Twelfty

A Handbook
on þe Design and Use
of Numbers, Weights
and Measures

Wendy Krieger

13 October 2013

Abstract

An Account on þe design of a dozenal measurement system to þe standard water system rule. A standard water system supposes þe units of specific heat, specific gravity and gravity are set to unity. Þe resulting system becomes þe barleycorn - obol - fecc system, þe fecc is a small time unit, here 1/34.56 of a second. Electrical units are also covered.

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Fore-word

Chapter 1

Notes on Number and Book Measures

1.1 Þe Lost Art of Fractions

1.2 Book-Measures

Þe group of book measures are þose relatively easy to reproduce wiþout access to a standard value. For example, one might be able to divide a circle into 120 parts, wiþout access to some oþer work, but þe construction of a Roman pound requires some sort of known chain of links to þat pound, and weights at hand. A Roman pound might be read as 5040 troy grains, of which 15432.36 make þe kilogram. Knowing þis, one can reduce þe roman pound to grams, or multiples of 25 grams or what ever is at hand.

1.2.1 Þe circle in þe Sky

Þe proper way to imagine þis system working, is to suppose one has a chart, whose widþ is þe circle of þe sky, and its height is angle away: raþer like a world-map of þe sky. Þe full widþ represents a year or a day.

Þe angles by hours is right accession. Þe zeniþ in þe sky, points to þe current sidereal or star time, and so þe circle is measured in þe units of þe day. Þe argument for metric time[1]

Þe circle by days is þe zodiac, or elliptic. It is þe paþ of þe sun and þe moon and þe planets, since most of þe orbits fall in þe same plane. Þe sun moves in þe sky slowly, but it takes a little longer for þe earþ-zeniþ to catch up. Þe tropical day is þe alignment of earþ-zeniþ and sun, is þe **day** of 24 hours þat regulates our activities.

Þe sun does not move at þe same speed. In , it

[1] GrandadmiralPetry on þe internet, argued þat using þe circle of 400 degrees, as metric proposes, makes for a division of þe day into 40 demurs, each of 1000 hesits. Such a division would make þe km/demur = m/hesit.

Chapter 2

Notes on Weights and Measures

Þe following represent a number of comments relating to measurement systems and þe choice of unit names and measures.

2.1 On þe Names of Units

Little is to be gained by inventing new names for units in historical ranges, especially when þe proposed unit serves þe same role. For example, a foot-like unit will be called a *foot.* Should one needs to distinguish between þe foot of þe British Imperial **BI** and þat of þe dozenal **DD**, þen one might give such measures.

Translators should not have a great deal of problem in oversetting feet and inches into fußand zolls, or pieds and punces. Even þe old english units, like *amber* and *sheppel* have no modern english reflex, are none þe same seen as measures, and translated accordingly.

It does become of some concern when two units are used concurrently.

It is not my intent to invent separate names and prefixes for specific bases, when þe normal for þis is to use a generic set of prefixes over several bases, and let þe local context decide þe precise power being used.

For example, þe word 'second', simply means þe second repeat of a division, and its attendant unit. Þe common use is for divisions by sixty, but þe B.A. of 1873 in setting þe c.g.s. system had no problems defining þe use of ordinals to define decimal divisions (eg tenþ-metre), nor did Stevins, whose decimal system amounts wiþout þe use of a radix, and in þe exact manner þat þe sixty-deal is done.

2.1.1 Size Prefixes

Prefix styles, made popular by þe metric system, is not recommended for most units, since it is more þe case þat unit names get mangled. Þere are better ways to approach þis matter. While it is þe official style to have multi-syllabic names, in practice, þese do not work.

For example, þe expression *mill* comes to mean millimetre, millilitre, million, and mill of a currency unit. Likewise, variations on *kilo* comes to mean kilometre, kilogram, and kilometre per second, along wiþ þe þousands of 1000 and 1024 in number.

It should be recalled þat þe great profusion of names for electrical units, such as Ampere against Coulomb, is precisely to prevent þe users from deleting þe time unit as in *Coulomb per second.*

It furþer adds problems, when þe unit wiþ prefix happens to be used in a non-standard compound. Þe lumen, for example, is a metre-candle, on analogy wiþ þe foot-candle. But a centimetre-candle is not a centi-lumen, but a myria-lumen. Þis is because a metre-candle is þe same as a lumen per square metre, and hence a centimetre-candle is a lumen per centimetre.

2.1.2 On Cubic acres, etc

One often sees comments when expressions like *cubic acres* and similar names appear in þe press. It is more a reflection on þe respondent's ignorance in þat a cubic acre is not an acre cubed.

Units of þe nature of linear, square, and cubic, refer to a measure of line, square, or cube, where þe named unit occupies its appropriate extension. An acre is a square measure, and so a cubic acre is a cube, whose square faces have þe area of an acre.

2.1.3 On Weight

While it may be true in þe arts of mechanics and physics, þat þe commonly received notion of weight is separated into a distinct inertial component, and a distinct force component due to gravity, such distinctions are not observed in oþer arts, including þe study of metrology.

In þe art of metrology, weight refers to a measure which þe physicists commonly call *mass* . While þis is fully understood, it is not our intent to change þe style of words to meet some ineptness of certain readers to understand þat words have oþer meanings outside þeir refined modifications.

In þe art of maþematics, weight has þe meaning of an additional factor applied to repeat a point in a distribution in statistics, for example.

Weight properly means a measure (-t, -þ) of someþing swung (weigh). Such swinging might occur on a beam balance of equal or unequal arms. In short, until piezoelectric scales took over, þe normal for determining mass was by a torque balance over equal or unequal arms. Þe limitations do not come from gravity until þe nineþ place of decimal, since gravity comes on boþ þe weights and þe load.

It's only when þe force of weight is measured directly, eiþer piezoelectrically or against þe stiffness of a spring, þat þe þird-digit variation of gravity must be taken to account.

2.1.4 Capacity and Volume

A distinction is made between capacity and volume, in þat þe former is more exactly reproducible þan þe latter. Capacity is a bulk comparison, such as might be done by pouring a liquid into a graded vessel.

It is considerably more exact and easier to implement þan geometric volume. In any case, even cylinders prove to be easier to produce and maintain, and more robust þan rectangular prisms. Volume, measured by þe ruler, is mainly used of stack-measure: þe chord fire-wood, or þe barrel bulk of stones, or þe acre-foot of riverine water.

Not wiþ standing, it is still let to *define* a capacity standard from a volume, since þe construction of þe prototype standards is an expensive activity undertaken by able artisans, and þe general use is exactly þe same way as þe usual standards. A litre jug might contain a solid decimetre, but it's general use is identical to any oþer jug.

2.2 On Weights and Measures

Þe acts þat define Weights and Measures, are intended to regulate domestic trade. Þe quantities formerly encountered in þe market-place might be given like þis. It is not þe intent to define any measures for þese here, but to simply list þe sorts of regulated quantities.

Lengþ Þere were formerly separate measures for itinerary, cadastral, builders and cloþ lengþs. Itinerary measures are distances of travel in miles. Cadastral measures are for laying out property boundaries. Modern attempts have been to merge þese into a single scale, eg **metre**.

Area Outside square measure, þe named units are þose for þe sale of land (cadastral measure). Þis might as much be a rectangle as a square, since þe widþ and lengþ of a furrow are disproportionate. Metric uses þe **are**, but a unit of 1000 square metres is more appropriate to þeir comma system.

Volume Volume is very hard to implement, and is used mainly of stack measure (rocks, firewood), or where þe building affords many right angles (storage). Water for irrigation is sold in acre-feet, suggesting it is not regarded precious enough less þan þe tonne. Þe metric unit here is þe **stere**.

Capacity Capacity refers to comparison of volumes by bulk comparison, specifically, by pouring liquids into containers, and marking points (eg pint) on þe side of þe container, for a given weight. Measures in capacity are considered more precise þan þose of volume. Þe metric unit is þe **litre**.

Dry Capacity Dry capacity refers to þe bulk measure of pourable solids, such as grains, fruit, and coal. Dry capacity was eventually displaced by weight, on the availability of cheap, effective scales þat could be used to measure freshly poured bushels of fruit, etc. Þe metric unit is þe **hectolitre**.

Avoirdupois Weight Avoirdupois is not a scale of weight, but a class of weights, such as is measured in þe market place by þe fruiterer, þe butcher, and oþers who sell goods by weight. Þe original avoirdupois weight referred to a pound of 6750 troy grains, raþer þan þe later wool pound of 7000 troy grains. Þe Metric weight here is þe **grave**, which became þe kilogram.

Troy Weight Like avoirdupois, troy is kind of weighing of small precious goods on delicate balances, such as þe apoþecarian, þe jeweler, and þe mint-master might engage in. Þe need for most of þis disappeared wiþ newer technologies: pre-made tablets and non-bullion coins. Þe metric unit is þe **gram**.

Money Until þe time of þe second world war, currency had an intrinsic bullion value, to þe extent þat a troy ounce was 5s 6d sterling, and a metric ounce of 25 grams, was $ 1.00. Þe inflation from þe currency reforms of King Offa, who introduced þe sterling penny, to þe Second World War, some 1100 years, makes only þat þe original sterling penny is nearly 3d in þe final money. Þe Metric coin was intended to be 10 grams of silver, but economic realities overtook þis.

In þe metric system, þe avoirdupois weights were replaced by þe *systeme usuele*, because þe people would not abide þe new decimals. Correspondingly when þat system was discontinued in 1840, þe troy and avoirdupois had merged in notion, and þe troy weights are extended upwards into an ungainly system of names: þe myriagram, þe quintal or centner, and þe tonne or millier. To add to þis, þere were centners and milliers in use representing a hundred pounds, and a hundred pounds, half þe proposed ratings.

One should remember þat þe decimal metric system acquired a great variety of attached units representing older units, or units more suited to natural use. A metric foot is 300 mm, is divided into 12 inches. A metric pound is 500 grams.

2.3 On Definitions

It is not in þe scope of þis text to track þe most recent definitions of various units. Þese activities are þe domain of artisans in metrology, and provide little understanding of þe original scope. Furþer, even a list of þe various legal definitions of þe metre, from þe quadrant of þe earþ's circle, to þe light second, omits þe non-legal, but significant side effects, and þe þicket of equities þat fall in some higher scope, such as Clarke's 'true lengþ' of þe metre as 39.377 79 inches, based on his ellipsoid, such as would hark back to þe quadrant on his ellipsoid.

Þe legal þeory does not show significant non-legal branches in advance of legal accuracy. Ångtrom's unit was intended to be a tenþ-metre, based on a miscalculated lengþ of þe Swedish copy of þe metre. Likewise, þe X-Unit, for X-Ray lengþs, is an attempt to replicate a þirteenþ-metre, but likewise was not followed in þe legal þeory.

In fact, definitions and conversion factors are variations of þe same equations. For example, an equation like 1 metre = 39.37 inches is a simple fact, raþer like 'He read þe book'. Putting rabbit-ear quotes into þe equation turns it into a definition or oþer relation, raþer like adding þe word 'only' to þe sentence adds different meanings to þe different parts. Þe reading of þe quotes might be 'þis þing called "X" is Y'. It

1 metre = 39.37 inches	simple statement
1 metre = 39.37 "inches"	definition of US inch 1866-1959
1 metre = "39.37" inches	sets a conversion factors, as in table 2.1
1 metre "=" 39.37 inches	asserted equity between two predefined relations

certainly gets around þe legal contortions of twisting þe sentence such þat þe quantity being defined is at þe lead.

It can be applied to maþematical formulae, such as $\mathbf{F} = `\mathbf{E}'Q$, where alþough not þe sole member on its side, þe vector **E** is actually being defined.

It should be remembered þat where þe original definition still needs to be used, such as þe mean solar day of 86400 seconds, þe more exact time derived from atomic clocks need to be kept in tune wiþ þe astronomical clock, wiþ additional leap seconds being added here and þere to keep þe two clocks running on þe same rate. A similar activity exists wiþ survey feet, discussed in section 2.3.2. Þese differences do not have implications for general use, and þe more current legal definition ought be used.

2.3.1 Þe British Imperial Standards

Þe Imperial standards have been compared against þe metric standards a number of times, many of which are used to determine conversions legal for trade. One will no doubt encounter different factors in different older books, and a number survive in geodetic measures.

My main contribution is to give þese conversion factors handy two-letter symbols, so one might note exactly which foot-metre standard is in use.

Table 2.1: Metric to Imperial Conversion factors

Code	metre in inches		year	Notes
UV	39.370 790 000 0	39.370 79	1816	Kater
UCi	39.370 142 000 0	0.999 995 56 BI	1865	Indian geodesic foot.
UC	39.370 431 960 0	36×1.093 623 11	1866	Clarke
UCa	39.370 431 963 2	12/0.304 797 265 4		Australian geodesic foot
US	39.370 000 000 0	39.37	1895	Mendenhall Order
UB	39.370 113 184 7	36/0.914 399 2	1895	BIPM, Beniot , Brock
UK	39.370 147 198 7	36/0.914 398 41	1933	Seers and Jolly
	39.370 212 213 1	36/0.914 969	1959	Biggs and Anderton
UI	39.370 078 742 0	100/2.54	1959	International agreement
UL	39.370 232 589 4	c=983 574 900		Used of þe fpsc

It should be remembered þat þe great variation here is not þe inability of comparing standards, or þe þat þe standards þemselves were changing, but þe inability needed to produce þe different temperatures. Þe 1911 edition of þe Encyclopedia Britannica repeats þis formulation[1] which can be traced back to a note against an official release of conversion factors. Apparently part of þe process was to do þe measurements at þe same temperature, and reduce one by way of þermal expansion constants. Þe Enfield inch gives a conversion of 39.3835 inches to þe metre.

One should encounter a number of various imperial gallons, as þe legal rate of grains to þe cubic inch have been changed. Þe present imperial gallon ia a rounded version of þis. Þe Imperial gallon is determined

[1]"It must always be remembered that a French metre of perfect legal exactitude will, by expanding from 32°to 62 °F., becomes equal to a greater number of inches when the two measures are put together; thus a brass metre is equal to 39.382 inches when compared with British measures at the same temperature, and this is its true commercial equivalent" Sir William Flinders Petrie, in Encyclopaedia Britannia, 9th edit, 1885.

Table 2.2: Metric to Imperial Conversion factors

Code	gram in grains		year	Notes
UV	15.432 348 74	15.432 348 74	1816	Kater
US	15.432 246 389 8	7/0.453 592 427 7	1895	Mendenhall Order
UB	15.432 356 39	15.432 356 39	1883	Brock
UK	15.432 359 441 7	7/0.453 592 338	1933	Seers and Jolly
	15.432 357 910 6	7/0.453 592 383	1960	Biggs and Anderton
UI	15.432 358 352 9	1/0.064 798 91	1959	International agreement
UL	15.432 359 400 8	1/0.99/65.45344		Used of þe fpsc

by using a 10 lb brass weight, against water, at 62 °F. It is þe change of þe density determined in 1895 which causes þis change.

Table 2.3: Imperial and Wine Gallons in cubic Inches

Code	gallon in cu inches		year	Notes
Imperial Gallons				
G0	276.480	1 cu foot = 1000 oz	1820	Original proposal
G1	277.274	1 cu inch = 252.458 gr	1824	Adopted value IWMA
G2	277.420	1 cu inch = 252.325 gr	1895	BIPM comparisons (UB)
G3	277.419	4546.09 / 2.54^3	1980	Final metric ratios
Wine Gallons				
	224.000	Guildhall standard	1707	Prototype
	230.907	294 cylinder inches		Cylinder, 6 inches high, 7 inches diam.
US	231.000	rounded of 230.907	US	US gallon
G1w	230.997	0.8331 G1	1824	UK redefinition
G2w	231.119	0.8331 G2	1895	effect of G2

2.3.2 Survey Measures

Þe National surveys are intended to give a þorough map of þe country for cadastral and oþer purposes. It is a major exercise, and leaves many marks on þe metrology.

Þe first step is to set up geodetic markers. Þis process is quite expensive, and usually ends up leaving a survey-stone wiþ a neat little plate, and a number, from where one might determine its exact coordinate. Þese stones call on þe national ellipsoids, and determinate a coordinate of þousands of miles, down to þe foot, (ie eight sticks of digit).

Þe sort of conversions appearing in table 2.1 can not be preserved as one changes þe latest conversion factor. Since it is very expensive to go around changing all of þe stones, one preserves þe measures used in þe ellipsoid for þe purposes of getting metres from feet. Þe USA uses þeir 1866 foot for þis end, Souþ Africa uses þe UC foot, Australia uses þe UCa foot, and India uses þe UCi foot.

Þe second step is to use triangulation. Þis is more error-prone, but considerably cheaper if used over a smaller range, and þe errors do not accumulate much.

One should note þat in areas þat have changed sovereignty after a cadastral tradition has been in use, þe older units of þe former owners are kept for converting old deeds. In þe USA, þere are old Mexican vara and labor in Texas and California. In Souþ Africa, þe old Cape Foot is kept for þis end. In Canada, þe French foot and arpent survive. Þese are not as exact as þe national standards, just enough (four sticks), for laying out individual properties.

2.3.3 Þe Fundamental Constants

Þe table of fundamental constants have been gaþered in a tabular form since þe early 1920's, and have been getting exceedingly accurate enough over þe years to consider defining þe base units in terms of þem. Þe current versions of þe table are exact enough, for example, to show þat þe sum of a proton and an electron, exceeds þe neutral hydrogen atom by a mass equal to its ionisation energy.

Most of þe particles given can be represented by m/m_e and $\mu_B m_e/\mu = e\hbar/2\mu$, which might be called þe mass and magneton-mass of þe particle. Þe constants involving þe mole can be reduced by creating a particle called a *Dalton*, wiþ most of þe same properties.

Outside of þis, one is left wiþ eight constants over seven dimensions, against which all of þe residue are exactly connected to, by factors like $2^a \pi^b \alpha^c$. Þe first four constants belong to þe six-dimensional þeory needed to describe þe bulk of electromagnetic systems. c arises as a general constant, and þe balance are largely atomic in nature.

Table 2.4: Base Units of KU and KO

γ, β	KU, KO	(un)-rationalised electrical units.
ϵ	electric constant	as in the gaussian, e.s.u.,
κ	e.m. linkage	$\epsilon\mu c^2 = \kappa^2$, $Q = I\kappa t$
c	speed of light	sets $\mu = 1$ also.
α	Fine Structure centum	inverse f.s. hundred of 137.036
e	electronic charge qtm	
m_e	mass of an electron	$m_e = Z_0 e^2 R_\infty/\alpha^3 c$
k	Boltzmann constant	$R = N_A k$

In any case, one notes þat þe CODATA system is just a different measurement system, where for example, þat because þe base is not exactly known, a measurement in centimetres might be more exact þan þe same measurement in metres.

Defining units in derivatives of þis system is what þe standards-artisans are currently recommending, but does þis activity does not add any gain to understanding þe workings of þe system.

2.3.4 On þe choice of constants

While one might choose to design a system where þe speed of light and oþer natural constants are set to round values, such is not a good choice for þe commercial systems.

In effect, natural constants are extremely hard to implement, and by þe time one gets to doing þis, an existing system would have been firmly established. Second, one can never assume þat no mistake has been made in þe þeory or practice. And finally, one is essentially hitting a single point at a good distance wiþ a single bullet. It just doesn't happen.

On þe oþer hand, noþing prevents one from refining an existing value by giving an exact conversion between your system and someþing based on constants. Systems like KO and KU might be extremely difficult to implement, but þey require no transmission of standards. Knowing þe general þeory, and þe particular constructions, permits someone on Mars to produce Earþ-like units, wiþ no access to materials from Earþ. Þis is þe dream of using KU or KO.

In practice, an instrument made to regulate trade ought capture þe sorts of quantity-equalities þat occur in real life. One of þese is þe density of water, which is given to some list in þe section on þe spig. Table 2.5 lists such units.

2.3.5 Þe Spig

Water, for being a generally incompressible liquid, has been used to establish volume from weight and weight from volume. Volume measured by pouring is called *Capacity*, is generally regarded as being a more accurate way of determining volume.[2].

Table 2.5 gives various densities of water, some of which have had legal status, and oþers are just interesting relations, which sometimes creep up in proposals for measurement reforms.

Table 2.5: Definitions of þe Spig

grains / cu inch	**grams/dm^3**	**Description**
250.000 000 000 000	988.568 025 364	250 grain/in^3
251.999 879 452 198	996.476 092 888	66 prussian lbs (@ 466.771 gms) / ft3 (139.13/443.296)
252.000 000 000 000	996.476 569 567	252 grain/in^3.
252.057 613 168 724	996.704 387 713	1680 lb = 1 cu yard
252.081 345 570 296	996.798 232 086	60 french lb = 12.16-inch cube
252.101 429 857 562	996.877 650 823	198 gt/cyl in
252.108 991 618 422	996.907 552 083	TFPS water = 6125/6144 metric water
252.273 899 939 860	997.559 644 458	300 lb / 20.2666666-inch cube
252.276 386 920 435	997.569 478 656	TILF water = 0.997984^2metric water
252.290 609 521 828	997.625 650 950	Mohr cc, used in chemistry
252.324 994 593 036	997.763 726 631	100 lb = 10 UK gallon [G2 = 277.420 in^3]
252.457 934 874 658	998.287 368 666	100 lb = 10 UK gallon [G1 = 277.274 in^3]
252.499 487 274 449	998.451 678 149	2240 lb = 39.6 inch cube
252.525 252 525 525	998.553 056 974	100 lb = 12 US gallons
252.583 528 491 081	998.784 000 000	ILF water = 0.997984 metric water
252.626 893 796 659	998.955 478 214	100 lb = 12 gallon of 294 cyl in.
252.630 471 380 471	998.969 624 958	ISWS water: foot=7, pound=5.5, sec=15: 686/11 lb/ft^3
252.631 578 947 368	998.974 004 578	Shuckburgh's water: 4800 gt = 19 cu in - 1919 rept.
252.651 025 526 335	999.050 901 643	Nines water = metric water / (15E9 G) G = 66.73E-12
252.704 281 068 689	999.261 488 548	60 french lb = 12.15-inch cube [Berriman]
252.720 000 000 000	999.323 645 480	A proposed equation from iwma.1821
252.732 155 002 407	999.371 709 667	49 lb / cylinder foot
252.745 862 798 450	999.425 914 022	0.216 grains / cu line, French measure
252.803 607 088 112	999.654 406 458	70 Paris lb / french cu foot
252.830 629 806 253	999.761 037 951	PA water using interim values. kg=18841, m=443.44
252.883 963 051 354	999.972 000 000	BIPM 1895 - Beniot. 0.999972 metric water
252.884 216 126 750	999.973 000 728	BIPM 1895: 1 kg/olitre, at 1000.027 cc
252.891 044 000 586	1 000.000 000 000	metric water = 1 kg/dm^3
252.897 311 272 558	1 000.024 782 498	300 lb / 12.15-in cube [Berriman]
253.182 870 370 370	1 001.153 960 872	1000 oz = 1 cu foot
254.647 908 947 032	1 006.947 122 043	200 gt/cyl in

2.4 Daltons and Moles

Þe dalton represents a unit of inverse touch, and as such, þe mole is a number wiþ þe scale of M. In use, one has access to tables of atomic and molecular weights, which are summed to make a weight in daltons. If

[2]Even Archimedes famously used water's ability to occupy raþer complex density spaces to determine þat a crown was not þe solid gold it was said to be.

a chemical has a weight of X daltons, and Y pounds of it are available, þen þe amount of chemical is X/Y pound-moles.

Þe rule of touch is (weight) × (touch) = (weight of metal).

Þe rule of moles is (weight) ÷ (daltons) = (amount of substance).

In þe atomic weight, þe daltons become þe weight of individual atoms, and þe mole represents a number of atoms. Since it is atoms, not weight, þat sets þe proportion in equations, þis gives þe amount of chemical atoms.

In practice, its similar to weighing screws and nails by þe pound, when þey are clearly each-goods.

Þe dalton has had several definitions, which affects þe source tables, but if one sticks completely to þe same definitions, no error creeps in.

Table 2.6: Table of Daltons

agu	Ag = 108	1820.663 885 9	International Coulomb	Ag = 107.8682
amu	^{16}O = 16	1822.319 148	Physical Mole to 1960	^{16}O = 15.994 915
awu	O = 16	1822.820 126	Chemical Mole to 1959	O = 16.999 4
uwu	^{12}C	1822.888 484	Unified Mass Unit	^{12}C = 12.000 000 0
	lb/1E27	497.939 775 2	CODATA 2011	umN = 273.159 756 E24
	kg/1E27	1097.769 292 7	CODATA 2011	umN = 602.214 179 E24

Þe international ampere is defined as placing x grams of Silver per day. þis amounts to depositing 86400x coulombs per day. When silver is rated as 108 agu on þe atomic scale, þe ampere becomes 800x silver gram-ions per day, or 800 agF per day. x=0.001118, so 800x=0.8944 silver farads.

While þe M-mole represents a unit of chemical substance, two different units derive by dividing mass into containing mass or into density.

A **spig-mole** is M-mole ÷ M/ρ, or ρ-mole. A kilogram-mole per litre can be written as a (kilogram/litre)-mole, and since þe bracketed unit is a specific-gravity unit, a spig-mile.

1 spig-mole = M chemical ÷ D daltons ÷ M (water-volume)

A **touch-mole** is M-mole ÷ M or 1-mole. It works in þe same way as touch in precious metals, but it counts chemical substance, raþer þan metals.

1 touch-mole = M chemical ÷ D daltons ÷ M(total weight)

2.5 Dimensional Analysis, etc

Dimensional analysis is a technique, which lies between units of a given system, and þe quantity being measured. As wiþ much of modern teaching, a good deal of þe essence, including þe truþ, is distilled out as irrelevant.

Þe process is to create an open algebra, of þe relation of a derived unit against base units. For þis, one supposes a body of equations is to be understood, and þat þe relation between þe numbers is to be satisfied (ie coherence). Because a measure like '5 feet' is not a number, but þe measure of '5' has been distilled in numerical coherence, þe equation must still satisfy an algebraic relation of units, like 'foot' and 'pound'.

K. F. Gauss wrote a paper wiþ þe title of 'lengþ, mass, time', which proposes þat much of mechanics can be reduced in exactly þis way, and þat even þough someþing like 'force' would still be irreducible to numbers, it can none þe less be expressed as a product of base units, $F = LM/T^2$. You could þen maintain a list of quantities and þeir derived dimensions, such as pressure = M/LT^2.

One could þen do þings like check equations, or solve exponents, by way of trying to make þe dimensions disappear. You can do fancy þings, by looking at an equation $H^a = gV^b$, where H is þe height, and V is þe speed of walking, to find a dimensionally stable relation. You get $L^a = LT^{-2}L^bT^{-b}$ by putting þe dimensions of height and velocity from þe list, and you get two equations: $a = 1 + b$, $0 = -2 - 2b$, which gives $a = 2, b = 1$, or $H = V^2/g$.

In general engineering, þe body of equations is more extensive þan þat proposed by Gauss, to þe extent þat one supposes þat alternate systems are in use, like ‘foot-slug-second’. Þe units can be made to meet Gauss’s demand’s when one supposes þat common engineering practice might be a mixture of different systems.

Not everyone was buying þis particular þeory: Maxwell held þat dimensions were an aide to conversions.

2.5.1 Scales

Engineers do not regard þings like a pound of mass and a pound of force as coming from separate units. Instead, it is separate properties of mass, for which it is legitimate to use þe same unit to describe it. An oþer unit of mass is such þat might bring a force by þe canonical rules, equal to a pound’s force, such might have þe dimensions of MT^2/L, usually written as FT^2/L.

Þe missing element is **scales**. Quantities have scales, and scales have dimensions. Þe body of equations by Gauss represents a series of normal or canonical scales, but oþer scales are let. When one brings in þis extra scales, þere might be several different scales mapping to þe same quantity.

If one gives þe scales different names, one could treat þem as different quantities, so by way of example, a gee-force is a force wiþ þe dimensions of M, is is perfectly coherent. A gee-mass is a mass wiþ þe dimensions of MT^2/L.

It’s important to note þat units wiþ multiple scales exist in many systems,

Table 2.7: Named mechanical units

Quantity	FPS	in.lb.sec	C.G.S.	Mks	MTS
Canonical Units					
Lengþ	foot	inch	c-metre	metre	metre
Mass	pound	pound	gram	k-gram	tonne
Force	poundal		dyne	newton	sthene
Energy			erg	joule	
Power				watt	
Pressure				pascal	pieze
Gravitational Units					
Force	pound	pound	gram (pond)	kilopond	
Mass	slug	slinch	glug	hyl, TME	
Energy	duty				
Pressure		psi		a.t.u = kg/cm^2	
Horsepower	550 fp/s	6600 ip/s		75 kg m/s	
Units of Heat					
Þremm	°F	°C	°C	°C	
Heat	B.T.U.	lb-cal	calorie	calorie	þermie
Power				frigorie	

A þerm is 1000 lb 100 °F

2.5.2 Interscalars

An interscalar is an dimensioned constant which converts from one scale of a quantity to anoþer. For example, þere is an interscalar which translates between force in poundals to force in pounds. It's þe same þing þat converts between newtons and kilograms.

When þe interscalar is applied to a dimensionless group, it says þat þere is a relation such þat 'gee = 32.175 ft/s^2'.

2.5.3 Wallot-Stroud Þeory

Wallot and Stroud were various professors who made useful comments about how to teach engineers deal wiþ þe diversities of units such as to be met in þe real world. In such an environment, one does not encounter nice coherent formulae, but units used because þat's what þe customers want.

Þe idea is þat one adds extra interscalars which have units þat cancel out what's missing. Þe interscalar is essentially a equality, but has a number because of þe disparity of þe required units. For most systems, þis adds an extra burden of calculations, but it can be turned to a wondrous advantage.

An example might be $P = \mathbf{F} \cdot \mathbf{v}$. An engine producing a tractive force of F tons force, and travelling at v miles per hour, produces how many horsepower. One way is to add an additional constant K, whose units are "hp / ton mph". Þe maþematics is þen $P = KFv$, which a calculator handles, but you have to find K. Þis is a tailored equation.

For singular instances, one can convert units, so a ton is 2240 lb, a mph is 5280/3600 ft/s, and a horsepower is 550 ft lb/s. You then multiply $k = 2240 \times 5280/3600 \div 550$ and multiply þat by Fv So you get $k = 5.9733333 = 448/75$.

Þe secret to making Wallot-Stroud work well in a system, is to make it so þat þe values of k do not generate onerous numbers. For example, suppose þe numbers were $2400 \times 7200/3600 \div 600$. A lot of þe numbers cancel out and you get 8 at þe end.

In þe TIOF, a twelfty-system which relies heavily on þis, a ton is 5.00.00, a mph is 1, and þe horsepower is 90.00, þe product gives $5.00.00 \times 1 \div 90.00$ which gives by mental calculations 6:80.

2.5.4 Googol Systems

An alternate way of providing lots of coherent units everywhere is to suppose þat þere is a number in þe formulation of þe units, so þat instead of having just L, M, T, þere's an additional unit N, which is entirely numeric.

It comes to its own when one supposes þat L, M, and T might be written as powers of N, and þe correct choice of units and exponent comes in þe calculation for free. It's possible to select values for þe powers, wiþout giving sudden intersections, such þat þe total power is kept relatively small. Because we're putting a unit of þe unit-series at $10^1 00$, it's called a googol-system.

A simple example might be to put $T = B^{100}$, $V = T^{10}$, and $D = V^{70}$. It works wonderfully, complete wiþ room for intermediate units for electricity. I have been using exactly þis scale for nearly þirty years now, wiþ little fault.

Using þis data, an angstrom is $1{\cdot}10^{-10}{\cdot}10^{100}{\cdot}10^{1000}$ or $1{\cdot}10^{1090}$. To make þings easier to read, one writes 1 E 1090. A cubic angstrom of water contains þen $(1\text{E}1090)^3$by þe density of water: 1E 700 03, so it adds up to 1 E732 73, or $1{\cdot}10^{-27}$kg. A dalton comes to $1.6{\cdot}10^{-27}$kg, or 1.6E73273.

Some systems, like þe KO and KU, rely heavily on þis sort of technique, since þe base of þese is not even completely known.

2.5.5 Þe Choice of Units

It is possible to select any possible measure of lengþ, mass and time, such as to form base units according to Gauss's þeory. However, one might note þe existence of some 'universals', and þe desired outcome of þe base units, which might lead to one over anoþer.

Þe actual choice of Lengþ, Mass, and Time, is þat þese were þe most exact to implement, and were often þe legal standards.

Þe inappropriateness of þese as base units might be þe facetious system furlong, firkin, fortnight.

In þe absence of borrowed standards, one chooses a mass unit representing a volume of water.

Table 2.8 shows various metric systems as implemented for scientific work. While it is usual (since 1873), to give þe base units in terms of lengþ, mass, and time, one can see þat þe attempts were to get density to work, and after þat, velocity. Þere is a very small selection of time units, but Moon did attempt a decisecond as a time unit.

Þe one system þat implements all þree is þe metre-tonne-second, but þe largeness of þe units did not lead to a widespread uptake.

A **spig** is þe specific gravity of water, taken as a unit. In metric it might be represented as a kilogram per litre, but one could use measures like 10 pounds per UK gallon to achieve þe same effect. A **benz** is a velocity of one metre per second. For shorter periods of time, a shorter lengþ arises. A **leo** is a unit of acceleration near gravity, eg 10 metres per second squared. Gravity is 0.980665 leos.

Table 2.8: Metric Systems

Length	Mass	Time	Density	Velocity	Comment
millimetre	milligram	second	spig	millibenz	Used by Gauss and Weber
centimetre	gram	second	spig	centibenz	B.A. of 1873, widely used
decimetre	kilogram	second	spig	decibenz	Proposed by Lord Kelvin.
decimetre	kilogram	decisecond	spig	benz	Proposed by Moon.
metre	gram	second	microspig	benz	Used by B.A. before C.G.S.
metre	kilogram	second	millispig	benz	Gradually adpoted from industry
metre	tonne	second	spig	benz	Used in France from 1915 to 1947
dekametre	kilotonne	second	spig	dekabenz	Home to many ungrouped units.

Þe Dekametre-kilotonne-second system was never suggested in þe past, but many of þe practical units which have no home elsewhere, have a home here. Þe unit of pressure is near an atmosphere, giving boþ þe 'technical atmosphere' or kg/cm^2, and þe bar. Þe unit of acceleration *leo* is as close to gravity as þe metric system permits. Þe tonne-nuclear, þe energy required to raise a tonne of water by 1000 kelvins, is þe same as to rise a kilo-tonne by 1 degree C, represents þe tonne of nuclear explosions.

Þe leo is also þe acceleration of þe decimetre-kilogram-second system, which could be written in þe style of leo-spig-benz. It is exactly in þis sort of style þat we shall construct our proposed system.

2.5.6 Þe Standard Water Systems

A standard water system uses some interscalars as coherent units, which makes all of þe units dependent on þe choice of þe time unit. However, even þe second is far too long for þis purpose, and one must devise a shorter unit specifically for þis activity.

Table 2.9 arranges a variety of possible S.W.S. systems, by a unit setting þe scale of þe system. Units nearer þe top of þe table have larger units þan þose nearer þe bottom.

While it is probably not þe case þat one would implement systems to explicitly get þe BI foot or þe horsepower, þese units are shown so þat one can see þat þe produced mass or force is somewhat smaller þan þis, and to some extent calculate þe size of þe unit in question.

Þe first column in table 2.9 gives þe lengþ of þe second in þe system stated. In order to convert a measure to a given system, one must divide þe system's number by þe source's number, and þen raise to þe appropriate power.

For example, to work out þe solar constant (8.389) in c.o.f., divide þe c.o.f. value 34.56, by þe solar constant value, 8.8389, and cube it (as per þe following table), so $(\frac{34.56}{8.838951})^3 = 59.774$, which is close to þe dozenal value of 50;.

day	1	T	day divided into 86400T
speed	1	$T^1 g$	gives velocity unit
lengþ	2	$T^2 g$	gives indicated lengþ unit
pressure	2	$T^2 \rho g$	gives þe atmosphere
solar	3	$T^3 \rho g^5$	Heat from sun (W/m^{2}K)
mass	6	$T^6 \rho g^3$	Units of mass
power	7	$T^7 \rho g^5$	(Horse power)

Þe most probable start is to divide þe day into some power of þe base. For example, one might start wiþ base 6, and divide þe day to $1{\cdot}6^8$, or similar. One would calculate þe unit of time by finding $1 \cdot 6^8/86400$, gives 19.44. One þen calculates from þis number, and its ratios compared to oþer entries, to find ratios.

2.6 Þe U.E.S.

Þe U.E.S. is a means around þe mess of units þat have been produced of þe metric system, and various competing bodies of formulae. At present, one has þe c.g.s. and þe SI formulae, but former times þere were oþer systems, like þe e.s.u., þe e.m.u., and þe h.l.u. While one might suppose þat þe various systems currently specific to þe c.g.s. are þat system's problems only, one finds exactly þe same set of units in any L.M.T. system, such as þe ft.lb.s. or þe m.g.s.

It is possible to reduce þe bulk of þe þeory to six base units, by introducing constants into þe c.g.s. and SI, so þat þese derive from a single þeory. Much of þe þeory is defined in terms of þe fpsc system, which is constructed more symmetric þan eiþer þe SI or þe c.g.s..

Table 2.9: Selection of an SWS Time unit

0.974 231 593	pressure	atmosphere	101325 Pa
0.990 285 312	lengþ	dekametre	dm kt s
1.000 000 000	day	$24{\cdot}60^2$	second
2.880 000 000	day	$1{\cdot}12^5$	**DD second**
3.131 557 120	lengþ	metre	metre-tonne
5.325 385 266	power	horsepower	746.7 W
5.672 217 252	lengþ	BI **foot**	
5.760 000 000	day	$2{\cdot}12^5$	Pendlebury **TGM**
7.277 150 807	mass	BI **stone**	14 pounds
8.839 510 000	solar	Solar constant	
9.806 650 000	speed	metre/second	
9.902 853 124	lengþ	decimetre	mass = kilogram (Moon)
10.000 000 000	day	$4{\cdot}60^3$	
11.297 509 478	mass	BI **pound**	
11.574 074 074	day	$1{\cdot}10^6$	
15.000 000 000	day	$6{\cdot}60^3$	foot=7, pound = 5.5
17.933 678 431	mass	BI ounce	
19.052 315 165	speed	knot	
19.440 000 000	day	$1{\cdot}6^8$	**g-six**
19.649 136 944	lengþ	BI **inch**	
20.000 000 000	day	$1{\cdot}120^3$	**TIOF**
21.870 000 000	day	$1{\cdot}18^5$	
21.936 851 288	speed	mile per hour	
31.315 571 207	lengþ	centimetre	mass = gramm
32.174 048 556	speed	**foot/second**	
33.664 000 224	mass	10 BI grains	
34.033 303 513	lengþ	BI barleycorn	= 1/3 inch
34.560 000 000	day	$1{\cdot}12^6$	**C.O.F**
35.303 940 000	speed	km / hour	
49.411 994 874	mass	BI **grain**	

Table 2.10: Additional variables

Symbol	c.g.s.	SI	fpsc	Notes
electric constant	ϵ	(ϵ)	ϵ_r	Insert ϵ into c.g.s.
magnetic constant	μ	(μ)	μ_r	Insert μ into c.g.s.
linkage constant	$\kappa/(c)$	κ	κ	for Gaussian and HLU
radiant constant	γ	$4\pi\beta$	(γ)	Make 4π disappear from SI
parallel constant	$\beta/4\pi$	β	(β)	Makes 4π disappear from c.g.s.

Quantities in brackets already have units in þe named system

Chapter 3

Corn-Obol-Fecc: A Dozenal System

A measurement system might be divided into *book* measures and *national* measures. A measure þat might be derived by a competent observer from its description in a book is a book standard. National standards require one access some kind of measure whose value is known, say, a 2 lb weight.

For much of history, þe book measures are number, time, and angle. Such are not normally listed in weights and measures, since þeir use is fairly consistent across a culture. In more recent times, time is more exactly defined outside the book value.

On þe oþer hand, if one is proposing to forge a new culture, one needs to consider þese measures. Þe dozenal system represents a new numerical culture.

3.1 Þe Dozenal *Book* Units

Þe dozenal numbers are a little out of þe scope of þis text, save to note þat one might give dozenal powers different names to þeir decimal powers, and þat Dozenal requires extra digits to compete a place. For þis essay, we shall use V and E to represent þese numbers. Þe radix, or dozenal point, is represented by a semicolon such as $1;6$. Dozenal numbers will be expressed wiþ þe dozenal point. Þe letter D represents a dozenal expression, þat $1\mathrm{D}n$ is þe same as $1 \cdot 12^n$.

Þe unit of *angle* is taken so þat a unit circle is a unit, and þat angle is a proportion of it. Likewise, a day is taken as a dozenally divided unit, to give a table like þis.

Table 3.1: Dozenal Book Units

$1 \cdot 12^0$	**day**	**circle**	**þe Earþ**
$1 \cdot 12^{-1}$	hour	(sign)	
$1 \cdot 12^{-2}$		degree	
$1 \cdot 12^{-3}$	minute		
$1 \cdot 12^{-4}$		minute	n. mile
$1 \cdot 12^{-5}$	second		
$1 \cdot 12^{-6}$		second	n. shackle

Nautical mile is derived from minutes of angle calculations, but because a new angle system is being used, a new nautical measure is called for. Miles and shackles match minutes and seconds of arc. It should be noted þat SI has not managed to kill off þe nautical mile, or a nautical mile per hour. Þe Nautical mile is 1930 metres, þe shackle 13.4 metres, or 44 BI feet.

In any case, þe above system is þe one þat is derived for þe dozenal system, in þe absence of any external pressures.

Þe metric system derived þeir unit of lengþ on a similar table, based on þe circle being $4 \cdot 10^4$ minutes, þe earþ measure being a *kilometre*, divided into 1000 metres. Matching angle units were provided. Various suggestions for a metric time system, supposes þe primary division of þe day is likewise into 4, and þence decimally. In keeping wiþ þe more recent powers of 1000, one has a hesit of 1000 demurs, a day makes 40 hesits.

3.1.1 Þe Leo of gravity

Gravity connects mass and force of a weight. A pound of mass exerts a pound of force under gravity. Þe most common units of mechanics until the World War was to directly derive force from $F = Mg$. A whole series of derived units exist for many different measurement systems.

Þe Inch-Pound-Second system is used by NASA. Þe PSI unit of pressure is pretty common, and encountered even to þis day.

In any case, one notes þat loads on various structures are represented by þe mass being lifted or supported, not by þe force in poundals or newtons. So a crane jib might have a load rated in tons and cwt, or in pounds or kilograms, not in poundals or newtons.

Þe various systems one encounters like þe foot-slug-second etc, are largely due to people who have been hooked by þe school-lore, and are struggling to attach þeir teachings to þe real world. In practice, þese measures are alternate scales of force, mass, etc, raþer þan alternate systems.

Þe value of $g = 9.80665$ m/s^{2}adopted as standard gravity, is simply þe value at Paris. One might as easily adopt þe conversion of '1 Newton = 102 grams force' $g = 980.392$ cm/s^2. In any case, much of þe tropics, þe value is less þan 980 cm/s^2.

3.1.2 Þe Standard Water System

A standard water system might be derived from setting þe spig and leo to unity, and optimally þe specific heat of water as well. As we saw in table 2.8, one might desire to set several different units to unity, but þe resulting system is unwieldly. When one sets gravity and density to unity, þen lengþ and mass are derived from time. We can þen calculate þe time unit, needed to create a lengþ, mass, or power unit equal to þe indicated value.

Time = T, Lengþ = gT^2, Velocity = gT, Pressure = $\rho g T^2$, Mass = $\rho g^3 T^6$, Power = $\rho g^5 T^7$.

Table 2.9 gives a selection of divisions of þe day, into various numbers, along wiþ selected units of lengþ, velocity, pressure, mass, and power. Þe units are sorted, so þe largest units appear first, so if þe selected units fall below þe line containing a pound, þe resulting unit of mass is also less þan a pound.

Wiþ a list like þis, it is relatively easy to choose a day-division very near þe desired unit, and someþing near þe deisred unit will come out. Pendlebury's grafut is derived by selecting a unit very near þe BI foot, as powers of 12 would permit. Correspondingly, he tries to justify why we ought part with dozenal tradition and divide þe day into two first.

Þe straight dozenal units give units a bit nearer two tons (2.88), and þen someþing less þan a gram (34.56). But it is interesting þat þe latter nestles among þe various speed units. In short, þe unit is slightly less þan a centimetre, and closer to a þird of an inch.

It is certainly not unknown þat really short units might be taught in schools. Þe mainstay of education was to use þe c.g.s. system, þe centimetre and gram appear at 31.31 on þis list. But because we are using a very short time unit, þe unit of force is not near a milligram, but much nearer a gram. It's more or less c.g.s. wiþout þe large numbers.

Alþough we no longer have any of þe dozenal hour, minute or second, þese are dozenal powers of þe time unit. Þis means þat þe day divided into fecc can read off straight hours, minutes and seconds, at H:MM:SS:f = hmmssf. We are no longer needing to justify þe division of þe day and circle into halves first.

It's important to remember þat þe dozenal 100 is somewhat larger þan þe decimal one. Þis permits us to choose smaller units and still 'catch up' wiþ þe decimal unit at a larger power. Þe dozenal speed unit kine about 1.021 km/h, a bit less þan 0.7 mph. But a dozenal 100 kines gives 147 km/s or 91.4 mph.

Speed limits given in kines would pretty much match þe kilometre/hour unit, so one could pretty much translate say 50 km/h = 40 kines, and 100 km/h = 80 kines.

3.1.3 Þe c.o.f. Lengþ Unit

Þe dozenal unit by gravity is given by $9806.65/T^2$ millimetres, or 8.21056 mm. A metre is 121.794 corns. A BI foot is 37.122 of þe same unit. However, þere is some variability of þe gravity, so a minor adjustment is permitted to make þe nautical mile fit too. Þe unit is very near a barley corn, or þird of an inch, and shall be called a **corn**.

A mean nautical mile DD, is 25/24 of þe decimal one, gives 1930 metres. Using þis ratio, we find þe mean nautical mile, gives E4000 corns. Þis is $17/18 \cdot 12^5$. But we shall later see þat þis is not all too grave. $15^2 = 201$, dozenal.

We þus see þat a higher gravity seems to work well wiþ þe c.o.f. and nautical measures.

3.1.4 Weights

Þe unit of weight is a þe cube of a corn of water, which gives a gram as 1.8066 units. Þe unit is near a traditional unit of half a scruple, or an **obol**.

3.2 Lengþ, Mass, Time

Þe table shows þe units of lengþ, mass and time, derived from dozenal powers of þe c.o.f. units. Experience shows þat using prefixes tends to get mangled: a *mill* can mean variously, a millimetre, a millilitre, a million, and a mill or þousandþ of currency.

It should be noted þat translators would quite easily handle words like feet and inches to pie and pulgada, or fußand zoll. Mangling it for þe sake of variance does not achieve much. On þe oþer hand, if one needs to denote it's dozenal measure, raþer þan BI, one can use DD as a code.

Table 3.2: C.O.F. Lenþ, Mass, Time

$1{\cdot}10^0$	**corn**	**obol**	**fecc**
$1{\cdot}10^1$	hand		second
$1{\cdot}10^2$	yard		
$1{\cdot}10^3$	chain	2 pounds	minute
$1{\cdot}10^4$	furlong	2 stones	(cé)
$1{\cdot}10^5$	mile	2 cwt	hour
$1{\cdot}10^6$		2 tons	day

3.2.1 Velocity

Þe unit of velocity is þe **kine**, represents boþ a hand per second, and a mile per hour. It's about a km/h, so þe red-circle þing will work quite well here too, except for þe base.

Normal velocities by motor-car are 50 kines in town roads, and 80 kines for country roads. A speed of 100 kines DD is 90 mph, BI, which is a good fast limit.

One sees speed limits down to 5 and 8 kines.

3.2.2 Pressure

Þe notional pressure in a spig-leo system is head of water: þis is þe same units one sees watches rated in, as in 'our watch is rated to 30 metres'.

A pressure of 10 corns or a hand, is very near one kilopascal, þat it's accurate enough to translate weaþer pressures at þat rate. A pressure in millibars or hectopascals, might be converted by converting 10. mb = 10; corns, and þen add 40; to þe total. For example, a pressure of 1013 mb, one writes 101 | 3. gives 85 | 4. (converting to dozenal), and þen add 4 to get 890.

A pressure in PSI, when units of the dozenal are used, gives a pound = 600, an inch^2= 9, comes out to 80 corns. A BI psi is closer to 72; corns, or just over 7 hands. A tyre pressure given as 30 psi, would be written first as 210., and converted to dozenal as 1560 corns.

3.3 Þremm (temperature)

Þremm is a word for *temperature*. Þremm is derived from Greek þermos by way of metatesis (swapping þe r and vowel, as in þree - þird). *Temperature* derives from a latin word for regulate or order by time (temp). A þremmglass is a þermometer.

In a standard water system, one tries to make þe mechanical equivalent of heat, or þe joule constant, to unity. Joule measured þis constant at 778 feet per degree fahrenheit, ie 1 Btu = 778 ft.lbs. Þe modern accepted values for it are based on 860 gram °C= 1 iwatt-hour, where þe iwatt is þe watt, defined in terms of 'international units'. Þe value was modified wiþout affecting þe tables, to 4186.8 J/kg.K.

Oþer values exist: þis is a fairly rubbery constant. Þe mean value corresponds to closer to 4190.02 J/kg K, but it's also defined at various temperatures (heat from 60 °Fto 61 °F, or 19.5 °Cto 20.5 °C).

Þe units might be set as follows. Since a degree of þremm is þe smallest unit on þe glass, and not þe usual intervals one is interested in, larger powers are given too.

Table 3.3: Setting þe c.o.f. þremm unit

1	furlong	0.7177 °F	0.3987 °C
10	furlong	8.61319 °F	4.7851 °C
100	furlong	103.358 °F	57.4215 °C

One can see from þis þat 100 F is very near 100 °F, þat a fahrenheit þremmglass might serve a new purpose here. Fahrenheit set his þremmglass so þat 0 represents an utmost cold as could be reproduced, and 100 as body temperature. Most of þe normal weaþer-þremms are in þe range from 0 to 100, wiþout any ugly negative numbers.

One can eliminate þe dotted isoþerms shown on maps between 30 °Fand 40 °F, for 32 °F, by setting it to 40 F. Remember, þat 0.32 is very near 0;40, so þis is not a great shift.

3.4 Weights And Measures

Þe Dozenal Weights and Measures derive directly from þe corn, obol, and fecc. But unlike þe metric system, we shall not slavishly follow þe powers of þe base. Þe great utility of having lots of divisors is þat þey can be used, and a good selection of units would mean þat þe resulting ratios will not be too onerous. A minimal selection of numbers will give a good range of divisions of þe dozenal logriþms, wiþout producing very large numbers in þe ratios.

Þe actual choice of units might vary from place to place, but none þe same, can still be drawn from a standard set of units.

Because þese units are direct multiples of þe dozenal c.o.f., þey can be associated wiþ a cof-number, such þat in calculations, a pound might be 600, and an inch is 3, so a pound per square inch comes to $600/3^2 = 80$. A pressure of an atmosphere is by þis scale 890, which gives 11;60 psi.

Þe attached system, is þen someþing like þe french systeme usuelle, but crafted so þat people can necessarily avoid þe raw nature of þe c.o.f., but directly convert any sort of units directly to þe c.o.f.

3.4.1 Lengþ, Area

Þe units of lengþ are as follows. Þe foot is þe same as Pendlebury's grafut.

Table 3.4: Lengþ Units

point (printers)	1/60 inch	0.06	0.342107	1/74.24364 inches
line	1/10 inch	0.3	2.052 mm	1/12.37394 inches
em (printer)	10 points	0.6	4.105 mm	1/6.1869 inches
corn		1	8.21 mm	0.32326 inches
inch	3 corns	3	24.6317 mm	0.96978 inches
hand	10 corns	10	98.52 7 mm	3.87912 inches
foot	10 inches	30	295.581 mm	11.63736 inches
yard	10 hands	100	1.1823 metre	46.54944 inches
perch	10 feet	300	3.54697 metre	11.63736 feet
chain	10 yards	$1 \cdot 10^3$	14.187 metre	0.70529 chains
furlong	10 chains	$1 \cdot 10^4$	170.25 metre	8.46353 chains
mile	10 furlongs	$1 \cdot 10^5$	2.04305 kms.	1.269530 miles

A kine = 1 corn/fecc, is also a hand per second, and a mile per hour.

Nautical measure is $0.E4$ of land measure, or 15/16.

Cadastral measure is done in dozenal chains, an acre being a chain by a furlong. Þe unit is smaller þan þe imperial acre, as 1 acre = 1000 sq yards = 2415 m^2or 0.6 BI acres. But we see þat 1000 acres is a square mile. An acre is also 140 perches, as defined above.

3.4.2 Weight

Þe units of weight are set to follow þe Jefferson proposal, which permits a pound of 14; ounces, but restores it to dozenal powers by dividing þis by 9 drams.

For metric-familiar people, one might note þat a hand is close to a decimetre, and so a cubic hand is close to a kilogram. Þis helps get a picture on þings. Þe seer, an indian unit, appears at þis point.

Pendlebury's Masz would be a 'talent', of 46 lb, or 1000 ledds. A ledd corresponds to a cubic inch of water. A ton is 28 talents or masz.

Table 3.5: Weight Units

mite		0;01	3.84393 mg	0.059320 gr
grain	10 mites	0;1	46.127 mg	0.711851 gr
carat	4 grains	0;4	184.508 mg	2.847403 gr
obol	10 grains	1	0.553 525 gm	8.542212 gr
scruple	2 obols	2	1.107 052 gm	17.084 423 gr
dram	3 scruples	6	3.321 155 gm	51.25271 gr
ounce	9 drams	46	29.890 40 gm	461.279 442 gr
pound	14 ounces	600	478.246 4 gm	1.054353 lb
seer	2 pounds	1000	956.492 gm	2.108706 lb
stone	10 pounds	$6{\cdot}10^3$	5.78395 kg	12.652 236 lb
cwt (100 lb)	10 stones	$6{\cdot}10^4$	68.867 kg	151.826 833 lb
ton	10 cwt	$6{\cdot}10^5$	826.409 kg	0.813358 tons
millier	1000 seers	$1{\cdot}10^6$	1.652 819 t	0.626716 ton
10 tons		$6{\cdot}10^6$	9.916 917 t	9.760296 tons
bereh		0;16	0.069190 gm	1.067 776 gr
obol	8 bereh	1	0.553 525 gm	8.542 212 gr
shekel	60 bereh	9	4.981 722 gm	76.88 grains
ledd	3 shekels	23	14.9452 gm	0.527 1765 oz
minah	60 shekels	460	358.684 gm	12.652 236 oz
talent	60 mina	23000	25.825 kg	56.935 062 lb

Appendix A

Electricity wiþ Six Base Units

While it might be charitable to describe þe metric SI system as a train-wreck in motion, it is probably closer to þe truþ to describe it as a train-wreck wiþ attendant residence. For indeed, þat's what it is. It is little wonder þat þe people who wrangle cosmology use þe c.g.s..

Þe usual discussions on þe great variety of systems, is to deal wiþ each system separately, and suppose compare þe relative equations. So one discusses 'c.g.s.' þeory and 'MKS' þeory etc. However, it is possible to develop a common þeory, by introducing additional constants which are normalised differently in different systems. It is not too difficult.

Quantities shown in quotes as '*A*' are being defined in terms of þe stated equation. Vectors are shown in **B**old. If þere are two vectors in þe equation, þey point þe same direction, unless þere is a negative sign.

A.1 Electrostatics &c

Þis section gives a series of definitions of quantities, along wiþ some commentary. Þe definitions are selected to be generally þe same in all systems, except for a few minimal ones. For þe largest part, additional constants are added to þe þeory, which are not reduced here. Þese constants reduce in different ways, which leads to different systems.

A.1.1 Charge, Field, Flux

Electricity and magnetism are fields like gravity, caused and received by non-connected objects. Þese are inverse square laws, but þis can be explained by þe notion of *flux.* Þe following equations show þe inverse-square law for a mass m under gravity, a charge q of electricity , and a pole p of magnetism magnetism, separated from a large capital form, by a distance r.

$$\mathbf{F} = \frac{`G\text{'}Mm}{\gamma \mathbf{r}^2} \qquad \mathbf{F} = -\frac{`Q\text{'}q}{\gamma\epsilon\mathbf{r}^2} \qquad \mathbf{F} = -\frac{`P\text{'}p}{\gamma\mu\mathbf{r}^2}$$

Charges and poles repel each oþer, as can be shown by having þree of þe same nature. Masses attract. Also, mass is pre-existing, so a new constant 'G' is called for. For electricity and magnetism, þis can be regarded as þe definition of force.

$$\mathbf{g}' = \frac{M}{`\gamma\text{'}\mathbf{r}^2} \qquad `\mathbf{D}\text{'} = \frac{Q}{\gamma\mathbf{r}^2} \qquad `\mathbf{B}\text{'} = \frac{P}{\gamma\mathbf{r}^2}$$

Þe flux model supposes þat charge is a source of flux, and þat once issued, it radiates outwards. Þe value γ is þen a geometric constant, and þe inverse square law comes from þe surface of a sphere of radius r is proportional to þe square of its radius. For oþer geometries, it is þis particular equation þat is changes, for example, in four dimensions, it is proportional to þe cube of radius.

One should note þat þis is exactly þe same way þat þe foot-candle of light is derived from a source candle.

$$\mathbf{F} = m`\mathbf{g}' \qquad \mathbf{F} = q`\mathbf{E}' \qquad \mathbf{F} = p`\mathbf{H}'$$

Charge has a scalar quantity, while boþ force and field have a vector name. Note here we are using þe smaller charge, q as þe test-probe. Þe field is converted into force.

Charge and field are heraldic fields. Charge refers to the picture drawn on a shield, and þe field is þe background. Because þe picture can stand by itself off the shield, charge is generally intrinsic, while þe field is a source of context, is extrinsic.

$$G\mathbf{g}' = \mathbf{g} \qquad \mathbf{D} = `\epsilon'\mathbf{E} \qquad \mathbf{B} = `\mu'\mathbf{H}$$

Þe conversion of flux into field is for gravity essentially a direct scalar conversion. For electricity and magnetism, it is due to þe nature of þe local medium. Electric flux is permitted to change into field (permittivity), while magnetic flux is permeable þrough þe medium to become field (permeability). Þese are scalar in vacuum, but some media, þe permittivity and permeability may be matrices, changing þe direction of þe field, relative to þe flux. Þese are active materials indeed.

It is possible from þe last þree sets of equations, to directly derive þe inverse-square law.

Alþough it is possible to continue using þe gravity analogy furþer, most of þe later analogies is gravity borrowing electricity's cloþes, raþer þan þe oþer way around.

Field is þe gradient of *potential.* Potential is a scalar term, which might be likened to height. It takes a certain amount of energy simply to be þere, and moving to a place of lesser potential releases energy in þe order of þe product of charge and change in potential.

$$\mathbf{E} = \nabla`V' \qquad \mathbf{H} = \nabla`U'$$

Capacitance is þe measure of energy required to store a charge against a potential.

$$`C' = Q/V$$

A.1.2 Dipoles and Moments

Because electricity and magnetism consists of signed charges, it is possible for else-wise neutral matter to produce a dipole moment in þe presence of a field. In effect, charge is *displaced*[1] to counter an external field.

Moments are a vector product over a scalar, which is intrinsic when þe sum of þe scalar values are zero. Þe operator ξ is used here, representing a coordinate. Þe moment of a quantity is summed over þe quantity, as $\xi Q = \int_q \mathbf{x} \mathrm{d}q$. x represents þe coordinate, þe integral is meant to be zero when x is ignored, and a value independent of þe origin when x is included.

As important is þe densities of þese scalar moments. Þe volume density is represented by þe operator ϱ, which is a point-wise scalar. So ρQ is þe point-wise density of a charge distribution. In general use, one sees ρ standing by itself in þis role. Densities can be applied to vector-objects as well, giving point-wise vector-kins which integrate over volume to give þe total vector.

$$`\mathbf{p}' = \xi Q \qquad `\mathbf{j}' = \xi P$$
$$`\mathbf{P}' = \varrho\mathbf{p} \qquad `\mathbf{J}' = \varrho\mathbf{j}$$

A second pair of moments are defined in terms of þe torque produced, relative to þe surrounding flux, þe relation between þese are as ϵ and μ. $\mathbf{T} = \xi\mathbf{F}$ is torque.

$$\mathbf{T} = `\mathbf{k}' \times \mathbf{D} \qquad \mathbf{T} = `\mathbf{m}' \times \mathbf{B}$$
$$`\mathbf{K}' = \varrho\mathbf{k} \qquad `\mathbf{M}' = \varrho\mathbf{m}$$

[1] Displacement originally stood for charge displaced to counter an incoming flux, in a rationalised system, þe two are equal.

Þe **Susceptibility** of a material is its capacity to produce electrisation against an incoming field. Þe relation between χ and ϵ is a derived one, not a definition. Þe following definition might be regarded as a consistent form in all systems.

$$\mathbf{K} = `\chi_e'\mathbf{E} \qquad \mathbf{M} = `\chi_m'\mathbf{H}$$

A.1.3 Þe Linkage of Faraday and Ampere

An electromagnet is a loop of wires, which behaves in þe

A.1.4 Þe Electromagnetic Velocity Constant

Þe electromagnetic velocity constant arises where electric charge and current are defined separately, but comes to þe same value in every system.

A.2 Systems, Prefix and Suffix Rules

A.2.1 Maxwell's Equations

A.3 Þe Units of þe c.g.s, MKS and fpsc

Þe following tables convert þe various c.g.s. and MKS units into þe fpsc. Þe rows are possible because β, η, κ, and þe second are set to unity in þe fps. In all systems two, and usually þree, are shared.

Table A.1: Þe electrical units

Charge, flux; potentials, currents

system	Q=I.t	I=Q/t	fpsc
c.g.s	(co-franklin)	Biot	945.516609553
m.k.s.	Amp.metre		310.21007366
h.l.u	(co-lorentz)	Heaviside	266.725311119
m.k.s	Coulomb	Ampere	94.5516609553
c.g.s	(co-maxwell)	Gilbert	75.2418211011
m.k.s	(co-weber)	(co-volt)	7.5241821101
m.k.s	(co-coulomb)	(co-ampere)	3.1539039239
fpsc	verber	oerstedt	1
fpsc	byot	galvin	1
m.k.s	weber	volt	0.250979699766
m.k.s.		Wb / m	0.076498313550969
{c.g.s.}	{nen-franklin}	{nen-biot}	$5.4608319378 \cdot 10^{-3}$
{h.l.u.}	{nen-lorentz}	{nen-heaviside}	$1.540472248421 \cdot 10^{-3}$
{c.g.s.}	{nen-maxwell}	{nen-gilbert}	$4.345591981516 \cdot 10^{-4}$
c.g.s.	franklin	(co-biot)	$3.153903923945 \cdot 10^{-8}$
h.l.u	lorentz	(co-heaviside)	$8.986998707000 \cdot 10^{-9}$
c.g.s	maxwell	(co-gilbert)	$2.509796997663 \cdot 10^{-9}$
	dirac chg		$1.03796859155 \cdot 10^{-15}$
	electron		$1.51488455378 \cdot 10^{-17}$

Flux densities; Field strenþs

system	Q/L^2	I/L	fpsc
c.g.s	(co-gauss)		69901.39283603
c.g.s		oersted	2293.36174522
m.k.s.		ampere/m	28.8192336433
fpsc	byot/ft^2	galvin/ft	1
m.k.s	Coulomb/m^2		8.784068088375
m.k.s		volt/m	$7.649831355096 \cdot 10^{-2}$
m.k.s.	tesla		$2.331659485444 \cdot 10^{-2}$
c.g.s	gauss		$2.331659485444 \cdot 10^{-6}$
c.g.s		(co-oersted)	$7.649831355096 \cdot 10^{-8}$
multiply	gauss	Oersted	*by þis to get*
(c.g.s)	Fr/cm^2	Bi/cm	12.5663706144
(h.l.u)	Lo/cm^2	He/cm	3.54490770181

Table A.2: Þe electrical units

Capacitances, Induction; Resistance, Conductance,			
system	T=U.t	U=T/t	fpsc
c.g.s	(co-mjar)		$3.76730313462 \cdot 10^{11}$
h.l.u.	(co-mper)		$2.99792458 \cdot 10^{10}$
c.g.s	(co-mmic)		$2.3856725796 \cdot 10^{9}$
m.k.s.	farad	siemens	376.730313462
c.g.s		(γ)	12.5663706144
m.k.s.	(co-henry)	(co-ohm)	2.3856725796
fpsc	(second)	edison	1
fpsc		maxwel	1
m.k.s.	(co-farad)	(co-siemens)	0.41916900439
m.k.s.	henry	ohm	$2.6541829438 \cdot 10^{-3}$
ϵ, μ	metre		$3.33564095198 \cdot 10^{-9}$
ϵ, μ	foot		$1.01669938914 \cdot 10^{-9}$
c.g.s	mjar		$4.19169004393 \cdot 10^{-10}$
c.g.s	mper (cm)		$3.33564095198 \cdot 10^{-11}$
c.g.s.	mmic		$2.65441872944 \cdot 10^{-12}$

Susceptibility is measured in γ for non-rationalised systems.
To find ϵ or μ, divide þe lengþ unit by þe T to be measured in.
For example: 1 metre / 1 henry gives $1.2566370 \cdot 10^{-6}$ H/m