

**A Proposal for Reordering and Making Additions to  
the Complete List of Fundamental Physical and Chemical Constants Published by NIST**  
*[Preliminary Version of a Work in Progress]*

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**Introduction**

In this table, I am presenting a proposal to reorder the complete list of fundamental physical and chemical constants presented by U.S. Department of Commerce, National Institute of Standards and Technology, NIST [*physics.nist.gov/cuu/Constants/Table/allascii.txt*]. The data listed on the following table are also referenced as the CODATA, Committee for Data for Science and Technology, [[www.codata.org](http://www.codata.org)]. In a previous book, I have examined some of the errors and omissions in the CODATA [Johnson, C.W., *Errors and Omissions in the CODATA*, Earth/matrix Editions], as well as extending a proposal to include certain physical constants in the CODATA.

In the following table, I do not contest many of the fundamental constants that require discussion. That is not my purpose herein. In this brief examination, I limit my observations to reordering the complete NIST list, together with a few suggested additions of constants. Currently, I am in the process of writing an accompanying text to this reordered table, but at times it would appear senseless to do so, and simply offer a totally distinct table of fundamental spacetime events, without reference to the questionable word-concept of "constants". This remains, however, to be decided upon as I advance in writing the accompanying text.

There are some glaring aspects of the table presented here as a tentative proposal. It is impossible however to examine each one in this brief essay. One need only examine each constant and the selected observation about its composition. That in itself might suffice at times to call into question the thorough play-on-numbers that appears to exist behind the word-concept "constant".

As I write this brief introduction to the proposed table, it would be very easy to expand the introduction into a full-length manuscript. That must be kept in check, however, and I wish to touch upon the most outstanding points here, without falling into a full-blown analysis of each constant. What is required, however, is a detailed analysis of each constant. Such an analysis would immediately have us question why the same numerical value of a particular constant appears in fact four or five times on the list. For example, consider the elementary charge and its multiple appearances in order of apparition on the list:

<u>Numerical value</u>	<u>Physical constants</u>	=	<u>Reciprocal physical constants</u>	=	<u>Reciprocal numerical value</u>
1.602176565	= atomic unit of charge				
1.602176565	= electron volt				
1.602176565	= electron volt   joule relationship	=	joule electron volt relationship	=	0.624150934
1.602176565	= elementary charge				

But, what intrigues me is the fact one constant may be named a certain way (Atomic unit of permittivity) when its reciprocal counterpart is more easily recognized and explained (c-square).

<u>Numerical value</u>	<u>Physical constants</u>	=	<u>Reciprocal physical constants</u>	=	<u>Reciprocal numerical value</u>
8.854 187 817	= permittivity of free space				
8.854 187 817	= absolute permittivity				
8.854 187 817	= vacuum permittivity				
8.854 187 817	= speed of light in vacuo squared				
8.854 187 817	= electric constant	=	atomic unit of permittivity	=	1.112650056

\* As one examines the numerical expressions in this essay, consider the idea of a fractal number as being expressed in today's scientific notation with all numbers being expressed as a significant number, decimal and a mantissa (1.2345, 2.3456, 3.4567, etc.). However, with the fractal expressions that I employ the particular units of each numerical value are suppressed in order that one captures the numerical relationships unhindered by fractional unit expressions. This helps us view multiples of the numerical values, especially through the *mediatio-duplatio* method (doubling and halving values).

One may only wonder what four or five particular physical constants share the same numerical value, while generally the reciprocal value derives fewer physical constants.

One may immediately wonder whether that particular numerical value represents four different spacetime events or it is simply referenced with four different word-concepts. One may also wonder why only one reciprocal relationship is singled out for notice. Do the four word-concepts actually reflect four different spacetime/motion events, each distinct from one another? One could suggest a presentation of the table of fundamental constants based upon their singular numerical values and their reciprocal values, with a side reference to the different conceptual words used to identify each particular relationship. Instead of illustrating simply the numerical values and their reciprocals, I have chosen to emphasize the relationships behind each physical constant when possible. This means, when I am able to recognize it; some constants I have been unable to decipher their base relationship. This generally occurs because their numerical values offer no clue as to how they were derived or how they might relate to other fundamental physical constants. This fact occurs especially with regard to the constants relating to mass, which, by definition in a sense, do not reflect a specific relationship, but rather a characteristic of their composition.

alpha particle mass		6.644 656 75 e-27	kg	[2 protons, 2 neutrons; generally produced in the process of alpha decay]
atomic mass constant		1.660 538 921 e-27	kg	
atomic mass unit, unified		1.660 538 921 e-27	kg	[Standard unit for indicating mass on an atomic or molecular scale (atomic mass)]
atomic unit of mass		9.109 382 91 e-31	kg	
deuteron mass		3.343 583 48 e-27	kg	[1 proton, 1 neutron; the deuteron is the nucleus of deuterium]
electron mass		9.109 382 91 e-31	kg	[Lepton]
helion mass		5.006 412 34 e-27	kg	[nucleus of a helium-3 atom consists of 2 protons and 1 neutron]
molar mass constant		1 e-3	kg mol <sup>-1</sup> (exact)	[relative atomic mass and molar mass; given divided by its amount of substance]
muon mass		1.883 531 475 e-28	kg	[Lepton]
natural unit of mass		9.109 382 91 e-31	kg	
neutron mass		1.674 927 351 e-27	kg	
Planck mass		2.176 51 e-8	kg	[ ~ Fractal seventh power of c     2176.431087     ]
proton mass		1.672 621 777 e-27	kg	
tau mass		3.167 47 e-27	kg	[Similar to the electron with negative electric charge and a spin of 1/2; a lepton]
triton mass		5.007 356 30 e-27	kg	[nucleus of tritium contains 1 proton and 2 neutrons]

Numerous unit 1.0 constants exist that are simply not identified as such, nor even recognized other than as being presented as reciprocal numerical values of one another. Consider a few of the more outstanding examples of unit 1.0 formed by two complementary constants:

<b><u>Fundamental physical constants</u></b>		<b><u>Respective numerical/fractal values</u></b>		<b><u>Unit 1.0</u></b>
Atomic mass constant times Avogadro constant	=	1.660538921 times 0.602214129	=	1.0
(Atomic mass unit / hartree) times (Hartree energy / mass unit) times	=	3.4231776845 times 2.921 262 3246	=	1.0
Atomic unit of charge times (joule / electron volt)	=	1.602176565 times 6.24150934	=	1.0
Atomic unit of energy times (Joule/Hartree)	=	4.35974434 times 2.29371248	=	1.0

Atomic unit of permittivity times c-square	=	1.112650056 times 8.987551787	=	1.0
atomic mass unit /electron volt	=	931.494 061 e6	Ev	1.492417954 / 1.602176565 [atomic mass constant energy equivalent / electron volt]
atomic mass unit   hertz	=	2.252 342 7168 e23	Hz	1 / 4.4398216689 [reciprocal of hertz / atomic mass unit]
atomic mass unit   inverse meter	=	7.513 006 6042 e14	m^-1	1 / 1.331025051 [reciprocal of inverse meter/atomic mass unit] 3.335650952 / 4.4398216689 [reciprocal of light speed / reciprocal hertz]
atomic mass unit   joule	=	1.492 417 954 e-10	J	1 / 6.70053585 [reciprocal of joule / atomic mass unit] 6.62606957 / 4.4398216689 [Planck constant / reciprocal of hertz]
atomic mass unit   kelvin	=	1.080 954 08 e13	K	1 / 9.2510868 [reciprocal of kelvin / atomic mass unit]
atomic mass unit   kilogram	=	1.660 538 921 e-27	kg	1 / 6.02214129 [reciprocal of kilogram / atomic mass unit]

and so on, infinitely so....

In fact, as may be surmised, there are too many combinations to be listed here of the fundamental physical constants that produce a relationship of unit through their reciprocal numerical values. But, consider the following intriguing set of constants based on reciprocals.

quantum, conductance	7.748 091 7346 e-5	S	2x 1 / 25 812.807 4434 ["Twice the reciprocal of the von Klitzing constant (2/RK)"]
quantum, conductance, Inverse of...	12 906.403 7217	ohm	1 / 7.7480917346 [ <i>Reciprocal of a reciprocal</i> ] [1 / conductance quantum]
quantum, conductance, magnetic flux	2.067 833 758 e-15	Wb	25 812.807 4434 / 2 [von Klitzing constant] 1 / 4.835979 {reciprocal (exact) Josephson constant, conventional value of...}

All of spacetime/motion is related. Hence indubitably all of the numerical values representing material aspects of the fundamental physical constants are themselves relational. One question may revolve around the issue of producing multiple names for a single numerical value. And, how is a reciprocal of a reciprocal in math similar to a double negative in language?

But, then what kind of relationships might one seek in the complete list of the fundamental physical constants? Consider one series of relationships; there are numerous others, some of which I have already made public [*The Planck Constants Based on the Fundamental Physical Constants*, [www.earthmatrix.com/scientoday/planckconstants/index.html](http://www.earthmatrix.com/scientoday/planckconstants/index.html)]. Variations exist in the values of the constants shown in this exercise. I will adjust some values in order to offer the related analysis.

(1) Planck mass energy equivalent [Planck implied energy] *multiplied by* (2) Planck implied mass = (3) Planck constant

$$1.9561 \times 3.3875 = 6.62629$$

(4) Planck constant *divided by* (5) Elementary charge = (6) Planck constant in eV s

$$6.62606957 / 1.6027167 = 4.135667$$

(7) Planck constant in eV s *divided by* (8) Elementary charge = (9) von Klitzing constant

$$4.135667516 / 1.6027165 = 2.581280744$$

(10) Unit 1.0 *divided by* (11) von Klitzing constant = (12) Reciprocal of von Klitzing constant

$$1 / 2.58128074434 = 3.874045867^*$$

(13) Reciprocal of von Klitzing constant *divided by* (14) Elementary charge = (15) ca. Atomic unit of time

$$3.874045867 / 1.602176565 = 2.418064987$$

[\*Consider the reciprocal of the von Klitzing constant (3.874), an unknown constant, in relation to the Planck implied mass given as 3.387 and 3.487.  $3.874 \text{ minus } 3.487 = .387$ ; while  $3.874 \text{ minus } 3.387 = .487$ . At this point, I suspect that this relationship of fractal unit values does not obtain from mere happenstance.]

Repetitions of constants are assigned numbers in the group as they constitute distinct relationships with one another.

The outstanding point remains regarding the number of relationships among the constants as cited. Fifteen constants are related in the procedure cited for the group/series. Eight different constants appear in the series, in different relationships to one another. As I mentioned, many more possible relationships exist among the numerical values and their reciprocals. Some of these relationships have been noted on the distinct reordering of the complete list by NIST offered in this analysis and in previous essays published on my web-site. For example, one particular table presents around a dozen relations of Planck mass energy equivalent (1.9561) relationships to a similar number of pairs of constants. Knowing that the 1.9561 numerical value is of such dominant significance within the fundamental physical constants, it is intriguing to consider by that particular constant/value has been left out of the complete NIST list for so many decades.

(1) Planck mass energy equivalent [Planck implied energy] *multiplied by* (2) Planck implied mass = (3) Planck constant

(4) Planck constant *divided by* (5) Elementary charge = (6) Planck constant in eV s

(7) Planck constant in eV s *divided by* (8) Elementary charge = (9) von Klitzing constant

(10) Unit 1.0 *divided by* (11) von Klitzing constant = (12) Reciprocal of von Klitzing constant

(13) Reciprocal of von Klitzing constant *divided by* (14) Elementary charge = (15) ca. Atomic unit of time

An inverse series may be derived from the same values:

(1) Planck mass energy equivalent divided by Planck implied mass = .577514744

$$1 / .577514744 = 1.731557524$$

1.731557524 squared = 2.998291458 [near the speed of light in a vacuum; adjustments could be made in the numerical values to derive exactly 2.99792458 without toil].

And so on, infinitely so. All of the fundamental physical constants appear to be related through their numerical values given their theoretical origin of creation.

For example, one particular constant that does not appear on the NIST complete list concerns the numerical value: 1.231618143.

Reduced Planck in Me V fm divided by Elementary charge equals Unknown constant not given

$$1.97326963 / 1.602176565 = 1.231618143 \text{ [Unknown constant, which according to the theoretical criteria for the Planck constants be some kind of "Reduced" Planck constant involving eV.]}$$

Consider it reciprocal:  $1 / 1.231618143 = 8.119399716 \times 2 = 1.623879943$  very near the triton / Bohr magneton constant's numerical value: 1.622 393 657 (derived reciprocal 1.232746437).

Consider further then:

Reduced Planck in MeV fm *divided by* Reduced Planck in eV s *equals* 299792458 (speed of light *in vacuo*)

$$1.97326963 / 6.58211899 = 2.99792458$$

The previous relationship to the speed of light in a vacuum is explainable given the nature of the other two constants:

Reduced Planck constant *divided by* Elementary charge *equals* Reduced Planck in eV s

$$1.054571628 / 1.602176565 = 6.58211899$$

Reduced Planck in eV s *divided by* Reciprocal of light speed in vacuo *equals* Reduced Planck in MeV fm

$$6.58211899 / 3.33564095 = 1.97326963$$

**Fundamental Physical Constants --- Complete Listing with a Reordering and Selected Additions by the Earth/matrix Project [www.earthmatrix.com]**

Source Data From: <http://physics.nist.gov/constants>

Quantity	Value	Unit	Comments: Selected relationships among constants. Fractal numerical values.
alpha particle mass	6.644 656 75 e-27	kg	[2 protons, 2 neutrons; generally produced in the process of alpha decay]
alpha particle energy equivalent	5.971 919 67 e-10	J	6.64465675 / 1.112650056 [alpha particle mass / atomic mass constant]
alpha particle energy equivalent in MeV	3727.379 240	MeV	5.97191967 / 1.602176565 [alpha particle mass energy equivalent / electron volt]
alpha particle in u	4.001 506 179 125	u	6.64465675 / 1.660538921 [alpha particle mass / atomic mass unit]
alpha particle molar mass	4.001 506 179 125 e-3	kg mol <sup>-1</sup>	6.64465675 / 1.660538921 [alpha particle mass / atomic mass unit kilogram]
alpha particle molar mass / electron mass	7294.299 5361		6.64465675 / 9.10938291 [alpha particle mass / electron mass]
alpha particle molar mass / proton mass	3.972 599 689 33		6.64465675 / 1.672621777 [alpha particle mass / proton mass]
Atmosphere standard	101 325	Pa (exact)	[Distinguish US (101325) and International Standard Atmosphere (1013.25)]
atomic mass constant	1.660 538 921 e-27	kg	1 / 6.02214129 [Reciprocal of Avogadro constant]
atomic mass constant energy equivalent	1.492 417 954 e-10	J	1.660538921 x <b>8.987551787</b> [atomic mass constant x c-square] 1.660538921 / 1.112650056 [atomic mass constant / atomic unit of permittivity]
atomic mass constant energy equivalent in MeV	931.494 061	MeV	1.492417954 / 1.602176565 [atomic mass constant energy equivalent / electron volt]
atomic mass unit, unified	1.660 538 921 e-27	kg	{ Also referenced as <i>atomic mass constant</i> }
atomic mass unit /electron volt	931.494 061 e6	Ev	1.492417954 / 1.602176565 [atomic mass constant energy equivalent / electron volt]
atomic mass unit   hartree	3.423 177 6845 e7	E <sub>h</sub>	1 / 2.9212623246 [reciprocal of hartree energy mass unit relationship]
atomic mass unit   hertz	2.252 342 7168 e23	Hz	1 / 4.4398216689 [reciprocal of hertz / atomic mass unit]
atomic mass unit   inverse meter	7.513 006 6042 e14	m <sup>-1</sup>	1 / 1.331025051 [reciprocal of inverse meter/atomic mass unit] 3.335650952 / 4.4398216689 [reciprocal of light speed / reciprocal hertz]
atomic mass unit   joule	1.492 417 954 e-10	J	1 / 6.70053585 [reciprocal of joule / atomic mass unit] 6.62606957 / 4.4398216689 [Planck constant / reciprocal of hertz]
atomic mass unit   kelvin	1.080 954 08 e13	K	1 / 9.2510868 [reciprocal of kelvin / atomic mass unit]
atomic mass unit   kilogram	1.660 538 921 e-27	kg	1 / 6.02214129 [reciprocal of kilogram / atomic mass unit]
atomic unit of First hyperpolarizability	3.206 361 449 e-53	C <sup>3</sup> m <sup>3</sup> J <sup>-2</sup>	{beta} [Bohr radius   ionization energy of hydrogen; a hartree]
atomic unit of Second hyperpolarizability	6.235 380 54 e-65	C <sup>4</sup> m <sup>4</sup> J <sup>-3</sup>	{gamma}
atomic unit of action	1.054 571 726 e-34	J s	6.62606957 / 6.283185307 [Planck constant over 2 pi. Also, Natural unit of action]
atomic unit of charge	1.602 176 565 e-19	C	1 / 6.24150934 [ joule / electron volt] Also, referenced as Electron volt; Electron volt   Joule; and, Elementary charge

atomic unit of charge density	1.081 202 338 e12	C m <sup>-3</sup>	[length x time x electric current]
atomic unit of current	6.623 617 95 e-3	A	--
atomic unit of electric dipole moment	8.478 353 26 e-30	C m	1.602176565 x 5.2917721092 [atomic unit of charge x atomic unit of length]
atomic unit of electric field	5.142 206 52 e11	V m <sup>-1</sup>	8.47835326 / 1.6487772754 [a. u. of electric dipole moment / electric polarizability ]
atomic unit of electric field gradient	9.717 362 00 e21	V m <sup>-2</sup>	1.081 202 338 x 8.987551787 [a.u. of charge x c-square ]
atomic unit of electric polarizability	1.648 777 2754 e-41	C <sup>2</sup> m <sup>2</sup> J <sup>-1</sup>	8.47835326 / 5.14220652 [a.u. of electric dipole moment / a.u. of electric field ]
atomic unit of electric potential	27.211 385 05	V	1 / 3.674932379 [Reciprocal of electron volt   hartree]
atomic unit of electric quadrupole mom.	4.486 551 331 e-40	C m <sup>2</sup>	2.721138505 x 1.6487772754 [a.u. electric potential x electric polarizability]
atomic unit of energy	4.359 744 34 e-18	J	4.35974434 [hartree energy; reciprocal of Joule / hartree ]
atomic unit of force	8.238 722 78 e-8	N	4.35974434 x 5.2917721092 [a. u. energy x a.u. length]
atomic unit of length	0.529 177 210 92 e-10	m	8.23872278 / 4.35974434 [a.u force / a.u. energy]
atomic unit of magnetic dipole moment	1.854 801 936 e-23	J T <sup>-1</sup>	2.350517464 x 7.891036607 [a.u. of magnetic flux density x a.u. of magnetizability]
			1.112650056 / 60 [a.u. of permittivity / 60]
atomic unit of magnetic flux density	2.350 517 464 e5	T	1.854801936 / 7.891036607 [a.u. of magnetic dipole moment / a.u. of magnetizability]
atomic unit of magnetizability	7.891 036 607 e-29	J T <sup>-2</sup>	1.854801936 / 2.350517464 [a.u. of magnetic dipole moment / a.u. of magnetic flux density]
atomic unit of mass	9.109 382 91 e-31	kg	[Also, referenced as electron mass; natural unit of mass; Dalton (Da)]
	5.446170219		5.0578353 / 927.400 968 [nuclear magneton / Bohr magneton ]
atomic unit of momentum	1.992 851 740 e-24	kg m s <sup>-1</sup>	9.10938291 x 2.187691263 [a.u. of mass x a.u. of velocity]
atomic unit of permittivity	1.112 650 056... e-10	F m <sup>-1</sup> (exact)	{ 1 / 8.987551787 [ reciprocal of c-square] }
atomic unit of time	2.418 884 326 502 e-17	s	--
atomic unit of velocity	2.187 691 263 79 e6	m s <sup>-1</sup>	1.991851740 / 9.10938291 [a.u. momentum / a.u. of mass]
Avogadro constant	6.022 141 29 e23	mol <sup>-1</sup>	1 / 1.660538921 [Reciprocal of atomic mass constant]
Boltzmann constant	1.380 6488 e-23	J K <sup>-1</sup>	8.3144621 / 6.02214129 [molar gas constant / Avogadro constant]
Boltzmann constant in eV/K	8.617 3324 e-5	eV K <sup>-1</sup>	1.3806488 / 1.602176565 [Boltzmann constant / electron volt]
Boltzmann constant in Hz/K	2.083 6618 e10	Hz K <sup>-1</sup>	1.3806488 / 6.62606957 [Boltzmann constant / Planck constant]
Boltzmann constant in inverse meters per kelvin	69.503 476	m <sup>-1</sup> K <sup>-1</sup>	2.0836618 x 3.335640938 [Boltzmann c. in Hz/K times reciprocal of c]
<b>Coulomb's constant</b>	<b>8.9875517873681764</b>	<b>10<sup>9</sup> N-m<sup>2</sup>/C<sup>2</sup></b>	<b>[Addition to the list: the electric force constant; electrostatic constant]</b>
Coupling constant, Fermi	1.166 364 e-5	GeV <sup>-2</sup>	1 / .8574382308 [Reciprocal of deuteron g factor] [In description of Beta decay.]
cross section, Thomson	0.665 245 8734 e-28	m <sup>2</sup>	--
Cu x unit	1.002 076 97 e-13	m	--



deuteron g factor	0.857 438 2308		$1 / 1.166364$ [Reciprocal Fermi coupling constant. Deuteron mag. mom. to nuclear magneton] 0.8574382308 [deuteron magnetic moment / nuclear magneton]
deuteron magnetic moment	0.433 073 489 e-26	J T <sup>-1</sup>	4.669754556 x 9.27400968 [Magneton Bohr mag.mom to Bohr magneton x magneton Bohr]
deuteron magnetic moment / Bohr magneton	0.466 975 4556 e-3		4.330734896 / 9.27400968 [deuteron mag. mom. / Bohr Magneton ]
deuteron magnetic moment / nuclear magneton	0.857 438 2308		$1 / 1.166364$ [Reciprocal Fermi coupling constant. Also, Deuteron g factor.] 0.8574382308 [deuteron g factor]
deuteron magnetic moment / electron magnetic moment	-4.664 345 537 e-4		4.33073489 / 9.28476470 [deuteron magnetic moment / electron magnetic moment ]
deuteron magnetic moment / neutron magnetic moment	-0.448 206 52		4.33073489 / 9.6623647 [deuteron magnetic moment / neutron magnetic moment]
deuteron magnetic moment / proton magnetic moment	0.307 012 2070		4.33073489 / 1.410606743 [deuteron magnetic moment / proton magnetic moment]
deuteron magnetic moment rms charge radius	2.1424 e-15	m	4.33073489 / 2.01440763 = 2.1424
deuteron magnetic moment   Magneton, Bohr	927.400 968 e-26	J T <sup>-1</sup>	$\approx (1 / 5.39124) / 2$ [reciprocal of Planck time]
deuteron mass	3.343 583 48 e-27	kg	[1 proton, 1 neutron; the deuteron is the nucleus of deuterium]
deuteron mass energy equivalent	3.005 062 97 e-10	J	3.34358348 / 1.112650055 [deuteron mass / a.u. of permittivity]
deuteron mass energy equivalent in MeV	1875.612 859	MeV	3.00506297 / 1.602176565 [deuteron mass energy equivalent / electron volt ]
deuteron mass in u	2.013 553 212 712	u	--
deuteron mass / electron mass	3670.482 9652		3.34358348 / 9.10938291 [deuteron mass / electron mass]
deuteron mass / proton mass	1.999 007 500 97		3.343583478 / 1.672621777 [deuteron mass / proton mass]
deuteron mass rms charge radius	2.1424 e-15	m	3.34358348 / 1.560671901 = 2.1424 [The deuteron involved in the rms charge radius is not clarified in the CODATA list.]
deuteron molar mass	2.013 553 212 712 e-3	kg mol <sup>-1</sup>	3.343583 / 1.660538921 [deuteron mass / atomic mass unit kilogram]
Displacement law constant, Wien frequency	5.878 9254 e10	Hz K <sup>-1</sup>	--
Displacement law constant, Wien wavelength	2.897 7721 e-3	m K	[Also, referenced as Wien's displacement constant]
electric constant	8.854 187 817... e-12	(exact) F m <sup>-1</sup>	[Also, permittivity of free space; absolute permittivity; vacuum permittivity; ]
electron charge to mass quotient	-1.758 820 088 e11	C kg <sup>-1</sup>	1.602176565 / 9.10938291 [electron charge / mass quotient ]
electron g factor	-2.002 319 304 361 53		1.00115965218076 x 2 [electron magnetic moment / Bohr magneton x 2]
electron gyromagnetic ratio	1.760 859 708 e11	s <sup>-1</sup> T <sup>-1</sup>	--
gyromagnetic ratio / 2 pi	28 024.952 66	MHz T <sup>-1</sup>	--
electron magnetic moment	-928.476 430 e-26	J T <sup>-1</sup>	$\sim 1.00159652180 \times 9.27400968$ [electron magnetic moment/Bohr magneton x Bohr magneton]
electron magnetic moment anomaly	1.159 652 180 76 e-3		--
electron magnetic moment / Bohr magneton	-1.001 159 652 180 76		9.28476430 / 9.27400968 [electron magnetic moment / Bohr magneton ]
electron magnetic moment / deuteron magnetic moment	-2143.923 498		9.28476430 / 4.33073489 [electron magnetic moment / deuteron magnetic moment]

electron magnetic moment / muon magnetic moment	206.766 9896		9.28476430 / 4.49044807 96 [electron magnetic moment / muon magnetic moment ]
electron magnetic moment / neutron magnetic moment	960.920 50		9.28476430 / 9.6623647 [electron magnetic moment / neutron magnetic moment ]
electron magnetic moment / nuclear magneton	-1838.281 970 90		9.28476430 / 5.05078353 [electron magnetic moment / nuclear magneton]
electron magnetic moment / proton magnetic moment	-658.210 6848		9.28476430 / 1.410606743 [electron magnetic moment / proton magnetic moment ]
electron magnetic moment / shielded helion magnetic moment	864.058 257		9.28476430 / 1.074553044 [electron magnetic moment / shielded helion magnetic moment ]
electron magnetic moment / shielded proton magnetic moment	-658.227 5971		9.28476430 / 1.410570499 [electron magnetic moment / shielded proton magnetic moment ]
electron mass	9.109 382 91 e-31	kg	[Also, electron rest mass; mass of a stationary electron]
electron mass energy equivalent	8.187 105 06 e-14	J	9.10938291 x <b>8.987551787</b> [electron mass / c-square ]
electron mass energy equivalent in MeV	0.510 998 928	MeV	8.18710506 / 1.602176565 [electron mass energy equivalent / electron volt ]
electron mass in u	5.485 799 0946 e-4	u	9.10938291 x 6.02214129 [electron mass / Avogadro constant ]
electron mass / alpha particle mass	1.370 933 555 78 e-4		9.10938291 / 6.64465675 [electron mass / alpha particle mass ratio ]
electron mass / deuteron mass	2.724 437 1095 e-4		9.10938291 / 3.34358348 [electron mass / deuteron mass ]
electron mass / helion mass	1.819 543 0761 e-4		9.10938291 / 5.00641234 [electron mass / helion mass ]
electron mass / muon mass	4.836 331 66 e-3		9.10938291 / 1.883531475 [electron mass / muon mass ]
electron mass / neutron mass	5.438 673 4461 e-4		9.10938291 / 1.674927351 [electron mass / neutron mass ]
electron mass / proton mass	5.446 170 2178 e-4		9.10938291 / 1.672621777 [electron mass / proton mass ]
	5.4461702178		5.0578353 / 927.400 968 [nuclear magneton / Bohr magneton ]
electron mass / tau mass	2.875 92 e-4		9.10938291 / 3.16747 [electron mass /tau mass ]
electron mass / triton mass	1.819 200 0653 e-4		9.10938291 / 5.00735630 [electron mass / triton mass ]
electron molar mass	5.485 799 0946 e-7	kg mol <sup>-1</sup>	9.10938291 / 1.660538921 [electron mass / atomic mass unit kilogram]
electron volt	1.602 176 565 e-19	J	1 volt x elementary charge [1 joule per coulomb, 1 J/C]
electron volt / atomic mass unit	1.073 544 150 e-9	u	1.602176565 / 1.492417955 [electron volt / atomic mass unit ]
electron volt / hartree	3.674 932 379 e-2	E <sub>h</sub>	1.602176565 / 4.359754532 [electron volt / hartree joule ]
electron volt / hertz	2.417 989 348 e14	Hz	1.602176565 / 6.626085655 [electron volt / hertz joule ]
electron volt / inverse meter	8.065 544 29 e5	m <sup>-1</sup>	1.602176565 / 1.986445685 [electron volt / inverse meter joule ]
electron volt / joule	1.602 176 565 e-19	J	1.602176565 / 1.0 [electron volt / joule]
electron volt / kelvin	1.160 4519 e4	K	1.602176565 / 1.380648836 [electron volt / kelvin joule ]
electron volt / kilogram	1.782 661 845 e-36	kg	1.602176565 / 8.987551787 [electron volt / kilogram joule ]
elementary charge	1.602 176 565 e-19	C	{ Also, referenced as a.u. of charge; electron volt; electron volt joule. Electric charge carried by a single proton or opposite of the electric charge carried by a single electron }
elementary charge / h	2.417 989 348 e14	A J <sup>-1</sup>	{ Also, referenced as electron volt hertz }
Faraday constant	96 485.3365	C mol <sup>-1</sup>	1.602176565 x 6.02214129 [elementary charge times Avogadro constant] { Amount of electric charge

			carried by one mole; coulombs per mole (C/mol).}
Faraday constant for conventional electric current	96 485.3321	C <sub>90</sub> mol <sup>-1</sup>	--
Fine-structure constant	7.297 352 5698 e-3		1 / 137.035999
Fine-structure constant, Inverse...	137.035 999 074		1 / 7.2973525698
gravitation, Newtonian constant of...	6.673 84 e-11	m <sup>3</sup> kg <sup>-1</sup> s <sup>-2</sup>	[Empirical physical constant involved in calculation of gravitational force between two bodies] {Also, referenced as the universal gravitational constant; Newton's constant}
gravitation, Newtonian constant of.../ h-bar c	6.708 37 e-39	(GeV/c <sup>2</sup> ) <sup>-2</sup>	{G/π times c}
Gravity, standard acceleration of...	9.806 65	m s <sup>-2</sup> (exact)	[length x time <sup>-2</sup> ]
Hartree energy	4.359 744 34 e-18	J	2R <sub>∞</sub> hc [2 x Rydberg constant times planck constant times speed of light in vacuo]
Hartree energy / eV	27.211 385 05	eV	4.35974434 / 1.602176565 [Hartree energy / electron volt]
Hartree energy / hertz	6.579 683 920 729 e15	Hz	4.35974434 / 6.626069569 [Hartree energy / hertz joule]
Hartree energy / inverse meter	2.194 746 313 708 e7	m <sup>-1</sup>	4.35974434 / 1.986445684 [Hartree energy / inverse meter joule ]
Hartree energy / joule	4.359 744 34 e-18	J	4.35974434 / 1.0 [Hartree energy / joule ]
Hartree energy / kelvin	3.157 7504 e5	K	4.35974434 / 1.38064881 [Hartree energy / kelvin(Boltzmann constant) ]
Hartree energy / kilogram	4.850 869 79 e-35	kg	4.35974434 / 8.987551787 [Hartree energy / c-square]
Hartree energy / mass unit	2.921 262 3246 e-8	u	4.35974434 / 1.492417954 [hartree energy / atomic mass constant energy equivalent ]
helion g factor	-4.255 250 613		2.127625306 x 2 [helion magnetic moment / nuclear magneton x 2]
helion magnetic moment	-1.074 617 486 e-26	J T <sup>-1</sup>	--
helion magnetic moment / Bohr magneton	-1.158 740 958 e-3		1.074617486 / 9.27400968 [helion magnetic moment / Bohr magneton ]
helion magnetic moment / nuclear magneton	-2.127 625 306		1.074617486 / 5.05078353 [helion magnetic moment / nuclear magneton ]
helion magnetic moment, shielded...	-1.074 553 044 e-26	J T <sup>-1</sup>	--
helion mass	5.006 412 34 e-27	kg	
helion mass energy equivalent	4.499 539 02 e-10	J	5.00641234 / 1.112650056 [helion mass / atomic unit of permittivity]
helion mass energy equivalent in MeV	2808.391 482	MeV	4.49953902 / 1.602176565 [helion mass energy equivalent / atomic unit of charge]
helion mass in u	3.014 932 2468	u	3.0149322468 / .602214129 [helion mass / avogadro constant]
helion mass / electron mass	5495.885 2754		5.00641254 / 9.10938291 [helion mass / electron mass]
helion mass / proton mass	2.993 152 6707		5.00641254 / 1.672621777 [ helion mass / proton mass]
helion molar mass	3.014 932 2468 e-3	kg mol <sup>-1</sup>	5.00641234/ 1.660538921 [helion mass / atomic mass unit kilogram]
helion gyromagnetic ratio, shielded...	2.037 894 659 e8	s <sup>-1</sup> T <sup>-1</sup>	--
helion gyromagnetic ratio over 2 pi, shielded...	32.434 100 84	MHz T <sup>-1</sup>	2.037894659 / 6.283185307 [shielded helion gyromagnetic ratio / 2pi\]
helion, shielded / Bohr magneton ratio	-1.158 671 471 e-3		-1.074 553 044 / 9.27400968 [helion shielded magnetic moment / Bohr magneton ]
helion, shielded / nuclear magneton ratio	-2.127 497 718		-1.074 553 044 / 5.05078353 [helion shielded magnetic moment / nuclear magneton ]

helion, shielded / proton magnetic moment ratio	-0.761 766 558		-1.074 553 044 / 1.410606743 [helion shielded magnetic moment / proton magnetic moment]
helion, shielded / shielded proton magnetic moment ratio	-0.761 786 1313		-1.074 553 044 / 1.410570499 [helion shielded magnetic moment / shielded proton magnetic moment]
hertz / atomic mass unit	4.439 821 6689 e-24	u	6.62606957 / 1.492417954 [hertzjoule / atomic mass constant energy equivalent ]
hertz / electron volt	4.135 667 516 e-15	eV	6.62606957 / 1.602176565 [hertzjoule / electron volt ]
hertz / hartree	1.519 829 846 0045 e-16	E_h	6.62606957 / 4.35974434 [hertzjoule / hartree energy ]
hertz / inverse meter	3.335 640 951... e-9	m^-1 (exact)	6.62606957 / 1.986445684 [hertzjoule / inverse meter [joule ]
hertz / joule	6.626 069 57 e-34	J	6.62606957 / 1.0 [hertzjoule / joule ]
hertz / kelvin	4.799 2434 e-11	K	6.62606957 / 1.3806488 [hertzjoule / kelvinjoule ]
hertz / kilogram	7.372 496 68 e-51	kg	6.62606957 / 8.987551787 [hertzjoule / kilogramjoule ]
inverse meterjoule / atomic mass unit	1.331 025 051 20 e-15	u	1.986445684 / 1.492417954 [inverse meterjoule / atomic mass constant energy equivalent ]
inverse meterjoule / electron volt	1.239 841 930 e-6	eV	1.986445684 / 1.602176565 [inverse meterjoule / electron ]
inverse meterjoule / Hartree	4.556 335 252 755 e-8	E_h	1.986445684 /4.35974434 [inverse meterjoule / Hartree energy ]
inverse meterjoule / hertz	299 792 458	Hz (exact)	1.986445684 /6.62606957 [inverse meterjoule / hertzjoule ]
inverse meterjoule / joule	1.986 445 684 e-25	J =	1.986445684 /1.0 [inverse meterjoule / joule]
inverse meterjoule / kelvin	1.438 7770 e-2	K	1.986445684 /1.3806488 [inverse meterjoule / kelvinjoule]
inverse meterjoule / kilogram	2.210 218 902 e-42	kg =	1.986445684 /8.987551787 [inverse meterjoule / kilogramjoule ]
Josephson constant	483 597.870 e9	Hz V^-1	1 / 2.067833758 [inverse of the flux quantum]
Josephson constant, conventional value of...	483 597.9 e9	Hz V^-1 (exact)	4.835978696 value rounded off
joule / atomic mass unit	6.700 535 85 e9	u	1.0 / 1.492417954 [Joule / atomic mass constant energy equivalent ]
joule / electron volt	6.241 509 34 e18	eV	1.0 / 1.602176565 [joule / electron volt ]
joule / hartree	2.293 712 48 e17	E_h	1.0 / 4.35974434 [joule / hartree energy ]
joule / hertz	1.509 190 311 e33	Hz	1.0 / 6.62606957 [joule / hertzjoule ]
joule / inverse meter	5.034 117 01 e24	m^-1	1.0 / 1.986445683 [joule / inverse meterjoule ]
joule / kelvin	7.242 9716 e22	K	1.0 / 1.380648793 [joule / kelvinjoule ]
joule / kilogram	1.112 650 056... e-17	kg (exact)	1.0 / 8.987551788 [joule / kilogramjoule ]
kelvinjoule / atomic mass unit	9.251 0868 e-14	u	1.3806488 / 1.492417954 [kelvinjoule / atomic mass constant energy equivalent ]
kelvinjoule / electron volt	8.617 3324 e-5	eV	1.3806488 / 1.602176565 [kelvinjoule / electron volt ]
kelvinjoule / hartree	3.166 8114 e-6	E_h	1.3806488 / 4.35974434 [kelvinjoule / hartree energy ]
kelvinjoule / hertz	2.083 6618 e10	Hz	1.3806488 / 6.62606957 [kelvinjoule / hertz joule ]
kelvinjoule / inverse meter	69.503 476	m^-1	1.3806488 / 1.986445684 [kelvinjoule / inverse meter joule ]
kelvinjoule / joule	1.380 6488 e-23	J	1.3806488 / 1.0 [kelvinjoule / joule]
kelvinjoule / kilogram	1.536 1790 e-40	kg	1.3806488 / 8.987551787 [kelvinjoule / kilogramjoule ]

kilogramjoule / atomic mass unit	6.022 141 29 e26	u	8.987551787 / 1.492417954 [kilogramjoule / atomic mass constant energy equivalent ]
kilogramjoule /electron volt	5.609 588 85 e35	eV	8.987551787 / 1.602176565 [kilogramjoule / electron volt ]
kilogramjoule / hartree	2.061 485 968 e34	E_h	8.987551787 / 4.35974434 [kilogramjoule / hartree energy ]
kilogramjoule / hertz	1.356 392 608 e50	Hz	8.987551787 / 6.62606957 [kilogramjoule / hertz joule ]
kilogramjoule / inverse meter	4.524 438 73 e41	m^-1	8.987551787 / 1.986445684 [kilogramjoule / inverse meterjoule ]
kilogramjoule / joule	8.987 551 787... e16	J (exact)	8.987551787 / 1.0 [kilogramjoule / joule ]
kilogramjoule / kelvin	6.509 6582 e39	K	8.987551787 / 1.3806488 [kilogramjoule / kelvinjoule ]
light in vacuum, speed of...	299 792 458	m s^-1 (exact)	--
<b>light in vacuum, speed of...squared</b>	<b>898 755 1787</b>	<b>(inexact)</b>	<b>[The speed of light in vacuo is postulated as a physical limit; its square is therefore denied]</b>
Loschmidt constant (273.15 K, 100 kPa)	2.651 6462 e25	m^-3	["Number of particles (atoms or molecules) of an ideal gas in a given volume (number density)."]
Loschmidt constant (273.15 K, 101.325 kPa)	2.686 7805 e25	m^-3	["The Loschmidt constant is exactly 1 amagat."]
magnetic constant	12.566 370 614... e-7	N A^-2 (exact)	(4π x 10^-7 henry per meter) [Absolute permeability of empty space; permeability of free space]
magneton, Bohr	927.400 968 e-26	J T^-1	["The magnitude of an electron's spin magnetic moment is approximately one Bohr magneton."]
magneton, Bohr in eV/T	5.788 381 8066 e-5	eV T^-1	9.27400968 x 6.241509343 [Bohr magneton x (joule/electron volt)]
magneton, Bohr in Hz/T	13.996 245 55 e9	Hz T^-1	5.7883818066 / 4.135 667 516 [Bohr magneton in eV/T / (Planck constant / eV s)]
magneton, Bohr in inverse meters per tesla	46.686 4498	m^-1 T^-1	--
magneton, Bohr in K/T	0.671 713 88	K T^-1	--
magneton, Bohr / magneton, nuclear	1.836152672		927.400 968 / 5.0578353 [Bohr magneton / nuclear magneton]
	1.836152672		1.672621777 / 9.10938291 [proton mass / atomic unit of mass]
magneton, nuclear	5.050 783 53 e-27	J T^-1	--
magneton, nuclear in eV/T	3.152 451 2605 e-8	eV T^-1	--
magneton, nuclear in inverse meters per tesla	2.542 623 527 e-2	m^-1 T^-1	--
magneton, nuclear in K/T	3.658 2682 e-4	K T^-1	--
magneton, nuclear in MHz/T	7.622 593 57	MHz T^-1	--
nuclear magneton / Bohr magneton	5.446170219		5.0578353 / 927.400 968 [nuclear magneton / Bohr magneton ]
	5.446170219		9.10938291 / 1.672621777 [atomic unit of mass / proton mass ]
mixing angle, weak	0.2223		--
Mo x unit	1.002 099 52 e-13	m	[Also, referenced as Weinberg angle; a parameter in the Weinberg-Salem theory of the electroweak interaction; relationship between masses of W and Z bosons]

molar gas constant	8.314 4621	J mol <sup>-1</sup> K <sup>-1</sup>	[pressure p times volume V of the gas divided by its absolute temperature T]
molar mass constant	1 e-3	kg mol <sup>-1</sup> (exact)	[relative atomic mass and molar mass]
molar mass of carbon-12	12 e-3	kg mol <sup>-1</sup> (exact)	--
molar Planck constant	3.990 312 7176 e-10	J s mol <sup>-1</sup>	6.62606957 / 1.660538921 [Planck constant / atomic mass unit kilogram]
molar Planck constant times c	0.119 626 565 779	J m mol <sup>-1</sup>	3.9903127176 x 2.99792458 [molar Planck constant x speed of light in vacuo]
molar volume of ideal gas (273.15 K, 100 kPa)	22.710 953 e-3	m <sup>3</sup> mol <sup>-1</sup>	8.3144621 x 2.7315 [molar gas constant times 273.15 k temperature]
molar volume of ideal gas (273.15 K, 101.325 kPa)	22.413 968 e-3	m <sup>3</sup> mol <sup>-1</sup>	--
molar volume of silicon	12.058 833 01 e-6	m <sup>3</sup> mol <sup>-1</sup>	--
muon Compton wavelength	11.734 441 03 e-15	m	--
muon Compton wavelength / 2 pi	1.867 594 294 e-15	m	11.734 441 03 / 2 pi [muon Compton wavelength / 2 pi]
muon Compton wavelength g factor	-2.002 331 8418		2.0023318418 / 2 = 1.001165921 [Note: muon magnetic moment anomaly 1.16592091]
muon magnetic moment	-4.490 448 07 e-26	J T <sup>-1</sup>	-4.84197044 x 9.27400968 [(muon magnetic moment / Bohr magneton) times Bohr magneton]
muon magnetic moment anomaly	1.165 920 91 e-3		--
muon magnetic moment / Bohr magneton	-4.841 970 44 e-3		-4.49044807 / 9.27400968 [muon magnetic moment / Bohr magneton]
muon magnetic moment / nuclear magneton	-8.890 596 97		-4.49044807 / 5.05078353 [muon magnetic moment / nuclear magneton]
muon mass	1.883 531 475 e-28	kg	1.692833667 x 1.112650056 [muon mass energy equivalent x atomic unit of permittivity]
muon mass energy equivalent	1.692 833 667 e-11	J	1.883531475 / 1.112650056 [ muon mass / a.u. of permittivity]
muon mass energy equivalent in MeV	105.658 3715	MeV	1.692833667 / 1.602176565 [muon mass equivalent / electron volt ]
muon mass in u	0.113 428 9267	u	1.883531475 / 1.660538921 [muon mass / atomic mass constant]
muon mass / electron mass	206.768 2843		1.883531475 / 9.10938291 [muon mass / electron mass]
muon mass / neutron mass	0.112 454 5177		1.883531475 / 1.674927351 [muon mass / neutron mass]
muon mass / proton magnetic moment	-3.183 345 107		1.883531475 / 1.410606743 [ <i>Error?</i> ] [muon mass / proton magnetic moment]
muon mass / proton mass	0.112 609 5272		1.883531475 / 1.672621777 [muon mass / proton mass]
muon mass / tau mass ratio	5.946 49 e-2		1.883531475 / 3.16747 [muon mass / tau mass]
muon molar mass	0.113 428 9267 e-3	kg mol <sup>-1</sup>	1.883531475 / 1.660538921 [muon mass / atomic mass constant]
natural unit of action	1.054 571 726 e-34	J s	
natural unit of action in eV s	6.582 119 28 e-16	eV s	1.054571726 / 1.602176565 [natural unit of action / electron volt]
natural unit of energy	8.187 105 06 e-14	J	{electron mass energy equivalent}
natural unit of energy in MeV	0.510 998 928	MeV	8.18710506 / 1.602176565 [n.u. of energy / electron volt]
natural unit of length	386.159 268 00 e-15	m	--
natural unit of mass	9.109 382 91 e-31	kg	[Also, referenced as electron mass; natural unit of mass; atomic unit of mass; Dalton (Da)]
natural unit of momentum	2.730 924 29 e-22	kg m s <sup>-1</sup>	9.10938291 x 2.99792458 [natural unit of mass x speed of light in vacuo]

natural unit of momentum in MeV/c	0.510 998 928	MeV/c	2.73092429 / 1.602176565 / 2.99792458 [n.u. of momentum / electron volt]
natural unit of time	1.288 088 668 33 e-21	s	--
natural unit of velocity	299 792 458	m s <sup>-1</sup> (exact)	[Also, referenced as speed of light in a vacuum.]
neutron Compton wavelength	1.319 590 9068 e-15	m	--
neutron Compton wavelength / 2 pi	0.210 019 415 68 e-15	m	1.3195909068 / 6.283185307 [neutron Compton wavelength / 2pi]
neutron Compton wavelength g factor	-3.826 085 45		1.91304272 x 2 [neutron magnetic moment / nuclear magneton x 2]
neutron Compton wavelength gyromagnetic ratio	1.832 471 79 e8	s <sup>-1</sup> T <sup>-1</sup>	--
neutron Compton wavelength gyromagnetic ratio / 2 pi	29.164 6943	MHz T <sup>-1</sup>	1.832471 / 6.283185307 [neutron gyromagnetic ratio / 2pi]
neutron magnetic moment	-0.966 236 47 e-26	J T <sup>-1</sup>	--
neutron magnetic moment / Bohr magneton	-1.041 875 63 e-3		-0.96623647 / 9.27400968 [neutron magnetic moment / Bohr magneton]
neutron magnetic moment / nuclear magneton	-1.913 042 72		-0.96623647 / 5.05078353 [neutron magnetic moment / nuclear magneton]
neutron magnetic moment / electron magnetic moment	1.040 668 82 e-3		-0.96623647 / -9.28476430 [neutron magnetic moment / electron magnetic moment]
neutron magnetic moment / proton magnetic moment	-0.684 979 34		-0.96623647 / 1.410606743 [neutron magnetic moment / proton magnetic moment]
neutron magnetic moment / shielded proton magnetic moment	-0.684 996 94		-0.96623647 / 1.410570499 [neutron magnetic moment / shielded proton magnetic moment ]
neutron mass	1.674 927 351 e-27	kg	--
neutron mass energy equivalent	1.505 349 631 e-10	J	1.674927351 / 1.112650056 [neutron mass / joule kilogram ]
neutron mass energy equivalent in MeV	939.565 379	MeV	1.505349631 / 1.602176565 [neutron mass joule kilogram / electron volt]
neutron mass in u	1.008 664 916 00	u	1.674927351 / 1.660538921 [neutron mass / atomic mass constant]
neutron mass / electron mass	1838.683 6605		1.674927352 / 9.10938291 [neutron mass / electron mass]
neutron mass / muon mass	8.892 484 00		1.674927352 / 1.883531475 [neutron mass / muon mass]
neutron mass   proton mass difference	2.305 573 92 e-30		1.674927352 - 1.672621777 [neutron mass - proton mass]
neutron mass   proton mass difference energy equivalent	2.072 146 50 e-13		2.30557392 / 1.112650056 [neutron mass proton mass difference / atomic unit of permittivity]
neutron mass   proton mass difference energy equivalent in MeV	1.293 332 17		2.07214650 / 1.602176565 {neutron mass proton mass difference / a. u. of permittivity} / electron volt]
neutron mass   proton mass difference in u	0.001 388 449 19		2.30557392 / 1.660538921 [neutron mass proton mass difference / atomic mass constant]
neutron mass   proton mass	1.001 378 419 17		1.674927352 / 1.672621777 [neutron mass   proton mass]
neutron mass   tau mass	0.528 790		1.674927352 / 3.16747 [neutron mass / tau mass]
neutron molar mass	1.008 664 916 00 e-3	kg mol <sup>-1</sup>	1.674927352 / 1.660538921 [neutron mass / atomic mass unit kilogram]
Planck constant	6.626 069 57 e-34	J s	1.9561 x 3.387 [Planck implied energy x Planck implied mass]
Planck constant / eV s	4.135 667 516 e-15	eV s	6.62606957 / 1.602176565 [Planck constant / electron volt]
			4.4398216689 x 9.31494061 [reciprocal of hertz / (atomic mass unit/electron volt)]
Planck constant / 2 pi	1.054 571 726 e-34	J s	6.62606957 / 6.283185307 [Planck constant / 2pi]
Planck constant / 2 pi in eV s	6.582 119 28 e-16	eV s	1.054571726 / 1.602176565 [ [Planck constant / 2pi] / electron volt]
Planck constant / 2 pi times c in MeV fm	197.326 9718	MeV fm	6.58211928 x 2.99792458 [ [Planck constant / 2pi] x c]
<b>Planck implied energy</b>	<b>1.9561</b>		<b>[Constant proposed for inclusion on the complete list by Charles William Johnson; ~ c<sup>9</sup> ]</b> 6.62609657 / 1.9561 = 3.387 [Planck constant/ Planck implied energy = Planck implied mass]

Planck length	1.616 199 e-35	m	2.99792458 / 3.741736091 = halves to 1.9561 [speed of light in vacuo / first radiation constant]
Planck mass	2.176 51 e-8	kg	[speed of light in a vacuum Planck constant gravitational constant] [ ~ Fractal seventh power of c    2176.431087    ] <b>3.487 / 1.6022176565 [Planck implied mass / Elementary charge ]</b>
Planck mass energy equivalent	1.956148749		2.17651 / 1.11265056 [Planck mass / atomic unit of permittivity] [I use the concept of <i>Planck implied energy</i> in my work; see above; URL]
Planck mass energy equivalent in GeV	1.220 932 e19	GeV	1.9561 / 1.602176565 [Planck energy / electron volt]
<i>Planck implied length</i>	<b>2.589605075</b>		<b>1.37035999074 / 5.2917721092 [Inverse fine structure / Bohr radius]</b>
<i>Planck implied mass</i>	<b>3.387 and/or 3.487</b>		<b>[Error in the Planck constants as they derived from two different values for Planck implied mass]</b>
<i>Planck implied mass</i>	<b>~3.3870</b>		<b>6.62606957 / 1.9561 [Planck constant / Planck implied energy]</b>
<i>Planck implied mass</i>	<b>~3.4870</b>		<b>3.33564095 x 1.672621777 = halves to 3.487041058</b> <b>[ Reciprocal of speed of light in vacuo / proton mass]</b>
<i>Planck implied mass / elementary charge</i>	<b>3.4870</b>		<b>[ Reciprocal of speed of light in vacuo / proton mass]</b>
<i>Planck implied temperature</i>	<b>2.269939614</b>		<b>1.660538921 x 1.367 [Unified atomic mass unit x Solar constant]</b>
Planck temperature	1.416 833 e32	K	2.269939614 / 1.602176565 [Planck implied temperature / Elementary charge]
<i>Planck implied time</i>	<b>8.63771764</b>		<b>3.33564095 x 2.589605097395 [reciprocal speed of light in vacuo x Planck implied length]</b>
<i>Planck implied time</i>	<b>~8.633275294</b>		<b>1.00115965218076 / 1.15965218076</b> <b>[electron magnetic moment anomaly/(electron magnetic moment/Bohr magneton)]</b>
Planck time	5.391 06 e-44	s	[time required for light to travel in a vacuum a distance of 1 Planck length]
Pressure, standard-state	100 000	Pa (exact)	--
proton charge to mass quotient	9.578 833 58 e7	C kg <sup>-1</sup>	1.602176565 / 1.672621777 [elementary charge / proton mass. <i>Mass quotient</i> is given as 9.10938291 for other constants]
Proton   Compton wavelength	1.321 409 856 23 e-15	m	--
Proton   Compton wavelength / 2 pi	0.210 308 910 47 e-15	m	1.32140985623 / 6.283185307 [ [proton Compton wavelength] / 2-pi]
Proton   Compton wavelength g factor	5.585 694 713		2.792847356 x 2 [proton magnetic moment / nuclear magneton x 2 ]
proton gyromagnetic ratio	2.675 222 005 e8	s <sup>-1</sup> T <sup>-1</sup>	--1 / 373.15
proton gyromagnetic ratio / 2 pi	42.577 4806	MHz T <sup>-1</sup>	2.675222005 / 6.283185307 [proton gyromagnetic ratio / 2-pi]
proton magnetic moment	1.410 606 743 e-26	J T <sup>-1</sup>	--
proton magnetic moment / Bohr magneton	1.521 032 210 e-3		1.410606743 / 9.27400968 [proton magnetic moment / Bohr magneton]
proton magnetic moment / neutron magnetic moment	-1.459 898 06		1.410 606 743 / -0.966 236 47 [proton magnetic moment / neutron magnetic moment]
proton magnetic moment / nuclear magneton	2.792 847 356		1.410606743 / 5.05078353 [proton magnetic moment / nuclear magneton]
proton magnetic shielding correction	25.694 e-6		--
proton mass	1.672 621 777 e-27	kg	--
proton mass energy equivalent	1.503 277 484 e-10	J	1.672621777 / 1.11265056 [proton mass / atomic unit of permittivity]



proton mass energy equivalent in MeV	938.272 046	MeV	1.503 277 484 / 1.602176565 [proton mass energy equivalent / electron volt]
proton mass in u	1.007 276 466 812	u	1.672621777 / 1.660538921 [proton mass / atomic mass constant]
proton mass / electron mass	1836.152 672 45		1.672621777 / 9.10938291 [proton mass / electron mass]
	1.836152672		927.400 968 / 5.0578353 [Bohr magneton / nuclear magneton]
proton mass / muon mass	8.880 243 31		1.672621777 / 1.883531475 [proton mass / muon mass]
proton mass / neutron mass	0.998 623 478 26		1.672621777 / 1.674927351 [proton mass / neutron mass]
proton mass / tau mass	0.528 063		1.672621777 / 3.16747 [proton mass / ]
proton molar mass	1.007 276 466 812 e-3	kg mol <sup>-1</sup>	1.672621777 / 1.660538921 [proton mass / atomic mass unit kilogram]
proton rms charge radius	0.8775 e-15	m	--
proton, shielded gyromagnetic ratio	2.675 153 268 e8	s <sup>-1</sup> T <sup>-1</sup>	--
/ 2 pi	42.576 3866	MHz T <sup>-1</sup>	2.675153268 / 6.283185307 [shielded proton gyromag. / 2-pi ]
proton shielded magnetic moment	1.410 570 499 e-26	J T <sup>-1</sup>	--
proton shielded magnetic moment / Bohr magneton	1.520 993 128 e-3		1.410570499 / 9.27400968 [shielded proton magnetic moment / Bohr magneton]
proton shielded magnetic moment / nuclear magneton	2.792 775 598		1.410570499 / 5.05078353 [proton magnetic moment / nuclear magneton]
quantum of circulation	3.636 947 5520 e-4	m <sup>2</sup> s <sup>-1</sup>	--
quantum of circulation times 2	7.273 895 1040 e-4	m <sup>2</sup> s <sup>-1</sup>	3.6369475520 x 2 [quantum of circulation times 2]
quantum, conductance	7.748 091 7346 e-5	S	2x 1 / 25 812.807 4434 ["Twice the reciprocal of the von Klitzing constant (2/RK)"]
quantum, conductance, Inverse of...	12 906.403 7217	ohm	1 / 7.7480917346 [ <i>Reciprocal of a reciprocal</i> ] [1 / conductance quantum]
			25 812.807 4434 / 2 [von Klitzing constant]
quantum, conductance, magnetic flux	2.067 833 758 e-15	Wb	1 / 4.835979 {reciprocal (exact) Josephson constant, conventional value of...}
Radiation constant, first	3.741 771 53 e-16	W m <sup>2</sup>	2.99792458 / 1.9561 = halves to 3.74175 [speed of light in vacuo / Planck implied energy]
Radiation constant, first for spectral radiance	1.191 042 869 e-16	W m <sup>2</sup> sr <sup>-1</sup>	--
Radiation constant, second	1.438 7770 e-2	m K	--
Radius, Bohr	0.529 177 210 92 e-10	m	--
Radius, classical electron	2.817 940 3267 e-15	m	--
Rydberg constant	10 973 731.568 539	m <sup>-1</sup>	1 / 9.11267051 [hydrogen]
Rydberg constant <i>times</i> c in Hz	3.289 841 960 364 e15	Hz	1.0973731568539 times 2.99792458 [Rydberg constant times c]
Rydberg constant <i>times</i> hc in eV	13.605 692 53	eV	1.0973731568539 times 6.62606957 times 2.99792458 divided by 1.602176565 [Rydberg constant times <i>h</i> times <i>c</i> ] / electron volt
Rydberg constant <i>times</i> hc in J	2.179 872 171 e-18	J	1.0973731568539 times 6.62606957 times 2.99792458 / 1.0 [Rydberg constant times <i>h</i> times <i>c</i> divided by Joule]
Sackur-Tetrode constant (1 K, 100 kPa)	-1.151 7078		--

Sackur-Tetrode constant (1 K, 101.325 kPa)	-1.164 8708	--	--
silicon, lattice spacing of..., {220}	192.015 5714 e-12	m	--
silicon, lattice parameter of...	543.102 0504 e-12	m	--
star, Angstrom	1.000 014 95 e-10	m	--
Stefan-Boltzmann constant	5.670 373 e-8	W m <sup>-2</sup> K <sup>-4</sup>	--
Tau Compton wavelength	0.697 787 e-15	m	--
Tau Compton wavelength / 2 pi	0.111 056 e-15	m	0.697787 / 6.283185307 [Tau Compton wavelength / 2-pi]
tau mass	3.167 47 e-27	kg	--
tau mass energy equivalent	2.846 78 e-10	J	3.16747 / 1.112650056 [tau mass / joule kilogram]
tau mass energy equivalent in MeV	1776.82	MeV	2.84678 / 1.602176565 [tau mass / joule kilogram / electron volt]
tau mass in u	1.907 49	u	3.16747 / 1.660538921 [tau mass / atomic mass constant]
tau mass / electron mass	3477.15		3.16747 / 9.10938291 [tau mass / electron mass]
tau mass / muon mass	16.8167		3.16747 / 1.883531475 [tau mass / muon mass]
tau mass / neutron mass	1.891 11		3.16747 / 1.674927351 [tau mass / neutron mass]
tau mass / proton mass	1.893 72		3.16747 / 1.672621777 [tau mass / proton mass]
tau molar mass	1.907 49 e-3	kg mol <sup>-1</sup>	3.16747 / 1.660538921 [tau mass / atomic mass unit kilogram]
triton g factor	5.957 924 896		2.97892448 x 2 [triton magnetic moment / nuclear magneton x 2 ]
triton magnetic moment	1.504 609 447 e-26	J T <sup>-1</sup>	--
triton / Bohr magneton	1.622 393 657 e-3		1.504609447 / 9.27400968 [triton magnetic moment / Bohr magneton]
triton / nuclear magneton	2.978 962 448		1.504609447 / 5.05078353 [triton magnetic moment / nuclear magneton]
triton mass	5.007 356 30 e-27	kg	--
triton mass energy equivalent	4.500 387 41 e-10	J	5.00735630 / 1.112650056 [triton mass / Joule kilogram]
triton mass energy equivalent in MeV	2808.921 005	MeV	4.50038741 / 1.602176565 [triton mass energy equivalent / electron volt]
triton mass in u	3.015 500 7134	u	5.00735630 / 1.660538921 [triton mass / atomic mass constant]
triton mass / electron mass	5496.921 5267		5.00735630 / 9.10938291 [triton mass / electron mass]
triton mass / proton mass	2.993 717 0308		5.00735630 / 1.672621777 [ triton mass / proton mass]
triton molar mass	3.015 500 7134 e-3	kg mol <sup>-1</sup>	5.00735630 x 1.660538921 [triton mass energy equivalent x atomic mass constant energy equivalent]
Vacuum, characteristic impedance of...	376.730 313 461...	ohm (exact)	1.2566370614 x 2.99792458 [magnetic constant x speed of light in a vacuum]
von Klitzing constant	25 812.807 4434	ohm	12 906.403 7217 x 2 [quantum, conductance, Inverse of... x 2 ]
von Klitzing constant, conventional value of...	25 812.807	ohm (exact)	12 906.403 7217 x 2 [quantum, conductance, Inverse of... x 2 ]

Wavelength, Compton	2.426 310 2389 e-12	m	Compton wavelength for the electron. [quantum mechanical property of a particle: equivalent to the wavelength of a photon whose energy is the same as the rest-mass energy of the particle]]
Wavelength, Compton / 2 pi	386.159 268 00 e-15	m	2.4263102389 / 6.283185307 [Compton wavelength / 2-pi]

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The previous table does not list the "Uncertainty" values of the constants. A brief explanation follows.

Selected Relationships on "The Complete NIST Listing of Fundamental Physical and Chemical Constants"

**A Proposal for Reordering and Making Additions to  
the Complete List of Fundamental Physical and Chemical Constants Published by NIST**  
*[Preliminary Version of a Work in Progress]*

By Charles William Johnson

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## A Comment on the Idea of "Uncertainty" in the Fundamental Physical Constants: Relational Computations without Physical Bases

By Charles William Johnson  
©September, 2014

If a particular constant represents the relationship or ratio of three or four different constants, the question arises regarding the concept of "uncertainty" in the measurements.

Take a hypothetical example, where you have constant 1.0 = to (constant 2.0 divided by constant 3.0) divided by (constant 3.0 divided by constant 4.0).

The simple sum or relationships of the "uncertainty" of each constant (1 - 4) would affect the cited "uncertainty" of constant 1.0

Consider an example of a constant that contains or represents four fundamental physical constants. Consider its apparent nature as shown on the complete list of fundamental physical constants provided by NIST. It appears as follows:

<i>Constant</i>	<i>Value</i>	<i>Uncertainty</i>	<i>Unit</i>
Atomic mass constant energy equivalent in MeV	931.494061	0.000021	MeV

This constant needs to be broken down into its constituent parts, as it represents minimally four other constants according to the tenets of the complete listing of the fundamental physical constants of the NIST:

a) Atomic mass constant energy equivalent in MeV (931.494061) =  
atomic mass constant energy equivalent (1.492417954) divided by electron volt (1.602176565)

b) Atomic mass constant energy equivalent (1.492417954) = atomic mass constant (1.660538921) multiplied times  $c$ -square (8.987551787)

Further, one may consider additional complementary derivations. But, for our analysis we limit our observations to the four or five main constants cited.

c) Atomic mass constant = (1/6.02214129)

d)  $c$  times  $c$  (2.99792458 times 2.99792458); in other words the constant of the speed of light *in vacuo* multiplied times the constant of the speed of light *in vacuo*.

e) electron volt, elementary charge, atomic unit of charge, etc. 1.602176565 = joule/electron volt (1 / 6.24150934)

Now, without examining all the different levels of relationships that intervene previously in order to derive the constant 1.0, consider the uncertainties of the four constants cited in relation to one another. This may be done visually by simply replacing the values of the constant (1-4) with their corresponding values of uncertainty.

Again consider the four|five constants:

a) Atomic mass constant energy equivalent in MeV (931.494061) =  
atomic mass constant energy equivalent (1.492417954) divided by electron volt (1.602176565)

b) Atomic mass constant energy equivalent (1.492417954) = atomic mass constant (1.660538921) multiplied times  $c$ -square (8.987551787)

Now, consider those same constants replaced with their respective values of *uncertainty*:

a) Atomic mass constant energy equivalent in MeV (0.000021 e6) =

atomic mass constant energy equivalent (0.000 000 000 066 e-10) divided by electron volt (0.000 000 035 e-19)

b) Atomic mass constant energy equivalent (0.000021 e6) = atomic mass constant (0.000 000 073 e-27) multiplied times  $c$ -square (exact\*)

[\*the value for  $c$  (299792458) is cited as being, but one can only wonder whether the square of that value represents an exact measurement; doubtful in my mind as  $c$  is the physical limit to spacetime motion; the physical limit to spacetime motion cannot be physically multiplied by itself, it would derive a numerical value that has no existence in spacetime. In my view,  $c$ -square is an inexact theoretical concept regarding the speed of light in a vacuum. And, I say this because  $c$  does not represent the physical limit to spacetime motion of matter-energy. Superluminal velocities exist regarding  $c$ , but not in the manner proposed by the concept of  $c$ -square. However, this theme represents a different line of discussion from the one being presented here regarding the notion of uncertainty in the physical constants.]

Now, place the uncertainty values in the mathematically corresponding places of the constants. The corresponding uncertainty values represent variations in the "constants" that literally multiply exponentially when related to one another in the manner as they are presented on the complete list of fundamental physical constants.

a) (0.000021 e6) = (0.000 000 000 066 e-10) divided by (0.000 000 035 e-19)

b) (0.000 000 000 066 e-10) = (0.000 000 073 e-27) multiplied times (inexact)

By all appearances the potential relationships of the variation in the numerical values of the constants, their values of uncertainty, would be greater than what is presented for each constant. To propose the idea that constant  $1.492417954 \times 10^{-27}$  has a possibility of uncertainty of  $0.000\ 000\ 066 \times 10^{-10}$ , when this constant is based upon four other uncertain constants [  $(0.000\ 000\ 035 \times 10^{-19})$ ;  $(0.000\ 000\ 000\ 066 \times 10^{-10})$ ;  $(0.000\ 000\ 073 \times 10^{-27})$  (inexact) ] is misleading to say the least. In my view, the reasoning offered for the nature of the fundamental physical constants in their aspect of "uncertainty" is without any physical basis. The numerical values of "uncertainty" of the physical constants in some relational instances are simply numbers ---not physical measurements.

The case presented here is one of many to be found on the complete list of the fundamental physical constants. It is unnecessary, in my view, to examine all of the relational cases of a constant based on multiple constants. A single example should suffice to recognize the weakness in the theoretical presentation of the fundamental physical constants in terms of relating their numerical values of uncertainty.

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