COUNTING IN DOZENS

1	2	3	4	5	6	7	8	9	X
one	two	three	four	five	six	seven	eight	nine	dek

Our common number system is decimal - based on ten. The dozen syste twelve as the base, which is written *10*, and is called *do*, for dozen quantity *one gross* is written *100*, and is called *gro*. *1000* is call representing the meg-gross, or great-gross.

In our customary counting, the places in our numbers represent succ powers of ten; that is, in 365, the 5 applies to units, the 6 applies and the 3 applies to tens-of-tens, or hundreds. Place value is even m portant in dozenal counting. For example, *265* represents *5* units, *6* d *2* dozen-dozen, or gross. This number would be called *2 gro 6 do 5*, coincidence, represents the same quantity normally expressed as 365.

Place value is the whole key to dozenal arithmetic. Observe the fol additions, remembering that we add up to a dozen before carrying one.

94	136	Five ft. nine in.	5.9'
31	694	Three ft. two in.	3.2'
96	3Ɛ2	Two ft. eight in.	2.8'
19Ɛ	1000	Eleven ft. seven in.	Ɛ.7'

You will not have to learn the dozenal multiplication tables since ready know the 12-times table. Mentally convert the quantities into and set them down. For example, 7 times 9 is 63, *which is* 5 dozen ar set down *53*. Using this "*which is*" step, you will be able to multiply divide dozenal numbers without referring to the dozenal multiplicati

Conversion of small quantities is obvious. By simple inspection, i 35 years old, dozenally you are only *2Ɛ*, which is two dozen and eleven. For larger numbers, keep dividing by 12, and the successive remainders are the desired dozenal numbers.

```
12 ) 365
 12 ) 30 + 5
  12 ) 2 + 6
        0 + 2    An
```

Dozenal numbers may be converted to decimal numbers by setting dow figure, adding to it 12 times the second figure, plus 12^2 (or 144) t third figure, plus 12^3 (or 1728) times the fourth figure, and so on needed. Or, to use a method corresponding to the illustration, keep by X, and the successive remainders are the desired decimal number.

Fractions may be similarly converted by using successive multiplic instead of divisions, by 12 or X.

Numerical Progression

1	One		
10	Do	.1	Edo
100	Gro	.01	Egro
1,000	Mo	.001	Emo
10,000	Do-mo	.000,1	Edo-mo
100,000	Gro-mo	.000,01	Egro-mo
1,000,000	Bi-mo	.000,001	Ebi-mo
1,000,000,000	Tri-mo	and so on.	

Multiplication Tab

1	2	3	4	5	6	7	8
2	4	6	8	X	10	12	14
3	6	9	10	13	16	19	20
4	8	10	14	18	20	24	28
5	X	13	18	21	26	2Ɛ	34
6	10	16	20	26	30	36	40
7	12	19	24	2Ɛ	36	41	48
8	14	20	28	34	40	48	54
9	16	23	30	39	46	53	60
X	18	26	34	42	50	5X	68
Ɛ	1X	29	38	47	56	65	74

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E DUODECIMAL SOCIETY OF AMERICA
rlton Place ~ ~ ~ ~ ~ Staten Island 4, N. Y.

THE DUODECIMAL SOCIETY OF AMERICA

is a voluntary nonprofit organization for the conduct of research and education of the public in the use of Base Twelve in numeration, mathematics, weights and measures, and other branches of pure and applied science.

Full membership with voting privileges requires the passing of elementary tests in the performance of twelve-base arithmetic. The lessons and examinations are free to those whose entrance applications are accepted. Remittance of $6, covering initiation fee ($3) and one year's dues ($3), must accompany applications.

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CONTENTS

WHY CHANGE?

This same question was probably rife in Europe between the years 1000 and 1500, when the new Arabic numerals were slowly making their inching progress in displacing the comfortable and familiar Roman numbers universally used. *"Why even try to learn to use these heathenish scrawly symbols, with their stubborn propensity for error, in place of the beautiful clear numbers which our fathers have used for untold generations? Think of the needless waste. We would have to change all of our counting boards and abaci. X is X, isn't it? And why do we need a symbol for nothing? You can't count it! No! Let us keep to our simple tried and true numerals, and let the barbarians scratch their heads, and rub themselves out. It will all come to 0 anyhow."*

Yet, although it took D years, the new notation became generally used, and man's thinking leapt forward like an arrow sped from a bow. The early years of the Renaissance marked a new stage in the use of symbols, with the advent of algebra, fractionals (decimals?), logarithms, analytical geometry, and the calculus. Can you imagine what it would be like to try to express the coordinates of points on a curve in Roman notation?

Mathematicians became conscious of a new dimension in symbolism, and the fundamental concepts of numbers were reexamined. Man awoke to the fact that different number bases could be used, and Simon Stevin stated in 1585 that the duodecimal base was to be preferred to the decimal.

The new Arabic notation accomodated mathematical statement better, and facilitated ideation. All thinking accelerated when released from the drag of the cumbrous Roman notation.

The parallel seems tenable. The notation of the dozen base accomodates mathematical statement better, and facilitates ideation. It, too, is a step forward in numerical symbolism. The factorable base embodies a concurrent analysis and definition of numbers that stimulates classification and generalization. Yet this is accomplished by such simple means that students in the primary grades can tell why they are better. Literally, the decimal base is unsatis-factory because it has "not-enough-factors."

Then shouldn't we change? No! No change should be made, and we urge no change. All the world uses decimals. But people of understanding should learn to use duodecimals to facilitate their thinking, and to ease the valuative processes of their minds. Duodecimals should be man's second mathematical language. They should be taught in all the schools. In any operation, that base should be used which is most advantageous, and best suited to the work involved. We expect that duodecimals will progressively earn their way into general popularity. But no change should be made. Perhaps by the year 2000, or maybe by *1200*, which is *14* years later, duodecimals may be the more popular base. But then no change need be made, because people will already be using the better base.

When one is familiar with duodecimals, a number of accessory advantages become apparent. Percentage is a very useful tool, but many percentages come out in awkward figures because of the inflexibility of decimals. When based on the gross, twice as many ratios come out in even figures, and among them are some of those most used, as thirds, sixths, and twelfths, – eighths and sixteenths. There are advantages associated with time and the calendar. Monthly interest rates or charges are derived from annual rates, or the reverse, by simply moving the unit (decimal?) point. The price of a single item bears the same relation to the price of the dozen, and so does the inch to the foot.

The proper correlation of weights and measures has always been one of the world's serious problems. None of the present systems is completely satisfactory. The American and English standards are convenient to use since they are the final result of a long process of practical evolution in which many inconvenient measures have been adjusted or abandoned. The French decimal metric measures have the advantage of being set upon the same base as the number system, and are well systemized. But many of the units are awkward because of their arbitrary sizes, and because their decimal scale does not accomodate division into thirds and fourths readily.

The duodecimal system of weights and measures, based on the inch and yard, the pint and the pound, has the desirable elements of both systems, and few of their faults. This Do-Metric System retains the familiar units of the American and British standards in approximately their present size, and arranges them into an ordered metric system using the scale of twelve. This fits perfectly into the duodecimal notation, and the combination accomodates the inclusion of the units of time and of angular measure within the system, which hitherto has not been possible.

If "playing with numbers" has sometimes fascinated you, if the idea of experimenting with a new number base seems intriguing, if you think you might like to be one of the adventurers along new trails in a science which some have thought staid and established, and without new trails, then whether you are a professor of mathematics of international reputation, or merely an interested pedestrian who can add and subtract, multiply and divide, your membership in the Society may prove mutually profitable, and is cordially invited.

The Duodecimal Bulletin

All figures in italics are duodecimal.

MODERN COMPUTING MACHINES and SPLIT-BASE ARITHMETIC

by Harry C. Robert, Jr.

Last January at the annual meeting of the Duodecimal Society it was suggested that the relationships between the arithmetic of modern computing machines and base twelve arithmetic might offer a profitable field for investigation. A cursory, elementary and very preliminary sort of examination of this subject has produced a number of problems which apparently have not been thoroughly examined previously. The extensive ramifications of the subject makes it desirable to outline at this time the nature of some of these problems in order to stimulate interest in the subject and also to provide other amateurs with a starting point for a comprehensive study of the interesting questions involved.

From the published information available it appears that all of the modern high speed computers make use of two-response relays, some of the electro-mechanical type but more generally of the electronic or vacuum tube type. A two-response relay has two and only two answers to any question. Its answers may be listed as yes and no or as 1 and 0. Under no circumstances can such a relay give the answers, – yes, no, maybe, or 0, 1, 2. While the development of satisfactory relays capable of three or more responses is probable, those now available sacrifice greater compactness and speed to the trouble free reliability characteristic of the simple on-off two-response types.

From the limitation of the two-response relay it was a logical step to construct computers to operate on the binary system; that is, base Two. Several of the better known machines have been built for base Two operation. The known difficulty of the large number of figures required to express numbers in base Two is overcome by using base Eight as a sort of short-hand for expressing each three figures of the base Two number. Obviously conversion between bases Two and Eight can be rapidly performed by inspection, thus

Base Two N =	001	010	011	101	110	111
Base Eight N =	1	2	3	5	6	7

If we chose to group our base Two figures by fours instead of threes we could use base Do-Four (Sixteen) as our short-hand.

The use of base Eight in connection with base Two provides such a simplification of the problem that the remainder of this discussion would be purely academic if base Eight were in general use. The ever increasing use of super-computers on computations of all kinds could eventually lead to a change in the number base in common use. Even the most rabid advocate of the duodecimal system must admit that the choice of a new base might be confined to bases Eight and Do-Four unless we can find reasonable methods of combining the other advantages of base Twelve with the simplicity of base Two computers. As matters stand at present, all data given a base Two computer and all results must be converted either by the machine or independently between bases Two or Eight and base Ten. In so far as our present knowledge goes the same situation would exist if base Twelve were in general use.

Obviously any computer requiring extensive conversions from one base to another suffers in efficiency, either from loss of time or complexity of construction or combinations of these factors with loss of accuracy. For this reason a number of the super-computers have been built using various combinations of two-response relays to represent each digit of a base Ten number. One of these is the development of Bell Laboratories which requires seven relays for each digit and operates on the Bi-Quinary system. Since this machine has been described in several publications, the relay arrangement will not be given. Instead we will show how the same seven relays may be used to represent the figures required for base Twelve notation, -

Relay / Number	00	4	8	0	1	2	3	or	00	3	6	9	0	1	2
0	1	0	0	1	0	0	0		1	0	0	0	1	0	0
1	1	0	0	0	1	0	0		1	0	0	0	0	1	0
2	1	0	0	0	0	1	0		1	0	0	0	0	0	1
3	1	0	0	0	0	0	1		0	1	0	0	1	0	0
4	0	1	0	1	0	0	0		0	1	0	0	0	1	0
5	0	1	0	0	1	0	0		0	1	0	0	0	0	1
6	0	1	0	0	0	1	0		0	0	1	0	1	0	0
7	0	1	0	0	0	0	1		0	0	1	0	0	1	0
8	0	0	1	1	0	0	0		0	0	1	0	0	0	1
9	0	0	1	0	1	0	0		0	0	0	1	1	0	0
χ	0	0	1	0	0	1	0		0	0	0	1	0	1	0
Ɛ	0	0	1	0	0	0	1		0	0	0	1	0	0	1

The figure, 1, in the above table, shows which relays are used for the representation of each number. The general arrangement for base Ten is similar, with the relays grouped two and five instead of three and four as in the table on the left, or four and three as in the table on the right. Since base Twelve numbers can be represented with the same number of relays as base Ten, the Bell Laboratories machine which has a capacity for numbers up to about 10^{19} in base Ten could, without using any more relays, handle numbers approximately thirty times greater if connected for base Twelve operation. Obviously for computers of this type base Twelve has an advantage over base Ten. It will be readily seen that less than seven relays might be used to represent either base Ten or Twelve numbers. However it will be noted in both of the above tables that one relay only is actuated in each group of three and one relay only in each group of four. This permits detection of error whenever no relay or more than one relay is actuated in any group.

It is apparent that if suitable relays were available, it would be possible to represent base Twelve numbers with one three-response relay and one four-response relay. These two relays could be used in two different orders. First, corresponding to the left hand table, we would use the 3-response relay to count the number of complete fours in the number and then use the 4-response relay to register the number of units in excess of fours. The second arrangement would reverse the order of the two relays, with the 4-response relay being used to count the number of complete threes and the 3-response relay used to represent excess units. Designating these two arrangements as bases 3(4) and 4(3) respectively, the representation of base Twelve numbers would be,-

Number	Base 3(4)	Base 4(3)
0	00	00
1	01	01
2	02	02
3	03	10
4	10	11
5	11	12
6	12	20
7	13	21
8	20	22
9	21	30
χ	22	31
Ɛ	23	32

The above may, for lack of any better designation, be referred to as split-base notation. Under base 3(4) the left hand column is in base Three and the right hand column is in base Four notation. For base 4(3) the bases are reversed. In this notation each base Twelve place is represented by two figures which alternate base Three and Four. Addition in such split notation is simple;- thus in base Twelve, *75* + *47* = *100* may be handled:

Base 3(4)	Base 4(3)
13 11	21 12
10 13	11 21
01 00 00	01 00 00

It is evident that multiplication may be somewhat more complicated. A simple procedure that might be applied to machines involves the following consideration.

Any number, N, written in split-base a(b) notation when multiplied by a retains the same sequence of figures followed by 0, but the result is now written in notation b(a). Thus:

Base Twelve *75·3 = 1ᘔ3*

or 13 11 Base 3(4) times 3 = 01 31 10 Base 4(3).

If this result is now multiplied by 4, we obtain,-

13 11 00 Base 3(4) = *750* Base Twelve, as it should be.

Since only a dozen correspondences are required to convert a number from base 4(3) to its complement, base 3(4), a device for converting such numbers could easily be built into a machine. Thus 01 31 10 Base 4(3) could automatically be converted to 01 22 03 Base 3(4) which would then be in form to add to any previously accumulated partial product written in the notation of that base. Only one conversion is necessary, other places being obtained by adding pairs, 00, to either the converted number or the original number.

The idea of a split-base notation may or may not be new. The idea may or may not have value. Of course for square bases such as Do-Four (Sixteen) it is obvious that numbers could be written in split-base 4(4) and all manual operations could then be performed in base Four. Individuals would always have the choice as to whether they used the smaller or larger base. If the mechanics for handling split-base notation can be developed without too much complexity, this device would permit use of the sexagesimal system, introducing the factor, 5, by means of split-base *5(10)* or its complement *10(5)*. Certainly it appears that the split-base idea should be carefully studied.

There is at least one possible approach to the idea of adapting base Twelve to base Two operations. If we use four 2-response relays and base Two notation, we can represent the dozen values required by base Twelve, thus

0	0000	*6*	0110
1	0001	*7*	0111
2	0010	*8*	1000
3	0011	*9*	1001
4	0100	*ᘔ*	1010
5	0101	*Ɛ*	1011

Now two numbers represented in this manner may be added just as for base Two with the exception that any carry forward from the fourth column from the right also must result in a carry-back to the third column. This is obvious, since the carry forward if it were regular base Two would amount to 14, but since our group of four figures represents base Twelve, we only carry 10 forward and must carry-back four, that is 1 added to the column on the right.


```
Thus, -      ᘔ   =      1010
           + Ɛ   =      1011
            19   =    1 0101
                    +      1   (carry-back)
                      1 1001
```

The only other departure from regular base Two procedure is necessary only in the final interpretation of results. Since the four columns of base Two figures can normally be used to represent *10, 11, 12* and *13* in addition to the values in the table above for *0* to *Ɛ*, some of these values may occur in final results. This operation can be accomplished by inspection or could be done automatically on a machine by adding columns third and fourth from the right in each group and carrying forward 1 to the column to the left whenever 1 appears in both the third and fourth columns in any group. Thus we may add,

```
   13Ɛ   =   0001 0011 1011
 + 268   =   0010 0110 1000
   3ᘔ7       0011 1010 0011
           +              1   (carry-back)
             0011 1010 0111
 + 378   =   0011 0111 1000
             0111 0001 1111
           +         1        (carry-back)
             0111 0101 1111
           +         1        (carry-forward
                               two 1's under-
                               scored)
   763   =   0111 0110 0011
```

Multiplication can of course be performed as a succession of additions, however the multiplicand must vary depending on whether the figure in the multiplier in use is in hhe 1, 2, 3 or 4 sub-places. As an example, we wish to multiply 95 by 4Ɛ.

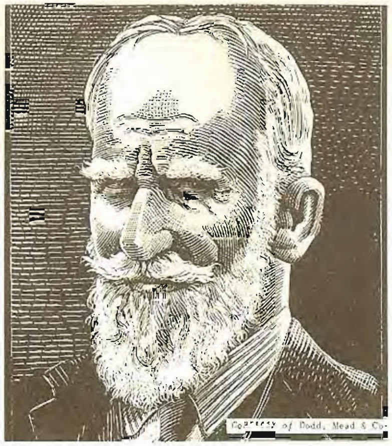
```
    95   =        1001 0101 = M1
                  1001 0101
 (2)95   =   0001 0110 1010 = M2
             0001 0110 1010
 (4)95   =   0011 0001 1000 = M3
             0011 0001 1000
 (8)95   =   0110 0011 0100 = M4
```

Now we are ready to multiply,-

	1001 0101	=	*95*
×	0100 1011	=	*4Ɛ*
	1001 0101	=	M_1
	0001 0110 1010	=	M_2
	0001 1111 1111		
	0110 0011 0100	=	M_4
	1000 0111 0111		
	0011 0001 1000	=	M_3*(10)*
	0011 1001 1111 0111		
+	1		(carry underlined excess)
	0011 1010 0011 0111	=	*3X37*

These operations are all performed as on base Two with the exception of the carry-back to the third place whenever there is a carry-forward at the fourth place, and the use of three auxiliary multiplicands when multiplying by the figures in the second, third and fourth sub-places. These are irksome and time consuming when added to a manual operation but should be very simple devices to incorporate in a machine which has a mechanical memory and built-in instructions. The same system could be adapted for base Ten but the carry-back rule requires a carry-back of 6, that is, we add 1 to both the second and third sub-places from the right of each group. The carry-forward of excess is also somewhat more complicated and has two contingencies, one of which requires a carry-back. The greater complexity of handling base Ten by this method may account for the fact that none of the super-computers about which there is published information have used such a system.

In for foregoing we have looked only at the operations of addition and multiplication. Usually if these two operations can be performed without too much difficulty in a consistent manner, some method can be found to accomplish other operations. Certainly these other operations should be investigated. The methods outlined here are first thoughts only. Probably they can be improved. Perhaps other and superior methods exist. The field is new and there is an opportunity for a great deal of interesting exploration. The split-base idea may have possibilities in recreational mathematics even if it should have no value in more serious work.



G. B. S.

The whole world pays its respects to George Bernard Shaw, who died November 2nd, 1950, in his 95th year. We may expect to learn of disturbances and commotions on Olympus, of some rearrangement of established dignities, and a considerable increase in merriment, with his belated arrival.

Of importance to us, is the loss of an effective advocate of the advantages of the 12-base. There are a number of favorable allusions to duodecimals in his extensive writings, but two of his statements are important in duodecimal history.

In a letter to the London Times on Basic English and Spelling, published in its issue of March 30, 1944, Shaw said, "Basic English is a natural growth which has been investigated and civilized by the Orthological Institute on the initiative of Mr. C. K. Ogden, whose years of tedious toil deserve a peerage and a princely pension. The only job comparable to it is that of the American George S. Terry, who has given us tables of duodecimal logarithms."

The other is a strong letter of commendation, dated October 21, 1949, to a firm of music publishers in London, on Velizar Godjevatz' New Musical Notation. This letter was reporduced in the Duodecimal Bulletin of February, 1950. In it, Mr. Shaw said, "I am greatly taken by Mr. G's plan. It is enormously more readable, writable, logical, graphic, and labor saving than any I can remember. Its adoption would save a world of trouble. Mr. G's plan would teach people to count duodecimally with two new digits: eight, nine, deck, ell, ten; and this by itself would recommend it, as duodecimal arithmetic is a coming reform. I am no longer a reviewer; but if my valuation of the plan will help to call attention to it, you may quote this letter as much as you please.

G. Bernard Shaw."

TABLE OF EQUIVALENTS FOR 1 METER

by Dallas H. Lien

1 METER =	Decimal	Duodecimal
angstroms	1 x 10^{10}	*1.Ɛ30 Ɛ91 054* M^{3}
astronomical unit	6.689 x 10^{-12}	*4Ɛ.78* M^{-4}
barleycorn (Br.)	118.11	*9X.14*
bolt (U.S. cloth.)	0.027 340	*0.03Ɛ 2Ɛ1*
cable's length	0.004 556 8	*0.007 X5X 6*
cad (DD)	3.265 505 2 x 10^{6}	*1.115 915 3* M^{-2}
centimeters	100	*84*
chain (engineer's or Ramden's)	0.032 808 3	*0.048 839 1*
chain (Gunter's)	0.049 709 60	*0.071 X94 0X*
cosrau (Br.)	1.684 933 x 10^{15}	*1.115 922* M^{5}
cosrau (U.S. OR DD)	1.684 928 98 x 10^{15}	*1.115 915 3* M^{5}
cubit (Br. 18")	2.187 228	*2.22Ɛ 644*
cubit (U.S. 18")	2.187 222 2	*2.22Ɛ 62X 6*
dekameter	0.1	*0.124 972 497*
digit (Br. ¾")	29.527 6	*25.63Ɛ 8*
ell (Br. cloth. 45")	0.874 891 2	*0.X5Ɛ 98Ɛ*
em or pica (print.)	236.22	*178.28*
fathom	0.546 81	*0.668 X8*
feet (Br.)	3.280 843	*3.345 368*
feet (Fr. pied)	3.078 4	*3.0Ɛ3 6*
feet (U.S.)	3.280 833 3	*3.345 343 9*
furlong	0.004 970 96	*0.008 70Ɛ 26*
gamrau (Br.)	9.750 772 x 10^{12}	*1.115 922* M^{4}
gamrau (DD)	9.750 746 4 x 10^{12}	*1.115 915 3* M^{4}
grovic (DD naut. mi.)	5.174 092 x 10^{-4}	*.X88Ɛ 85X* M^{-1}
hand (Br.) (4")	9.842 526	*9.X13 X75*
hand (DD 4") (U.S.)	9.842 499 9	*9.X13 X0Ɛ 3*
hectometer	0.01	*0.015 343 X10*

1 METER =	Decimal	Duodecimal
inch (Br.)	39.370 10	*33.453 66*
inch (Paris pouce)	36.941 3	*30.Ɛ36 7*
inch (U.S.)	39.370 000	*33.453 439*
karl (Br.)	1889.765	*1115.922*
karl (DD)	1889.760 0	*1115.915 3*
kilometer	0.001	*1.889 Ɛ98* M^{-1}
league (naut.)	1.798 7 x 10^{-4}	*.389 11* M^{-1}
league (statute)	2.071 3 x 10^{-4}	*.436 5* M^{-1}
light year	1.056 7 x 10^{-16}	*1.765* M^{-5}
ligne (Paris line)	443.296	*30Ɛ.367*
line (Br.)	472.441 2	*334.536 6*
line (U.S. 1/12")	472.440 00	*334.534 39*
link (engr. or Ramden's; 1 US ft.)	3.280 833 3	*3.345 343 9*
link (Gunter's)	4.970 960	*4.Ɛ79 99Ɛ*
mark	4.130 94	*4.16X 32*
megameter	1 x 10^{-6}	*2.ƐX0* M^{-2}
micro-millimeter	1 x 10^{9}	*23X.X93 854* M^{2}
micron	1 x 10^{6}	*402 854*
mil (U.S.)	39370.000	*1X94X.000*
mile (Br.)	6.213 73 x 10^{-4}	*1.0X7 4Ɛ* M^{-1}
mile (naut.)	5.396 1 x 10^{-4}	*Ɛ.233 2* x 10^{-4}
mile (US statute)	6.213 699 x 10^{-4}	*1.0X7 4X* M^{-1}
millimeter	1 x 10^{3}	*6Ɛ4*
milli-micron	1 x 10^{9}	*23X.X93 854* M^{2}
millionth micron	1 x 10^{12}	*141.981 Ɛ87 854* M^{3}
myriameter	1 x 10^{-4}	*.20X 722* M^{-1}
nail (Br. 2¼")	17.497 82	*15.5Ɛ8 2X*
pace (Br. 2½')	1.312 34	*1.38Ɛ 88*
palm (Br. 3")	13.123 368	*11.159 22*
palm (U.S.)(3")	13.123 333	*11.159 153*

1 METER =	Decimal	Duodecimal
parsec	3.243×10^{-17}	*0.5ƐƐ5* M^{-5}
perch (Br. & U.S.)	0.198 838 4	*0.247 714 3*
pica or em (print.)	236.22	*178.28*
pied (Fr. ft.)	3.078 4	*3.0Ɛ3 6*
point (print. 1/72")	2834.6	*1782.7*
point (Br. DD)	5669.295	*3345.366*
point (US. DD)	5669.279 9	*3345.343 9*
pole (Br.) rod	0.198 838 4	*0.247 714 3*
pouce (Paris inch)	36.941 3	*30.Ɛ36 7*
quan (Br.)	157.480 4	*111.592 2*
quan (DD)	157.480 00	*111.591 53*
quarter (Br. linear)	4.374 46	*4.45Ɛ 0X*
rentrau (Br.)	$5.642\ 808 \times 10^9$	*1.115 922* M^3
rentrau (DD)	$5.642\ 793\ 1 \times 10^9$	*1.115 915 3* M^3
rod (surveyor's)	0.198 838 4	*0.247 714 3*
rope (Br.)	0.164 042 2	*0.1Ɛ7 56Ɛ 5*
skein	$9.113\ 3 \times 10^{-3}$	*0.013 8Ɛ8 2*
span (1 quarter)	4.374 46	*4.45Ɛ 0X*
toise (Fr. fathom)	0.513 074 02	*0.61X 712 99*
ultrau (Br.)	$3.265\ 514 \times 10^6$	*1.115 922 x* M^2
ultrau (DD)	$3.265\ 505\ 2 \times 10^6$	*1.115 915 3* M^2
wave lengths of cadmium red	$1.553\ 164\ 13 \times 10^6$	*62X.9X4 17 M*
wave lengths of mercury green	$1.831\ 249\ 625 \times 10^6$	*743.901 52 M*
X-Unit	$9.979\ 74 \times 10^{12}$	*115.218* M^3
yard (Br.)	1.093 614	*1.115 922*
yard (U.S.)	1.093 611 1	*1.115 915 3*

MATHAMERICA

or, The American Dozen System of Mathematics

by Grover Cleveland Perry

The purpose of this work is to set forth a new theory and motive regarding numbers – to explain and demonstrate an improved process of calculation, and to point out some of the benefits and economies that follow the understanding and uses of this new discovery.

The higher and immensely valuable symbolism of mathematics has been lost in the confusion of a mis-fit number system. The mathematical interpretation of things has been merely mechanical in its significance. Its practical and symbolical meaning is not indicated in the disrupted and broken sphere of decimal operations. Let the beginner in the study of twelve, as herein treated, ponder the simple but universal lessons that this great number teaches, and mathematics will become to him a living subject, all-absorbing, interesting – full of useful lessons and indicative of good works.

Twelve, the base of the new system, is well established in the respect and customs of the people of all lands. The mathematics of the new system will grow and develop for it is not only demonstrative and symbolical as a theory, but more than adequate as a tool, – meet for this age of pioneering, engineering and general progress.

The American Dozen System of Mathematics, founded on the base twelve, provides a complete workmng system of nimbers that can be handled by twelves in large and small denominations and computed in a manner that is as rapid, and more accurate and comprehensive than the well-known Arabic Decimal System of tens.

Twelve is the natural arithmetical and geometrical base for the use of numbers. It is the center of the perfect mathematical universe, in and around which all forms and numbers operate harmoniously. Twelve is the number of science and service complying with all mathematical law; while ten is the number of physical sense, having its origin as a base number in counting on the ten fingers and thumbs of the human hands.

The decimal system of tens is out of step with all natural law and order. It does not and cannot satisfy the numerical requirements of mankind. It is used, where used, not because of

The late Mr. Perry published a number of pamphlets on the dozen system, of which Mathamerica (1929) is the most comprehensive. Since these publications are now largely out of print, this abstract will serve to acquaint our readers with his work. Mr. Perry is to be credited with the unique accomplishment of having cleared through his Chicago bank a number of checks in which the amounts of money involved were expressed in grosses and dozens of dollars and cents, the figures being duodecimal.

its superiority, but because it has been the only system with functions that made possible the handling of the larger amounts. Wherever real practical service is required, as in division of numbers, weights and measures, the handling of merchandise, etc., twelve is in every way preferable to ten. The only reason that twelve has not displaced the decimal ten completely is because there has been neither method, names nor characters i.e., a system, for handling numbers by units, dozens, grosses, etc., as is done by units, tens, hundreds and thousands.

While number itself exists as a mental or spiritual fact, its exemplification is suggested by the form of the things surrounding the individual and dawns on consciousness very slowly. The primeval and elementary number-forms are symbolized by names: Two, Three and Four, and also by figures 2, 3 and 4 - all factors of twelve. These simple concepts are observable as objects about us. The divisions of 2 are seen in the horizon dividing earth and sky; a North and South line dividing the East from the West; the path or highway dividing the right from the left; day and night; up and down, and countless other divisions of 2. Number 3 is seen in earth, sea and sky; the forked path; the confluence of two streams making a third. Number 4 - in the crossroads; the tree bisecting the horizon; the square plot of ground; the 4 cardinal points of the compass or circle. Numbers 6, 8 and 9 are seen in compound forms of 2, 3 and 4, and certain forms that are modifications of the circle and sphere.

As it is with numbers so it is in geometrical theory. The line, circle or cycle divides: By 2 - into the half or semicircle: By 3 - into the third, the Y, or triangle: By 4 - into the cross, square or quadrant: By 6 - into the hexagon. The cube has 6 sides and twelve edges. These forms and numbers are the factors of the twelve unit but not of the ten.

Man began counting with these primary number concepts, but in recording or tabulating the amounts the digits or fingers of the hands were used. Very oddly these fingers do not correspond in number to anything in science or nature, but are manifest as 5 and ten. This counting gives us a system of tens, or decimals, on which our whole number scheme is founded. Ten is not, unfortunately a multiple of divisors other than 2 and 5.

Division is the test of all things. The multiplication of forms and numbers is not difficult; after the problem or unit has been solved - its factors and parts divided and determined - or a model constructed. And it is just here that the decimal system reveals its disintegrating, schismatic nature. Any continued division of numbers by decimals breaks these numbers into prolonged and recurring fractions; which to reassemble requires the most complicated and drastic treatment in all arithmetic.

If further evidence is required to show the inherent superiority of twelve over ten it may be useful to observe how mankind

has divided its units of measure when uninfluenced by decimal usage and practices.

National or natural measures, (as distinct from artificial measures, such as the decimal and Metric measures) were in existence centuries before the decimal ten system of numbers was in general use. Consequently these measures were not influenced by decimal calculation. Here we may expect to find, and do find, that the divisions of the unit are either factors of twelve, twelve itself or multiples of twelve. This unlabored selection would be enough of itself to prove that twelve is the logical base number for the divisions and subdivisions of the unit.

The English-American yard is a natural measure, and is the most wonderfully convenient and mathematically perfect measure in existence. The yard with its 3 dozen inches divides evenly (without a recurring fraction) by 2, 3, 4, 5, 8 and 9. Its one-third is the foot of twelve inches, divisible by 2, 3, 4 and 6. With the inch subsidided into twelfths - lines, (French lignes) - comes another unit divisible by the same divisors. This is the acme of mathematical perfection.

Other natural measures are notable for their divisibility. The gallon has 8 pints and 4 quarts. The bushel has 4 pecks each with 8 quarts. The pound has ounces twelve and four. The day 2 dozen hours. The Zodiac twelve signs or divisions. The year twelve months. In music and other forms of sound the meter, time or rhythm automatically arranges itself into factors of twelve; while the full chromatic scale of tones is made up of twelve equal intervals within the octave, as of black and white keys on the piano keyboard. None of these divisions are normal factors of ten, but all are even divisors of the unit of twelve parts.

The beginner in Dozen System of numbers should remember that the mathematical habits of mankind are built up on the decimal method of thinking. He will constantly encounter the tendency to think a certain way and should not be discouraged if this age-long habit is not immediately overcome. No good thing is ever attained without some effort, and success can generally be measured by the amount of effort put forth; not only in attaining the new, but in overcoming the old, which in this case is the greater part of the required effort.

The digits or figures in the Dozen System are:-

1, 2, 3, 4, 5, 6, 7, 8, 9, T, Ɛ, 0

The character T is referred to as "figure ten" and L as "figure eleven". Their numerical values are the same as in the decimal system. Figure 0 represents zero: no value. Printers type or typewriter characters may be used for ten and eleven; letters T for the former and L for the latter.

The columns or scale of values ascend from left to right by twelves; as units, dozens, grosses (twelve dozens).

The first column, right, is the units column; the second, to the left, the dozens column:

0	zero	*10*	one dozen
1	one	*11*	one dozen one
2	two	*12*	one dozen two
3	three	*90*	nine dozen
4	four	*T0*	ten dozen
5	five	*T1*	ten dozen one
6	six	*TT*	ten dozen ten
7	seven	*TL*	ten dozen eleven
8	eight	*L0*	eleven dozen
9	nine	*LL*	eleven dozen eleven
T	ten		
L	eleven		

The third column to the left is the gross (twelve dozen), the fourth column is the grand (dozen gross).

100 one gross
101 one gross one
1LL one gross eleven dozen eleven
200 two gross
1,000 one grand
6,T00 six grand, ten gross
L,6T5 eleven grand, six gross ten dozen five
2T,360 two dozen ten grand, three gross six dozen

The seventh position or place is called the Americ.

T,310,L24 ten Americ, three gross 1 dozen grand, eleven gross two dozen four.

The tenth position is the Brithain *(Bre-thain)*.

4T,50L,042,89T four dozen ten Brithain, five gross eleven Americ, four dozen two grand, eight gross nine dozen ten.

The complete scale of numbers, up to 9 places on the units side and 5 places on the less-than-units side of the twelve-point, is shown herewith:

gross Brithain	dozen Brithain	BRITHAIN	gross Americ	dozen Americ	AMERIC	gross grand	dozen grand	GRAND	gross column	dozen column	units column	twelfth point	twelfths	gross parts	grand parts	twelfth-grand	gross-grand pts.
6	0	2,	3	6	T,	4	7	1,	5	L	8	:	3	T	1	2	L

The above string of figures should be read as follows:
Six gross two Brithain, three gross six dozen ten Americ, four gross seven dozen one grand, five gross eleven dozen eight and three twelfths, ten gross parts, one grand part, two dozen-grand parts, eleven gross-grand parts.

The language of the American Dozen System is the same as with decimals from 1 up to twelve. From twelve on the language is distinct from that of any other system.

When writing numbers a distinction between the decimal and dozen systems is sometimes required. Note the figures 315 for example. This number may be read as, Three gross one dozen five, or as three hundred fifteen. Whenever a page or form is used that embodies the numerals T and L then, of course, the context itself indicates that it belongs to the Dozen System. When an expression may be read either way, then the colon (:) should be affixed if the amount is in dozens and the decimal sign (.) if in decimals. Thus, 315: should be read by dozens - but 315. as a decimal expression. It is the same with less-than-unit parts, except that the sign precedes the number, as :4, meaning 4 twelfths and not as a decimal expression as .4 (four tenths).

The word "dozen" has a noun form that the word ten does not have. We can say A dozen, half-dozen, quarter or third dozen: but similar expressions for ten do not seem to be used. Perhaps the fact that a half-ten would be a very unusual requirement; and that a quarter or third of ten does not exist (except in decimal arithmetic) accounts for the absence of such terms.

Twelve is the natural base for the division of the unit as it is for the multiplication of units. In the American System numbers may be likened to a train of gears, with twelve the main wheel and all gears and sub-gears meshing perfectly. Twelve, or the unit of twelve parts, can be divided evenly by all the digits except 5, 7, T and L without a recurring fraction; and any resulting quotient can likewise be re-divided, continually, with an even remainder. The quotients divide out in one or 2 places; that is, the divisors 2, 3, 4 and 6 fit into twelve evenly; numbers 8 into 2 dozen, and 9 into three dozen. The numbers 5, 7, T and L function perfectly as numbers per se, in their respective order and places, but in their relation to other numbers they are erratic - like comets - with orbits that do not synchronize with the movement of the other numbers. They are seldom used as divisors, therefore they make no trouble in arithmetic.

With unity based on twelve - that is, assumed to have twelve parts - 1/3 becomes :4 (4 twelfths) and not the decimal .333 1/3. Likewise 1/6 = :2 (2 twelfths) not .166 2/3; and 2/3 becomes :8 (8 twelfths) instead of .666 2/3. It will thus be seen that these inexact, awkward, but much used decimal forms have no existence in the American System. In their places are less-than-unit-parts, expressed exactly and conveniently in twelfths, without prolonged or recurring values.

In the arithmetic of dozens, twelve or its multiples becomes the base or denominator for every divisional representation, when less than a unit in value; as well as for every number or group of numbers when considered as more than a unit. The *place* where the whole number *ends* and the unit-parts *begin* is purely theoretical and the processes of arithmetic apply to both in exactly the same manner. The twelfth point (:) is inserted between the whole number and its parts, but the entire number is never separated for treatment.

Since all integers (except 5, 7, T and L) will divide twelve or any of its factors or multiples evenly we can express twelfths, as follows:

Common Fractions	Dozenal Equivalents		Decimal Equivalents
1/2	:60	6 twelfths	.5
1/3	:40	4 "	.333+
2/3	:80	8 "	.666+
1/4	:30	3 "	.250
3/4	:90	9 "	.750
1/6	:20	2 "	.166+
5/6	:T0	T "	.833+
1/8	:16	1 " , 6 gross parts	.125
3/8	:46	4 " , 6 " "	.375
5/8	:76	7 " , 6 " "	.625
1/9	:14	1 " , 4 " "	.111+
2/9	:28	2 " , 8 " "	.222+
4/9	:54	5 " , 4 " "	.444+
5/9	:68	6 " , 8 " "	.555+
7/9	:94	9 " , 4 " "	.777+
8/9	:T8	T " , 8 " "	.888+

Out of the above sixteen divisions, expressed in twelfths, all divide out evenly. Expressed decimally, however, ten of them have recurring fractions, with half of the even quotients requiring 3 places to complete the division.

It is in its application to actual problems of measurement that the full beauty and utility of the Dozen System is seen. Authorities state that the twelve-inch foot rule has been used as far back as history can be traced. It is a singular thing that our Anglo-Saxon measurements are founded on twelve, contrary to all decimal theory and practice. It seems like one of those strange decrees of Wisdom, a sign, the meaning of which is revealed only in process of time and growth. The American System comes not to destroy, but to extend, maintain and fulfill the high destiny of Anglo-Saxon weights and measures.

The natural measure of volume (liquid and dry) is the cubic yard, the cubic foot and their cubic subdivisions. The cubic yard volume, has all the advantages of both container or linear calculations and with the cubic foot, the cubic inch, and cubic line, as in the Dozen System, offers all the variations in size that are required in general practice and laboratory work. With the cubic foot weight (1 cu. ft. of water) used as the standard weight with its natural cubic subdivisions we have prophetic fulfillment of the great Magna Charta:

"There shall be one measure throughout our whole realm; and it shall be of weights as it is of measures."

Twelve vs. Decimal-Metric Systems

The decimal propaganda (Metric measures and decimal coinage) has troubled the English-speaking peoples for more than a century. It will continue to trouble them until they perfect their own Systems or else yield to the greater error of the various systems founded on decimals. As the decimal theory has spread over the world, gradually embracing one after another of countries, the fuller force of the decimal assault has been directed at the United States and Great Britain.

The United States uses the decimal currency, and some have inquired of the writer if he would be willing to go back to the old English system of pounds, shillings and pence, as was used by the American Colonies, and is current today in Great Britain.

There are 2 important factors in the consideration of this subject. They are: (1) the respective merits of ten *versus* twelve for the base or unit of the currency; and (2) the advantages that would accrue to the institutions of large finances *versus* the advantages to the individual of small means. It is not, fundamentally, a matter of weights, measures, nor coinage; but appertains to mathematics and numbers. Progress is the law of life, and our apprehension of mathematics cannot escape or evade the law of progress.

Previously to the invention of the American Dozen System the decimal system was the only method by which numbers could be handled conveniently in columns, with a fixed value between each group or column. The decimal system was a great improvement over the old Roman system of notation, and has been very convenient for banks, insurance corporations, and in fact all business institutions that use the larger sums of money. Amounts do not necessarily have to be handled that way, as the English non-decimal system well proves; but that the regular order of columnar calculation is the easier in adding, subtracting and multiplying is conceded.

We in America have the decimal system of coinage and along with it all its limitations; chiefly, its lack of divisibility into aliquot parts. So if Congress, in making the dollar with its disme (tenth) and legal unit of coinage gave us a system that could be added and multiplied readily; the same act deprived us of the divisibility that was inherent in the shilling of twelve pence. The Parliament of Great Britain has steadfastly refused to change their system to decimals.

There is good reason why England has never changed its money system to decimals, and there is also good reason why the American people would disapprove of changing back to the English System. There is no good reason, however, why each country should not improve its coinage, which could be done by using the Dozen System of calculation instead of the decimal. The changes required would be slight, and assuming the shilling as the unit for Great Britain, and the Dollar for America, it would work out after this manner:

The English shilling consists of twelve pence. The pound now consists of twenty shillings. Let a new value of twelve shillings be coined which could be known as a twelve-shilling or short-pound or something else. The new denomination would then represent 3/5 of a pound, or 1 pound would be to the value of 5/3 short-pounds. The scale would then read; four farthings = 1 penny, twelve pence = 1 shilling, twelve shillings = 1 short-pound. The farthing remains 1/4 pence, as at present, and would be written :003, or 3 twelfth-pence. Such a sum as £ 1:8L would be read: 1 short-pound, 8 shillings, eleven pence. Here we have the coinage adapted to the Dozen System of Mathematics with but one change, and no change in the standard of value.

American coinage could also be made perfect with but slight change. Let the dollar remain as is, also the half and quarter-dollar. The dime (tenth) would be dropped for the twelfth dollar (silver). Each twelfth-dollar would in turn be coined into twelfths (copper), similar to the decimal cents but of smaller size and value. Then such an amount as $21:3L would be read, 2 dozen 1 dollars, 3 twelfths and eleven gross-parts of a dollar. Appropriate names could be given these 2 new coins. Multiples of the dollar would be the $6:00 piece, instead of the $5.00; the $10:00 (twelve dollar) instead of the ten; the 2 dozen, the half-gross, and the gross of dollars, instead of the twenty, the fifty, and the hundred dollar notes. They are perfect multiples of all other divisions, and would represent enormous economy in coinage.

The factors of the dollar would then be; the gross part of a dollar; the twelfth dollar; the 1/9, 1/8, 1/6, 1/4, 1/3, 1/2, 2/3, 3/4 and 5/6 dollar. Every division is represented except the 5th, 7th, Tth and Lth. The twelfth-dollar piece would contain the same divisions. The new coins could circulate with the present coinage with no confusion. Great advantages, in the form of better multiples and factors, would immediately be in evidence.

Bibliographical Notes

Few of us realize that the history of duodecimals goes back over three hundred and fifty years. Perhaps a short review of the present stage of our findings as to the pioneer advocates might be valuable to some of us, and interesting to others.

We have been unable to verify the earliest reference that we have. But W. Ahrens, in his "Mathematische Unterhaltungen und Spiele," (Leipzig, 1901) says that Simon Stevin proposed the replacing of the decimal base by the duodecimal, in his book, "L'Arithmetique," published in 1585. This is the Simon Stevin who is credited with the introduction of the decimal point. We have been unable to find a copy of the 1585 edition of L'Arithmetique, and later editions omit the reference to duodecimals.

In 1665, Blaise Pascal, who was the inventor of the first computing machine, published "De Numeriis Multiplicibus," which deals with the handling of numbers on any base. And in 1670, Bishop Joannis Caramuel published "Mathesis Biceps, Vetus et Nova," which included an exposition of the use of the bases from two to ten, and the twelve base. He used the letters of the alphabet to represent figures in his demonstrations.

Christopher Frideric Vellnagel published his "Numerandi Methodi," in 1740, covering the bases from two to twelve, and Johann Albert Berckenkampf issued "Leges Numerandi Universales" in 1747, which explored the bases from two to thirteen, and bases fifteen, twenty-four and thirty.

Georges Louis Leclerc, Comte de Buffon, the famous naturalist, wrote his "Essai d'Arithmetique Morale" in 1760, which emphasized the advantages of the twelve base. The mathematics section of the Encyclopedie Methodique, published in Paris in 1784, included a chapter on Echelles Arithmetique, which reviewed the use of duodecimals. The editors of the mathematics section were d'Alembert, Bossut, de La Lande, and Condorcet, who were later to be better known as members of the committee which formed the French decimal metric system. In the "Histoire des Mathematiques," published in Paris in 1799, J. F. Montucla discusses the use of other bases than ten, including the "duodecuple."

The early 1800's are marked by John Playfair's strong article on the base of the decimal metric system, in which he stated that the duodecimal system would have been far preferable, - and by the duodecimal proposal of Peter Barlow. It is surprising to note that Barlow thought himself the first to propose the adoption of the duodecimal base. From thence forward, duodecimal proposals become increasingly frequent. The roll of the authors of these works includes many famous names, among them Baron von Humboldt, Piere Laplace, Sir Isaac Pitman, Herbert Spencer, and de Montholon on the comment of Napoleon Bonaparte.

A CONVENIENT COMPROMISE BETWEEN BINARY SCALES AND DECIMALS

by Warren H. Chapin

While working as the layout carpenter on a housing project, several years ago, I found a method of computing the length of rafters mentally, and after reviewing other cumbersone and less accurate methods, I wondered if the teaching of arithmetic was all that it was cracked up to be.

My father used to tell me that twelve should have been the number base, rather than ten. I fully agree that ten is an inferior base, but it seems a moot question to me whether twelve or eight would make the most convenient base.

As the adoption of either seems unlikely in the immediate future, I am suggesting the use of 96, the product of 8 and 12, as an expedient until the time is ripe for the adoption of either eight or twelve. I believe it has advantages which can be of practical use now.

The 96 is to be used, not as a true number base, but as a sort of common denominator. It is a highly divisible number, and only 4 less than 100. To change 96ths to decimals, divide by 24 and add the quotient. To change decimals to 96ths, divide by 25 and subtract the quotient. This can be done mentally, with no trouble.

Most of the sizes the various trades deal with are expressed in eighths, twelfths, or sixteenths. Using 96ths as a common multiple, they are readily combined or co-ordinated. And decimal measurements can be as easily assimilated, or approximated.

I have given considerable time and thought to the development of this practice, and have prepared tables of percentages, time, coinage, and the more commonly used fractions. I suggest the use of a 96 degree circle, because of its approximation to percentage, and its apportionment of 3 degrees to each point of the compass card.

The early Babylonians thought it reasonable to adopt the most highly divisible base for their numbers. And binary subdivision is usually found to be most convenient and economical. Since the present decimal notation demands accomodation, the use of 96 presents a convenient comprise between these elements, and we can leave the problem of selection of the best base to the survival of the fittest.

DO-METRIC STANDARDS

Units of Mass

The basic units of measure are the standards of length, mass, and time, (l, m, t.) From these, in various combinations of their powers, are derived all measurement units. The Do-Metric standard of length is the yard, with subordinate units of the foot (*.4* yard,) and the palm (*.1* yard.)

There is a considerable amount of scientific verbiage employed in distinguishing between mass and weight, yet both are measured in the same units. Technically, mass is defined as the relative resistance of a body to any change of its state of rest or motion, while weight is defined as the relative resistance required to counter the attraction exerted by the force of gravity upon mass.

The force of gravity acts equally upon equal masses, and the mass of a body is usually determined by weighing it on a beam scale against another body whose mass is known.

The standard of mass for the International System of Absolute Standards is the Prototype Kilogram, a platinum-iridium body, stored at the International Bureau of Weights and Measures, at Sevres, France. The mass of this body is defined as 1000 grams. The U.S. standard of mass is the pound avoirdupois, identical with the British pound avoirdupois of 7000 grains. But it is now defined against the Prototype Kilograms, as of 453.592 427 7 grams.

The unit of mass of the Do-Metric System is the duodecimal pound, which is defined as of equal mass to one cubic palm (27 cubic inches,) of water at maximum density and standard barometric pressure. The mass of the U.S. pound avoirdupoise equals that of 27.~~692~~ cubic inches of water.

27.6805

Table of Weights and Masses

10 Carrats	equal	*1* Gram
10 Grams		*1* Ounce
10 Ounces		*1* Pound
1000 Pounds		*1* Ton

The following table of equivalents is to be entered from the left.

	Decimal		
	Pound (A)	Pound (D)	Kilogram
Pound Avoirdupois	1	1.025 63	.453 592
Pound, Duodecimal	.975 011	1	.442 258
Kilogram	2.204 622	2.261 126	1
	Duodecimal		
Pound (A)	1	1.038 356	.553 984
Pound (D)	.Ɛ84 99Ɛ	1	.538 27Ɛ
Kilogram	2.255 71Ɛ	2.317 286	1

The mass of 1 Pint of water is 1 Pound, its volume 1 cubic Palm
The mass of 1 Tun 1 Ton 1 cubic Yard

Units of Time

The standard of reference for the measurement of time in the International System of Absolute Standards is the mean solar day, and the unit of measurement is the second of that day.

Since time is also one form of circular measure, the measurement of time and of angle in the Do-Metric System is unified into one set of measurement units, based on the mean solar day or one complete revolution.

Table of Units

10 Duors	equal		1.	Day or Circle
10 Temins	"	1 Duor or	.1	"
10 Minettes	"	1 Temin	.01	"
10 Grovics	"	1 Minette	.001	"
10 Dovics	"	1 Grovic	.000 1	"
10 Vics	"	1 Dovic	.000 01	"
1 Vic	"		.000 001	"

The duor is two hours of time, or 30° of angle. The duration of a temin is ten of our accustomed minutes. The minette is fifty seconds of time, or twelve and a half minutes of arc.

The present nautical mile is one minute of arc. The grovic, being 1.04 minutes of arc, will probably be the new nautical mile. The length of the dovic is midway between one second of time and one second of arc, and will probably be the preferred unit for small time measurements. It is about one third second of time.

The time-beat of the vic is very nearly the vibration frequency of $C^{\#}_1$ of the standard diatonic scale on the American pitch. The frequency of A_4 on the American pitch is 440 per second. If the $C\#_1$ were exactly the frequency of one vibration per vic, the frequency of A_4 would be 439 per second.

The following table of equivalents is to be entered from the left.

	DECIMAL					
	Duor	Temin	Minette	Hour	$Minute_t$	Degree
Duor	1	12	144	2	120	30
Temin	.083	1	12	.16	10	2.5
Minette	.006 94	.083	1	.013 8	.83	.208 3
Hour	.5	6	72	1	60	15
$Minute_t$	.008 3	.1	1.2	.016	1	.25
Degree	.03	.4	4.8	.06	4	1
	DUODECIMAL					
Duor	1	10	100	2	X0	26
Temin	.1	1	10	.2	X	2.6
Minette	.01	.1	1	.02	.X	.26
Hour	.6	6	60	1	50	13
$Minute_t$	.012 497	.124 97	1.249 7	.024 97	1	.3
Degree	.049 72	.497 2	4.972 4	.097 24	4	1

	DECIMAL					
	Grovic	Dovic	Vic	$Second_t$	$Minute_a$	$Second_a$
Grovic	1	12	144	4.16	1.041 6	62.5
Dovic	.083	1	12	.347 2	.086 805	5.208 3
Vic	.006 94	.083	1	.028 935	.007 234	.434 028
$Second_t$	.24	2.88	34.56	1	.25	15
$Minute_a$	.96	11.52	138.24	4	1	60
$Second_a$	.016	.192	2.304	.06	.016	1
	DUODECIMAL					
Grovic	1	10	100	4.2	1.06	52.6
Dovic	.1	1	10	.42	.106	5.26
Vic	.01	.1	1	.042	.010 6	.526
$Second_t$	.2X6 878	2.X68 782	2X.687 81Ɛ	1	.3	13
$Minute_a$	.Ɛ62 X68	Ɛ.62X 688	Ɛ6.2X6 878	4	1	50
$Second_a$	.023 794	.237 939	2.379 38Ɛ	.097 24	.024 97	1

THE MAIL BAG

Eugene M. Scifres recently attended one of the series of Seminars on Industrial Computation, conducted by the International Business Machines Corporation at Endicott, N.Y., for his concern, the Gates Rubber Company, of Denver. On his way back he stopped off for a visit with us. It is always a great pleasure to meet the members of our dispersed fellowship, whom we have known only through correspondence.

We are intensely interested in the new electronic computing machines, now developing in such amazing proliferation. We are constantly reminded that we live in an age of robot mechanisms. Giant machines convert raw materials into finished product under the control of a few men on the bridge. Instrumentation centralizes the manipulation of remote or dangerous operations in monitoring stations which are conditioned for comfort and efficiency. Testing and sampling are mechanical routines. Some of these robots perform tasks which exceed our human capacities, as the types of function involved in radar, the proximity fuze, and the homing bomb.

The most impressive fruits of this line of development are the robot brains. These electronic computers complete in minutes tasks which were long deferred for lack of time, or the means to defray the man-hour costs. They determine solutions for many indeterminate problems not hitherto solved because of the complexity of interlaced variables.

Most of these computers operate on the binary base, - using a yes or no choice, a *0* or *1* indication, a stop or go activation. Rationally, this is not a sufficient deployment in depth. It resembles confining the activities of a metropolis like New York to a single floor, the street level.

Many solutions involve three elements. Examples of this type are: right, left, or center; greater than, less than, or equal; past, present, or future; outside, inside, or border; forward, backward, or repeat. The binary machines handle these results by additional operations. That is certainly one solution. Division and multiplication are, after all, but repeated subtraction and addition. However, we use more direct and simpler means, and the use of a more comprehensive base would facilitate these machine operations. Mr. Robert's timely paper on Modern Computing Machines in this issue reviews the methods of handling rationalizations of this type.

This issue was not themed around these automatons. That much of its content is in one way or another affected with them, is but a parallel with most current publications. It is the spirit of the times. We should note that much of this development stems from the work of Blaise Pascal on the theory of probability.

It is not our function to philosophize on where we are going. Man, the plastic, unspecialized initiator, will survive his fancy machines. He is only half rational, half emotional. Duodecimals will facilitate his cerebration, his reactions to reason or feeling, by clarifying the underlying pattern.

Ye Ed.

ANNUAL MEETING

The seventh annual meeting of the Duodecimal Society will be held at the Gramercy Park Hotel, Lexington Avenue and 21st Street, New York City, at 8:30 P.M., on Thursday, January 25th, 1951. All members and friends of the Society are invited.

The meeting will receive the reports of its officers and committees on the activities of the past year. The members will take action on the report of the Nominating Committee as to the election of Directors of the Class of 1954, replacing the Class of 1951 whose terms expire this year; namely: F. Emerson Andrews, Chairman of the Board, William Shaw Crosby, and Nathan Lazar. A new Nominating Committee for 1951 will also be elected.

After the transaction of the necessary official business, there will be several talks on duodecimal subjects, and a general discussion period, when comments, questions, and suggestions from anyone present will be welcomed.

Our annual meetings are thoroughly enjoyable occasions. We are able to meet those whom we have known only by reading or hearing about them. Occasionally, there are new ideas expressed from the floor by those who are not yet ready to submit papers, and the discussions are always interesting. Refreshments will be served.

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MECHANIZING BASE CHANGING

by H. F. Stevens
744 Lexington Ave., R.D. 1, Union, N.J.

Axiomatically, any number may be stated on any base, and these statements are equivalent. Only predetermined digital substitutions are involved.

It would be possible without much trouble to construct a simple machine to display a number, say of six digits, on the 10-base and the 12-base simultaneously. Two unit-wheels, geared together in the 10:12 ratio, operating separate counter trains, would display in every position a decimal number and its duodecimal equivalent.

A refinement of this simple arrangement might avoid the necessity of working up through the series until the desired number is reached. A dialing mechanism could be arranged for association with either train, and dialing-up the number involved, in successive steps, would activate parallel motions in the other train.

There may not be sufficient need to justify the trouble and expense of constructing a machine of this type, but communication with anyone interested would be welcome.

CONGRUENT CONVERSIONS

Those who have read Mr. Andrews' "Excursion in Numbers," are familiar with the fact that duodecimally the year has *265* days, to correspond with the decimal 365. Of course, this congruence extends through 360/9 ≡ *260/9*.

Carrying the series forward, at intervals of 360 *(260)* or 960 *(680)*, similarly congruent groups occur. A short list of these congruences follows, which includes five three-figure congruences. One remarkable conversion double was found in 24660, which is the equivalent of *12330*. This led to the discovery of three others. Perhaps you can find other such doublets.

360	*260*	11160	*6560*
1320	*920*	12120	*7020*
1680	*Ɛ80*	12480	*7280*
2640	*1640*	13440	*7940*
3600	*2100*	14400	*8400*
3960	*2360*	14760	*8660*
4920	*2X20*	15720	*9120*
5280	*3080*	16080	*9380*
6240	*3740*	17040	*9X40*
7200	*4200*	18000	*X500*
7560	*4460*	18360	*X760*
8520	*4Ɛ20*	19320	*Ɛ220*
8880	*5180*	19680	*Ɛ480*
9840	*5840*	20640	*ƐƐ40*
10800	*6300*	21600	*10600*

Conversion Doubles

24660	*12330*
49320	*24660*
75060	*37530*
99720	*49860*

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Some General Physical Constants

Light Year	=	5 878 000 000 000 Miles_A
		7XƐ 200 000 000 Miles_D

Convenient approximations for the light year are 6 trillion Miles_A or *.8* M^4 Miles_D.

Astronomical Unit		93 004 000 Miles_A
or Distance to Sun	=	*27 192 000* Miles_D
Distance to Moon,		*Ɛ8 954* Miles_D
Approx.	=	*100 000* Miles_D
Dimensions of Earth		
Circumference	=	*12 800* Miles_D
Diameter	=	*4 800* Miles_D
Nautical Mile_D	=	*120X* yards
Land Mile_D	=	*.X5* Nautical Mile_D

THE RANK OF NUMBERS

The Ratio of the Number of Dividers of a Number to the Number

by Louis P. d'Autremont

Rank	No.	Dividers	Dividers	Fractional Ratio	Per Cen Ratio
1	12	6,4,3,2................	4	1/3	33 1/3
2	6	3,2....................	2	1/3	33 1/3
3	24	12,8,6,4,3,2...........	6	1/4	25
4	8	4,2....................	2	1/4	25
5	4	2......................	1	1/4	25
6	18	9,6,3,2................	4	2/9	22 2/9
7	30	15,10,6,5,3,2..........	6	1/5	20
8	20	10,5,4,2...............	4	1/5	20
9	10	5,2....................	2	1/5	20
10	36	18,12,9,6,4,3,2........	7	7/36	19 4/9
11	16	8,4,2..................	3	3/16	18 3/4
12	48	24,16,12,8,6,4,3,2......	8	1/6	16 2/3
13	60	30,20,15,12,10,6,5,4,3,2	10	1/6	16 2/3
14	40	20,10,8,5,4,2..........	6	3/20	15
15	42	21,14,7,6,3,2..........	6	1/7	14 2/7
16	28	14,7,4,2...............	4	1/7	14 2/7

The above is a table of numbers in the order of the ratio of their dividers to the number. Of these, 12 is the largest possible number having divisions, not counting unity equal in number to a third of itself. The next number in rank is 6. These are the only two numbers the per cent of the number of whose dividers reach 33 1/3, and are by far the best numbers for divisions. The percentage of the number of dividers to their numbers in all other numbers is less than 33 1/3%. The next largest number with the dividers ratio is 24, with a 25% ratio; the next 8, and the next 4, each with a 25% ratio. The number 30 is seventh in rank, with six dividers, giving a 20% ratio. 28 is the last number listed, having four dividers, giving a ratio of 14 2/7%.