A NEW UNIT SYSTEM TO DEFINE ALL PHYSICAL CONSTANTS AS WELL AS THE SI UNITS BY DIMENSIONLESS NUMERICAL VALUES

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ABSTRACT

A new system of unit, zero zone, is proposed where seven SI base units are defined by their corresponding dimensionless numerical values with the lowest uncertainty. The new system of unit exclusively adopted a comprehensive systematic approach based on four physical constants and one base unit in such a manner that all these five items take the numeric value of one, simplifying all algebraic expressions of physical laws. A few physical constants with the lowest experimental uncertainty including Rydberg constant and fine structure constant were used for the derivation of dimensionless values with optimized uncertainty.

Keywords: zero zone theory, zero zone system of units, zero zone dimensionless number, SI unit, natural unit, fine structure constant, Rydberg constant, uncertainty.

1 INTRODUCTION

The International System of Units(SI), which is the modern form of the metric system, is universally adopted today in international trade as well as in the fields of science and technology(BIPM). Seven base quantities used in the SI and the symbols used to denote them are length(m), mass(kg), time(s), electric current(A), thermodynamic temperature(K), amount of substance(mol) and luminous intensity(cd). Units for all other quantities other than the aforementioned are mostly derived as products of powers of base units and these units are called as derived units. Some examples of quantities and the corresponding derived units are force(N=kg·m/s^2), energy(J=N·m), power (W=J/s), etc.

The metric system is not a natural system of units. Historically, metric units were not defined in terms of universal physical constants, nor were they defined in such a manner that some chosen set of physical constants would have exact numerical values of 1. Metric system was defined considering the meridian and rotation of Earth.

After the French Revolution at the end of the eighteenth century, new metric units of metre and kilogram were introduced. In 1875, Metre Convention was signed and the system of units based on metre, kilogram and second, the MKS system was established. At this time, Stoney (1826-1911) from England was thinking about a system of units based on constants those were observed in nature, rather than human standards of convenience such as standard mass of a kilogram or a length of a metre. The reason behind the idea was that they are anthropocentric in principle and he wanted to establish a unit system which does not depend on where you are located in the universe beyond the Earth. He proposed a system of units in 1883 based on the constants of physics assuming they are the same everywhere in universe(G. Stoney). The constants that Stoney adopted were speed of light(c), universal gravitation constant(G), and basic electron charge(e). It is notable that he considered the speed of light is constant well before Einstein proposed it to be constant. He showed that those constants could be combined so that a unit of mass, a unit of length and a unit of time can be derived from them.

Later in 1899, Planck (1858-1947) proposed a unit system which is independent of special bodies or substances by adopting natural units of mass, length and time constructed from the most fundamental constants of Nature such as the gravitation constant G, the speed of light c, and the constant of action h, which is now called as Planck constant(M. Planck). Planck constant h indicates the smallest amount of energy required for action, 'quantum'. Note that the Planck constant divided by 2π is called 'the reduced Planck constant' or known as 'the Dirac constant'. In addition, by adopting the Boltzmann's constant, k, natural temperature was defined. When these four constants are properly combined, Planck's unit with the dimensions of mass, length, time and temperature are derived. These are called as Planck mass, Planck length, Planck time and Planck temperature, respectively. Nowadays, Planck units of measurement are defined exclusively in terms of the five fundamental constants, including Coulomb force constant, in such a way that all of these constants take on the numerical value of '1'(J. Barrow).

These units are also known as natural units because the origin of their definition does not come from any human construct and hence they eliminate anthropocentric arbitrariness from the system of units. As a result, invariant scaling of nature becomes possible by using natural units. By setting the numerical values of the five fundamental constants to unity, Planck units simplify many of the algebraic expressions in physics by removing conversion factors. The simplifications natural units afford make them quite common in quantum gravity research and high energy physics. Other advantage of using Planck unit is that if all physical quantities were expressed in terms of Planck units, those quantities would be dimensionless values. In other words, universal quantities with dimensions are normalized by the choice of natural units. Note that all of those five fundamental constants are all related to dynamic phenomena those are observed in the nature.

Despite of the fact that natural units including Planck units may be useful in a number of fields and more natural in a sense that they are derived from the fundamental constants, they cannot replace all SI units and be applied to other areas due to the unacceptably large uncertainty of those units. According to the values of the fundamental physical constants recommended by CODATA in 2006, the relative standard uncertainty of Planck mass, Planck temperature, Planck length and Planck time is 5.0×10^{-5} which is very large compared with the relative standard uncertainty of the same kind of physical quantities appeared in 2006 CODATA values(Peter J. Mohr & Barry N. Taylor). This large uncertainty in Planck units is due to the large uncertainty of Newtonian constant of gravitation, G, of 1.0×10^{-4}. As a consequence, Planck system of units is considered practically inappropriate for deployment to all scientific areas due to the large uncertainty except some special scientific fields where the benefits from adopting natural units are clear.

In this paper, a new natural system of units is proposed by which all physical units including seven SI base units and all physical constants as dimensionless numeric values with the estimated relative standard uncertainties to be within permissible range for being deployed in all scientific areas. It is worthwhile to note that all kind of physical constants and units has been investigated and analyzed for more than 16 years to develop the proposed Zero Zone system of units which can remove the barrier between the units.

2 ZERO ZONE SYSTEM OF UNITS

2.1 Candidates of physical constants for natural units

Natural units are physical units of measurement defined in terms of universal physical constants, such that some chosen physical constants have a numerical value of '1'. Natural units are intended to simplify particular algebraic expressions of physical laws or to normalize some chosen physical quantities that are properties of free space or universal elementary particles that may be reasonably believed to be constant.

In many cases, five physical quantities such as length, mass, time, temperature, and electric charge are adopted and defined as the quantities of base units in natural system of units. By constraining the numerical values of some fundamental constants to be '1', base units of those five quantities are defined. Physical constants subject to normalization are selected from such candidate physical constants as speed of light in vacuum(c), gravitational constant(G), Dirac's constant or reduced Planck's constant($h/2\pi$), Coulomb force constant($1/4\pi\varepsilon_0$), elementary charge(e), electron mass(m_e), proton mass(m_p), and Boltzmann constant(k).

It is noteworthy that only five of the foregoing constants can be normalized or defined to be 1 in any system of units without conflict. (*e.g.*, m_e and m_p cannot be defined simultaneously as a unit of mass in a single unit system). Dimensionless physical constants such as the fine-structure constant,

$$\alpha = e^2/2\varepsilon_0 hc = 1/137.035\ 999\ 679(94) \quad (1)$$

has fixed dimensionless numeric value as shown above no matter what system of units is applied. Since α is a fixed dimensionless value, we cannot define a system of natural units that normalize all of the four physical constants comprising α. Out of four constants, c, $h/2\pi$, e, or $4\pi\varepsilon_0$, any combination of three constants can be normalized but not all four constants at the same time.

In almost all of the system of natural units, the Boltzmann constant is normalized to k =1, which can be viewed as expressing the definition of unit temperature. And the permittivity of free space tends to be normalized to $\varepsilon_0 = (4\pi)^{-1}$ or the Coulomb force constant to be $1/4\pi\varepsilon_0 = 1$, which can be regarded as expressing the definition of unit charge.

2.2 Postulates of zero zone system of units

Zero zone system of units is developed to express all of the seven base SI units such as second(s), meter(m), kilogram(kg), Kelvin(K), Ampere(A), mole(mol) and candela(cd) as dimensionless values with the lowest optimized uncertainty. In order to convert all of the seven base units into dimensionless values, it is necessary to determine which physical constants should be selected to be defined as a dimensionless numeric value of '1' like the natural units. It is worthwhile to note that independent physical constants should be chosen so that conflicts among them in definition or normalization of more than two SI base units could be avoided.

Among the seven SI base units, unit of time, second(s), is defined to be a dimensionless numerical value of '1' as shown in Eq. (2), in order to simplify physical equations including velocity and acceleration and to link static and dynamic physical phenomena in an integrated manner. By this definition, an arbitrary quantity of time, 1 s, 20 s, or 300 s, for example, can easily be converted into its corresponding non dimensional numeric value of 1, 20, or 300, respectively.

$$s \equiv 1 \tag{2}$$

The above postulate is thought to play some special role in zero zone system of units by converting s into the dimensionless number of 1 independently. For proper understanding on the importance of this postulate and the background of its meaning, a brief explanation is given below.

Among prominent philosophers, there are two distinct viewpoints on time. One view is that time is part of the fundamental structure of the universe, a dimension in which events occur in sequence. The opposing view is that time does not refer to any kind of "container" that events and objects "move through", nor to any entity that "flows", but that it is instead part of a fundamental intellectual structure together with space and number within which humans feel the sequence and compare events. This second view holds that time is neither an event nor a thing. Thus, it is not measurable at all. Scientists can measure only motions and define it to be time.

From the perspectives of classical Newtonian mechanics, it is assumed that existence of objective substances is self-evident, without the need for proof. This can also be understood as believing that an object will stay forever as is if there is no external stimulus. Thus, classical mechanics views time and space separately. This is well illustrated in that time unit s(second) and length unit m(meter) representing space are defined respectively. Given that units of time and space are separately defined, SI units is also considered to fall in the category of "static system of units" of classical mechanics

However, according to quantum physics, everything in the universe does exist as it moves, in other words, in motion. Thus, views from quantum physics are considered as "dynamic" whereas those from classical mechanics are "static." From the dynamic perspectives of quantum physics, it is natural to establish a system of units based on physical constants related with dynamic phenomena of the nature.

Considering these two different perspectives, static or dynamic point of view, and to unite them into one unified system, SI base unit of time s has been set to '1' beside the fore mentioned reason of simplifying physical equations related with motion of objects.

In order to convert all of the seven SI base units into their corresponding dimensionless values, four more base units of length, mass, electric current and temperature should be independently converted without conflict. Among candidates of physical constants, speed of light c, Planck constant h and Boltzmann constant k is selected to be defined as the numeric value of '1' for conversion of meter(m), kilogram(kg) and Kelvin(K), respectively, which is similar to the natural system of units.

Finally, for converting SI base unit of electric current, Ampere(A), the ratio of elementary charge to electron mass e/m_e is selected to be defined as the numerical value of '1'. It is worthwhile to note that $e/m_e \equiv 1$ provides a link between the dimensionless values of C and kg in zero zone system of units.

In summary, zero zone system of units is developed under five postulates for defining four physical constants and one SI base unit to be the numerical value '1' as shown in Eq. (3).

$$c = h = \mathrm{s} = k = e/m_e \equiv 1 \tag{3}$$

2.3 Derivation of dimensionless numeric value for each SI base unit

As is previously explained, five postulates given in Eq. (3) are applied for the conversion of seven SI base units into dimensionless values.

First of all, for the SI base unit of time, s = 1 simply by the definition given in Eq. (2). In this case, s is an exact value with zero uncertainty.

The dimensionless value of SI base unit of length, meter(m), can easily be obtained by substituting s=1 in Eq. (4) which is given by the definition of the speed of light c. The result is shown in Eq. (5) and it is also an exact value.

$$\mathrm{c} = 299\ 792\ 458\ \mathrm{m/s} \equiv 1 \tag{4}$$

$$\mathrm{m} = 1/299\ 792\ 458 \tag{5}$$

The dimensionless value of SI base unit of mass, kilogram(kg) can also be obtained from the postulate of Planck constant $h = 1$ given in Eq. (6). By substituting s = 1 and the dimensionless value of m shown in Eq. (5) for Eq. (6), the dimensionless value for kg is calculated as shown in Eq. (7) and its relative standard uncertainty is calculated to be identical to that of the Planck constant, i.e., $5.0\mathrm{x}10^{-8}$.

$$h = 6.626\ 068\ 96(33)\ \mathrm{x}\ 10^{-34}\ \mathrm{Js} = 6.\ 626\ 068\ 96(33)\ \mathrm{x}\ 10^{-34}\ \mathrm{kgm^2s^{-1}} \equiv 1 \tag{6}$$

$$\mathrm{kg} = 1.356\ 392\ 733(68)\ \mathrm{x}\ 10^{50} \tag{7}$$

In order to obtain the dimensionless value of SI base unit of electric current, Ampere(A), several steps of consecutive calculation are needed. First, the dimensionless value of electron mass(m_e) can be obtained from Rydberg constant with lowest relative standard uncertainty of $6.6\ \mathrm{x}\ 10^{-12}$ as is given in Eq. (8)

$$R_\infty = \alpha^2 m_e c/2h = 10\ 973\ 731.568\ 527(73)\ \mathrm{m^{-1}} \tag{8}$$

By substituting $c = h = 1$ defined by the postulate in Eq. (3), the dimensionless value of m in Eq. (5) and fine structure constant α, $7.297\ 352\ 5376(50)x10^{-3}$, for Eq. (8), the dimensionless value of electron mass(m_e) can be calculated. As per the postulate of $e/m_e = 1$, the dimensionless value of elementary charge(e) takes the same value as that of electron mass(m_e) and is given by Eq. (9)

$$e = m_e = 1.235\ 589\ 9746(17)\ \mathrm{x}\ 10^{20} \tag{9}$$

It is worth noting that the relative standard uncertainty of the dimensionless value of e and m_e can be calculated by substituting $c = h = 1$ for Eq. (8) and depends only on relative standard uncertainty of Rydberg constant, 6.6 x 10^{-12}, and that of the fine structure constant, 6.8 x 10^{-10}. It is, therefore, calculated to be 1.4 x 10^{-9} and is better than 2.5 x 10^{-8} and 5.0 x 10^{-8} which are the relative standard uncertainty of e and m_e , respectively, announced by CODATA in 2006. (Peter J. Mohr & Barry N. Taylor)

Elementary charge e is related with SI unit of electric charge C as is shown in Eq. (10),

$$e = 1.602\ 176\ 487(40) \times 10^{-19}\,\mathrm{C} \qquad (10)$$

from which the dimensionless value of C can be obtained directly by using the dimensionless value of e in Eq. (9). Since A = C/s by definition and s=1, the dimensionless value for the SI base unit of current A is the same as that of C and is shown in Eq. (11).

$$\mathrm{A} = \mathrm{C} = 7.711\ 946\ 75(23) \times 10^{38} \qquad (11)$$

The relative standard uncertainty of C can be calculated by applying the calculated relative standard uncertainty of the dimensionless value of e, 1.4 x 10^{-9}, as was mentioned above to e in Eq. (10). Since the standard uncertainty of the physical constant value of e expressed in the parenthesis as shown Eq. (10) is equivalent to 2.5 x 10^{-8} in relative standard uncertainty, the relative standard uncertainty of C could be calculated to be 2.9x10^{-8}

As for the thermodynamic temperature unit K, it can be expressed by Boltzmann constant k and SI unit of energy, Joule(J) as is shown in Eq. (12).

$$k\mathrm{K} = 1.380\ 6504\times10^{-23}\,\mathrm{J} = 1.380\ 6504\times10^{-23}\mathrm{kgm^2s^{-2}} \qquad (12)$$

By applying the postulate $k = 1$ and s = 1 and substituting the dimensionless values of m and kg obtained above <u>for</u> Eq. (12), the dimensionless value of K is obtained as is shown in Eq. (13). The relative uncertainty is calculated to be 1.7 x 10^{-6}

$$\mathrm{K} = 2.083\ 6644(36) \times 10^{10} \qquad (13)$$

The SI base unit for the amount of substance, mol, is defined as the amount of substance which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12. This definition of mole also determines the value of Avogadro constant, N_A, which relates the value of entities to the amount of substance for any sample. Note that $N_A$mol is dimensionless value in SI unit by itself as shown in Eq. (14) and is the same in zero zone system of units and the relative uncertainty is 5.8x10^{-8} which is the same as is published in 2006 CODATA .

$$N_A\mathrm{mol} = 6.022\ 141\ 79(30) \times 10^{23} \qquad (14)$$

The definition of SI base unit of luminous intensity(cd) can be expressed as is shown in Eq. (15). Note that this unit depends on three SI base units of kg, m and s although it is one of the seven SI base units.

$$\mathrm{cd} = (1/683)\mathrm{Ws^{-1}} = (1/683)\mathrm{kgm^2s^{-4}} \qquad (15)$$

When the postulate of s = 1 is applied and the dimensionless values of m and kg are substituted for Eq. (15), dimensionless value for the unit cd is obtained as <u>is</u> shown in Eq. (16). Here, the relative uncertainty is calculated to be 5.0x10^{-8}

$$\mathrm{cd} = 2.209\ 649\ 27(11) \times 10^{30} \qquad (16)$$

Table 1. shows the results of conversion of the seven base SI units into nondimensional numerical values. By this set of numeric values for the seven SI base units, it is possible to derive corresponding numeric values for all the other derived units and physical quantities.

Table 1. Summary of the derived zero zone dimensionless values for the seven SI base units

Quantity	Unit	Zero zone dimensionless value	Calculated relative standard uncertainty
second	s	1	Exact value
meter	m	1/299 792 458	Exact value
kilogram	kg	$1.356\ 392\ 733(68)\text{x}10^{50}$	$5\ \text{x}10^{-8}$
Ampere	A	$7.711\ 946\ 75(23)\text{x}10^{38}$	$2.9\ \text{x}10^{-8}$
Kelvin	K	$2.083\ 664\ 4(36)\text{x}10^{10}$	$1.7\ \text{x}10^{-6}$
candela	cd	$2.209\ 649\ 27(11)\text{x}10^{30}$	$5.0\ \text{x}10^{-8}$
mole	mol	$6.022\ 141\ 79(30)\text{x}10^{23}$	$5.0\ \text{x}10^{-8}$

In Table 2, equivalent physical quantities corresponding to each dimensionless value '1' are expressed in SI units. As the numeric values those are proposed here do not reveal any information about unit, it is necessary to convert them into SI equivalent physical quantities to understand them in the concept of physical quantities in existing unit system using the conversion ratio in Table 2.

Table 2. Zero zone dimensionless value of '1' and its equivalent physical quantity in SI unit

Quantity	Value	Equivalent physical quantity in SI unit
Time	1	1 s
Length	1	$2.997\ 924\ 58\ \text{x}\ 10^{8}$ m
Mass	1	$7.372\ 495\ 99[37]\ \text{x}\ 10^{-51}$ kg
Current	1	$1.269\ 689\ 452[38]\ \text{x}\ 10^{-39}$ A
Temperature	1	$4.799\ 2374[82]\ \text{x}\ 10^{-11}$ K
Amount of substance	1	$1.660\ 538\ 782[83]\ \text{x}\ 10^{-24}$ mol
Luminous intensity	1	$4.525\ 605\ 10[23]\ \text{x}\ 10^{-31}$ cd

It is worth noting that some nondimensional numerical value in Zero Zone system unit can be converted into its corresponding physical quantity in a desired SI unit. And it can be understood that a nondimensional numerical value means a physical quantity embedding unit and it is called by a newly invented word as 'qunit'.

2.4 Verification of zero zone system of units

The zero zone system of units in numeric values proposed in this paper shall be verified for its self-consistency and validation by comparing the relative standard uncertainties of the values derived herein and those of the 2006 CODATA set of values of the fundamental constants and conversion factors between 8 energy equivalent units.

As a first step, with respect to the fundamental constants, dimensionless values derived from the proposed zero zone system of units are compared with the values published in 2006 CODATA to verify if they show reasonable consistency within the internationally permissible uncertainty range.

First, according to the 2006 CODATA, the ratio of elementary charge (e) to electron mass (m_e) in SI unit is as follows;

$$e/m_e = 1.785\ 820\ 150(44) \times 10^{11}\ \mathrm{C/kg} \quad (16)$$

By substituting $e/m_e = 1$ for Eq. (16), we get

$$\mathrm{kg/C} = 1.785\ 820\ 150(44) \times 10^{11} \quad (17)$$

This value can be understood as a numeric value obtained using natural unit system, i.e., $c=h=e/m_e=1$.

Secondly, the dimensionless value for kg/C, the left side of Eq. (17), is calculated by adopting dimensionless values of kg given in Table 1 and that of C given in Eq. (11), we get

$$\mathrm{kg/C} = 1.785\ 820\ 149 \times 10^{11} \quad (18)$$

Those dimensionless values derived herein in Eq. (17) using 2006 CODATA values and that in Eq. (18) based on zero zone dimensionless values shown in Table 1 are comparable within the permissible uncertainty range. The same process could be applied for the calculation of dimensionless values of all other physical constants such as von Klitzing constant, Josephson constant, Faraday constant, etc. Examples of the calculated dimensionless values related with these constants are shown in Table 3 for comparison.

Table 3. Comparison of some dimensionless values derived from 2006 CODATA recommended values and from dimensionless values in zero zone system of units.

Related Quantity	Calculated item for comparison	From 2006 CODATA recommended values	From dimensionless values zero zone system of units
Ratio of elementary charge to electron mass	kg/C	$1.785\ 820\ 150(44) \times 10^{11}$	$1.785\ 820\ 149 \times 10^{11}$
Von Klitzing constant	$1/\Omega e^2$	$2.581\ 280\ 7557(18) \times 10^4$	$2.581\ 280\ 7544 \times 10^4$
Josephson constant	$2e$V	$4.835\ 978\ 91(12) \times 10^{14}$	$4.835\ 978\ 91 \times 10^{14}$
Faraday constant	$(N_A\,\mathrm{mol})e/\mathrm{C}$	$9.648\ 533\ 99(24) \times 10^4$	$9.648\ 533\ 97 \times 10^4$

Table 4. Conversion factors obtained from dimensionless values of eight energy equivalent units.

unit	J	Kg	m^{-1}	Hz
J	1	1.112 650 056… x 10^{-7}	5.034 117 47(31) x 10^{24}	1.509 190 451(94) x 10^{33}
kg	8.987 551 787… x 10^{16}	1	4.524 439 15(16) x 10^{41}	1.356 392 733(68) x 10^{50}
m^{-1}	1.986 445 500(123) x 10^{-25}	2.210 218 70(13) x 10^{-42}	1	2.997 924 58 x 10^{8}
Hz	6.626 068 96(41) x 10^{-34}	7.372 496 00(43) x 10^{-51}	3.335 640 951… x 10^{-09}	1
K	1.380 6504(24) x 10^{-23}	1.536 1807(27) x 10^{-40}	6.950 356(12) x 10^{1}	2.083 6644(36) x 10^{10}
eV	1.602 176 487(154) x 10^{-19}	1.782 661 758(164) x 10^{-36}	8.065 544 65(27) x 10^{5}	2.417 989 454(82) x 10^{14}
u	1.492 417 830(95) x 10^{-10}	1.660 538 782(99) x 10^{-27}	7.523 006 671(14) x 10^{14}	2.252 342 7369(40) x 10^{23}
E_h	4.359 743 94(27) x 10^{-18}	4.850 869 34(28) x 10^{-35}	2.194 463 313(14) x 10^{7}	6.579 683 920 722 (43) x 10^{15}

Table 4. Continued.

unit	K	eV	u	E_h
J	7.242 963(13) x 10^{22}	6.241 509 65(60) x 10^{18}	6.700 536 41(43) x 10^{9}	2.293 712 69(14) x 10^{17}
Kg	6.509 651(11) x 10^{39}	5.609 589 12(52) x 10^{35}	6.022 141 79(36) x 10^{26}	2.061 486 16(12) x 10^{34}
m^{-1}	1.438 7752(24) x 10^{-2}	1.239 842 875(42) x 10^{-6}	1.331 025 0394(24) x 10^{-15}	4.556 335 252 760 (30) x 10^{-8}
Hz	4.799 2373(81) x 10^{-11}	4.135 667 33(14) x 10^{-15}	4.439 821 6294(80) x 10^{-24}	1.519 829 846 006 (10) x 10^{-16}
K	1	8.617 343(15) x 10^{-5}	9.251 098(16) x 10^{-14}	3.166 8153(54) x 10^{-6}
eV	1.160 4505(20) X 10^{4}	1	1.073 544 188(38) X 10^{-9}	3.674 932 540(125) X 10^{-2}
u	1.080 9527(18) X 10^{13}	9.314 940 28(33) X 10^{8}	1	3.423 177 7150(62) X 10^{7}
E_h	3.157 7465(54) X 10^{5}	2.721 138 386(93) X 10^{1}	2.921 262 2986(53) X 10^{-8}	1

As a last step to show the equivalence between 2006 CODATA recommended value and dimensionless values in zero zone system of units, 64 conversion factors between 8 energy equivalent units such as J, kg, m^{-1}, Hz, K, eV, atomic mass unit(u) and Hartree energy(E_h) recommended by CODATA in 2006 are compared with those calculated from zero zone system of units. Dimensionless values according to zero zone system of units for these eight energy equivalent units can be calculated from the dimensionless values for those seven SI base units in Table 1.

The results of calculation for the 64 conversion factors among units based on dimensionless values for the 8 energy equivalent units are shown in Table 4. Conversion factor in each box represents the value of unit in row divided by the value of unit in column. For example, the value in the box where kg in row and J in column crosses, represents the conversion factor directly calculated from zero zone dimensionless values as in kg/J.

It is understood that the number in parentheses is the numerical value of standard uncertainty referred to the corresponding last digits of each value. Conversion factors without uncertainty mean that those units related with this calculation have exact values or they cancel each other. For example, conversion factor for kg/J is obtained from kg/kgm^2s^{-2}. In this case, kg cancels out each other and s is '1' according to the postulate and m has exact value since the speed of light c is defined to have exact value. As a result, this conversion factor appears to have exact value. However, conversion factor for kg/m^{-1}, it has standard uncertainty of $0.000\ 000\ 16 \times 10^{41}$. In this case, m has exact value but kg has uncertainty due to the uncertainty in Planck constant which is in the range of 10^{-8} order. When this value is converted into dimensionless value following zero zone system of units, the conversion factor would have that uncertainty as shown in Table 4.

Conversion factors presented in the Tables XXXI and XXXII of 2006 CODATA were calculated from the relations $E=mc^2=hc/\lambda=h\nu=kT$ and other related equations based on the 2006 CODATA adjustment of the values of the constants. Whereas conversion factors those are given in Table 4 were calculated directly from the dimensionless value of each unit. Consistency between them within the permissible uncertainty range can be verified through comparison of the two tables.

3 CONCLUSION

A new innovative 'Zero zone system of units' has been proposed where all of the seven SI base units and derived units as well as physical constants are converted successfully into the unified dimensionless values by defining $c = h = \mathrm{s} = k = e/m_e \equiv 1$. This dimensionless system of units can be verified for its self-consistency and validity by comparing the relative uncertainty between the values derived from the proposed system of unit and the 2006 CODATA adjusted values of fundamental constants and conversion factors among the eight energy equivalent units.

The new system of unit has been developed based on the natural unit with an additional postulate of s=1 which is the unique character of zero zone system of units. Actually, by this postulate it was possible to link fundamental physical constants and SI system of unit through consistent dimensionless values. Currently, the most accurate fundamental constants with the lowest uncertainty are Rydberg constant and fine structure constant. By adopting these two constants for the calculation of the dimensionless values, it was possible to derive optimized system of units with lower uncertainties compared to 2006 CODATA values. This implies that if the two constants are defined to have exact values, then the uncertainty level of current adjusted physical constants could be lowered further. This is also related with the redefinition of kg and other SI base units and hence more serious discussion is suggested(Ian Mills, Peter J. Mohr, Tarry J. Quinn, Barry N. Taylor & Erwin R. Williams).

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