# Proposal for the Universal Unit System

Takashi Suga, Ph.D.

July 2, 120Ɽ;(2026.) [1]


## Abstract

This paper presents recent extensions and revisions to the Universal Unit System.[2] This system defines coherent units by employing the duodecimal number system (base 12) and fundamental physical constants, such as the speed of light in a vacuum, the quantum of action, and the Boltzmann constant. The central aim is to unify physical measurements (e.g., length, mass, temperature, and time) with a consistent duodecimal structure while accommodating human, atomic, and cosmic phenomena.

A noteworthy feature is the Harmonic System, which was conceptually designed so that crucial physical constants (including the Bohr radius and the atomic mass unit) and astronomical constants (including the year and day length of the Earth, the age of the solar system, and the universe) can be approximated using multiples or submultiples of integer powers of twelve. The Harmonic System simultaneously embraces duodecimal efficiency, atomic and cosmic relevance, and human convenience.

Compared to the previous official version, this revised document expands the discussion of calendar time units (such as "nodus "(=$2^{-7}$ day)) by introducing new definitions and clarifications.

Additionally, the system identification for units has been shifted from the suffix to the prefix, and the identifier for the Harmonic System has changed from "h" to "±." The optional proposal to rename specific metric units after mythological figures, first introduced in the previous version, has been further refined in footnote 47 to address improved consistency.

This revision also clarifies the structural role of universal, Earth-local, and alias quartets, and resolves several common misunderstandings regarding the independence of UUS from CODATA and the scope of its notation system. Furthermore, since the 2019 redefinition of the SI—where the defining constants such as $c_0$, $\hbar$, $k_B$, and $N_A$ were fixed—no subsequent revisions have altered these definitions. As a result, SI conversion factors for UUS have remained stable, with no changes even in the 2022 CODATA adjustment, which did not revise the gravitational constant.


## 0. Positioning Note

This revision improves the explicitness and consistency of the Universal Unit System (UUS) for systematic interpretation.

**Note**: This system is designed to **coexist with SI** [3], not replace it—offering a complementary educational perspective.

---

[1] In this paper, SI units are combined only with the decimal figures (indicated by a period "." as the fractional separator), and units of the Universal Unit Systems are combined only with duodecimal figures (indicated by a semicolon ";" as the fractional separator. 'Ɽ' expresses ten and 'Ɛ' expresses eleven). Both notations may use a comma "," and "_" as the digit group separator. Non-dimensional quantities are mostly expressed using all figures in duodecimal first, with the decimal given parenthetically. There are also cases where the octal fractional separator is represented by "∴". See also Appendix A.1 for aliases that can be used for non-ascii characters.

[2] NOTICE: The official entry point for the Universal Unit System (UUS) and the Harmonic System is **http://dozenal.com** (GitHub repository: https://github.com/suchowan/a_converter). Please start with the README for a conceptual overview, then see the Eight Quartets diagram for a one-page map of the system.

[3] To support such coexistence, the naming rules and notation of the Harmonic System are intentionally designed so that its prefixes and unit symbols remain unambiguously distinguishable even when they appear alongside other unit systems—such as SI—within the same document, dataset, codebase, or analytical context.

When describing a system, the initial choice of references such as origin, scale, or number base—is conventional. However, once such a choice is made, the structures that follow are no longer conventional: they emerge necessarily from internal consistency.

- **UUS adopts the duodecimal system as its number base**, as formalized by **Eq.Ω**, which yields minimal representational complexity.
- Within this same structural framework, **the Harmonic System introduces a fixed offset to the Rydberg constant**—an adjustment characterized jointly by the relation $35\,G = 1$ and by **Eq.α**, whose calendar symmetry naturally aligns with this offset.

From these initial choices alone, the structural relationships summarized in Figure 2 follow inevitably. This document does not argue that these choices are uniquely correct. Rather, it shows that once they are adopted, the resulting structure is not arbitrary but constrained.

The Harmonic System's theoretical framework is relatively radical, while its practical scales remain close to everyday experience. In this sense, the system is better understood as a structural reinterpretation of existing measurement practices rather than as a replacement. This perspective also explains why the Harmonic System does not always align smoothly with mainstream dozenal communities: it is adjacent in notation, but distinct in motivation.

The Harmonic System is not designed to be "small" or "minimal" by deliberate engineering. Rather, its compactness arises naturally from the emerged structural constraints imposed by Eq.α and Eq.Ω. The observed economy of structure is a consequence of the system's internal coherence, not an imposed objective. Base-12 is not chosen but discovered as the representation that minimizes entropy across physical and astronomical quantities.

In this revision, the emphasis is therefore placed not on numerical adjustment, but on structural clarity: which elements of a unit system are universal, which are conventional, and which function as relations rather than quantities. To support this goal, the following clarifications are introduced:

・Units and relations

Some quantities traditionally treated as units are more naturally interpreted as conversion relations (e.g. solar, meridian). Making this distinction explicit reduces ambiguity rather than adding complexity.

・Canonical notation and aliases

Canonical symbols are used where unambiguous Unicode representations exist. Historical or socially established forms are retained strictly as documented aliases.

・Specified quantities

Certain socially meaningful measures (such as counting words or monetary units) are treated as specified quantities, not as members of the UUS core. This mirrors the role of specification already present in the SI definition of the mole.

These clarifications do not expand the scope of UUS. They make explicit assumptions that were previously implicit, improving interpretability for both human readers and computational analysis.

To maintain clarity across the UUS documentation set, if any discrepancy arises between this document and other files, the definitions and conventions in this revised.pdf should be regarded as authoritative.

# 1. The Universal Unit System

## 1.1. Before the Universal Unit System

A unit of measure is "a quantity that is used as the basis for expressing a given quantity and is of the same type as the quantity that is to be expressed". A unit that is used in exchanges between people must be guaranteed to have a constant magnitude within the scope of that exchange. Quantities that can, by consensus, serve as common standards over a broad scope were sought and selected to serve as units. The ultimate example of such a quantity is an entity common to all of the humankind, the Earth itself, which was selected as the foundation for the metric system.

## 1.2. The next stage?

Of course, we can consider going beyond the framework of the Earth and defining units with concepts for which agreement can be reached within a broader scope. The quantities that then become available to serve as the standards for defining units include the quantities of the fundamental physical constants, quantities such as the speed of light in a vacuum ($c_0$), the quantum of action ($\hbar$), the Boltzmann constant ($k_B$), and so on. These quantities are believed to have values that remain constant everywhere in the universe. When trying to construct a coherent unit system, however, it is not possible to use all of the fundamental physical constants in the definitions of units. Therefore, would not we expect the fundamental physical constants that were not used in defining units to have fractional magnitudes of unit quantities of the same dimension?

For example, the Rydberg constant ($R_\infty$) is 115,3789;470075/ft (10973731.56816/m) [4] and the Bohr radius ($a_B$) is 0;X8EE6E522×10;$^{-9}$ft (5.29177210544×10.$^{-11.}$ m). Therefore, the relation between these two constants is:

| DOZENAL | DECIMAL | |
|---|---|---|
| $R_\infty^{-1}$ = EE6;06604 $a_B$ | $R_\infty^{-1} = 1{,}722.04515\ a_B$ | (1) |

If one of these two constants is chosen as a unit quantity, the other constant cannot be expressed as a unit quantity.

By surprising coincidences [5] described in Appendix F and §2.1 of univunit-e.pdf ( http://dozenal.com/doc/dozenal_com/univunit-e.pdf ), however, if the duodecimal number system is used to express the speed of light in vacuum and the quantum of action as the defining constants such that these constants are strictly multiples of integer powers of twelve of the unit quantities, it is possible to construct a coherent unit system in which not only the constant that was used in the definition but also the Rydberg constant, the Bohr radius, the unified atomic mass unit ($u$), and half the value of the Planck length ($l_P/2=\sqrt{36.Gh/c_0^3}/12.$) can be approximated to about or within an error of 2 per gross ($1^1/_2$%) by a multiple of integer powers of twelve of the unit quantities.

In that case, many other physical constants, including the charge and mass of an electron, the fine structure constant, the molar volume of an ideal gas under standard conditions, the black-body radiation at the ice point, the density and surface tension of water, and others, can be approximated by multiples of integer powers of twelve of the unit quantities. Moreover, by adding the Boltzmann constant and using it in the definition of thermodynamic temperature, the gas constant of an ideal gas can be approximated by a multiple of an integer power of twelve of the unit quantity and the Stefan-Boltzmann constant, and the specific heat of water can be approximated by multiples of integer powers of twelve of the unit quantities with a factor 2 remaining. These conclusions are shown in Table 5.[6]

---

[4] In this paper, plane angle phase factor $2\pi$ is often treated as a non-dimensional parameter and omitted in order to simplify the explanation. See §A.2 and 3.2.2 of the paper univunit-e.pdf.

[5] To prevent any misunderstanding, let us emphasize that **these are merely coincidences as far as physical science is concerned**.

[6] A more detailed table is retrievable at http://dozenal.com/doc/condensed.xlsx.

A remarkable regularity appears when expressing macro-scale and micro-scale physical constants using powers of 12 together with a single auxiliary constant:

$$\textbf{Constant} \approx \boldsymbol{\Omega_0^n} \times \mathbf{12}^{\boldsymbol{m}}, \boldsymbol{\Omega_0} = \mathbf{2},\ \boldsymbol{n} \in \{\mathbf{0}, \pm\mathbf{1}\},\ \boldsymbol{m} \in \mathbb{Z} \qquad \textbf{(Eq.}\boldsymbol{\Omega}\textbf{)}$$

This pattern is not the result of adopting Base-12 *a priori*. Rather, Base-12 emerges as the representation that minimizes structural entropy across diverse physical quantities—such as the Earth's meridian length, gravitational acceleration, water's density, and specific heat. The role of $\Omega_0$ is discussed further in Appendix A.1(5).

We define the Universal Unit System as "the unit system that is constructed by using the duodecimal number system and the speed of light in vacuum, the quantum of action, and the Boltzmann constant as the defining constants in such a way that these constants become strict multiples of integer powers of twelve of the unit quantities, and the Rydberg constant, the unified atomic mass unit, the Bohr radius, and half the value of the Planck length can be approximated by multiples of integer powers of twelve of the unit quantities".

## 1.3. Variation of the Universal Unit Systems

To define three units for time, length, and mass, the Universal Unit System uses the speed of light in vacuum and the quantum of action. Another constant is necessary to define these three units. Therefore, the Universal Unit System has some variations in the constant that the system chooses as the last definition constant.

Universal Unit System with constant *A* is the Universal Unit System that uses constant *A* as the last definition constant and whose unit quantity of the last dimension is equal to constant *A* or its multiples of integer powers of twelve. In particular, the Universal Unit System with the Rydberg constant whose length unit is $10;^{6} / R_\infty$ ($12.^{6} / R_\infty$) and velocity unit is $10;^{-8}\ c_0$ ($12.^{-8}\ c_0$) is called the Universal System of Units Standard[7] corresponding to the International System of Units Standard (SI). We will use a symbol corresponding to the SI unit symbol prefixed with 'u' as a new symbol required by the Universal System of Units Standard; 'u' is the '**u**niversal' system prefix. The noun form is 'univer'. For example, the length unit is $_{\mathrm{u}}$m and is called the 'universal meter' or simply the 'univer'[8], and the time unit is $_{\mathrm{u}}$s and is called the 'universal second'[9]. **This unit system is comprised of six quartets.** The units of this system are listed in the 5th column of Table 4, and physical, material, and astronomical constants expressed using this system are presented in the 3rd column of Table 5. The ratio of the time unit $\mathrm{s_u}$ and the SI second is 0;4824707(0.3902675).

The Universal Unit System with the Bohr radius whose length unit is $10;^{9}\ a_\mathrm{B}$ ($12.^{9}\ a_\mathrm{B}$) and velocity unit is $10;^{-8}\ c_0$ ($12.^{-8}\ c_0$) can be defined in the same way. Its time unit is 1;005E857 $_{\mathrm{u}}$s (0.3916171 s). Roughly speaking, **if a time constant or its multiples of integer powers of twelve falls within the range between 1; $_{\mathrm{u}}$s (0.3902675 s) and 1;005E857 $_{\mathrm{u}}$s (0.3916171 s), we can construct the Universal Unit System using the constant as a time unit.**

---

7 The Universal System of Units Standard is strictly defined in §3 of the paper univunit-e.pdf.

8 The noun form of the system prefix is considered to be the abbreviation of the length unit like the length unit of the metric system is 'meter'.

9 Note that there is no vagueness at all even if the prefix is omitted if the notation of footnote 1 is adopted. Prefixes are necessary to identify plural Universal Unit Systems mutually. $4\times10.^{7}$ m, $4\times10;^{7}$ $\mathrm{m_u}$, and the Earth's meridian length are nearly equal. $10.^{5}$s, $10;^{5}$ $_{\mathrm{u}}$s, and 1⅛ days are nearly equal.

If half the value of the Planck length is used instead of the Bohr radius, the time constant becomes 1;0223 us (0.3962 s). This is out of range. To keep the time constant within the range, we should use $\sqrt{\mathbf{35.}G\hbar/c_0^3}$ instead of $\sqrt{\mathbf{36.}G\hbar/c_0^3}$. Then, the time constant becomes 1;00186 us (0.39065 s). We call this system the Gravitic System. The Gravitic System can be interpreted as a unit system that 35.$G$, $c_0$, $\hbar$, $K_B$ and $Z_P$ are strict multiples of integer powers[10] of twelve of the unit quantities. However, it is not practical because G's measurement accuracy is insufficient.

# 2. The GCD Unit System

## 2.1. Basic Concept

The length of the tropical year is strictly 265;2XX6 days in a certain year at the end of the 20th century. For human activities on Earth, year and day cannot be ignored as calendar time units. However, the ratio of year and day is not simple. **Therefore, any calendar time unit system must be a mixed radix system.** The ratio of one tropical year and one day is:

DOZENAL

$$\frac{\text{year}}{\text{day}} = 265;+\frac{27;}{X8;} = 1;003628 \times 264;6 = 1;003628 \times \frac{3^6}{2}$$

DECIMAL (2)

$$\frac{\text{year}}{\text{day}} = 365.+\frac{31.}{128.} = 1.002036..\times 364.5 = 1.002036..\times \frac{3^6}{2}$$

Because one year consists of twelve months, it is reasonable to adopt twelve as one of the radixes. Though this ratio contains the extra factor 3 six times,[11] by multiplying by factor $2^6(= 8 \times 8)$ twice, we can cancel factor 3 and obtain powers of twelve$(= 3 \times 2 \times 2)$:

DOZENAL

$$\frac{2^6\text{year}}{2^{-6}\text{half day}} = 2^6 \times 1;003628 \times \frac{3^6}{2} \times 2^7 = 1;003628 \times 10;^6$$

DECIMAL (3)

$$\frac{2^6\text{year}}{2^{-6}\text{half day}} = 2^6 \times 1.002036..\times \frac{3^6}{2} \times 2^7 = 1.002036..\times 12.^6$$

This ratio can be expressed by the following symmetric equation as the second structural anchor:

$$\mathbf{1\ year/half\text{-}day} \approx \mathbf{3^{+6} + 3^{+1}2^{-1} - 2^{-6}} \qquad \textbf{(Eq.α)}$$

This approximation is not merely numerological. It reflects a deep symmetry in the Earth–Sun system and preserves the familiar rhythm of human timekeeping. The resulting origin aligns naturally with the day–year structure without introducing discontinuities in everyday temporal

[10] If these integers are all set to 0, various constants are approximately expressed as follows: https://en.wikipedia.org/wiki/Talk:Planck_units/Archive_3#Other_possible_normalizations .

[11] Yang Xiong (45;(53.) BCE–16;(18.)) used the ratio $3^6/2$ in his Tai Xuan calendar (太玄暦).

See Hideki Kawahara "Chinese Scientific Thought (中国の科学思想)" 11X4;(1996.) [ ISBN: 978-4423194126] and Wikipedia http://en.wikipedia.org/wiki/Yang_Xiong_(author).

intuition. If we define ‘hexon’(=octal century, symbol : ⌬) as $2^6$ years, and define ‘nodus’ (symbol: ☆) as $2^{-6}$ of a half day[12], the relation between these two units is:

$$\text{hexon} = 1;003628 \times 10;^{6} \text{ nodus} \qquad (4)$$

There are some interesting coincidences. Also, please see Table 1.

- One nodus is the difference between a tropical year and a Julian year.
- One nodus is the greatest common divisor (GCD) of the length of a day and a tropical year.
- Two hexons are the least common multiple (LCM) of the length of a day and a tropical year, and so leap year rules become simpler than those of the Gregorian calendar.
- The geometric mean of one hexon and one nodus is approximately one fortnight.

**Table 1 Coincidences of rotation and revolution of Earth and other planets**

| Quantity A | Quantity B | Type | Common Quantity |
|---|---|---|---|
| day | Julian year | GCD | 1/4 day |
| | | LCM | 4 years |
| | tropical year | GCD | 1/X8;($2^{-7}$) day |
| | | LCM | X8;( $2^7$) years |
| year | rotation of Venus | LCM | 2 years and -3 rotations |
| | revolution of Venus | | 8 years and 11;(13.) revolutions |
| | revolution of Mars | | 28;( $2^5$) years and 15;(17.) revolutions |

It seems that the combination of the rotation and revolution of the Earth “forces” us to use base two in the middle of the calendar time range. People have a proclivity for using large units for large quantities and using small units for small quantities, so we can cover a wide calendar time range by a duodecimal number system using the following hierarchy shown in Figure 1 (a).

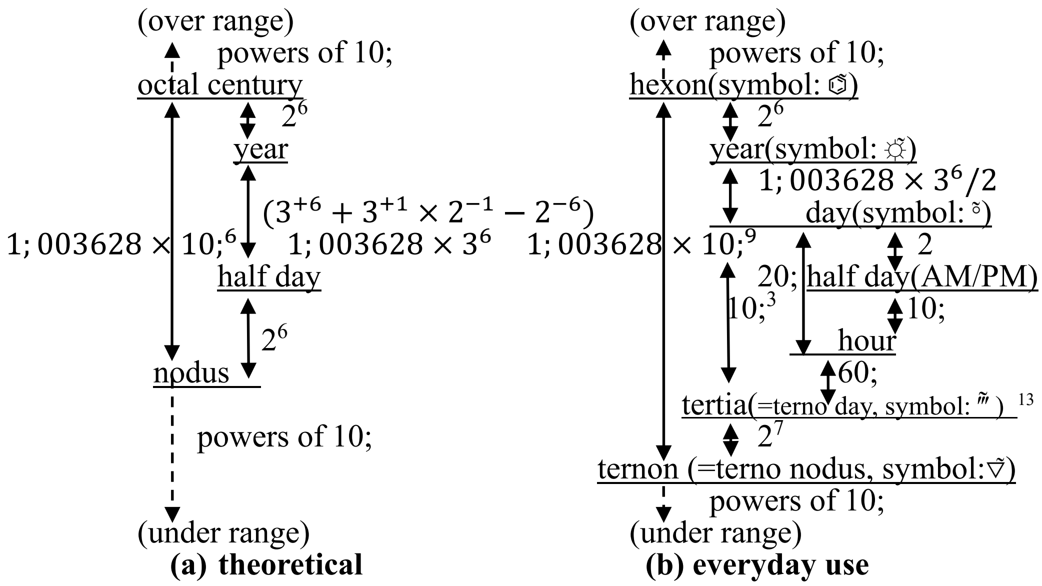



**Figure 1 The GCD Unit hierarchy**

[12] The Latin word ‘nodus’ signifies a knot or node, a point where multiple lines or elements intersect. See the Natural Time Scale Chart in Appendix E. The neologisms ‘hexon’ (nearly$10;^{+6}$ nodus) and ‘ternon’ ($10;^{-3}$ nodus) were coined by abbreviating hexa[6]on[+]nodus→hex(a)on n(odus)→hexonn →hexon, and ter[3]no[-]nodus→terno n(odus)→ternon, respectively. See Appendix A.2 and blog post Ref. 22.

[13] A terno day(‘tertia’) is equal to H. C. Churchman's ‘moment’. Please see http://www.dozenal.org/archive/DuodecimalBulletinIssue112-web.pdf .

We define ‘the GCD Unit’ as “the GCD of the length of a day and a tropical year, or its multiples of integer powers of twelve”, and ‘the GCD Unit System’ as “the 2:10;(2:12.) mixed-radix calendar time system using a day, a tropical year, and the GCD Unit”. **It is very natural to adopt a unit of calendar time that is an integer division of both a year and a day.**

## 2.2. Everyday use

Calendar time units are the most conservative units. Considering the easiness of the shift from the present 10;:50;(12.:60.) mixed-radix system to the future 2:10;(2:12.) mixed-radix system, there are some variations of connection points of the binary number system and duodecimal number system[14]. A variation designed for everyday use is shown in Figure 1 (b) and Table 8.

$$1 \text{ day} = 10;^3 \text{ tertias} = 10;^3 \times 2^7 \text{ ternons} \qquad (5)$$

This is a variation that is designed to maximize the range expressed by multiples of integer powers of twelve of a day. This permits ‘half day(AM/PM)’ and ‘hour’ to be used for clock notations. That is, the following four clock notations are all available. The notation ‘hour’ may fade out.

**Table 2 Clock Notations**

| clock notation | format | 2:10;(2:12.) system | 10;:50;(12.:60.) system |
|---|---|---|---|
| 10;-hour notation | H:TT$\tilde{'''}$NN$^{\triangledown}$nn…(AM/PM) | 3:16$\tilde{'''}$ 28$^{\triangledown}$0 PM | 3:15:12.5 PM |
| 20;-hour notation | HH:TT$\tilde{'''}$ NN$^{\triangledown}$nn… | 13:16$\tilde{'''}$28$^{\triangledown}$0 | 15:15:12.5 |
| 1000;-tertia notation | UTT$\tilde{'''}$ NN$^{\triangledown}$nn… | 776$\tilde{'''}$28$^{\triangledown}$0 | Not used |
| 10;-unitia notation | TT(to[-]/past[+])U | 46; tertias to the 8$^{th}$ unitia | 15 minutes past 3 PM |

Following the Titius-Bode law, the orbital semi-major axis of planets can be approximated by $(3 \times 2^N + 4)$ light solar tertias (see also Table 8), where $N$ = -∞,0,1,2,4,5,6 (Mercury, .., and Uranus). Ratio $2^7$:1 is the same as the ratio of the U.S. liquid gallon and fl oz.

# 3. The Harmonic System

## 3.1. Emergence of the Harmonic System [15]

The GCD Unit is derived from the combination of the rotation and revolution of the Earth without using the Universal Unit System concept[16]. However, we encounter the final surprising coincidences. 1; ternon is equal to a day/($10;^3 \times 2^7$). It is equivalent to 1;0016EE1 $_{u}$s (0.3906250 s). Therefore the equivalent value of 1; ternon falls within the range between 1; $_{u}$s (0.3902675 s) and 1;005E857 $_{u}$s (0.3916171 s). This value also almost agrees with the time constant of the Gravitic System 1;0018 $_{u}$s (0.3906 s). We can construct the Universal Unit System with the GCD Unit! [17] The Dozenal Society of America seems to recommend ‘dour’(day/10;) and ‘moment’(day/$10;^3$). Of course, these units are all available, but because the calendar time unit system includes ‘year’ by all means, it does not become a pure duodecimal system even if we choose 1/$10;^2$ of ‘moment’ as a unit. **We can enjoy all the advantages of Table 5 if we choose not 1/$10;^2$ but 1/$2^7$.**

---

[14] See detailed discussion in https://www.tapatalk.com/groups/dozensonline/the-universal-unit-system-f34/.

[15] In this document, the terms emerge and emergence are used solely to denote mathematical consequences of the defining axioms and equations. They are not intended in the philosophical sense of emergence, irreducibility, or ontological novelty. Accordingly, this work makes no claim about intentional design, teleology, or any hidden organizing principle of the universe. The structure is fully reducible to its defining equations; emerge simply means that certain relationships appear when those equations are worked out. What is noteworthy is that these mathematical consequences happen to align well with practical and cognitive scales familiar to humans. This work describes that correspondence, but deliberately takes no position on why such an alignment exists.

[16] Hexon and nodus arise naturally as the least common multiple and greatest common divisor of the lengths of a half-day and a tropical year.

[17] See the sheet ‘Clock’ in http://dozenal.com/doc/condensed.xlsx.

Because of tidal friction, the physical time length of a day is not constant and becomes longer little by little.[18] A length unit can be redefined exactly as 100,1700;/$R_\infty$ so that a physical time unit becomes exactly 1;001700 $_u$s (0.3906251 s) and approximately 1;0016EE1 $_u$s (0.3906250 s) similar to the redefinition of SI units to provide better stability and reproducibility. The calendar time unit length will strictly correspond to the physical time length of a day about 20; hexons (1400. years) later. We call this redefined system 'the Harmonic Universal Unit System with the GCD Unit', or simply 'the Harmonic System' and will use the prefix '±' for units of this system[19]. The adjective "Harmonic" comes from the major second of the just intonation, which corresponds to the "Harmonic" ratio $2^7$:10;$^2$ ($2^3$:$3^2$)[20], see also §3.3 Concluding Remarks. The length unit is $_\pm$h and is called 'harmonic universal meter', 'harmonic meter', or simply 'harmon'. We specifically granted dedicated names for the Harmonic System's length, time, mass and impedance unit. Please see footnote 44 on 'harmon'($_\pm$h), 'nic' ($_\pm$n), 'looloh' ($_\pm$l) and 'nohm'($_♮\Omega$).

We notice that the Harmonic System is also a unit system that redefines the Gravitic System which is not practical because G's measurement accuracy is insufficient. In other words, the Harmonic System can also be said to have given a strict and practical definition to the conceptual Gravitic System. As shown in the Venn diagram on p.21 of §E, the Gravitic System forms a conceptual superset of the Harmonic System (Gravitic ⊃ Harmonic)[29]. The document doc/README.md is written with this inclusion relationship as its premise, and therefore presents the technical specification of the Harmonic System independently of the philosophical background added in the expanded sections of the present revised edition.

The units of this system are listed in the 7th column of Table 4 and physical, material, and astronomical constants expressed using this system are presented in the 4th column of Table 5. Please see also Table 7 and Table 7 for details. The approximations shown in Table 5 are remarkable. For putting coincidences described in this paper to use, the duodecimal number system is indispensable. **We hope that the Harmonic System is acceptable for humans on Earth.**

Although the structure of the Harmonic System follows almost entirely from the initial choices, one element—the Earth-local temperature scale $T_E$—remains the only deliberately chosen component. It completes the quartet structure without altering the universal derivation.

## 3.2. Clarifications and Common Misunderstandings

The Harmonic System and the Universal Unit System (UUS) are sometimes described—incorrectly—as "based on CODATA". This misunderstanding arises because many physical constants, when expressed in UUS, appear numerically close to simple dozenal powers. However, this numerical proximity is a consequence of the internal structure of UUS, not its dependence on CODATA.

**UUS does not rely on CODATA values.** Its definitions are structural and proportional, derived from universal constants and dimensional relations. If CODATA updates its recommended values, the definitions of UUS remain unchanged. Only the *conversion factors from UUS to SI* shift accordingly, because SI is defined by fixing numerical values of CODATA constants such as $c_0$, $h$, $k_B$, and $N_A$.

---

[18] See Stephenson, F. R.; Morrison, L. V. (April 11X3;(1995.)) "Long-term fluctuations in the Earth's rotation: 700 BC to AD 1990." retrievable at http://adsabs.harvard.edu/abs/1995RSPTA.351..165S .

[19] In principle, the prefix '±' is pronounced as 'harmonic.' However, if the unit is the same amount in both the Universal and Harmonic systems, it is pronounced as 'universal.' For example, '$_\pm$A' is 'harmonic Ampere,' but '$_\pm$C' is 'universal Coulomb.' Also, if the context tells you it is a Harmonic System unit, you do not need to pronounce '±.' For example, in the voltage unit '$_♮\Omega_\pm$A,' when you read '$_♮\Omega$' as 'nohm,' you know that the next unit is not an SI but a Harmonic System unit so that you can pronounce it as 'nohm Ampere' instead of 'nohm harmonic Ampere.'

[20] The trivial case $\omega_0$ = 1 (a perfect unison) is the starting point of the harmonic-ratio series. This ratio–the Harmonic Ratio(9:8, $\omega_1$=9/8)–is also the ratio between one harmonic meter and the imperial unit of length, foot. This offset simultaneously links physical scaling, musical harmony, and nomenclature, reducing cognitive load. For the Fine Harmonic Ratio (41.:40. , $\omega_2$=41./40.), see Note 50.

Thus:

- **UUS is CODATA-independent.**
- **SI is CODATA-dependent.**
- **UUS → SI conversion coefficients reflect SI's revisions, not changes in UUS.**

This distinction is essential for understanding the philosophical independence of UUS. The Harmonic System is not tuned to match CODATA; rather, CODATA's values happen to lie near the natural dozenal structure revealed by UUS. [24]

A further source of misunderstanding concerns the perceived "lack of coverage" in UUS. This impression arises from the naming style of some historical systems, in which conceptual quantity names are reused as unit names, creating an illusion of completeness.[27] UUS deliberately avoids this practice: its vocabulary is intentionally minimal, with coverage provided structurally rather than lexically. In practice, the online converter supplies a far broader and more up-to-date catalog of definitions and relations than any paper-based system could maintain, eliminating the need for an inflated unit vocabulary.

Most dozenal proposals begin by adopting base-12 and then designing units around it. In contrast, the Harmonic System arrives at the duodecimal structure as a consequence of its internal relations. Figure 2 summarizes the eight quartets that define the layered structure of the Harmonic System and its surrounding domains, including universal constants, Earth-local quantities, physical interactions, and socially motivated aliases.

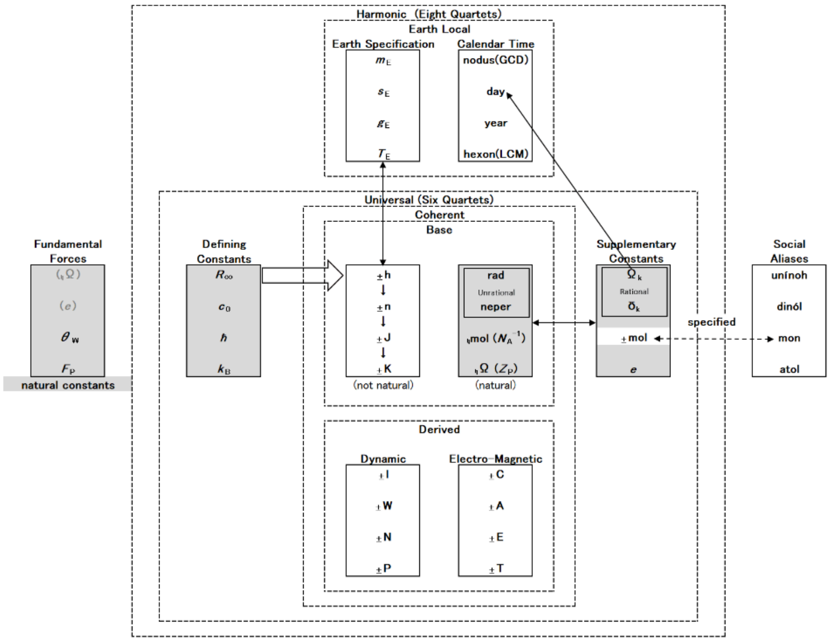



**Figure 2 Eight quartets that define the layered structure of the Harmonic System**

(A high-resolution version is available at GitHub: Eight_Quartets.pdf)

In reality, however, the quartets are arranged three-dimensionally in space. Below is a verbal description of the three-dimensional image:[28]

Viewed in three dimensions, the diagram consists of three parallel planes stacked like layers:
- Upper layer: Earth Local and Social Aliases (3 quartets)
- Middle layer: Universal core (4 quartets)
- Lower layer: Universal Derived (2 quartets)

The Fundamental Forces do not exist independently on the left side of the diagram. Instead, they form a 2×2 "force plate" represented by [[♮Ω, $e$], [$F_P$, $\theta_W$]], whose upper edge, [♮Ω, $e$], is shared with the middle layer. Because of this, the force plate penetrates the middle layer at an angle. In other words, [♮Ω, $e$] lies inside the rectangular solid of the Harmonic System, while $F_P$ lies on the surface[42], $\theta_W$ lies outside it. Social Aliases are likewise positioned outside the rectangular solid. Thus, the rectangular solid of the Harmonic System includes 8 quartets (32 elements).

## 3.3. Concluding Remarks

In summary, the structure of the Harmonic System is not the result of external tuning or empirical adjustment. Once the origin (Eq.α)[21,22] and the numerical base (Eq.Ω)[23] are selected, the scale of units[24], their naming[25,22,26,27], and the overall structure[28,29] follow naturally from within the system. The cognitive and practical affinity[30,20] observed in the resulting system is therefore not a design goal, but a consequence.

# A. Notation

This appendix explains the notation policy of the Universal Unit System (UUS), with particular emphasis on the controlled use of aliases. The underlying broader Design Principles are formulated with sufficient strength to yield essentially unique implementations, as evident in A.2 (e.g., the octal step avoiding lexical collisions).

## A.1. Aliases, and the Principle of Specification

UUS is designed as a coherent, closed system of definitions. At the same time, it must coexist with legacy notation, social conventions, and historically accumulated vocabularies. Aliases are therefore not accidental conveniences, but deliberate interface elements between UUS and its surrounding cultural, linguistic, and technical environments. This appendix clarifies: why aliases are permitted, where they are explicitly limited, and how they differ from core UUS definitions.

**(1) Canonical Symbols and Unicode Policy**

Whenever a symbol has an unambiguous and semantically appropriate Unicode character, that character is treated as the canonical notation. Well-known examples include:

・↊(x218A) and ↋(x218B) as the canonical digits for decimal ten and eleven in dozenal notation[31], with X and E retained strictly as aliases. No new artificial words are introduced to replace the ordinary words "ten" and "eleven"; the canonical distinction is made at the symbolic level, while the spoken forms remain continuous with ordinary English.

・∴(x2234) as the canonical symbol for the octal fractional separator(with @ retained as a historical and practical alias).

・♭,♮,♯(x266D-F) and ±(x00B1) used consistently as semantic modifiers rather than decorative marks. [25]

The existence of aliases for core UUS symbols does not weaken the canonical symbol. Rather, it acknowledges historical inertia, input-method constraints, and the reality of legacy documents. Aliases are therefore documented, not encouraged. Calendar time symbols are excluded from this policy: they are numerous and always have pronounceable lexical forms, so ASCII aliases are neither necessary nor intended. When disambiguation from existing symbols is required, a diacritical mark is added: the tilde ( ̃, x0303) or a superscript form of the symbol itself.

---

[21] A Beautiful Symmetrical Relationship (https://suchowan.seesaa.net/article/201202article_01.html)

[22] Renaming "clock" to "nodus" (https://suchowan.seesaa.net/article/202501article_17_3.html)

[23] Why TGM is not based on fundamental constants (https://suchowan.seesaa.net/article/201410article_11_1.html#:~:text=the%20unit%20of,%29)

[24] Human-scale constraints and unit determination (https://suchowan.seesaa.net/article/201410article_11_1.html)

[25] The Day Musical Symbols Fell Naturally into Place (https://suchowan.seesaa.net/article/202601article_10_1.html)

[26] Some Details on the Rational Unit Ʊ₁ (https://suchowan.seesaa.net/article/202601article_19_1.html)

[27] A naming method that uses the concept name (https://suchowan.seesaa.net/article/202005article_5_1.html)

[28] Three-Dimensional Arrangement of the Quartets (https://suchowan.seesaa.net/article/202601article_23_1.html)

[29] The Overlap That Creates the Harmonic System (https://suchowan.seesaa.net/article/202602article_6_1.html)

[30] What is The Harmonic System? - ChatGPT (https://suchowan.seesaa.net/article/202501article_17_1.html)

[31] ↊ and ↋ visually encode the decomposition 12 = 8 + 4 and reflect the $2^3$+{2,3} structure underlying the Harmonic System.

**(2) Aliases Are Not New Units**

This appendix—and the corresponding category in units.pdf—does not introduce new units as UUS members. Instead, it documents aliases of existing UUS units, socially entrenched names for specified quantities, and context-dependent shorthand forms. The distinction is essential:

・UUS units are defined by physical constants and formal relations.

・Aliases are linguistic or cultural handles applied to those definitions.

This distinction prevents uncontrolled growth of the system while allowing it to remain usable.

**(3) Aliases and Controlled Vocabulary Growth**

One motivation for explicitly listing aliases is to prevent uncontrolled proliferation. In several historical dozenal and alternative-unit communities, informal or "colloquial" names multiplied without clear constraints, making systems appear opaque to outsiders. For the absence of aliases for area and volume units, see the remarks on harmon in units.pdf.

UUS therefore adopts a psychological and structural boundary: a small, clearly delimited set of socially motivated aliases is acknowledged, further invention is neither prohibited nor endorsed, but remains outside the documented system. The last category in units.pdf is organized based on this principle.

**(4) "Specified" Quantities (mol as Prototype, mon as a Deliberate Non-UUS Unit)**

The concept of specification plays a central role. In the SI definition of the mole, the phrase"elementary entities (must) be specified" makes it clear that a mole is not merely a number, but a number applied to a named entity.

This allows rigorous reinterpretation: A counter word such as the Japanese hon (本) in "one pencil"can be understood as an alias of a specified mole: ♮mol_pencil.

Although this interpretation is rarely stated explicitly, it is fully consistent with the SI definition itself. Thus, everyday counting words can be seen as social aliases of specified amounts, not as conceptually separate objects.

The monetary unit mon is intentionally introduced outside the UUS as an example of "Specified" Quantity. It is a genuine addition, not merely a renaming. However, it is excluded from the UUS core by design. Its purpose is didactic: to illuminate the structure of mol by analogy, to demonstrate how "specified quantity" works in a familiar domain, and to clarify why exactness matters in some social contexts.

For example: $\text{mon}\_{\text{US}}$ is socially aliased to US cent[32]. In this sense, mon functions as a conceptual mirror of mol, not as an expansion of the UUS itself.

**(5) Rational Units for Logarithmic and Geometric Quantities (Ʊ, f, and Ω)**

For logarithmic measures of integer magnitude: Ʊ is adopted as the canonical symbol, reflecting the deep relation between logarithms and complex-plane structure[33], f (from figure) is retained as an alias, reflecting its established meaning as "number of digits". For the background and rationale behind these naming choices.[26]

Because practical usage always includes a suffix (e.g. $Ʊ_1$ = bit, Ʊz = dozenal digit), there is no risk of confusion with electrical conductance. This mirrors earlier decisions where: canonical notation was strengthened, while aliases were preserved for continuity.

In natural language, the words cycle and turn are often used interchangeably. In UUS, however, they are assigned distinct structural roles: cycle($\Omega_1$) as one-dimensional rotation (plane angle), turn($\Omega_2$) as two-dimensional rotation (solid angle). These assignments are conventional but

[32] Not to the dollar, because the cent is not a finite base-12 fraction and would introduce intolerable conversion ambiguity.

[33] See univunit-e.pdf §A.2.

structurally motivated. See also Ref.33§E.4 Fig. 2.

The symbol **Ω** is the final letter of the Greek alphabet and visually resembles an arch. Within the Harmonic System, this symbolism is intentional:

- The pair $\langle {}_{\natural}\Omega, \Omega_2 \rangle$ forms a dual structure in electromagnetic quantities.
- The constant $\Omega_0$ appears in the Constants Approximation (Eq.Ω) and serves as the *fermi component* of the representational lattice.

Together, these roles make Ω the **keystone** placed at the apex of the arch— the final element that completes the structural symmetry of the system.

The symbol **℧** (the inverted Ω) is paired with Ω in the logarithmic domain. However, it is essential **not** to interpret ℧ as a “container” or “vessel” merely because its numerical values sometimes resemble digital storage units like an example in **Table 7** , but this does **not** imply that ℧ measures storage capacity exclusively. The relationship between ℧ and byte is analogous to that between **gram and carat**— distinct units measuring the same logarithmic quantity— not like **USB port and USB memory**, where one is a container for the other.

**(6) Effective Units and Human Sensitivity (overline)**

Certain perceptual quantities—such as luminous flux, perceived sound pressure, or equivalent dose—are expressed in an effective form, indicated by a diacritical mark: the overline ( ̅ , x0305)[34]. In this framework, the SI lumen corresponds to an effective watt weighted by the dimensionless human visual sensitivity function, rather than to a distinct base or derived unit. Numerically, 1 $\overline{\mathrm{W}}$ ≈ 115.667 lm.

**(7) Multiplicative and Fractional Prefixes; Square and Cubic Prefixes**

The Harmonic System adopts a coherent and minimal set of prefixes for expressing multiplicative and fractional quantities. These prefixes follow the dozenal hierarchy generated by powers of 12.

Each prefix corresponds to a fixed exponent and applies uniformly across all dimensional quantities, and the system does not permit the omission of the unit symbol in formal usage. While natural language usage may occasionally employ prefixes in isolation, such expressions fall outside the formal specification, and their interpretation is left to the responsibility of the user.

Square and cubic prefixes are defined analogously, but their usage is restricted to contexts where dimensional clarity is essential. To avoid redundancy, detailed remarks on their application—especially in relation to the harmon—are provided in units.pdf, and are not repeated here.

**(8) Aliases as Interfaces, Not Weaknesses**

Aliases should be understood as interfaces, not compromises. They allow: legacy users to recognize familiar forms, newcomers to transition gradually, and formal definitions to remain uncompromised. UUS therefore treats aliasing as a design layer, distinct from the definition layer. Several social aliases, introduced independently, necessarily derive their final letter from the corresponding base unit names (-h from harmon, -l from looloh, -n from nodus) — a convergence reflecting the system’s structural constraints.

**(9) Summary**

This appendix clarified how UUS distinguishes
– canonical units,
– aliases,
– specified quantities,
– and perceptual extensions,
without expanding the UUS core. This separation ensures that the conceptual core of the system remains minimal and universal, while practical or perceptual variations can be introduced without altering the underlying structure.

---

[34] See examples in **Table 7** and Appendix E.

## A.2. Number Counting

### (1) Design Principles

The number-counting system of UUS is designed to balance three requirements:

・Compatibility with existing linguistic intuition
・Predictability and transparency for new learners
・Avoidance of uncontrolled vocabulary growth

The duodecimal myriad system introduced in this Appendix follows these principles. It reuses familiar morphemes such as -llion where possible, while drawing from classical Greek and Latin roots not adopted in English, thereby avoiding collisions with existing words. The paired endings -on (positive powers) and -no (negative powers) form a visually and semantically coherent duality, analogous to established pairs such as neutron and neutrino.

A deliberate design choice is that no artificial words are introduced for single-digit powers. This ensures that even first-time readers can infer meaning from context. Conversely, forms such as uni-on and uni-no are avoided because their values differ by only two dozenal orders, making them likely to appear in the same context and therefore prone to confusion. Therefore, there is no need to deliberately design the unit system to be small. Similarly, prefixes such as di- and ter- share etymological roots and are unsuitable for high-frequency usage where clear visual distinction is required.

The system adopts an octal step rather than a dozenal step for large-scale grouping. Although this may appear unfamiliar to strict dozenal purists, a dozenal step would inevitably produce forms such as octallion or octollion, which lie uncomfortably close to existing English words and are therefore unsuitable. The octal step avoids these lexical collisions while preserving regularity, readability, and long-term stability of the nomenclature.

In summary, the number-counting system is designed not merely as a naming scheme but as a controlled, psychologically stable vocabulary. It minimizes ambiguity, prevents proliferation of near-synonyms, and maintains coherence with the broader philosophy of UUS.

### (2) Specification

Many of the constants introduced in footnote 10 often have orders $8n - 1$.[10] Therefore, it is convenient to use the factor U(=10;$^8$(12.$^8$)) to make the units of the Universal Unit System into human scale. The factor U can be regarded as a conversion factor between atomic scale, human scale, and cosmic scale. Since power 8(=$2^3$) is a power of 2, the decimal myriad system[35] has affinity for our system. So, we propose a duodecimal myriad system in Table 3 [36] replacing ten/hundred with dozen/gross. Larger numbers consist of uni(1),di(2),ter(3),tetra(4),penta(5),hexa(6),hepta(7), lli(0) [37],on(+), and reciprocals are expressed by replacing on(+,positive power) with no(-,negative power)[12]. The choice of 'ter' is not an arbitrary preference among classical roots. It follows from the prior adoption of the existing word 'tertia' as the transparent name for the third dozenal subdivision of the day. This mirrors the pattern of SI 'second', which derives from the second (secunda) sexagesimal division of the hour—'minute' being the first (minuta prima).

---

[35] http://en.wikipedia.org/wiki/-yllion .

[36] "∴"is the octal fractional separator.

[37] The choice lli- = 0 in the duodecimal myriad system was inspired by the SDN concept of "nil," and is retained as a historical design note.

**Table 3 Duodecimal myriad system**

| decimal | dozenal | | read as 'one-' | origin of prefix part | decimal | dozenal | | read as 'one-' | origin of prefix part |
|---|---|---|---|---|---|---|---|---|---|
| $12.^{1.}$ | 10; | | dozen | Old Norse | $12.^{-1.}$ | $U^{-\therefore 1}$ | 1;′ | unino | Latin |
| $12.^{2.}$ | 100; | | gross | Old French | $12.^{-2.}$ | $U^{-\therefore 2}$ | 1;″ | dino | Greek |
| $12.^{3.}$ | 1000; | | doz gross | | $12.^{-3.}$ | $U^{-\therefore 3}$ | 1;‴ | terno | Latin |
| $12.^{4.}$ | 1,0000; | 1,; | myriad | Greek | $12.^{-4.}$ | $U^{-\therefore 4}$ | 1;, | tetrano | Greek |
| $12.^{5.}$ | 10,0000; | 10,; | dozen myriad | | $12.^{-5.}$ | $U^{-\therefore 5}$ | 1;,′ | pentano | Greek |
| $12.^{6.}$ | 100,0000; | 100,; | gross myriad | | $12.^{-6.}$ | $U^{-\therefore 6}$ | 1;,″ | hexano | Greek |
| $12.^{7.}$ | 1000,0000; | 1000,; | doz gross myriad | | $12.^{-7.}$ | $U^{-\therefore 7}$ | 1;,‴ | heptano | Greek |
| $12.^{8.}$ | U | 1_; | unillion | | $12.^{-8.}$ | $U^{-1}$ | 1;_ | unillino | |
| $12.^{16.}$ | $U^2$ | 1‗; or 1__; | dillion | | $12.^{-16.}$ | $U^{-2}$ | 1; ‗or 1;__ | dillino | |
| $12.^{24.}$ | $U^3$ | | terllion | | $12.^{-24.}$ | $U^{-3}$ | | terllino | |
| $12.^{32.}$ | $U^4$ | | tetrallion | | $12.^{-32.}$ | $U^{-4}$ | | tetrallino | |
| $12^{.40.}$ | $U^5$ | | pentallion | | $12^{.-40.}$ | $U^{-5}$ | | pentallino | |
| $12.^{48.}$ | $U^6$ | | hexallion | | $12.^{-48.}$ | $U^{-6}$ | | hexallino | |
| $12.^{56.}$ | $U^7$ | | heptallion | | $12.^{-56.}$ | $U^{-7}$ | | heptallino | |
| $12.^{64.}$ | $U^{10\therefore}$ | | unillillion | | $12.^{-64.}$ | $U^{-10\therefore}$ | | unillillino | |
| $12.^{72.}$ | $U^{11\therefore}$ | | uniunillion | | $12.^{-72.}$ | $U^{-11\therefore}$ | | uniunillino | |
| $12.^{128.}$ | $U^{20\therefore}$ | | dillillion | | $12.^{-128.}$ | $U^{-20\therefore}$ | | dillillino | |
| … | … | | … | | … | … | | … | |

For example, 1_2345,6789; is read as 'one unillion two doz three gross four dozen five myriad six doz seven gross eight dozen nine'. The first 'one' should not be omitted. The term 'dozen' is abbreviated as 'doz' when it appears in the $10;^{4n-1}$ position. In ordinary reading, 'and' may be inserted before the final residual quantity (e.g., 'eight dozen and nine'). It is omitted in the example above to make the structural pattern more explicit. The expression 'Unillion to the power of *octal number*' is also used as exponential expression[38]. For example, $1;2\times U^{3\therefore 4}$ is read as 'one point two times unillion to the power of three point four'. '∴4' can also be written 'H', in which case 'H' is read as 'and half'. The characters "′ ", "″ ", "‴ " , ", " and (diacritical mark)"_" following a fractional separator or digit group separator[1] shift them by 1, 2, 3, 4, and 8 places, respectively.[56]

# B. The Earth local extension

The Earth local extension, which consists of four unit series, and three supplementary constants, is designed for local use on Earth. Please see Table 8.

In this scheme, the CGD unit system is treated as part of the Earth local extension. **To distinguish calendar time units from physical time units, we regard the dimension of calendar time units as the plane angle.**[39] Conversion from calendar time to physical time is performed by multiplying by a conversion coefficient of dimension [physical time / plane angle], such as $s_E$

[38] Dr. Isaac Asimov made a similar proposal called 'T-formation'. See http://www.isfdb.org/cgi-bin/title.cgi?62431 and http://www.arvindguptatoys.com/arvindgupta/asimov-on-numbers.pdf .

[39] See Seaman, Rob (April 11XB;(2003.)). "A Proposal to Upgrade UTC" retrievable at https://web.archive.org/web/20150419125423/http://iraf.noao.edu/~seaman/leap/. It seems that the dimension of the quantity of a day (=calendar time) should be a plane angle rather than physical time. The calendar time is, in a word, the rotation angle of the Earth derived by using the direction of the sun as a coordinate origin.

(solar) inTable 1**Table 8**. In general, this coefficient is not constant, as it reflects the physical rotation rate of the Earth, which varies over time due to tidal friction and other geophysical factors.

On any planet X (including Earth), the supplementary constant $g_X$ is used to represent any force quantity as a corresponding mass quantity, such as 1±1 $g_X$ (“one looloh gee of X”). For Earth, this becomes $g_E$ and 1±1 $g_E$ (“one looloh gee”). In the same way, the supplementary constants $s_X$ and $m_X$ are used to represent any physical time and length quantity as corresponding plane angle quantities on planet X.

A new temperature unit, °H (degree H — the abbreviation of “degree of hyper Kelvin from $T_E$”($T_E$°♯K)), is introduced under the “Earth local extension” category to accommodate everyday use within the universal system. We define 0 °H at $T_E$ (=118,2354;±K (approximately -74.36°C, -101.85°F)) , and set 100; °H to match the boiling point of water (99.9839 °C). Consequently, 1 °H interval corresponds exactly to 1 **H**yper Kelvin (=1,0000;±K≑1.210724 K). This arrangement ensures that typical ambient temperatures on Earth remain in a convenient positive range, avoiding negative values for everyday measurements. While some may question the choice of offset and the use of 10;$^2$ as the boiling point reference, this design balances the duodecimal scaling of the universal system with practical concerns for daily life. H is an initial letter for both the Hyper and Human scale.

# C. Gravitational constant and gravity field equations

The equations of some categories[40] can be used efficiently if we introduce new constants. At this time, the total solid angle of a sphere[41], $\Omega_2$, and the speed of light in vacuum, $c_0$, appear in the equations. This is the reason that the speed of light in a vacuum should strictly be multiples of integer powers of the base number of the unit quantities.

**When representing the mass of a celestial body using the Universal Unit System, the gravitational radius (half the Schwarzschild radius) is used rather than using mass directly.** Because the accuracy of measuring the Newtonian constant of gravitation is poor, representing the mass of a celestial body directly in terms of mass results in poor accuracy, but the gravitational radius can be measured to an accuracy of around ten digits.

If we define a new constant that has the dimension ‘force’ as ‘the Planck force’, there is a good chance that the geometrical parts can be separated from the coefficients in the formula[42]. Make the Planck force, $F_P = c_0{}^4 G^{-1} = \hbar c_0 / l_P{}^2 = 35.\hbar c_0 / m_G{}^2$, then:

gravitational radius, $r_m = \frac{Gm}{c_0^2} = \frac{mc_0^2}{F_P}$ (half the Schwarzschild radius) (6)

gravitational force, $f = F_P \frac{r_m r_{m'}}{r^2} = c_0^2 \frac{r_m m'}{r^2}$ (7)

gravitational acceleration, $g = c_0^2 \frac{r_m}{r^2} = \frac{r_m}{(r/c_0)^2}$ (8)

gravity field equation, $\frac{T_{ik}}{F_P} = \frac{1}{2\Omega_2}\left(R_{ik} - \frac{1}{2}Rg_{ik} + \Lambda g_{ik}\right)$ (9)

---

[40] For a case of electromagnetism, see §B of the paper univunit-e.pdf. In the electromagnetic field, the natural unit of impedance, ♮Ω (=$Z_P$: the Planck impedance), plays the role of the Planck force in the gravitational field. ♮Ω, $e$, $\theta_W$, and $F_P$ are constants for the four fundamental forces.

[41] See electromagnetic units in Appendix E and §3.2.2 of the paper univunit-e.pdf, and http://dozenal.com/doc/dozenal_com/electromagnetism.pdf .

[42] Please note that Eq. (8) and (9) are geometrical and have no mass dimension. This is precisely why, in the three-dimensional structure presented in §3.2, $F_P$ is not placed inside the Harmonic System cuboid.

## D. Tables

**Table 4 Units with special names and symbols[43]**

ALL VALUES DECIMAL

| | Unit Category | Dimension | The Universal Unit Systems | | | |
|---|---|---|---|---|---|---|
| | | | with the Rydberg constant(u) | | Harmonic System (±) | |
| Coherent | base units that are not natural units | length | $_{\mathrm{u}}\mathrm{m}$ | 272.102883 mm | $_{\pm}\mathrm{h}$ [44] | 272.352206 mm |
| | | time | $_{\mathrm{u}}\mathrm{s}$ | 390.267520 ms | $_{\pm}\mathrm{n}$ | 390.625115 ms |
| | | energy | $_{\mathrm{u}}\mathrm{J}$ | 64.143275 mJ | $_{\pm}\mathrm{J}$ | 64.084556 mJ |
| | | temperature [45] | $_{\mathrm{u}}\mathrm{K}$ | 58.441041 μK | $_{\pm}\mathrm{K}$ | 58.387542 μK |
| | base units that are natural units | plane angle | rad | (2/π) arc sin(1) | | |
| | | logarithm | neper | log(e) | | |
| | | amount of substance | ♮mol or $N_{\mathrm{A}}^{-1}$ | mol / 6.02214076×10.$^{23.}$ In this context '♮' is equivalent to '3-' and ♮mol is called 'natural mol.' | | |
| | | impedance | ♮Ω or $Z_{\mathrm{P}}$ | 29.979245796 Ω (=1sr/($\varepsilon_0 c_0$) [46]) ♮Ω is called 'natural ohm' or more simply 'nohm.' | | |
| | derived units of electromagnetic quantities | charge | $_{\pm}\mathrm{C}$ | 28.896578 mC (can be called 'universal Coulomb' (or 'Clio' [47])) | | |
| | | electric current | $_{\mathrm{u}}\mathrm{A}$ | 74.043001 mA | $_{\pm}\mathrm{A}$ | 73.975219 mA |
| | | field strength | $_{\mathrm{u}}\mathrm{E}$ [41,47] | 272.113988 mA/m | $_{\pm}\mathrm{E}$ | 271.616007 mA/m |
| | | flux density | $_{\mathrm{u}}\mathrm{T}$ | 390.283447 mC/m$^2$ | $_{\pm}\mathrm{T}$ | 389.569211 mC/m$^2$ |
| | derived units of dynamical quantities | mass | $_{\mathrm{u}}\mathrm{g}$ | 131.950082 g | $_{\pm}\mathrm{l}$ (x006C) | 131.829289 g |
| | | power | $_{\mathrm{u}}\mathrm{W}$ | 164.357196 mW | $_{\pm}\mathrm{W}$ | 164.056415 mW |
| | | force | $_{\mathrm{u}}\mathrm{N}$ | 235.731701 mN | $_{\pm}\mathrm{N}$ | 235.300301 mN |
| | | Pressure | $_{\mathrm{u}}\mathrm{P}$ | 3.183843 Pa | $_{\pm}\mathrm{P}$ | 3.172201 Pa |

---

43 Please see also univunit-e.pdf for details. A web-based unit converter is available at http://hosi.org/cgi-bin/conv.cgi . This converter also teaches us the representation of units that belong to various unit systems.

44 'harmon'($_{\pm}$h), 'nic'($_{\pm}$n), 'looloh'[49]($_{\pm}$l, 'l' can also be a cursive 'ℓ' (x2113), the prefix '±' representing the Harmonic System's identity), and 'nohm'(♮Ω) constitutes a quartet.

45 The unit of thermodynamic temperature has been changed. The new unit is one-1,0000;$^{\mathrm{th}}$ of the old unit in the paper univunit-e.pdf along with the introduction of the Earth local extension.

46 If we adopt the elementary charge as one of the definition constants, $_{\pm}$Ω is used in substitution for ♮Ω.

47 The unit symbol E (Ørsted) is associated with the CGS system. In this paper, we adopt metric unit names based on the scientists' names as is.

However, under the Harmonic System, an alternative proposal suggests replacing these units with the names of Muses bearing the same initials — namely, Newton→**Nete**, **P**ascal→(Polymnia→)**Polym**, **C**oulomb→**Clio**, **A**mpere→**Aoide**, **Ø**rsted→**Erato**, **T**esla→**Thalia**, and **K**elvin→**Kalliope**. Notably, Polym derives from Polymnia, the Muse of sacred song; a lute piece titled Polymnia was composed by Vincenzo Galilei (father of Galileo), symbolically linking musical and scientific traditions of harmonic proportion. This proposal has two advantages: (1) it does not honor any individual, and (2) it allows the omission of redundant 'harmonic' terms[19]. The unit converter for this proposal is available at http://hosi.org/cgi-bin/conv_muse.cgi.

This proposal also renames units for which no corresponding Muse is found, such as Joule→**Juno**, **W**att→(Walküre→)**Walku**, **Boltzmann**→**Bia**, **neper**→(Nephelē→)**nephe**, **dirac**→**diana**, and **Ω**hm→**Ω**(**Omega**). Since no suitable Muse exists for Joule, Watt, or neper, the proposal instead borrows names from Roman, Norse, and Greek mythology. Moreover, because of the electromagnetic symmetry required to pair ♮Ω and $\Omega_2$ (see the 3$^{\mathrm{rd}}$ part of p. 20), 'Ω (Omega)' is adopted without a Muse equivalent.

| | | | | |
|---|---|---|---|---|
| Non-coherent | defining constants | wave number | $R_\infty$ | 10,973,731.568157/m ( is called ‘Rydberg’) |
| | | velocity | $c_0$ or ♮ $\gamma$ | 299,792,458 m/s (defined, and is called ‘light’) |
| | | action | $\hbar$ | 6.62607015×10.$^{-34.}$Js/2π( is called ‘quantum’) |
| | | heat capacity | $k_B$ | 1.380649×10.$^{-23.}$J/K ( is called ‘Boltzmann’) |
| | supplementary constants | the total solid angle of a hypersphere | $\Omega_k$ | $\frac{2\pi^{\frac{k+1}{2}}}{\Gamma(\frac{k+1}{2})}$ rad$^k$ $k$=0,1, 2<br>$\Omega_0$=2<br>$\Omega_1$=2π rad (is called ‘cycle’)<br>$\Omega_2$=4π sr (is called ‘turn’) |
| | | logarithm of an integer | $\bar{\mho}_k$ | log($2^k$) $k$=1(bit), z(figure), 4(nibble), 8(byte), ..<br>z=$\log_2$(12.) |
| | | amount of substance | ±mol | 132.007620 mol (=12.$^{24.}$/ $N_A$)<br>(±mol can be called ‘universal mol’) |
| | | elementary charge | $e$ | 1.6021766340×10.$^{-19.}$C (=$\sqrt{\frac{\alpha h}{\Omega_n}}$)<br>($e$ is called ‘electron’) |

**Table 5 Physical, material and astronomical constants**[48]

ALL VALUES DOZENAL

| Constant Symbols and Name (UNDERLINE INDICATES CONSTANT MAINTAINS SAME VALUE BETWEEN SYSTEMS u AND h) | | Constant Value expressed by the Universal Unit Systems: with the Rydberg constant (u) | Constant Value expressed by the Universal Unit Systems: Harmonic System (±) | Exponent $N$ of× 10;$^N$ | Unit Symbol (u and ± prefixes omitted) |
|---|---|---|---|---|---|
| $R_\infty$ | Rydberg constant | 1 | 1;00170000 | 6; | $\Omega_1$/m |
| $c_0$ | <u>the speed of light in vacuum</u> | 1 | | 8; | m/s |
| $\hbar$ | <u>quantum of action</u> | 1 | | -26; | J s |
| $k_B$ | <u>Boltzmann constant</u> | 1 | | -20; | J/K |
| $N_A$ | <u>Avogadro constant</u> | 1 | | 20; | mol$^{-1}$ |
| $R$ | <u>gas constant</u> | 1 | | 0; | J/(mol K) |
| $u$ | unified atomic mass unit | 1;00090610 | 1;00240733 | -20; | g [49] |
| $a_B$ | Bohr Radius | 1;005E85684 | 1;00447X74 | -9; | m |
| $\alpha$ | <u>fine structure constant</u> | 1;0739940472 | | -2; | - |
| $e$ | <u>elementary charge</u> | 1;0374439E14 [50] | | -14; | C |
| $m_e$ | electron mass | 0;E4692217E0 | 0;E48324X245 | -23; | g |

48 If CODATA (2022) values are required, see http://physics.nist.gov/cuu/Constants/index.html .

49 Because $_u$g is approximately 100;$^{10;}$ $u$, I add dedicated name ‘looloh’(lúːloʊ/əʊ, ±l) to mass unit of the Harmonic System.

50 This value equals 12.√α and matches the ratio 41. : 40. within an error of 0.009 %. The ratio 41. : 40. is termed the Fine Harmonic Ratio, named after the fine-structure constant α.

| | | | | | |
|---|---|---|---|---|---|
| $\sigma$ | Stefan-Boltzmann constant | 1;E82E28 | | -1E; | W/(m$^2$K$^4$) |
| m$_G$ | gravitic meter ($\sqrt{2E;}$ $l_P$) | 1;00186 | 1;00016 | -27; | m |
| $l_P$ | Planck length | 2;0445E | 2;04134 | -28; | m |
| $F_P$ | Planck force ($\hbar c_0/ l_P^2$) | 2;XE206 | 2;XEE32(≑ 2;E)[51] | 35; | N |
| $G$ | Newtonian constant of gravitation ($c_0^4/F_P$) | 4;15768 | 4;14663 | -X; | (m$^4$/s$^4$)/N |
| $\theta_W$ | weak mixing angle | E;304 | | -2; | $\Omega_1$ |
| $V_m$ | molar volume of an ideal gas under standard conditions [52] | 1;02X469 | 1;025665 | 2; | m$^3$/mol |
| | black-body radiation at the ice point | 0;EX2466 | 0;EX8784 | 2; | W/m$^2$ |
| | maximum density of water | 1;088183 | 1;092X47 (≑ 15;/14;) | 2; | g/m$^3$ |
| | density of ice at the ice point | 0;E7E9 | 0;E85E (≑1/$\omega_2$=34;/35;) | 2; | g/m$^3$ |
| | specific heat of water[53] | 0;6052 | 0;6045 (≑ 1/2) | 0; | J/(g K) |
| | surface tension of water at 25°C | 0;EE68 | 0;EEE4 | -1; | N/m |
| atm | standard atmosphere | 1;65008E | 1;659967 (≑ 1;66) | 4; | P |
| $g_n$ | standard gravitational acceleration | 5;5X54XE9 | 5;5E21264 (≑ E;/2) | 0; | m/s$^2$ |
| $r_E$ | gravitational radius of Earth | 2;41E8982X0X | 0;2418030652 (≑ 1/5) | -1; | m |
| au | astronomical unit | 8;X67575535 | 8;X55509X31 | X; | m |
| | astronomical unit | 9;E91731X53 | | -3; | $c_0$ $s_E$ day |

**Table 6 Power prefixes**

| name | symbol | TEX text | value | name | symbol | TEX text | value |
|---|---|---|---|---|---|---|---|
| dirac [54] | ♮♯ | dirac | 10; | | | | |
| **hyper** | ♯ (x266F) | hyper | **10;$^4$** | **sub** | ♭ (x266D) | sub | **10;$^{-4}$** |
| **cosmic** | + | _+ | **10;$^8$(=U)** | **atomic** | - | _- | **U$^{-1}$** |
| di-cosmic | 2+ | _{2+} | U$^2$ | di-atomic | 2- | _{2-} | U$^{-2}$ |
| ter-cosmic | 3+ | _{3+} | U$^3$ | ter-atomic | 3- | _{3-} | U$^{-3}$ |
| tetra-cosmic | 4+ | _{4+} | U$^4$ | tetra-atomic | 4- | _{4-} | U$^{-4}$ |
| penta-cosmic | 5+ | _{5+} | U$^5$ | penta-atomic | 5- | _{5-} | U$^{-5}$ |
| hexa-cosmic | 6+ | _{6+} | U$^6$ | hexa-atomic | 6- | _{6-} | U$^{-6}$ |
| hepta-cosmic | 7+ | _{7+} | U$^7$ | hepta-atomic | 7- | _{7-} | U$^{-7}$ |

51 If this is expressed as 2;E, the error from CODATA (2018) becomes -6;61(-6.51) times standard deviation.

52 At the thermodynamic temperature of the triple point of water (273.16 K), the pressure at which the ideal-gas molar volume becomes exactly 100;$_\pm$h$^3$/$_\pm$mol is 1;6975 ♯P (103061.2 Pa, 47./30. ♯P).

53 This corresponds to the definition of the thermodynamic calorie.

54 'dirac' is only used when expressing the unit of the Gravitic System with the Harmonic System. (i.e., gravitic meter = tetra-atomic dirac harmon, gravitic second = penta-atomic dirac nic, gravitic gram = atomic dirac looloh)

**Table 7 Examples of natural scale quantity representation** [55]

| quantity | symbol | value | refer to |
|---|---|---|---|
| 2E; penta-cosmic Newton | 2E;$_{5+}$N | 2E;×$U^5$ [harmonic] Newton | the Planck force |
| 6;di-cosmic nic | 6; $_{2+}$n | 6;×$U^2$ [harmo]nic[second] | the age of the universe |
| cosmic hyper bit [Boltzmann] | $_{+\#}$Ʊ̄$_1$[$k_B$] | $U^{1\because 4}$log$2^1$ [Boltzmann] | 1.01 Tera Byte(=$2^{43}$·bit) |
| cosmic harmon | $_{+}$h | $U^1$ harmon[ic meter] | the speed of light in vacuum |
| ato[mic ]l[ight] | $_{-}$γ | harmon[ic meter]/ [harmo]nic[second] | $U^{-1}$light(≑2.51 km / hour) |
| atomic unino[ ]h[armon] | 1; ′[0]$_{-}$h [56] | $U^{-1\because 1}$ harmon[ic meter] | the Bohr radius |
| di-atomic Coulomb | $_{2-}$C | $U^{-2}$ [universal] Coulomb | the elementary charge |
| di-atomic effective Watt [57] | $_{2-}$W̄ | $U^{-2}$[harmonic]effective Watt | a photon power (540.THz) |
| ter-atomic looloh | $_{3-}$l | $U^{-3}$ looloh | the unified atomic mass unit |
| 2; tetra-atomic harmon | 2; $_{4-}$h | 2;×$U^{-4}$ harmon[ic meter] | the Planck length |

**Table 8 The Earth local extension for the Harmonic Universal Unit System**

| category | | name / description | symbol | plain text | value |
|---|---|---|---|---|---|
| Non-coherent calendar time | units | year<br>month | ☼̃(x263C)<br>☽̃(x263D) | year<br>month | ☼̃ =365.days 31.nodus (265; °̃ 27; ☆̃)<br>☽̃ =10; $^{-1}$ ☼̃ |
| | | day<br>unino day<br>dino day<br>terno day (tertiary 12 divisions of one day) | °̃(x00B0)<br>′̃(x2032)<br>″̃(x2033)<br>‴̃(x2034) | day<br>unitia<br>ditia<br>tertia | Ω$_1$=1°̃ =10;′̃ =100; ″̃ =1000; ‴̃ [56]<br>'day' corresponds to 86,400. s at the beginning of year 1900.<br>**Each calendar time unit symbol is distinguished from existing systems by adding a tilde** ("~",x0303) or by **superscripting** the symbol itself. |
| | | nodus<br>terno nodus→terno n(odus)→ternon<br>hexaon nodus→hex(a)o(n) n(odus)→hexon | ☆̃(x2606)<br>▽̃(x25BD)<br>⌬̃(x232C) | nodus<br>ternon<br>hexon | °̃ =$2^{+7}$ ☆̃<br>▽̃ =10;$^{-3}$ ☆̃<br>⌬̃ =$2^{+6}$ ☼̃ =1;003628×10;$^{+6}$ ☆̃ |
| Non-coherent unit and constants | | difference between thermodynamic temperature and $\boldsymbol{T}_{\mathbf{E}}$(=118,2354; $_{\pm}$K (-74.36°C,-101.85°F))<br>approximate formula: ℃ $= \frac{1E;}{17;}$°H-62;44 ; °H $= \frac{17;}{1E;}$ ℃ + 51;50 | **°H** | deg[ree] H | 1,0000; $_{\pm}$K(≑1.210724 K ≑ 23./19. K)<br>100; 0000°H is 99.9839 °C<br>78;0000°H is 37.0262°C<br>61;0000°H is 14.0224°C<br>51;5026°H is 0.0000°C<br>99.9839 °C is the boiling point of water at the standard atmosphere. |
| | supple-mentary constants | the gravitational acceleration of the Earth (is called 'gee [of Earth] ') | $\boldsymbol{g}_{\mathbf{E}}$ | g_E or gee | 5;611X615 harmon/nic$^2$<br>$g_E$ is defined as $c_0{}^2 r_E (m_E \text{ rad})^{-2}$ |
| | | the rotation period of the Earth (is called '[Earth] solar')<br>at the beginning of year 1900. | $\boldsymbol{s}_{\mathbf{E}}$ | s_E or solar | 0;EEEEEE15336X nic/ ternon<br>(=86400 s /Ω$_1$)<br>(This should be 'coordinated'.[39]) |
| | | the meridian length of the Earth (is called '[Earth] meridian') | $\boldsymbol{m}_{\mathbf{E}}$ | m_E or meridian | 4124,216E; harmon/Ω$_1$<br>(≑ (ω$_2$ / 3) cosmic harmon/Ω$_1$) |

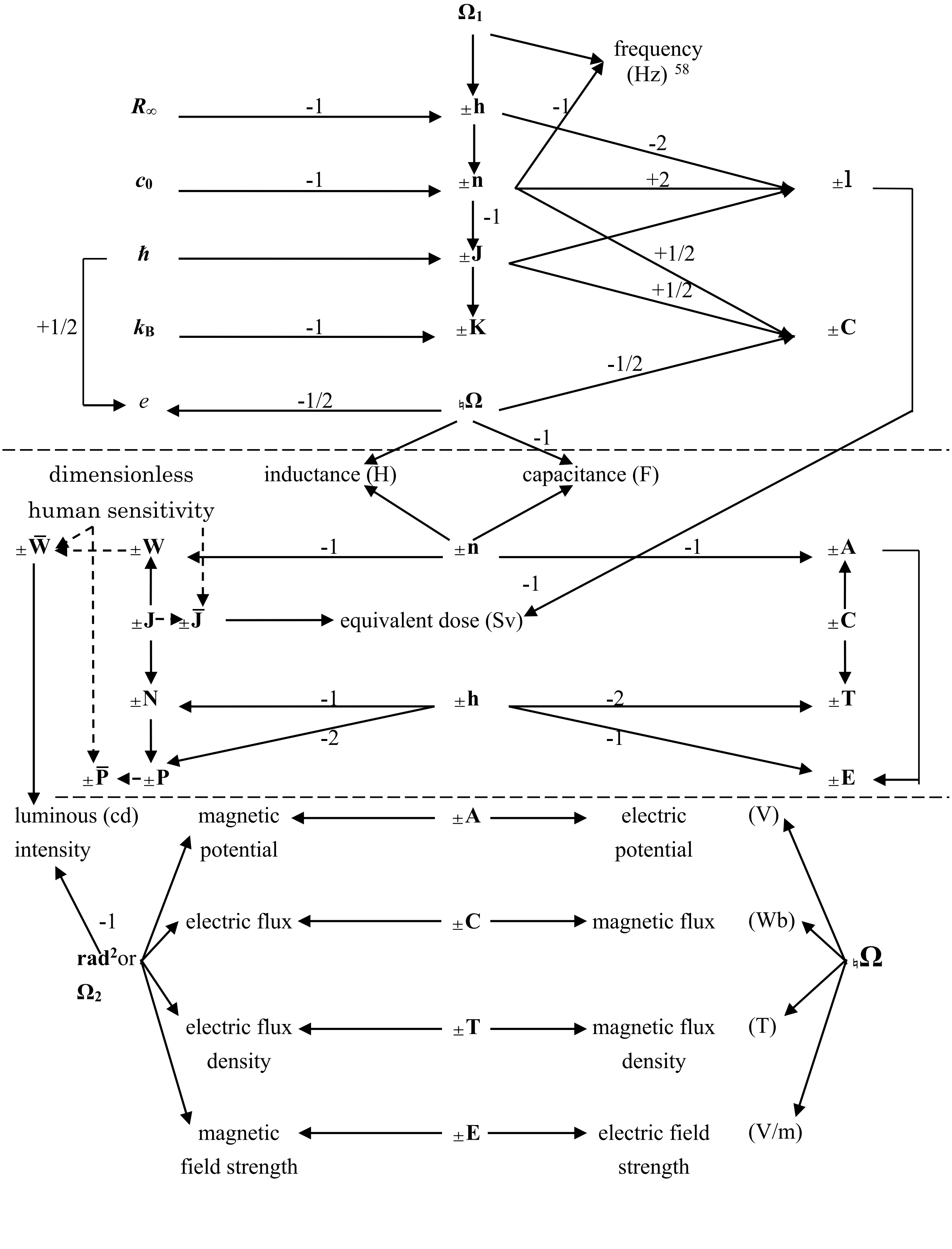
[55] The part enclosed with'[]' can be omitted in Table 7 and Table 8.

[56] This is the notation explained at the end of Appendix C.

[57] Units for quantity weighted by dimensionless human sensitivity are indicated by 'effective' and symbolled by overline.

W̄ corresponds to 1;di-cosmic photon energy(540.THz) / nic and 115.667212 lumen.

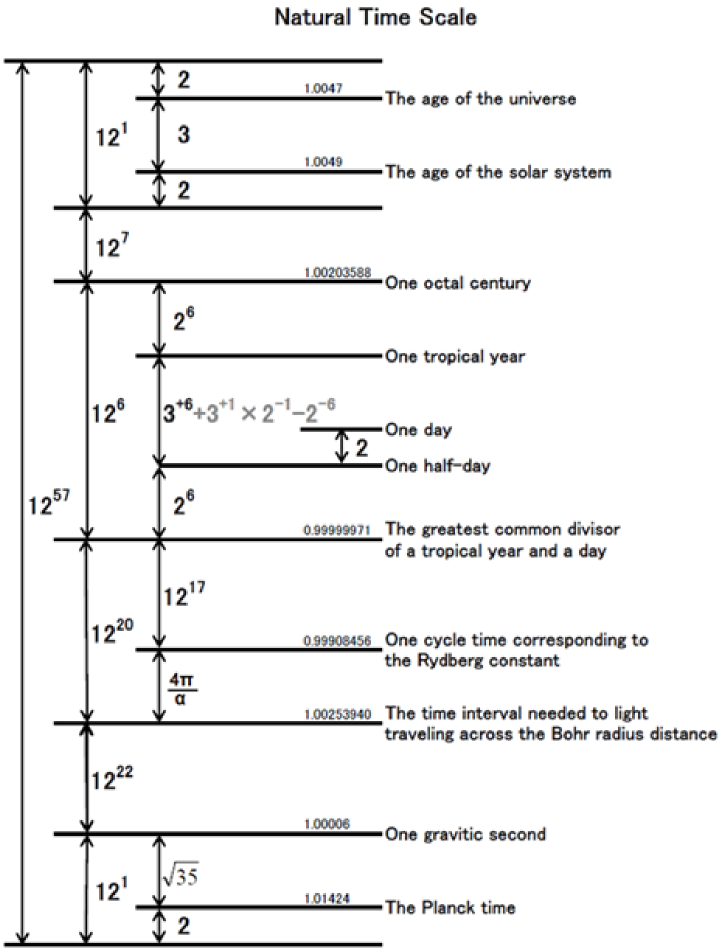
## E. Relation of Units and Dimensions

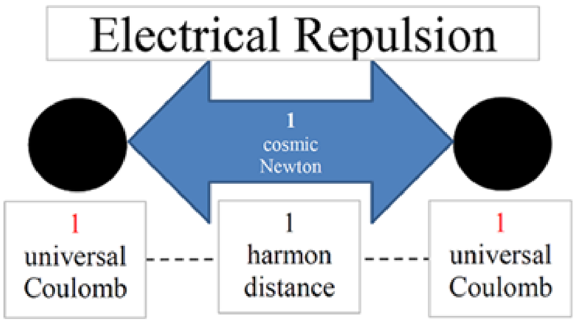


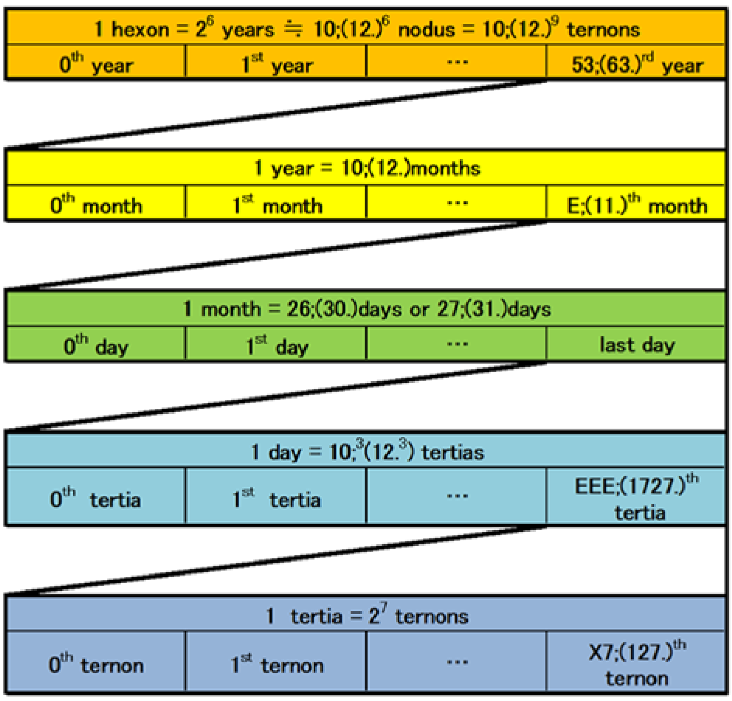

[58] The units enclosed with'()' are units of SI.

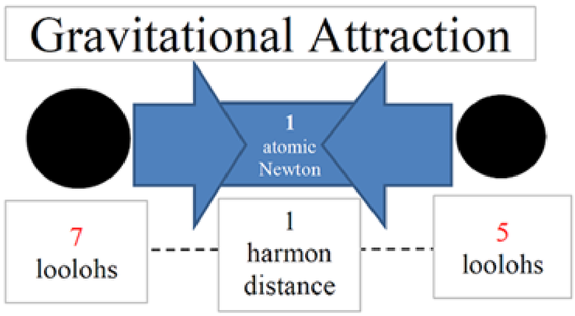
| | |
|---|---|
| Force between electrical quantities | $f = \frac{1}{\epsilon_0}\frac{\Omega_2 Q}{4\pi r^2}Q' = \Omega_n c_0 \frac{QQ'}{r^2}$ |
| Force between electrical currents | $df = \mu_0 \frac{\Omega_2 I}{2\pi r}I' = \frac{2\Omega_n}{c_0}\frac{II'}{r}$ |
| Lorentz force | $\mathbf{F} = Q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$ |
| Energy density of an electromagnetic field | $u = \frac{1}{2\Omega_2}(\mathbf{E}\cdot\mathbf{D} + \mathbf{H}\cdot\mathbf{B})$ |
| Poynting vector | $\mathbf{S} = \frac{1}{\Omega_2}\mathbf{E} \times \mathbf{H}$ |
| Electromagnetic induction law | $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$ |
| | $\nabla \times \mathbf{H} = +\frac{\partial \mathbf{D}}{\partial t} + \Omega_2 \mathbf{J}$ |
| Gauss' theorem (differential form) | $\begin{cases} \nabla\cdot\mathbf{D} = \Omega_2\rho \\ \nabla\cdot\mathbf{B} = 0 \end{cases}$ |
| Charge conservation law | $\nabla\cdot\mathbf{J} + \frac{\partial\rho}{\partial t} = 0$ |
| Scalar potential | $\mathbf{E} = -\nabla\phi - \frac{\partial \mathbf{A}}{\partial t}$ |
| Vector potential | $\mathbf{B} = +\nabla \times \mathbf{A}$ |
| Equation that satisfies the potential | $\begin{cases} \Delta\phi - \epsilon_0\mu_0\frac{\partial^2\phi}{\partial t^2} = -\Omega_2\frac{\rho}{\epsilon_0} \\ \Delta\mathbf{A} - \epsilon_0\mu_0\frac{\partial^2\mathbf{A}}{\partial t^2} = -\Omega_2\mu_0\mathbf{J} \end{cases}$ |

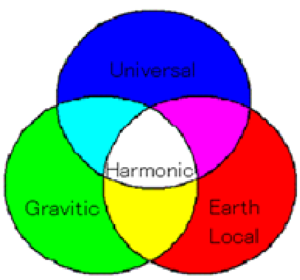
$$\text{Constant} \approx \Omega_0^n \times 12^m, \text{where } n \in \{0, \pm 1\}, m \in \mathbb{Z}$$



# F. Ratios of fundamental physical constants

## F.1. The fine structure constant and the elementary charge

The fine structure constant, α, a dimensionless quantity, was originally introduced for the purpose to explain the fine structure spectral emission lines.

$$\alpha = \frac{e^2}{4\pi\varepsilon_0 c_0 \hbar} \tag{X}$$

By multiplying both sides of Eq. (X) by $\frac{c_0\hbar}{r^2}$, we get

$$\alpha \frac{c_0\hbar}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \tag{E}$$

The right side of Eq. (E) expresses the Coulomb force acting between two elementary charges (i.e., the electrical charge of an electron) separated by a distance of $r$. The left side indicates that this force is proportional to $\frac{c_0\hbar}{r^2}$ by a factor of α. For this reason, the fine structure constant, α, can be interpreted as a dimensionless quantity that represents the strength of electromagnetic interaction.

The value of the fine structure constant, α, is close to $10;^{-2}(12.^{-2})$.

DOZENAL

$$\alpha = \frac{1}{\text{E5;052258E7}} = 1;073994047 \times 10;^{-2}$$

DECIMAL (10;)

$$\alpha = \frac{1}{137.03599918} = 1.050818769 \times 12^{-2}$$

Therefore, the ratio of the elementary charge, $e$, and "the dimensioned quantity of charge, which is derived from the speed of light in vacuum, $c_0$, and the quantum of action,$\hbar$" is:

DOZENAL

$$\alpha^{\frac{1}{2}} = \frac{e}{\sqrt{4\pi\varepsilon_0 c_0 \hbar}} = 1;0374439\text{E}1 \times 10;^{-1}$$

DECIMAL (11;)

$$\alpha^{\frac{1}{2}} = \frac{e}{\sqrt{4\pi\varepsilon_0 c_0 \hbar}} = 1.025094517 \times 12^{-1}$$

## F.2. The Rydberg constant and the Bohr radius

The deviation of the fine structure constant, α, from an integer power of twelve is nearly the same as the deviation of $4\pi$ from twelve.

DOZENAL

$$4\pi = 1;069683171 \times 10;^{1} = \frac{1}{\text{E5;6150822}} \times 10;^{3}$$

DECIMAL (12;)

$$4\pi = 1.047197551 \times 12^{1} = \frac{1}{137.5098708} \times 12^{3}$$

The ratio of the Bohr radius, $a_B$, and "the dimensioned quantity of length, $L = R_\infty^{-1}$, where $R_\infty$ is the Rydberg constant" is:

DOZENAL

$$\frac{a_B}{L} = \frac{\alpha}{4\pi}(\text{strict}) = 1;005\text{E}85684 \times 10;^{-3}$$

DECIMAL (13;)

$$\frac{a_B}{L} = \frac{\alpha}{4\pi}(\text{strict}) = 1.003458009 \times 12^{-3}$$

## F.3. The electron mass and the unified atomic mass unit

The ratio of the mass of an electron, $m_e$, and "the dimensioned quantity of mass, $M$, which is derived from $L$, the speed of light in vacuum, $c_0$, and the quantum of action $\hbar$,"

$$M = \frac{\hbar}{c_0 L}, \tag{14;}$$

is:

DOZENAL

$$\frac{m_e}{M} = \frac{4\pi}{\alpha^2}(\text{strict}) = 0;\text{E}4692218 \times 10;^{5}$$

DECIMAL (15;)

$$\frac{m_e}{M} = \frac{4\pi}{\alpha^2}(\text{strict}) = 0.948359448 \times 12^{5}$$

The ratio of the mass of an electron, $m_e$ and the unified atomic mass unit, $u$, is:

DOZENAL

$$\frac{m_e}{u} = \frac{1}{107\text{X};\text{X}7\text{E}4} = \frac{4\pi}{\alpha^2} \times 0.\text{EEE}2\text{E}66 \times 10;^{-8}$$

DECIMAL (16;)

$$\frac{m_e}{u} = \frac{1}{1822.8885} = \frac{4\pi}{\alpha^2} \times 0.9995641 \times 12^{-8}$$

This ratio corresponds to the ratio of typical nuclear energy and chemical energy. The deviations of ratio Eq. (15;) and ratio Eq. (16;) from multiples of an integer power of twelve are near to the same magnitude. Therefore:

DOZENAL DECIMAL

$$\frac{u}{M} = 1;0009060\text{E} \times 10;^{8} \qquad \frac{u}{M} = 1.00043606 \times 12^{8} \tag{17;}$$

## F.4. The Planck length

The ratio of the general expression of the Planck length, $\sqrt{\frac{G\hbar}{c_0^3}}$, and $L$ is close to 2 when factors of multiples of an integer power of twelve are eliminated.

DOZENAL

$$\sqrt{\frac{G\hbar}{c_0^3}}/L = 2 \times 1;0222\mathrm{E} \ \times 10;^{-22}$$

DECIMAL (18;)

$$\sqrt{\frac{G\hbar}{c_0^3}}/L = 2 \times 1.01519 \ \times 12^{-26}$$

Taking the expression $\sqrt{\frac{G\hbar}{c_0^3\alpha}}$, which has been adjusted[59] by the fine structure constant, α, in order to express the tensile force in a superstring in terms of the Planck length, the ratio of the adjusted Planck length and $L$ then becomes:

DOZENAL

$$\sqrt{\frac{G\hbar}{c_0^3\alpha}}/L = 2 \times 0;\mathrm{EX}737 \ \times 10;^{-21}$$

DECIMAL (19;)

$$\sqrt{\frac{G\hbar}{c_0^3\alpha}}/L = 2 \times 0.99034 \ \times 12^{-25}$$

The Gravitic Universal Unit System uses 140.0 to approximate $\alpha^{-1}$(=137.03599918). Because 1,0017;(20,755.=35.×593.) is divisible with 2E;(35.), we can approximate $G$ by Eq.(1X;) about 6.51 times standard deviation error of CODATA(2018):

$$G \fallingdotseq \frac{(5\times7)^2\times415;^2 c_0^3}{5\times7\times\hbar R_\infty^2} \times 10;^{-4X} = \frac{5\times7\times415;^2 c_0^3}{\hbar R_\infty^2} \times 10;^{-4X} \qquad (1X;)$$

59 See E. Witten, 'Reflections on the fate of spacetime' p. 24. in April 11X4;(1996.) *Physics Today*.