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A simpler system of dimensions and units, Part 3

Francis F. Pitard

In Parts 1 and 2 (*TOS forum* Nos 2 and 3) it was demonstrated that time, mass, permeability and permittivity are relative concepts originating in the human imagination and it was postulated that they do not necessarily require units of their own. This continues to suggest that a simpler system of fundamental units could be useful to perform serious science. Unless we are willing to make some changes, necessary changes, science as it is done today is unnecessarily complicated, and therefore ambiguous. This seems unacceptable to this passionate scientist.

Heat and temperature

Historically, heat has been regarded from two points of view; as a calorific quantity and as a dynamic quantity. The unit of heat is the calorie; it is the quantity of heat that is required to raise the temperature of one gram of water from 14.5° to 15.5° centigrade.

Thermodynamics, on the other hand, regards heat as equivalent to energy, with dimensions

$$[H]=\left[\frac{L^2\cdot M_i}{T^2}\right].$$

A conversion factor, J, converts a number of calories to a number of Joules.

$$[H]=\left[\frac{L^2\cdot M_i}{T^2}\right]=\left[P\cdot L^3\right]=J\cdot M\cdot K \qquad (1)$$

The gas equation $P\cdot V=R\cdot T$ must be rewritten here as $P\cdot L^3=R_g\cdot K$ to avoid confusion. The thermodynamic T is replaced by K, and the gas constant R is replaced by R_g. Dynamically

$$[K]=\left[\frac{L^2}{T^2}\right].$$

It follows that $[R_g]=[M]$. If K has the dimensions of energy, R_g is defined by the gas-kinetic equation and R_g is dimensionless. In the $LP\rho C$ system, $[P\cdot L^3]=[R_g\cdot K]=[\rho\cdot L^3\cdot C^2]$. This presents the possibility that the proper dimensions for K are $[K]=[C^2\cdot L^3]$, and the proper dimensions of R_g are those of density.

$$[R_g]=[\rho] \qquad (2)$$

and

$$[K]=[C^2\cdot L^3] \qquad (3)$$

Problem: Find an expression for the thermal conductivity of a gas in terms of the properties of its molecules, supposing the direction of heat conduction is parallel to the x-axis of the apparatus. The following seven physical quantities are involved: thermal conductivity, k; molecular mass, m; number of molecules per unit volume, N; mean velocity of molecules, v; mean free path, l; gas pressure, p; thermal capacity per unit mass, C_u. Conversion of the *LMTK* dimensions of these *SI* quantities to $LP\rho C$ proceeds through the following relationships:

$$[M_i]=[\rho\cdot L_x^3] \text{ (heat transfer parallel to x-axis) (see notes below)} \qquad (4)$$

$$[M_g]=[\rho\cdot L_x\cdot L_y\cdot L_z] \qquad (5)$$

$$[K]=[C^2\cdot L_x\cdot L_y\cdot L_z] \qquad (6)$$

$$[L]=[L_x] \text{ (see notes below)} \qquad (7)$$

$$\left[T^2\right]=\left[\frac{\rho\cdot L^2}{P}\right] \qquad (8)$$

$$[H]=\left[\frac{L^2\cdot M_i}{T^2}\right]=\left[L_x^3\cdot P\right] \qquad (9)$$

(see notes below)

$$[k]=\left[\frac{L\cdot M_i}{T^3\cdot K}\right]=\left[L_x^2\cdot L_y^{-2}\cdot L_z^{-2}\cdot\rho^{-1/2}\cdot P^{3/2}\cdot C^{-2}\right] \qquad (10)$$

$$[m]=[M_g\cdot L^3]=[\rho\cdot L_x\cdot L_y\cdot L_z] \qquad (11)$$

$$[N]=[L_x^{-1}\cdot L_y^{-1}\cdot L_z^{-1}] \qquad (12)$$

$$[v]=[L_x\cdot T^{-1}]=[L_x\cdot\rho^{-1/2}\cdot L_x^{-1}\cdot P^{1/2}]=[\rho^{-1/2}\cdot P^{1/2}] \qquad (13)$$

$$[l]=[L_x] \qquad (14)$$

$$[p]=[P] \qquad (15)$$

$$[C_u]=\left[\frac{H}{M_g\cdot K}\right]=\left[L_x\cdot L_y^{-2}\cdot L_z^{-2}\cdot\rho^{-1}\cdot P\cdot C^{-2}\right] \qquad (16)$$

Notes, with:

$$k=c\cdot m^a\cdot N^b\cdot v^c\cdot l^d\cdot p^e\cdot C_u^f \qquad (17)$$

$$L_x^{\,2}=L_x^{a-b+d+f} \text{ with } a-b+d+f=-2 \qquad (18)$$

$$L_y^{-2}=L_z^{-2}=L_y^{a-b-2f} \text{ with } a-b-2f=-2 \qquad (19)$$

$$\rho^{-1/2}=\rho^{a-\frac{c}{2}-f} \text{ with } a-\frac{c}{2}-f=-\frac{1}{2} \qquad (20)$$

$$P^{3/2}=P^{\frac{c}{2}+e+f} \text{ with } \frac{c}{2}+e+f=\frac{3}{2} \qquad (21)$$

$$C^{-2}=C^{-2f} \text{ with } 2f=2 \qquad (22)$$

$$a=1,\ b=1,\ c=1,\ d=1,\ e=0,\ f=1 \qquad (23)$$

$$k=c\cdot m\cdot N\cdot v\cdot l\cdot C_u \qquad (24)$$

Since $m\cdot N$ is the gas density, d, and v is proportional to K,

$$k=c\cdot d\cdot K\cdot l\cdot C_u \qquad (25)$$

Experiment confirms that thermal conductivity is proportional to absolute temperature. Surprisingly experiment also confirms that thermal conductivity is independent of pressure ($e=0$).

The *SI* "amount of substance", the mole, Avogadro's number, N_a, has a relation to mass, M. Scrutiny of the "dimensional independence" of M would be incomplete without investigation of N_a.

Avogadro's number and mass

Avogadro's number, N_a, is defined as the number of atoms in a gram-mole of carbon-12. In *SI* parlance it is "the amount of substance in a system that contains as many elementary entities as there are atoms in 0.012 kilograms of carbon 12". An *SI* directive gives as an example "1 mole of H_2 contains about $6.022\cdot10^{23}$ molecules or $12.044\cdot10^{23}$ H atoms". The *SI* value for N_a is listed (2011–2012) as 6.02214179 (30)$\cdot10^{23}$ mol^{-1}.

There is an obvious contradiction here. A hydrogen atom does not have exactly 1/12 the mass of a carbon-12 atom. The ratio $12(M_h/M_c)$ is about 1.00782503207(10). The number of atoms in 1 gram-mole of H_1 is not the same as the number of atoms of C_{12} in 1 gram-mole. It takes fewer hydrogen atoms to make a gram-mole of hydrogen. To deal further with this complication, it is first necessary to establish a **new unit (*NU*) of mass**, introduce a constant *t*, the **time thickness constant**, and develop an alternative to Avogadro's number on a new unit of mass, *NU*[*M*].

We have suggested that the gas constant, R_g, has the dimensions of density.

$$[R_g] = [\rho] = \left[\frac{M}{L^3}\right] \qquad (26)$$

In *SI* units, $R_g = 8.314472(15)$ Joules/mole/°K. Because a conversion factor from *NU* to *SI* has been established, there is the possibility of approximating a mass conversion factor (*M*). The new unit (NU) of length is by definition the radius of a unit vacuole, $r = 1 = 1NU[L] = 1(L)$. The square-bracketed [*L*] is simply a dimensional statement. The (*L*) in parentheses is a conversion factor from *NU* to *SI*.

From Equations (35) and (36) in publication #2, since $(L) = 5.006148\ldots\cdot 10^{-13}$ m, $(M) R_g \cdot L^3$ and $(M) = (8.314472\cdot 10^7)$ $(5.006148\ldots\cdot 10^{-13})^3 = 1.043147\ldots\cdot 10^{-23}$ grams. This supposes, of course, that $1NU[\rho] = 1$. If we chose 2π as a $NU[\rho]$ (good reasons for this!), $(M) = 1.6602\ldots\cdot 10^{-24}$ g/*NU*[*M*].

The inverse of this (approximate) mass conversion factor (*M*) is $6.02337\ldots\cdot 10^{23}$. If we assign the letter *N* to this inverse mass, $N/N_a = 1.0002$. This **"coincidence"** will be developed further as the speculative source of this writing is developed.

The time thickness constant *t*

In exploring the dimensions of length [*L*], we made use of the dimension-less fine-structure constant, $\alpha = 7.2973525376(50)\cdot 10^{-3}$ (from 2011–2012 *CRC Handbook*). Arguments not presented at this stage require development of the concept of a time-thickness of the 3-dimensional (3-D) Universe in which we find ourselves. If we regard time as a fourth dimension right-angled to up-down, east-west and north-south in a 4-D space, we can recognise that our perception of time is not instantaneous. There is a distance in time, very small, but real, that appears subjectively as **the duration of the present instant**. In finding a conversion factor *NU*[*T*] to m/s, the velocity of light was used to convert centimetres to seconds and vice versa, **giving a dimension-less value for light velocity as a ratio between two units of length**, the metre and the second. $c = 2.99792458\cdot 10^8$ is a conversion factor from seconds to metres.

Using thermal quantities, we estimated a conversion factor $M = 1.6602\cdot 10^{-24}$ grams/*NU*[*M*]. We have also found a conversion factor $L = 5.0061\ldots\cdot 10^{-9}$ m/*NU*[*L*]. From these, we estimated a conversion factor $\rho = 1.3233\cdot 10^7\,\mathrm{g\,cm^{-3}}/NU[M/L^3]$ or $\rho = 1.3233\cdot 10^{13}\,\mathrm{g\,m^{-3}}/NU[M/L^3]$ and an estimate of the gas constant $R_g = 8.3144\cdot 10^7\,\mathrm{g\,cm^{-3}}/NU[\rho]$.

A sphere with mass *M* and radius *L* has a density with dimensions $[\rho] = [M/L^3]$ and a surface area with dimensions $[L^2]$. If the time thickness referred to above has dimensions [*L*], it must be related to the radius of the unit sphere by a dimension-less constant. If the time thickness reveals itself as a measured wave length, *l*, of electromagnetic character, $l = t\cdot d$ or $2\cdot t\cdot r$, where *d* is the diameter and *r* the radius of the unit sphere.

As a speculative hypothesis, put $l = l_{ec}$, the Compton electron wave length (aka the Dirac wave length). Then

$$l_{ec} = 2\cdot t\cdot r \qquad (27)$$

and

$$t = \frac{l_{ec}}{2r} = \frac{2.4263102175(33)\cdot 10^{-12}}{2\cdot 5.006148\cdot 10^{-13}} = 2.42332\ldots \qquad (28)$$

Equation (27) is the basis for our discussions later on in subsequent publications.

The time thickness constant is related to the fine structure constant, α:

$$t = \frac{1}{2\cdot 3^2\cdot \pi\cdot \alpha} = 2.423322 \qquad (29)$$

and can replace α in calculating the conversion factor (*L*):

$$L = 2\cdot 3^2\cdot \pi^2\cdot \alpha^2\cdot a^0 = \left[\frac{a^0}{2\cdot 3^2\cdot t^2}\right] = 5.006148\cdot 10^{-13}\,m\,/\,NU[L] \qquad (30)$$

Selection of carbon-12 as the basis for a unit of "amount of substance" is completely arbitrary. Avogadro's number, N_a, can be replaced with any reasonable number without loss of truth or meaning. Accordingly, we suggest that N_a be replaced through the relation *M*:

$$M = 2^7\cdot t^3\cdot m_e = 2^7\cdot t^3\cdot [9.10938215(45)\cdot 10^{-28}]\,g/NU[M] \qquad (31)$$

The following factors *NU* to *SI* have now been established:

$$t = 2.423322 \qquad (32)$$

$$L = 5.006148\ldots\cdot 10^{-13}\,m/NU[L] \qquad (33)$$

$$T = 1.669872\ldots\cdot 10^{-21}\,s/NU[T] \qquad (34)$$

$$M = \rho\cdot L^3 = 1.659629\ldots\cdot 10^{-24}\,g/NU[M] \qquad (35)$$

$$N = 1/M = 6.02337\cdot 10^{23}\ \text{unit spheres/g} \qquad (36)$$

$$P = M/(L\cdot T^2) = 1.188888\ldots\cdot 10^{28}\,\text{pascal}/NU[P] \qquad (37)$$

$$\rho = M/L^3 = 1.322817\ldots\cdot 10^{13}\,g/m^3/NU[\rho] \qquad (38)$$

$$\text{Gas constant } R_g = 2\cdot\pi\cdot\rho = 8.311523\ldots\cdot 10^{13}\,g/m^3/NU[\rho] \qquad (39)$$

$$\text{Electron mass } m_e = 2^7\cdot t^3 NU[M] = 9.10938215(45)\ldots\cdot 10^{-31}\,kg \qquad (40)$$

The constants of physics

It is now possible to calculate *NU* values for the constants of Physics and their *SI* equivalents using the relationships:

$$L_{ec} = 2\cdot t\cdot L = \frac{h}{m\cdot c} \qquad (41)$$

$$\alpha = \frac{1}{2\cdot 3^2\cdot \pi\cdot t} = \frac{2\cdot \pi\cdot e^2}{h\cdot c} \qquad (42)$$

$$N = \frac{1}{M} = \frac{1}{2^7\cdot t^3\cdot m} \qquad (43)$$

$$c = \frac{L}{T} \qquad (44)$$

From (41): $$h = 2\cdot t\cdot L\cdot m\cdot c \qquad (45)$$

From (45):

$$m = \frac{1}{2^7\cdot t^3\cdot N} \qquad (46)$$

Substituting (44), (45) and (46) in (41):

$$h = \frac{1}{2^6\cdot t^2} NU\left[\frac{L^2}{N\cdot T}\right] \text{ or } NU\left[L^4\cdot \rho\cdot C\right] = 2.660711\ldots\cdot 10^{-3} NU \qquad (47)$$

$$h = 2.660711\ldots\cdot 10^{-3}$$
$$[L^4\cdot \rho\cdot C] = 6.62606896(33)\cdot 10^{-34}\,js$$

Substituting (44) and (45) in (42):

$$e^2 = \frac{h \cdot c}{2^2 \cdot 3^2 \cdot \pi^2 \cdot t} = \frac{1}{2^8 \cdot 3^2 \cdot \pi^2 t^3} NU\left[\frac{L^3 \cdot M}{T^2}\right] \quad (48)$$

Thus $1NU$ of quantity of electricity, Q is:

$$Q = e = \frac{1}{\sqrt{2^2 \cdot 3^3 \cdot \pi^2 \cdot t}} = \frac{1}{\sqrt{2^8 \cdot 3^2 \cdot \pi^2 \cdot t^3}} NU\left[\sqrt{\frac{L^3 \cdot M \cdot k}{T^2}}\right] = 1.757887 \cdot 10^{-3} NU\left[L^2\right] \quad (49)$$

$$Q = e = 4.803204\ldots \cdot 10^{-14} mgsSI \text{ taking } k = 1 \quad (50)$$

Compare the 2011–2012 *SI* value $1.602176487(40) \times 10^{-19}$ C.

There is no need for a unit of quantity of electricity in the *NU* system.

The conversion factor (L^2/P) is necessary instead of (L^2) because, while k has dimensions $[1/P]$, its numerical value is 1. The difference between N_a and N which is $(N/N_a) = 1.0007204$ shows up in all quantities with N in dimensional statements; for example, the Faraday, $F = e \cdot N$, the Boltzmann and Stefan constants and all other thermal quantities, sometimes in subtle ways that are difficult to detect. It happens that if Cesium-133 had been chosen instead of Carbon-12 in calculation of N_a, the ratio N/N_a would be 1.000009, about 9 parts in a million difference.

It seems that the attempt to establish an exact scale of atomic mass units is a mistake. This provides a reason to doubt that mass is a "dimensionally independent quantity" and supports the proposition that the proper dimensions of mass are $[\rho \cdot L^3]$.

Dimensions and conversion factors

In the *NU* system, physical quantities are written in the form:

$$\text{Mass of brick} = m_b = 1.205\ldots \cdot 10^{27} NU[M]$$

This should be read "the mass, m_b, of the brick is 1.205 times 10^{27} new units of mass, expressed to four-figure precision. The $[M]$ in square brackets is a dimensional statement. To convert from *NU* to *SI* or other system requires the use of conversion factors. These have been estimated for length, density, pressure and (secondarily) for mass and time. Conversion is written thus:

$$m_b = 1.205 \cdot 10^{27} NU[\rho \cdot L^3] = 1.205 \cdot 10^{27} \cdot (\rho \cdot L^3) \text{g} \quad (51)$$

The conversion factor $(\rho \cdot L^3)$ has been estimated at $1.659 \cdot 10^{-24}$ grams per $NU[M]$. The mass of the brick (remember it?) is then $m_b = 1.205\ldots \cdot 10^{27} NU[M] = 1.205\ldots \cdot 10^{27} \times 1.659\ldots \cdot 10^{-24}$ g $= 2000\ldots$ g.

In some instances, the dimensional statement and the conversion factor are not exactly the same. An example is the statement for unit charge, e.

In *SI*,

$$[e] = \left[\frac{\sqrt{L^3 Mk}}{T}\right]$$

In *NU*, $[e] = [L^2]$

But the conversion factor from *NU* to *SI* is $(L\sqrt{P})$.

This is due to the substitution of $\sqrt{(1/P)}$ for $\sqrt{k}$, as explained previously. Another example is the conversion factor for the gravitational constant, G. In SI,

$$[G] = \left[\frac{L^3}{M \cdot T^2}\right].$$

In *NU*,

$$[G] = \left[\frac{1}{P \cdot L^2}\right],$$

but the conversion factor is

$$\left(\frac{C^4}{P \cdot L^2}\right),$$

with a correction N/N_a.

In this case C^4 is numerically the unity, but must be included for dimensional homogeneity. Necessity for the correction factor involving $N = 1/M$ is due to the arbitrary selection of carbon-12 as the basis for the *SI* unit of "amount of substance".

Avogadro's number, N_a, and $(1/M) = N$

Avogadro's number, N_a, "the number of elementary entities as there are atoms in 0.012 kilograms of carbon-12" and $N = 1/M$ both have dimensions (number/mass). There are, however, subtle differences. Avogadro's number is best measured by electrolysis of a silver solution, not of a carbon solution. The ratio of atomic mass to mass number for carbon-12 is exactly 1.0000… This ratio for silver is 0.9991… For hydrogen-1, the ratio is 1.0079… The number N_a

Table 1. The many values of N.

Element or constant	U or $f(\,)$	$N \cdot 10^{23}$
^{o}n (neutron)	1.0086649	5.970404
^{1}H (Hydrogen-1)	1.007826	5.975379
p+ (proton)	1.0072765	5.978633
$G = 2[(N \cdot T^2)/L] = 6.67428(67) \cdot 10^{-11}\, m^3 kg^{-1} s^{-2}$ *SI* units		5.98966 (see note 1)
$k = 2 \cdot \pi(\rho/N) = 1.3806504(24) \cdot 10^{-23} JK^{-1}$ *SI* units		6.01894 (see note 2)
$\sigma = (2^{23} \cdot \pi^3 \cdot t^6)/15(D^5/C^5) = 5.670400(40) \cdot 10^{-8} Wm^{-2}K^{-4}$ *SI* units		6.01941 (see note 3)
^{12}C (Carbon-12)	12.00000000	6.0221367… (N_a)
^{207}Bi (Bismuth-207)	206.98037	6.0227023
^{133}Cs (Cesium-133)	132.905429	6.0264218
$N = 1/M$	1.0007204	6.0264751 (see note 4)
^{127}I (Iodine-127)	126.904473	6.0266698
^{59}Co (Cobalt-59)	58,933198	6.0289629

Note 1: G the gravitational constant depends on the cosmic abundance of the elements, which are mainly hydrogen and helium

Note 2: k is the Boltzmann constant

Note 3: σ is the Stefan Boltzmann constant

Note 4: N is the number of unit vacuoles per gram. N_a is the number of atoms in a gram-mole of Carbon-12 per mole. N may be assigned differing values depending on the elements or functions in which it is used. $1/N$ may replace M when appropriate differs from $N = 1/M$ in that it is an arbitrary constant unrelated to the mass of the particles it counts, whether they be atoms or molecules… or ships or shoes!

The ratio $N = 1/M$ would be identical to N_a only if masses of all atoms were independent of their mass numbers, and if an elemental isotope were chosen (e.g., to replace carbon-12) for an elemental standard with a ratio (i.e., atomic mass/mass number) such that the new value for $N_a = 1/M$. A decision that the conversion factor $M = 1.659345\ldots \cdot 10^{-24}\,\mathrm{g}/NU[M]$ be derived from the electron rest mass was, of course, also arbitrary. First efforts to find a best value for M took place when the oxygen-16 base was in favour. Then, $N_a = 6.025\ldots \cdot 10^{23}\,\mathrm{g\,mol^{-1}}$. Now $N_a = 6.022 \cdot 10^{23}\,\mathrm{g\,mol^{-1}}$. This approach led to complications, but also to awareness of subtle difficulties. In electromagnetic, N_a is useful. In thermal and dynamic situations it is better to recognise that mass is essentially a secondary approximate unit, and that its components must be considered in any fundamental scheme.

Table 1 shows the many values of N. The symbol (*) attracts the attention that the gravitational constant depends on the cosmic abundance of the elements, largely hydrogen and helium; k is the Boltzman constant; σ is the Stefan Boltzmann constant; N is the number of **unit vacuoles** (defined in a later publication) per gram; N_a is the number of atoms in a gram-mole of carbon-12. N may be assigned differing values depending on the elements or functions in which it is used. $1/N$ may replace M when appropriate.

Comparison between the 2-dimensional systems *LMTkN$_a$* and *LPρCN*

At this stage, useful physical quantities should be summarised and their dimensions compared, as they will have many applications; see Table 2. The *LPρCN* system more clearly reflects the nature of many of the quantities, especially electromagnetic quantities.

The constants of physics (e.g., *t* = 2.423322…)

Table 3 shows useful physical constants with conversion factors into new units *NU*, in which dimensions of Time [*T*] and Mass [*M*] no longer play a direct, structural role. In the new system *NU,* all values for the fundamental physical constants are absolute, with the exception of the time-thickness constant.

Table 4 may help the reader when comparing *NU* values with values from the *SI* system.

Table 2. Comparison of dimensional systems.

Physical quantity	LMTkN$_a$	LPρCN
Action (angular momentum)	$(L^2 \cdot M)/T$	$L^4 \cdot \rho \cdot C$
Avogadro's number	N_a	
Bohr magneton	$(L^{5/2} \cdot M^{1/2} \cdot k^{1/2})/T$	L^3
Density	M/L^3	ρ
Electric charge	$(L^{3/2} \cdot M^{1/2} \cdot k^{1/2})/T$	L^2
Electric current	$(L^{3/2} \cdot M^{1/2} \cdot k^{1/2})/T^2$	$L \cdot C$
Electric permittivity	k	$1/P$
Electric resistance	$T/(L \cdot k)$	$\rho \cdot C$
Energy	$(L^2 \cdot M)/T^2$	$M \cdot C^2 = L^3 \cdot P$
Gravimetric constant	$L^3/(M \cdot T^2)$	$L \cdot N \cdot C^2$
Inductance	$T^2/(L \cdot k)$	$L \cdot \rho$
Inverse mass		$1/(\rho \cdot L^3)$ or N
Length	L, L_x, L_y, L_z	L, L_x, L_y, L_z, L_t
Magnetic field strength	$(L^{1/2} \cdot M^{1/2} \cdot k^{1/2})/T^2$	$P^{1/2}/\rho^{1/2} = C$
Magnetic permeability	$u = 1/c^2k$	ρ
Mass	M	$\rho \cdot L^3$
Potential difference	$(L^{1/2} \cdot M^{1/2})/(T \cdot k^{1/2})$	$L \cdot P$
Pressure	$M/(L \cdot T^2)$	P
Surface tension	$M \cdot T^2$	$L \cdot P$
Temperature (dynamic)	L^2/T^2	C^2
Temperature (kinetic)	1	1
Time	T	$\rho^{1/2}/P^{1/2} = L/C$
Velocity	L/T	C/c

Electronic charge, *e*

Conventional dimensions of e are $[e] = [\sqrt{(L^3Mk)}/T]$ or $[\sqrt{(LM)}/u]$ with L = length, M = mass, T = time, k = electric permittivity, u = magnetic permeability.

The later exposed Vacuole Hypothesis puts the proper dimensions of e at $[L^2]$. Solving the equality:

$$L^2 = \frac{L^{3/2} \cdot M^{1/2} \cdot k^{1/2}}{T} = \frac{L^{1/2} \cdot M^{1/2}}{u^{1/2}} \tag{52}$$

gives:

$$[k] = [1/P] \tag{53}$$

and

$$[u] = [\rho] \tag{54}$$

Permittivity has dimensions [1/Pressure], permeability has the dimensions of density and

$$c^2 = [1/(u \cdot k)] = P/\rho \qquad [55]$$

For this reason P and ρ replace M and T as primary dimensions.

Gravitational constants G_n and G_r

Dimensions of the Newtonian constant G_n, $[L^3/(M \cdot T^2)]$ and the relativity constant G_r, $T/(L \cdot M)$ differ by $[1/c^4]$ or $[T^4/L^4]$. If one takes $c^4 = 1$, converting to the $LP\rho$ system gives the conversion factor listed above. The value given N_g derives from the fact that the universe contains much more Hydrogen and Helium than Carbon-12.

Table 3. New units *NU* and conversion factors.

Physical quantity	Value in *NU*	Conversion factor	Official Value in *SI* units (2011–2012)
Bohr magneton, u_B	$\frac{1}{2^5 \cdot 3 \cdot \pi^2 \cdot t^{1/2}} = 6.7798922 \cdot 10^{-4}$	$L^3 \cdot P^{1/2}$	$927.400915(23) \cdot 10^{-26} JT^{-1}$
Bohr radius, a_0	$2 \cdot 3^2 \cdot t^2 = 1.057054613 \cdot 10^2$	L	$0.52917720859(36) \cdot 10^{-10} m$
Boltzmann Constant, k	$2 \cdot \pi$	ρ / N	$1.3806504(24) \cdot 10^{-23} JK^{-1}$
Electron charge, e	$\frac{1}{2^4 \cdot 3 \cdot \pi \cdot t^{3/2}} = 1.757883944 \cdot 10^{-3}$	$L^2 \cdot P^{1/2}$	$1.602176487(40) \cdot 10^{-19} C$
Electron g-factor, g	1.001159652193	1	1.001159652193
Electron radius, r_e	$\frac{1}{2 \cdot 3^2 \cdot \pi^2} = 5.628954647 \cdot 10^{-3}$	L	$2.8179402894(58) \cdot 10^{-15} m$
Electron rest mass, m	$\frac{1}{2^7 \cdot t^3} = 5.489751035 \cdot 10^{-4}$	M	$9.10938215(45) \cdot 10^{-31} kg$
Faraday, F	$\frac{1}{2^4 \cdot 3 \cdot \pi \cdot t^{3/2}} = 1.7578839 \cdot 10^{-3}$	$L^2 \cdot P^{1/2} \cdot N$	$96485.3399(24) Cmol^{-1}$
Fine structure constant, a	$\left[0.5 - \left(0.25 - \frac{1}{137^2 \cdot g^{1/2}}\right)^{1/2}\right]^{1/2} = 7.2973525376 \cdot 10^{-3}$	1	$7.2973525376(50) \cdot 10^{-3}$
Inverse mass, N N_a	1.00000000	$1/M$ $N_{avogadro} =$	$6.02337 \cdot 10^{23} g^{-1}$ $6.02214179(3) \cdot 1\text{-}^{23} mol^{-1}$
Light velocity, c	1.00000000	L/T	$2.99792458 \cdot 10^8 m/s$
Planck constant, h	$\frac{1}{2^6 \cdot t^2} = 2.66069507 \cdot 10^{-3}$	$(L^2 \cdot M)/T$	$6.62606896(33) \cdot 10^{-34} Js$
Rydberg constant, $R_{¥}$	$\frac{1}{2^4 \cdot 3^4 \cdot \pi^2 \cdot t^3} = 5.4936105667 \cdot 10^{-6}$	$1/L$	$10973731 \cdot 568527(73) m^{-1}$
Stefan constant, σ	$\frac{2^{23} \cdot \pi^9 \cdot t^6}{15} = 3.337615 \cdot 10^{12}$	$\rho^5 \cdot C^5$	$5.670400(40) \cdot 10^{-8} Wm^{-2} K^{-4}$
Time thickness, t	$\frac{1}{2 \cdot 3^2 \cdot \pi \cdot a} = 2.423322$	1	2.423328345 preferred value (see References 4 and 5 in vacuole hypothesis paper from COI)
Time thickness,	$2 \cdot t = 4.846658901$	L	$2.426308377 \cdot 10^{-12} m$
Unit of density, ρ	1.00000000	$(M/L^3) = \rho$	$1.32259236 \cdot 10^{13} g/m^3$
Unit of length, L	1.00000000	$1/(2^4 \cdot 3^4 \cdot p^2 \cdot t^3 \cdot R)$	$5.00614635 \cdot 10^{-13} m$
Unit of mass, M	1.00000000	$2^7 \cdot t^3 \cdot m$	$1.659344784 \cdot 10^{-24} g$
Unit of pressure, P	1.00000000	$M/(L \cdot T^2) = P$	$1.18868673 \cdot 10^{28} pascal/NU[P]$
Unit of time, t	1.00000000	L/C	$1.66997068 \cdot 10^{-21} s$

Note that the conversion factors do not always show the actual dimensions of the quantities reported. Explanations are summarized in the following sections.

Temperature dependent constants, k_b

The Vacuole Hypothesis assigns dimensions $[(P \cdot L^3)/\rho]$ to temperature. This gives the gas constant the dimensions of density and $k = 2 \cdot \pi \cdot NU[\rho/N] = 1.3806504(24) \cdot 10^{-23} JK^{-1}$ *SI* units on the Carbon-12 scale.

Conclusion

In the new suggested system, all values for the "fundamental" physical constants are absolute, with the exception of the time-thickness constant, t. Planck's constant $h = 1/(2^6 \cdot t^2)$, electron charge $e = 1/(2^4 \cdot 3 \cdot \pi \cdot t^{3/2})$, electron rest mass $m = 1/(2^7 \cdot t^3)$, light velocity $c = 1$ etc. A "best value" for t, 2.42332945…

Table 4. New units *NU* and conversion factors to *SI*.

To convert from	To	Multiply by
NU[*L*]	Centimetres	$5.00614634 \cdot 10^{-11}$
centimetres	*NU*[*L*]	$1.99754448 \cdot 10^{10}$
NU[*M*]	grams	$1.65934478 \cdot 10^{-24}$
grams	*NU*[*M*]	$6.02647512 \cdot 10^{23}$
NU[*T*]	seconds	$1.66987067 \cdot 10^{-21}$
seconds	*NU*[*T*]	$5.98848770 \cdot 10^{20}$
NU[*P*]	pascals	$1.8868673 \cdot 10^{27}$
pascals	*NU*[*P*]	$8.412645544 \cdot 10^{-28}$
NU[ρ]	Grams cm^{-3}	$1.32259236 \cdot 10^{7}$
Grams cm^{-3}	*NU*[ρ]	$7.56090864 \cdot 10^{-8}$

has been estimated from the electron g-factor, experimentally determined to 10^{-5} ppm. Using these values, the fine structure constant $a = (2 \cdot \pi \cdot e^2)/(h \cdot c) = 0.00729735308\ldots$ The 1986 value is 0.00729735308(33).

A simple example may demonstrate the advantage of using the *LPρC* system instead of the *LMT* system. Solve the following:

Problem: Using the method of dimensions, determine the mass of viscous fluid flowing per second through a round tube.

Solution using the LMT system

A complete summary of parameters is given in Table 5.

Dimensionally, we have:

$$[M \cdot T] = \left[\frac{M}{L^2 \cdot T^2}\right]^x \cdot \left[\frac{M}{L^3}\right]^y \cdot \left[\frac{M}{L \cdot T}\right]^z \cdot [L]^w = p^x \cdot d^y \cdot n^z \cdot r^w$$

whence

$$x + y + z = 1$$
$$2x + z = 1$$
$$w - 2x - 3y - z = 0$$

We have three equations and four unknowns. The best result we can find is:

$$x = 1/2 - z/2$$
$$y = 1/2 - z/2$$
$$w = 5/2 - 3z/2$$

We must guess that $z = -1$ to obtain the correct solution.

Table 5. *LMT* system.

Physical quantity	Symbol	Dimensions
Mass per second	m	M/T
Pressure gradient	p	$M/(L^2 \cdot T^2)$
Density of liquid	d	M/L^3
Coefficient of viscosity	n	$M/(L \cdot T)$
Radius of tube	r	L

Table 6. *LPρC* system.

Physical quantity	Symbol	Dimensions
Mass per second	m	$L^2 \cdot \rho \cdot C$
Pressure gradient	p	P/L
Density of liquid	d	ρ
Coefficient of viscosity	n	$(P \cdot L)/C$
Radius of tube	r	L

Solution using the *LPρC* system

A complete summary of parameters is given in Table 6.

Dimensionally, we have:

$$[L^2 \cdot \rho \cdot C] = \left[\frac{P}{L}\right]^x \cdot [\rho]^y \cdot \left[\frac{P \cdot L}{C}\right]^z \cdot [L]^w$$

whence

$$w + z - x = 2$$
$$z = -1$$
$$y = 1$$
$$x + z = 0$$
and $x = 1$, $y = 1$, $z = -1$, $w = 4$

giving the correct solution, mass per second $m =$ (a dimension-less constant) $\times (p \cdot d \cdot r^4)/n$.

The reason for success of the *LPρC* system is that it automatically takes the difference between inertial mass M_i and gravitational mass M_g into account.

Epilogue

This concludes our initiating long journey that demanded three publications in *TOS forum* setting the background for a simpler system of dimensions and units. We have now reached a point where I must make an attempt to offer a vision about what could be the implications as we "sample" the Universe in which we live. Obviously we shall make an attempt to enlarge the concept of sampling as we explore the unknown. This new journey will start by breaking certain paradigms that have stood in our way for too long, making progress in science difficult—it is a daring journey.