_B}	Bohr magneton	{#mu_B}	None
{m_e}	electron mass	{#m_e}	None
{m_p}	proton mass	{#m_p}	None
{m_n}	neutron mass	{#m_n}	None
{R_inf}	Rydberg constant	{#R_inf}	None
{R_sol}	Solar radius	{#R_sol}	None
{sigma}	Stef.Bolt. const.	{#sigma}	None
{N_A}	Avogadro's const.	{#N_A}	None

5.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	m	—
<m>	mass	g	—
<t>	time	s	—
<T>	temperature	K	—
<I>	current	A	—
<Iv>	luminous intensity	cd	—
<n>	amount of substance	mol	—
<the>	angular displacement	rad	—
<v>	velocity	m/s	—
<a>	acceleration	m/s ²	—
<jerk>	jerk	m/s ³	—
<snap>	snap	m/s ⁴	—
<crac>	crackle	m/s ⁵	—

Symbol	Meaning	Quantity scale	Conversion factor
<pop>	pop	m/s ⁶	—
<rho>	density	kg/m ³	—
<rho_A>	area density	kg/m ²	—
<rho_l>	linear density	kg/m	—
<rho_E>	energy density	J/m ³	—
<A>	area	m ²	—
<V>	volume	m ³	—
<p_mom>	momentum	kg*m/s	—
<I_mom>	moment of inertia	kg*m ²	—
<ome>	angular velocity	rad/s	—
<a_ome>	angular acceleration	rad/s ²	—
<L_ome>	angular momentum	kg*m ² /s	—
<F>	force	N	—
<freq>	frequency	Hz	—
<J_i>	impulse	N*s	—
<Abs>	absent	m*s	—
<mu_v>	dynamic viscosity	Pa*s	—
<nu_v>	kinematic viscosity	m ² /s	—
<eps_s>	strain	1	—
<sig_s>	stress	Pa	—
<E_Y>	Young's modulus	Pa	—
<k_s>	spring constant	N/m	—
<gam>	surface tension	J/m ²	—
<tau>	torque	N*m	—
<E>	energy	J	—
<S>	entropy	J/K	—
<p>	pressure	Pa	—
<mu_c>	chemical potential	J/mol	—
<W>	work	J	—
<P>	power	W	—
<E_sp>	specific energy	J/kg	—
<C_sp>	specific heat capacity	J/(K*kg)	—
<V_sp>	specific volume	m ³ /kg	—
<Q>	heat	J	—
<C_p>	heat capacity	J/K	—
<phi_Q>	heat flux density	W/m ²	—
<C_mol>	molar concentration	mol/m ³	—
<E_mol>	molar energy	J/mol	—
<c_mol>	molar heat capacity	J/(K*mol)	—
<S_mol>	molar entropy	J/(K*mol)	—
<rr>	reaction rate	mol/(m ³ *s)	—
<kap>	thermal conductance	W/K	—
<lam_t>	thermal conductivity	W/(m*K)	—
<R_t>	thermal resistance	K/W	—
<R_lam>	thermal resistivity	K*m/W	—
<Q_vol>	volumetric flow rate	m ³ /s	—
<q>	electric charge	C	—
<rho_q>	electric charge density	C/m ³	—
<p_e>	electric dipole moment	C*m	—
<p_qe>	electric quadrupole moment	C*m ²	—
<D_e>	electric displacement field	C/m ²	—
<E_e>	electric field strength	V/m	—
<V_e>	electric field gradient	V/m ²	—
<alp_e>	electric polarizability	C ² *m ² *J ⁻¹	—
<alp_he>	1st hyperpolarizability	C ³ *m ³ *J ⁻²	—
<alp_hhe>	2nd hyperpolarizability	C ⁴ *m ⁴ *J ⁻³	—
<G_e>	electrical conductance	S	—
<sig_e>	electrical conductivity	S/m	—
<phi_e>	electric potential	V	—

Symbol	Meaning	Quantity scale	Conversion factor
<Phi_E>	electric flux	V*m	—
<R>	electrical resistance	Ohm	—
<rho_e>	electrical resistivity	Ohm*m	—
<Mag>	magnetization	A/m	—
<H>	magnetic field strenght	A/m	—
<Phi_M>	magnetic flux	Wb	—
	magnetic flux density	T	—
<mm>	magnetic dipole moment	N*m/T	—
<mu>	permeability	H/m	—
<eps>	permittivity	F/m	—
<C>	capacitance	F	—
<J_c>	current density	A/m2	—
<Z>	impedance	Ohm	—
<L>	inductance	H	—
<Rel>	reluctance	1/H	—
<P_o>	optical power	dpt	—
<lam_w>	wave length	m	—
<k_n>	wave number	1/m	—
<k_v>	wave vector	1/m	—
<E_il>	illuminance	lx	—
<E_ir>	irradiance	W/m2	—
<F_l>	luinous flux	lm	—
<In>	intensity	W/m2	—
<L_r>	radiance	W/(m2*sr)	—
<I_r>	radiant intensity	W/sr	—
<D_a>	absorbed dose rate	Gy/s	—
<H_de>	dose equivalent	Sv	—
<D_r>	radiation dose	Gy	—
<A_r>	radioactivity	Bq	—
<S_a>	action	J/Hz	—
<spin>	spin	kg*m2*s-1	—

6 ESU: Electrostatic CGS units

Select this system with the leading `ESU_` prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

6.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
Gal	Gal	cm/s2	None
dyn	dyne	g*cm/s2	All
Ba	Barye	dyn/cm2	None
b	Barye	Ba	None
erg	erg	dyn*cm	None
St	Stokes	cm2/s	c
P	Poise	g/(cm*s)	c
Ka	Kayser	cm-1	None
Pma	permeability	1e-4*m2	None
Rayl	Rayl	g/(cm2*s)	None
radd	radiation dose	100*erg/g	None
Fr	franklin	dyn1:2*cm	None
statC	Statcoulomb	Fr	None
esu	elstat. u.o. charge	Fr	None
statA	Statampere	Fr/s	None
statV	Statvolt	erg/Fr	None

Symbol	Meaning	Definition or reference	Prefixes
statOhm	Statohm	s/cm	None
statF	Statfarad	cm	None
statH	Stathenry	s ² /cm	None
statT	Stattesla	cm ⁻³ ·2·g ¹ ·2	None
statWb	Statweber	cm ² ·g	None

6.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{m_u}	atom. mass const.	1.660539069e-24·g	None
{a_0}	Bohr radius	5.291772105e-9·cm	None
{k}	Boltzmann const.	1.380649e-16·erg/K	None
{m_e}	electron mass	9.10938371e-28·g	None
{alpha}	fine-str. const.	0.007297352564	None
{G}	gravit. const.	6.6743e-8·dyn·cm ² /g ²	None
{h}	Planck const.	6.62607015e-27·erg·s	None
{hbar}	reduced Pl. con.	1.054571817e-27·erg·s	None
{c}	speed of light	2.99792458e10·cm/s	None
{pi}	pi num.	3.1415926	None
{e}	elementary charge	4.80320471e-10·Fr	None
{mu_B}	Bohr magneton	2.780278273e-10·statA·cm ²	None

6.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	cm	—
<m>	mass	g	—
<t>	time	s	—
<Iv>	luminous intensity	cd	—
<n>	amount of substance	mol	—
<the>	angular displacement	rad	—
<v>	velocity	cm/s	—
<a>	acceleration	Gal	—
<F>	force	dyn	—
<E>	energy	erg	—
<P>	power	erg/s	—
<p>	pressure	Ba	—
<mu_v>	dynamic viscosity	P	—
<nu_v>	kinematic viscosity	St	—
<k_n>	wave number	Ka	—
<q>	electric charge	statC	1e1/({c}*100)
<I>	current	statA	1e1/({c}*100)
<phi_e>	electric potential	statV	1e-8*({c}*100)
<E_e>	electric field strength	statV/cm	1e-6*({c}*100)
<D_e>	electric displacement field	statC/cm ²	1e5/(4*{pi}*({c}*100))
<p_e>	electric dipole moment	statC·cm	1e-1/({c}*100)
<Phi_E>	electric flux	statC	1e1/(4*{pi}*({c}*100))
<eps>	permittivity	1	1e11/(4*{pi}*({c}*100) ²)
<R>	electrical resistance	statOhm	({c}*100) ² /1e9
<rho_e>	electrical resistivity	statOhm·cm	({c}*100) ² /1e11
<C>	capacitance	statF	1e9/({c}*100) ²

Symbol	Meaning	Quantity scale	Conversion factor
<L>	inductance	statH	$(\{c\}*100)2/1e9$
	magnetic flux density	statT	$1e-4*(\{c\}*100)$
<H>	magnetic field strenght	statA/cm	$1e3/(4*\{pi\}*(\{c\}*100))$
<mm>	magnetic dipole moment	statA*cm2	$1e-3/(\{c\}*100)$
<Phi_M>	magnetic flux	statWb	$(\{c\}*100)*1e-8$
<mu>	permeability	s2/cm2	$4*\{pi\}*(\{c\}*100)2*1e-7$

7 EMU: Electromagnetic CGS units

Select this system with the leading `EMU_` prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

7.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
Gal	Gal	cm/s2	None
dyn	dyne	g*cm/s2	All
Ba	Barye	dyn/cm2	None
b	Barye	Ba	None
erg	erg	dyn*cm	None
St	Stokes	cm2/s	c
P	Poise	g/(cm*s)	c
Ka	Kayser	cm-1	None
Pma	permeability	1e-4*m2	None
Rayl	Rayl	g/(cm2*s)	None
radd	radiation dose	100*erg/g	None
G	Gauss	cm-1:2*g1:2*s-1	None
Oe	Oersted	g1:2/(cm1:2*s)	None
Gb	Gilbert	Oe*cm	None
Mx	Maxwell	dyn1:2*cm2	None
Bi	biot	dyn1:2	None
abA	Abampere	Bi	None
abC	Abcoulomb	Bi*s	None
aC	Abcoulomb	abC	None
abV	Abvolt	g1:2*cm3:2*s-2	None
abOhm	Abohm	cm*s	None
abF	Abfarad	cm-1*s2	None
abH	Abhenry	cm	None

7.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{m_u}	atom. mass const.	1.660539069e-24*g	None
{a_0}	Bohr radius	5.291772105e-9*cm	None
{k}	Boltzmann const.	1.380649e-16*erg/K	None
{m_e}	electron mass	9.10938371e-28*g	None
{alpha}	fine-str. const.	0.007297352564	None
{G}	gravit. const.	6.6743e-8*dyn*cm2/g2	None
{h}	Planck const.	6.62607015e-27*erg*s	None
{hbar}	reduced Pl. con.	1.054571817e-27*erg*s	None
{c}	speed of light	2.99792458e10*cm/s	None
{pi}	pi num.	3.1415926	None
{mu_B}	Bohr magneton	9.274010066e-21*erg/G	None
{e}	elementary charge	1.602176634e-20*abC	None

7.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	cm	—
<m>	mass	g	—
<t>	time	s	—
<Iv>	luminous intensity	cd	—
<n>	amount of substance	mol	—
<the>	angular displacement	rad	—
<v>	velocity	cm/s	—
<a>	acceleration	Gal	—
<F>	force	dyn	—
<E>	energy	erg	—
<P>	power	erg/s	—
<p>	pressure	Ba	—
<mu_v>	dynamic viscosity	P	—
<nu_v>	kinematic viscosity	St	—
<k_n>	wave number	Ka	—
	magnetic flux density	G	1e-4
<H>	magnetic field strenght	Oe	1e3/(4*{pi})
<mm>	magnetic dipole moment	erg/G	1e-3
<Phi_M>	magnetic flux	Mx	1e-8
<mu>	permeability	1	4*{pi}*1e-7
<q>	electric charge	abC	1e1
<I>	current	abA	1e1
<phi_e>	electric potential	abV	1e-8
<E_e>	electric field strength	abV/cm	1e-6
<D_e>	electric displacement field	abC/cm2	1e5/(4*{pi})
<p_e>	electric dipole moment	abC*cm	1e-1
<Phi_E>	electric flux	abC	1e1/(4*{pi})
<eps>	permittivity	s2/cm2	1e11/(4*{pi})
<R>	electrical resistance	abOhm	1e-9
<rho_e>	electrical resistivity	abOhm*cm	1e-11
<C>	capacitance	abF	1e9
<L>	inductance	abH	1e-9

8 GU: Gaussian CGS units

Select this system with the leading GU_ prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

8.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
Gal	Gal	cm/s2	None
dyn	dyne	g*cm/s2	All
Ba	Barye	dyn/cm2	None
b	Barye	Ba	None
erg	erg	dyn*cm	None
St	Stokes	cm2/s	c
P	Poise	g/(cm*s)	c
Ka	Kayser	cm-1	None

Symbol	Meaning	Definition or reference	Prefixes
Pma	permeability	$1\text{e-}4\cdot\text{m}^2$	None
Rayl	Rayl	$\text{g}/(\text{cm}^2\cdot\text{s})$	None
radd	radiation dose	$100\cdot\text{erg}/\text{g}$	None
Fr	franklin	$\text{dyn}^1:2\cdot\text{cm}$	None
statC	Statcoulomb	Fr	None
esu	elstat. u.o. charge	Fr	None
statA	Statampere	Fr/s	None
statV	Statvolt	erg/Fr	None
statOhm	Statohm	s/cm	None
statF	Statfarad	cm	None
statH	Stathenry	s^2/cm	None
G	Gauss	$\text{cm-}1:2\cdot\text{g}^1:2\cdot\text{s-}1$	None
Oe	Oersted	$\text{g}^1:2/(\text{cm}^1:2\cdot\text{s})$	None
Gb	Gilbert	$0\text{e}\cdot\text{cm}$	None
Mx	Maxwell	$\text{dyn}^1:2\cdot\text{cm}^2$	None

8.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{m_u}	atom. mass const.	$1.660539069\text{e-}24\cdot\text{g}$	None
{a_0}	Bohr radius	$5.291772105\text{e-}9\cdot\text{cm}$	None
{k}	Boltzmann const.	$1.380649\text{e-}16\cdot\text{erg}/\text{K}$	None
{m_e}	electron mass	$9.10938371\text{e-}28\cdot\text{g}$	None
{alpha}	fine-str. const.	0.007297352564	None
{G}	gravit. const.	$6.6743\text{e-}8\cdot\text{dyn}\cdot\text{cm}^2/\text{g}^2$	None
{h}	Planck const.	$6.62607015\text{e-}27\cdot\text{erg}\cdot\text{s}$	None
{hbar}	reduced Pl. con.	$1.054571817\text{e-}27\cdot\text{erg}\cdot\text{s}$	None
{c}	speed of light	$2.99792458\text{e}10\cdot\text{cm}/\text{s}$	None
{pi}	pi num.	3.1415926	None
{e}	elementary charge	$4.80320471\text{e-}10\cdot\text{Fr}$	None
{mu_B}	Bohr magneton	$9.274010066\text{e-}21\cdot\text{erg}/\text{G}$	None

8.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	cm	—
<m>	mass	g	—
<t>	time	s	—
<Iv>	luminous intensity	cd	—
<n>	amount of substance	mol	—
<the>	angular displacement	rad	—
<v>	velocity	cm/s	—
<a>	acceleration	Gal	—
<F>	force	dyn	—
<E>	energy	erg	—
<P>	power	erg/s	—
<p>	pressure	Ba	—
<mu_v>	dynamic viscosity	P	—
<nu_v>	kinematic viscosity	St	—
<k_n>	wave number	Ka	—
<q>	electric charge	statC	$1\text{e}1/(\{c\}\cdot 100)$

Symbol	Meaning	Quantity scale	Conversion factor
<I>	current	statA	$1\text{e}1/(\{c\}*100)$
<phi_e>	electric potential	statV	$1\text{e}-8*(\{c\}*100)$
<E_e>	electric field strength	statV/cm	$1\text{e}-6*(\{c\}*100)$
<D_e>	electric displacement field	statC/cm2	$1\text{e}5/(4*\{pi\}*(\{c\}*100))$
<p_e>	electric dipole moment	statC*cm	$1\text{e}-1/(\{c\}*100)$
<Phi_E>	electric flux	statC	$1\text{e}1/(4*\{pi\}*(\{c\}*100))$
<eps>	permittivity	1	$1\text{e}11/(4*\{pi\}*(\{c\}*100)^2)$
<R>	electrical resistance	statOhm	$(\{c\}*100)^2/1\text{e}9$
<rho_e>	electrical resistivity	statOhm*cm	$(\{c\}*100)^2/1\text{e}11$
<C>	capacitance	statF	$1\text{e}9/(\{c\}*100)^2$
<L>	inductance	statH	$(\{c\}*100)^2/1\text{e}9$
	magnetic flux density	G	$1\text{e}-4$
<H>	magnetic field strength	Oe	$1\text{e}3/(4*\{pi\})$
<mm>	magnetic dipole moment	erg/G	$1\text{e}-3$
<Phi_M>	magnetic flux	Mx	$1\text{e}-8$
<mu>	permeability	1	$4*\{pi\}*1\text{e}-7$

9 IU: Imperial units

Select this system with the leading IU_ prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

9.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
twip	twip	$17.6388888\text{e}-6*\text{m}$	None
th	thou	$25.4\text{e}-6*\text{m}$	None
mil	mil	th	None
in	inch	$0.0254*\text{m}$	None
''	inch	in	None
li	link	$0.201168*\text{m}$	None
ft	foot	$0.3048*\text{m}$	None
'	foot	ft	None
yd	yard	$0.9144*\text{m}$	None
rd	rod/pole/perch	$5.0292*\text{m}$	None
ch	chain	$20.1168*\text{m}$	None
fur	furlong	$201.168*\text{m}$	None
mi	mile	$1609.344*\text{m}$	None
lea	league	$4828.032*\text{m}$	None
le	league	lea	None
ftm	fathom	$1.8288*\text{m}$	None
cb	cable	$219.456*\text{m}$	None
nmi	nautical mile	$1852*\text{m}$	None
NM	nautical mile	nmi	None
ac	acre	$4046.8564224*\text{m}^2$	None
gr	grain	$64.79891\text{e}-3*\text{g}$	None
dr	drachm/dram	$1.771845195*\text{g}$	None
oz	ounce	$28.349523125*\text{g}$	None
lb	pound	$453.59237*\text{g}$	None
cwt	long hundredweight	$50.80234544\text{e}3*\text{g}$	None
ton	long ton	$1.0160469088\text{e}6*\text{g}$	None
slug	slug	$14.59390294\text{e}3*\text{g}$	None
min	minute	$60*\text{s}$	None
h	hour	$60*\text{min}$	None
day	day	$24*\text{h}$	None
yr_t	tropical year	$365.24219*\text{day}$	k, m, G

Symbol	Meaning	Definition or reference	Prefixes
yr_j	Julian year	365.25*day	k, m, G
yr_g	Gregorian year	365.2425*day	k, m, G
yr	year	yr_j	k, m, G
degR	degree Rankine	5/9*K	None
mph	miles per hour	mi/h	None
lbf	pound-force	4.448222e3*g*m*s-2	None
Cel	degree Celsius	K (temperature reference; offset conversion)	None
degF	degree Fahrenheit	K (temperature reference; offset conversion)	None
bc	barleycorn	8.4667e-3*m	None
hh	hand	0.1016*m	None
sqrd	sq. rod/po./per.	25.29285264*m2	None
ro	rood	1011.7141056*m2	None
sqmi	square mile	2589988.110336*m2	None
minim	minim	59.1938802083e-9*m3	None
fls	fluid scruple	1.18387760416e-6*m3	None
fldr	fluid drachm	3.5516328125e-6*m3	None
floz	fluid ounce	28.4130625e-6*m3	None
gi	gill	142.0653125e-6*m3	None
pt	pint	568.26125e-6*m3	None
qt	quart	1136.5225e-6*m3	None
gal	gallon	4.54609e-3*m3	None
bblo	oil barrel	0.16365924*m3	None
st	stone	6.35029318e3*g	None
qr	quarter	12.70058636e3*g	None

9.2 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	ft	—
<m>	mass	lb	—
<t>	time	s	—
<Iv>	luminous intensity	cd	—
<n>	amount of substance	mol	—
<the>	angular displacement	rad	—
<V>	volume	gal	—
<A>	area	ac	—
<v>	velocity	mph	—

10 US: United States customary units

Select this system with the leading **US_** prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

10.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
twip	twip	17.6388888e-6*m	None
th	thou	25.4e-6*m	None

Symbol	Meaning	Definition or reference	Prefixes
mil	mil	th	None
in	inch	0.0254*m	None
''	inch	in	None
li	link	0.201168*m	None
ft	foot	0.3048*m	None
'	foot	ft	None
yd	yard	0.9144*m	None
rd	rod/pole/perch	5.0292*m	None
ch	chain	20.1168*m	None
fur	furlong	201.168*m	None
mi	mile	1609.344*m	None
lea	league	4828.032*m	None
le	league	lea	None
ftm	fathom	1.8288*m	None
cb	cable	219.456*m	None
nmi	nautical mile	1852*m	None
NM	nautical mile	nmi	None
ac	acre	4046.8564224*m2	None
gr	grain	64.79891e-3*g	None
dr	drachm/dram	1.771845195*g	None
oz	ounce	28.349523125*g	None
lb	pound	453.59237*g	None
cwt	long hundredweight	50.80234544e3*g	None
ton	long ton	1.0160469088e6*g	None
slug	slug	14.59390294e3*g	None
min	minute	60*s	None
h	hour	60*min	None
day	day	24*h	None
yr_t	tropical year	365.24219*day	k, m, G
yr_j	Julian year	365.25*day	k, m, G
yr_g	Gregorian year	365.2425*day	k, m, G
yr	year	yr_j	k, m, G
degR	degree Rankine	5/9*K	None
mph	miles per hour	mi/h	None
lbf	pound-force	4.448222e3*g*m*s-2	None
Cel	degree Celsius	K (temperature reference; offset conversion)	None
degF	degree Fahrenheit	K (temperature reference; offset conversion)	None
p	point	352.778e-6*m	None
P	pica	4.233e-3*m	None
sqft	sq. survey foot	0.09290341*m2	None
sqch	square chain	404.68564224*m2	None
section	section	2.589998e6*m2	None
twp	survey township	93.23993e6*m2	None
cuin	cubic inch	16.387064e-6*m3	None
cuft	cubic foot	28.316846592e-3*m3	None
cuyd	cubic yard	0.764554857984*m3	None
acft	acre-foot	1233.482*m3	None
minim	minim	61.611519921875e-9*m3	None
fldr	fluid drachm	3.6966911953125e-6*m3	None
tsp	teaspoon	4.92892159375e-6*m3	None
tbsp	tablespoon	14.78676478125e-6*m3	None
floz	fluid ounce	29.5735295625e-6*m3	None
jig	jig	44.36029434375e-6*m3	None
gi	gill	118.29411825e-6*m3	None
c	cup	236.5882365e-6*m3	None
pt	pint	0.473176473e-3*m3	None
qt	quart	0.946352946e-3*m3	None

Symbol	Meaning	Definition or reference	Prefixes
pot	pottle	1.892705892e-3*m3	None
gal	gallon	3.785411784e-3*m3	None
bbl	liquid barrel	119.240471196e-3*m3	None
bblo	oil barrel	158.987294928e-3*m3	None
hhd	hogshead	238.480942392e-3*m3	None
ptd	dry pint	0.55061047135749e-3*m3	None
qtd	dry quart	1.1012209427149e-3*m3	None
gald	dry gallon	4.4048837708599e-3*m3	None
pk	peck	8.8097675417199e-3*m3	None
bu	bushel	35.239070166879e-3*m3	None
bbll	liquid barrel	115.62712358400e-3*m3	None
cwts	short hundredwe.	45.359237e3*g	None
tons	short ton	907.18474e3*g	None
dwt	pennyweight	1.55517384*g	None
ozt	troy ounce	31.1034768*g	None
lbt	troy pound	373.241721*g	None

10.2 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	ft	—
<m>	mass	lb	—
<t>	time	s	—
<Iv>	luminous intensity	cd	—
<n>	amount of substance	mol	—
<the>	angular displacement	rad	—
<V>	volume	gal	—
<A>	area	ac	—
<v>	velocity	mph	—

11 AU: Atomic units

Select this system with the leading AU_ prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

The fixed reference constants are also available.

11.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
E_h	hartree	{#hbar}2/({#m_e}*{a_0}2)	None

11.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{hbar}	reduced Pl. con.	1	None
{e}	elementary charge	1	None
{m_e}	electr. rest mass	1	None

Symbol	Meaning	Definition or reference	Prefixes
{kap_0}	permittivity	1	None
{a_0}	Bohr radius	$\{\#kap_0\}*\{\#hbar\}^2/(\{\#m_e\}*\{\#e\}^2)$	None
{alpha}	fine-str. const.	1/137	None
{c}	speed of light	$\{\alpha\}-1*\{a_0\}*E_h/\{\#hbar\}$	None
{r_e}	class. e. radius	$\{\alpha\}^2*\{a_0\}$	None
{lbar}	red. Com. wavele.	$\{\alpha\}*\{a_0\}$	None
{m_p}	proton mass	$1836*\{\#m_e\}$	None

11.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	{a_0}	—
<m>	mass	{#m_e}	—
<t>	time	{#hbar}/E_h	—
<I>	current	{#e}*E_h/{#hbar}	—
<Iv>	luminous intensity	cd	—
<n>	amount of substance	mol	—
<the>	angular displacement	rad	—
<v>	velocity	$\{a_0\}*E_h/\{\#hbar\}$	—
<p_mom>	momentum	$\{\#hbar\}/\{a_0\}$	—
<rho_q>	electric charge density	$\{\#e\}/\{a_0\}^3$	—
<q>	electric charge	{#e}	—
<p_e>	electric dipole moment	$\{\#e\}*\{a_0\}$	—
<p_qe>	electric quadrupole moment	$\{\#e\}*\{a_0\}^2$	—
<phi_e>	electric potential	$E_h/\{\#e\}$	—
<E_e>	electric field strength	$E_h/\{\#e\}*\{a_0\}$	—
<V_e>	electric field gradient	$E_h/\{\#e\}*\{a_0\}^2$	—
<eps>	permittivity	{#kap_0}	—
<alp_e>	electric polarizability	$\{\#e\}^2*\{a_0\}^2/E_h$	—
<alp_he>	1st hyperpolarizability	$\{\#e\}^3*\{a_0\}^3/E_h^2$	—
<alp_hhe>	2nd hyperpolarizability	$\{\#e\}^4*\{a_0\}^4/E_h^3$	—
	magnetic flux density	$\{\#hbar\}/(\{\#e\}*\{a_0\}^2)$	—
<mm>	magnetic dipole moment	$\{\#hbar\}*\{\#e\}/\{\#m_e\}$	—
<E>	energy	E_h	—
<F>	force	$E_h/\{a_0\}$	—
<S_a>	action	{#hbar}	—

12 PU: Planck units

Select this system with the leading PU_ prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

The fixed reference constants are also available.

12.1 Derived units and aliases

This system defines its characteristic scales through the quantity symbols below rather than additional named unit symbols.

12.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{c}	speed of light	1	None
{G}	grav. const.	1	None
{hbar}	reduced Pl. con.	1	None
{k_B}	Boltzmann const.	1	None

12.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	$(\{hbar\} * \{G\} / \{c\}^3)^{1:2}$	—
<m>	mass	$(\{hbar\} * \{c\} / \{G\})^{1:2}$	—
<t>	time	$(\{hbar\} * \{G\} / \{c\}^5)^{1:2}$	—
<T>	temperature	$(\{hbar\} * \{c\}^5 * \{k_B\} - 2 / \{G\})^{1:2}$	—
<A>	area	$\{hbar\} * \{G\} / \{c\}^3$	—
<V>	volume	$(\{hbar\} * \{G\} * \{c\}^{-3})^{3:2}$	—
<p_mom>	momentum	$(\{hbar\} * \{c\}^3 / \{G\})^{1:2}$	—
<E>	energy	$(\{hbar\} * \{c\}^5 / \{G\})^{1:2}$	—
<F>	force	$\{c\}^4 / \{G\}$	—
<rho>	density	$\{c\}^5 / \{hbar\} * \{G\}^{-2}$	—
<a>	acceleration	$(\{c\}^7 / \{hbar\} / \{G\})^{1:2}$	—

13 SRU: Units for special relativity

Select this system with the leading SRU_ prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

The fixed reference constants are also available.

13.1 Derived units and aliases

This system defines its characteristic scales through the quantity symbols below rather than additional named unit symbols.

13.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{c}	speed of light	1	None

13.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	m	—
<m>	mass	kg	—
<t>	time	m	{c}^{-1}
<E>	energy	kg	{c}^2

Symbol	Meaning	Quantity scale	Conversion factor
<p_mom>	momentum	kg	{#c}
<v>	velocity	1	{#c}
<L_ome>	angular momentum	kg*m	{#c}
<F>	force	kg/m	{#c}2
<a>	acceleration	m-1	{#c}2
<rho_E>	energy density	kg/m3	{#c}2

14 GRU: Units for general relativity

Select this system with the leading `GRU_` prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

The fixed reference constants are also available.

14.1 Derived units and aliases

Symbol	Meaning	Definition or reference	Prefixes
eV	electronvolt	$1.602176634e-19 \text{ m}^2 \text{ kg} \text{ s}^{-2}$	M, G, T

14.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{c}	speed of light	1	None
{hbar}	reduced Pl. con.	1	None
{eps_0}	permit. of vac.	1	None
{k_B}	Boltzmann const.	1	None
{pi}	pi num.	{#pi}	None
{alpha}	fine-str. const.	$\{#e\}^2 / (4 * \{#pi\} * \{#eps_0\} * \{#hbar\} * \{#c\})$	None
{e}	elem. charge	$(4 * \{#pi\} * \{#alpha\})^{1:2}$	None

14.3 Quantity symbols and conversion factors

<name> denotes the quantity scale in the third column. Where provided, the last column defines |name|, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	GeV-1	{#hbar} * {#c}
<m>	mass	GeV	{#c}-2
<t>	time	GeV-1	{#hbar}
<E>	energy	GeV	—
<p_mom>	momentum	GeV	{#c}-1
<v>	velocity	1	{#c}
<L_ome>	angular momentum	1	{#hbar}
<A>	area	GeV-2	({#hbar} * {#c})2
<F>	force	GeV2	({#hbar} * {#c})-1
<rho_E>	energy density	GeV4	({#hbar} * {#c})-3
<q>	electric charge	{#e}/{#e}	—

15 GEO: Geometrized units

Select this system with the leading `GEO_` prefix. The shared base-unit symbols are also available. Definitions below are interpreted within this system; aliases and capitalization are significant. Prefix rules follow the shared table legend.

The fixed reference constants are also available.

15.1 Derived units and aliases

This system defines its characteristic scales through the quantity symbols below rather than additional named unit symbols.

15.2 System-specific constants

Symbol	Meaning	Definition or reference	Prefixes
{c}	speed of light	1	None
{G}	grav. const.	1	None

15.3 Quantity symbols and conversion factors

`<name>` denotes the quantity scale in the third column. Where provided, the last column defines `|name|`, the factor used by contextual conversion to relate that scale to SI. A dash means no explicit factor is defined. The factor expressions are evaluated using SI metre-kilogram-second scaling, and their numerical results are stored as dimensionless conversion coefficients.

Symbol	Meaning	Quantity scale	Conversion factor
<l>	length	m	—
<m>	mass	m	{#c}2/{#G}
<t>	time	m	{#c}−1
<E>	energy	m	{#c}4/{#G}
<p_mom>	momentum	m	{#c}3/{#G}
<v>	velocity	1	{#c}
<L_ome>	angular momentum	m2	{#c}3/{#G}
<F>	force	1	{#c}4/{#G}
<a>	acceleration	m−1	{#c}2
<rho_E>	energy density	m−2	{#c}4/{#G}