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EDITORIAL

With this issue of the Review we are sending out, as a special supplement, copies of the dozenal metric system TGM, a system developed and proposed for our use by Mr. Pendlebury.

In the last Review I mentioned the various dozenal proposals for metric systems; you, as members of the DSGB, are now receiving as a membership privilege copies of the Bulletin published by the DSA. In the latest Bulletin you will find many references to the Dometron system developed by Mr. Churchman of the DSA. The publication of the TGM supplement will enable you to compare the two systems and, I hope, to decide on a system for your own use.

Since all printing is costly we have reduced the length of this particular issue of the Review in order to publish TGM with it. Future issues of the Review will return to the usual length unless financial problems cause us to curtail our programme. (See the Members' Newsletter for a discussion of this point).

In publishing TGM we have reached an important stage in our development; for a long while now we have made do with the present systems of measurement, without having any one system of our own to oppose to the spread of the decimal metric system; TGM provides us with an alternative system which is better than the decimal metric. I hope that you, the members, will agree, and that you will comment on the supplement.

Comments on the Review or on the Supplement should be sent to the Secretary at Carlisle.

A Newsletter for members is being sent out with this Review; it contains proposals which we wish you to vote upon; please read it carefully. If the next issue of the Duodecimal Bulletin is received from America by our publication date, this too will be sent out at the same time.

A Correction: the comment on nomenclature on page 20 of Review #25 was by Mr. Russell, and not by Mr. Whillock.

We wish to apologise to Mr. Russell for the error.

Libraries throughout the world classify their books by the Dewey Decimal System--or some variation thereof. Subjects are classified by numbers. First into ten (though really twelve) general classes, each of which is then broken down by tens into further classes. After three digits a decimal point is used and the classification can then continue as required.

As they are classification numbers only, that is, one does not add, subtract, multiply or divide them among themselves, the term "decimal" is more a convention than an epithet; "tenth parts" have nothing really to do with it. So without disturbing the present system it is possible to extend it to many more sections by supplementary use of the digits 2 and 2. Up to four digits, dozenal has more than twice as many numbers as decimal!

The first general breakdown is: 0 General, 1 Philosophy, 2 Religion, 3 Social Science, 4 Philology, 5 Pure Science, 6 Useful Arts, 7 Fine Arts, 8 Literature, 9 History, 910 Geography, 920 Biography (twelve in all!).

Mathematics is 510, and I have started to use 512 for Works on Dozenal. 512 for works on any base other than 2 or *10, the actual base being in parantheses, e.g. 512(2) on Binary, 512(8) on Octal, etc.

Arithmetic 511 is further broken down after a decimal point as follows:-

- | | | |
|-------------------------|--------------------|-----------------------|
| .1 Systems of | .5 Analysis | .8 Mercantile rules, |
| .2 Notation, numeration | Permutations, etc. | Interest, mensuration |
| Fundamental rules, etc. | .6 Proportion & | Gauging, etc. |
| .3 Prime Numbers | Progression | .9 Problems & Tables. |
| .4 Fractions | .7 Involution & | |
| | Evolution | |

This could also be used with the new categories shown above, and I suggest .2 Logarithms, and .2 Graphical.

For the application of dozenal (or other base) to other subjects, let the subject itself be the main classification, e.g. 780 is Music, so 782 can be Dozenal systems for Music. If the subject has three or more significant figures the 2 or 2? follows, with decimal point when necessary.--for works about the system for the subject.

If the work is primarily about the subject and simply uses dozenal (or other base) instead of decimal for its numbers etc. the base digits are appended in parantheses: 314 is Social Science, statistics, Europe. 314(2) ditto in dozenal. 314(28) ditto in octal.

This still leaves lots of extra categories that librarians could utilise for the general expansion of their system.

If other readers have ideas about this please let us hear from you, so that we can discuss and reach common agreement. Uniformity is important in this application.

BASES OF NUMERATION (2)

S. Ferguson

Counting, numeration.

Counting in bases other than ten follows the same pattern as in base ten; we write single symbols for the numbers until we reach the group-unit; the group-unit is written "10", after which we proceed with "11", "12" and so on. As an example, in base seven we would count:

1 2 3 4 5 6 10 11 12 13 14 15 16 20 21 22 23 24 25 26 30 ...
through 40, 50, 60 to reach
61 62 63 64 65 66 where we meet
our next higher unit "100" or "10" groups of "10".

In base seven the number before "10" is 6;
the number before "100" is 66;
the number before "1000" is 666.. and so on.

Arranging our numbers in terms of the basic group-unit is called writing them in the scale of or to the base of the chosen group-unit. Thus "20" in base 7 can be said to be written in the scale of seven, or to the base (of) seven. Another term, now rarely used, is radix; in base ten, ten is the radix of the scale, and what we here term fractionals were termed radix fractions. Since there has been some controversy over the word fractional it might be worth reviving the word radix for use in the phrase radix fractions; a radix fraction in base ten is what we would normally call a "decimal" fraction.

Capacities of the bases; composition of numbers.

To compare the capacities of the bases table 2 lists the values of the numbers "10", "100", "1000" and "10 000" for various bases, expressing these values in base ten notation, and in base twelve notation.

Base	"10 000"	"1000"	"100"	"10"	"10 000"	"1000"	"100"	"10"
Two	16	8	4	2	14	8	4	2
Three	81	27	9	3	69	23	9	3
Five	625	125	25	5	425	51	21	5
Nine	6561	729	81	9	3969	509	69	9
Eleven	14641	1331	121	11	8581	928	81	8
Twelve	20736	1728	144	12	10000	1000	100	10

To illustrate this: in base 3 "212" means "200 + 10 + 2" or, in base ten notation $2 \times 9 + 1 \times 3 + 2$ or "23" in base ten.

(Rules for converting numbers from one base to another will be given later.)

(6) (2)

To compare the composition of numbers in various bases, and to show that they all obey the same rules, let us look at some larger numbers.

In base ten "27 435" is composed of:

$$\begin{aligned} "20\ 000" &= 2 \text{ ten-thousands} = 2 \times 10^4 \\ "7\ 000" &= 7 \text{ thousands} = 7 \times 10^3 \\ "400" &= 4 \text{ hundreds} = 4 \times 10^2 \\ "30" &= 3 \text{ tens} = 3 \times 10^1 \\ "5" &= 5 \text{ units} = 5 \times 10^0 \end{aligned}$$

(Note that any number raised to the power 0 is equal to 1).

Suppose this number to be written in base eight instead; when we translate the number into decimal terms for comparison we find it to be composed of:

<u>base eight</u>	<u>base eight</u>	<u>base ten</u>	<u>base ten</u>
"20 000"	= 2 x "10 ⁴ "	= 2 x 8 ⁴	= 8 192
"7 000"	= 7 x "10 ³ "	= 7 x 8 ³	= 3 584
"400"	= 4 x "10 ² "	= 4 x 8 ²	= 256
"30"	= 3 x "10 ¹ "	= 3 x 8 ¹	= 24
"5"	= 5 x "10 ⁰ "	= 5 x 8 ⁰	= 5

"27 435" in base eight is, in base ten: "12 064"

As a further example the reader may like to show that "27435" in base twelve is equal to "54185" in base ten.

Bases in present use

Apart from base ten there is at present, despite the efforts of the DSGB and DSA, only one other base fairly widely known; this is base two (the binary system) used in computers. It is a base unsuitable for our everyday use, as it makes great demands on horizontal space - as will be shown later; in a computer, however, all calculations are carried out at so great a speed that this disadvantage of the base is minimized. In conjunction with base two, bases eight and sixteen are also used for the compact listing of binary numbers.

If it were possible to run computers on a different base then the binary system and other scales connected with it - such as eight and sixteen - would lose much of their present attractiveness. Research is being carried out into the possibility of using base three - with suitable modifications to the hardware - and if base three proved possible then base twelve - or base six, would be suitable for the print-out of results - more suitable than base ten, in fact. The computer can print its results in any base required.

Bases twelve and sixteen, which are in use by a few as alternatives to base ten, have both been suggested as replacements for base ten.

The development of positional notation.

At this point it is worth pausing and considering the rise and development of our present system before going on to the operations in various bases.

In the whole history of arithmetic there has been no more revolutionary step than that made by the introduction of the zero. It is thought that this step was first taken by the Indians in the 1st/2nd centuries AD. It was at least as early as the 9th century AD, for the completed number-system was introduced into Baghdad in that century; the mathematician Muhammed Ibn Musa Alcharismi explained the use of the numerals in an arithmetic written about 820 AD.

The Arabs developed two styles of numerals: the East Arabic, used in the present Arabic script, and the West Arabic, formerly prevailing in the Western Mediterranean region and in Spain. The zero first made its appearance as a point, and is still a stylized point in the present Arabic numerals.

In the course of a thousand years, and particularly in the centuries before the invention of printing, the forms of the numerals altered considerably. Other nations, using alphabets and scripts differing from ours, also have different forms for their numerals, and the Arabic numerals as used today bear little resemblance to our own. (See the sheet of numerals issued with Review #25).

The numerals reached Europe through traders who learned them through their traffic with Arab merchants, and through scholars who studied in Spanish universities. Leonardo Fibonacci, who lived in Algiers and there became acquainted with the Arab system of calculation, was the first European to write an extensive account of these numerals, his work, the Liber Abaci, appearing in 1203. There are occasional instances of the use of the numerals before this, but it was not until the publication of the Liber Abaci and translations of the works of Arab mathematicians that the use of the symbols became widespread. A Sicilian coin with the date 1134 AD is the first extant example of the official use of the numerals in Europe.

Gerbert of Aurillac (later Pope Sylvester II) is also said to have been influential in introducing the Arabic system of calculating into Europe, yet, though he suggested the use of the numerals as labels for the beads of the abacus, it is apparent he did not know of the zero. Berlinus, a pupil

of his, published a work on the abacus which is valuable in indicating that the Arab system of calculation was still unknown in Europe. (See Ball's History).

Attempts to suppress the new numerals were made; an edict of 1259, for instance, forbade the bankers of Florence to use the "infidel" symbols, and the ecclesiastical authorities of Padua in 1348 ordered the price lists of books to be published in "plain letters" not in "ciphers".

The popularity of the new numerals varied with the popularity of the abacus. Where counter-reckoning, as in Germany, or the abacus, as in France, was more prevalent, numerals were used only to record the result of operations, not to carry out the actual operations and computations, and the Roman system served this purpose as well as any other. In Italy, where the abacus was less popular the new numerals were in use a century earlier than in France or Germany. The transition from the Roman numerals to the "Indo-Arabic" numerals (as the new ones are known) took even longer in England; records of the reign of Elizabeth I, for example, show a mixture of both systems.

Once the new numerals were accepted it became possible for man to calculate quickly and efficiently without resource to a device. Decimal-form fractions followed later.

(to be continued)

NEWS ITEM

The budget of the Metrication Board last year (1970) was £70 000, and 'Engineering' for 2nd October reported that up to the previous March the British Standards Institution had turned out 1800 revised metric standards. Some £0pg of their effort has been devoted to this task of late. If we had a fraction of this money and resources to explain the true nature of things to an uncomprehending public these gentry would not be able to boast so much about the progress they are making to trade off our heritage for a litre of pottage.

SINCE EARLIEST TIMES

The Soviet correspondent of 'Nature' (vol 232, July 16 '71) reported some rock carvings just discovered in Armenia dating from 8000 to 1000 BC, depicting star groups, the brightest stars being larger than the others, with pictograms giving the group name. "The carvings, which have been found at various sites, indicate that the inhabitants divided the year into twelve parts, revealing a fairly good understanding of the length of the year and of the lunar month". We are not sure if the patronising tone indicates a reluctance to admit that the people of those days were as intelligent as a modern archaeologist, or whether they think the division into twelve parts is only fairly good. ...

GET WITH IT! (Part 6)

For Students and Beginners

T. Pendlebury

1 one, twelve to the dozen	*10 onezen	*10 Zen
2 two, six ;, ;, ;,	*20 twozen	*100 Duna
3 three, four ;, ;, ;,	*30 threezen	*1000 Trin
4 four, three ;, ;, ;,	*40 fourzen	*10000 Quedra
5 five, one less than half dozen	*50 fivezen	*10 ⁵ Quen
6 six, two to the dozen	*60 sixzen	*10 ⁶ Hes
7 seven, one more than half dozen	*70 sevenzen	*10 ⁷ Sev
8 eight, three to two dozen	*80 eightzen	*10 ⁸ Ak
9 nine, four to three dozen	*90 ninezen	*10 ⁹ Neen
10 ten, two less than dozen	*20 tenzen	*10 ² Dex
11 elv, one ;, ;, ;,	*20 elvzen	*10 ² Lef
* DEC (= in decimal, 123 hundred and twenty three)		*10 ¹⁰ Zennil
* DOZ (= in dozenal, 123 duna twozen three)		*10 ¹¹ Zenzen
; DIT (the dozenal point, 0.5 = 0;6 point five = dit six) and so on		

(The Complements)	
Addition: As indecimal up to:-	6 + 6
	5 + 7
	4 + 8
	3 + 9
	2 + 10
	1 + 11

When the sum goes over the dozen, put 1 for dozen, then take the complement of the first number from the second number to get the units figure:-
 $5 + 9$ is $*10 + (9 - 7 = 2) = *12$

Multiplication: As in decimal until the product goes over the dozen. Then forget decimals and think dozens. 4 eights are $*20 + 8 = *28$ (never mind thirty two). 9 eights are $*60$, so 2 eights are $*68$, and 9 nines are $*69$. The one-ups and one-downs $1, 5, 7, 11$: $1 \times 1 = 1$, $5 \times 5 = *21$, $7 \times 7 = *41$, $11 \times 11 = *21$. $5 \times 7 = *29$, $5 \times 11 = *47$, $7 \times 11 = *65$. Even multiples of 7: $*12$, $*24$, $*36$, $*48$, $*510$. ditto of 5: $*10 = 2$, $*20 = 4$, $*30 = 6$, $*40 = 8$, $*50 = 10$.

TIME OF THE MONTH. At this moment, the time by the clock is 9;16 hrs., and as it is evening the Time of the Day is 19;16 (1 for after midday).

Today's date is the 12th (which of course in dozenal is $*10$). But today is not yet finished, only 19;16 hrs gone, so we take yesterday's date (1), multiply it by $*20$ and add it to our 19;16 to get the Time of the Month:-

Yesterday's date X *20	120;00 hrs
Time of day	19;16 hrs
Time of Month:-	129;16 hrs

Reading this back: first we have 12 which mentally divided by 2 gives $6\frac{1}{2}$ days gone--so the date is the twelfth and it is pm. The 9 is the hour that the small hand of the clock last passed. The ;16 indicates the position of the long hand--half way between 1 and 2.

Work out the Time of the Month in the traditional system using this same time and date. Your answer should be: 285.07 $\frac{1}{2}$ hrs.!!!--no message in the first part, and you have to remember that the .07 $\frac{1}{2}$ is not decimal but sixtieths, minutes.

Look at your watch or clock now! Then, starting by doubling yesterday's date, write down the Time of the Month. Do this again in a week or two's time (providing it is in the same month). Subtract the former from the latter, and you have the time elapsed between the two instants.

In the next instalment we will deal with TIME OF THE YEAR, with similar advantages for calculating time spans across the calendar.

compare decimal: $\begin{array}{r} 9) 1.000\ 000\ \dots \\ \underline{0.111\ 111\ \dots} \end{array}$

Elv into 1 won't go, 0 down, carry 1. Elv into zen goes 1 and 1 over, 1 down, carry 1. Elv into zen goes 1 and 1 over, 1 down..... Obviously this goes on for ever, so 1 eleventh is DIT 1 RECURRING, just as one nineth is point 1 recurring.

For short, a dot is put over a digit that should be repeated for ever and ever, just as is done in decimal:-

$\frac{1}{2} = 0;\overset{\circ}{1}$ just as in decimal $\frac{1}{9} = 0.\overset{\circ}{1}$
 $\frac{2}{2} = 0;\overset{\circ}{2}$ " " " " " " $\frac{2}{9} = 0.\overset{\circ}{2}$
 etc. etc.

FIFTHS:- 5) 1:0000 0000 Aha! Not so easy as in decimal, is it?
 0:2497 2497 24..

But thirds, quarters, sixths, eighths, ninths, twelfths, sixteenths, eighteenths, etc. are all simpler in dozenal, don't forget that. We write books about the multitudinous advantages of dozenal over decimal; in my years' of research I have found two points in which decimal scores over dozenal, and naturally one of these is the handling of fives, tens and their relations.

Having been brought up on decimal spelling of numbers you are sure to have a deep feeling that fives, tens, hundreds, etc. are such very, very important numbers. It is only a feeling, and untrue; it is a delusion, caused by the decimal system itself. Division by even numbers far more often than not gives a number ending in 5, in decimal. Half the multiples of 5 end in 5, and we frequently round up to them, for the only way to obtain noughts at the end in decimal is to multiply multiples of 5 by even numbers.

In dozenal, one in twelve, not one in ten, numbers end in 5, so there are less of them to start with. Many of them are prime, so do not occur from multiplication. Those that are multiples cannot have any factors that end in 2,3,4,6,8,9,7 or 0, so even they do not usually turn up. Since 5 is not a factor of dozen, division also does not favour their appearance. Decimal working produces a "rash" of fives; dozenal working tends to eliminate them (also ones, sevens, and elvs).

To get back to Fifths: Five into zen goes 2 and 2 over. So the next stage gives 4 and 4 over, then 8 and 8 over (= 9 and 3 over)--so here is a short cut: instead of dividing, all we have to do is double up the last digit every time. Just one thing to watch: twice 6 is *10 giving 1 to carry. So whenever the digit we are about to write is 6 or more, ADD 1. e.g.:- 0 2 4 8 put 9 *16 put 7 (1 is already added to the 8) *12 4 9 and so on.

So there is nothing difficult about writing fifths in zenimals! 5 is one less than 6, so 5 into zen goes 2 (the first digit) and 2 over (so double up).

When a group of digits like this keeps repeating for ever, we do as in decimal, put a dot over the first and last digit of the group:

$\frac{1}{5} = 0.249\bar{7}$ $\frac{2}{5} = 0.497\bar{2}$ $\frac{3}{5} = 0.724\bar{9}$ $\frac{4}{5} = 0.972\bar{4}$
For $\frac{2}{5}$ we start by twice 2 is 4. For $\frac{3}{5}$, twice 3 is 6 put 7, etc.

TENTHS:- Half a fifth is a tenth, and twice half is 1, so $\frac{1}{2}$ is 0;12497--again doubling up but starting with 1. Ten into zen goes 1 and 2 over (double up).

Notice that the 1 does not come into the repetition, so the first dot is over the 2.

3/2 of course starts with 0;3..., 7/2 with 0;8... (7 put 8). Now your turn:-

(1) Write down the zenimals of $3/2$, $7/2$ and $9/2$.

Just out of curiosity $\frac{5}{2}$ comes out to $0;5222222\bar{2} = 0;6$. (Twice 5 is 2 put 2, twice 2 is $\frac{1}{2}$ put 2).

SEVENTHS:- The long way:-
$$\begin{array}{r} 7 \overline{) 1.0000 \ 0000 \ 0000} \quad \dots\dots \text{(In decimal)} \\ \underline{0 \ 1862 \ 3518 \ 6235} \quad \dots\dots \\ 0.142 \ 857 \end{array}$$

7 into zen goes 1 and 5 over. Yes, it is possible to do this one by continuously multiplying the last digit by 5, but the carry figures to be added get too involved to do it in your head.

But 7 is one over half dozen, so 7 into zen goes 2 and minus 2 over!!! Perfectly true if you work it out. It simply means zen is 2 short of twice 7. Anyway, it allows us to do the doubling-up trick again, but every second digit must be subtracted:-

1/7 = $0; \overline{274274}$ written for short $0; \overline{186235}$
 $\quad \quad \quad 427427$
 $0; \overline{186235186235}$

and the carry-over figures must be subtracted: twice 4 is 8 put 7 not 9.

(2) Finish the following divisions:-

(a) 7)2:000000 (b) 7)3:000000 (c) 7)4:000000 (d) 7)5:000000 (e) 7)6:000000

(3) What have they in common with each other and with the zenimal of 1/7?

Look again at the doubling-up example of $1/7$ above. We have:

$\frac{2}{4} \frac{7}{4}$ followed by $\frac{4}{2} \frac{7}{7}$ --same thing the other way up. Subtraction resolves
 $\frac{2}{4} \frac{7}{4}$ into 187, so the second group is minus 187.

Digits that count downwards instead of upwards like normal digits are called negative or reverse digits and are written by putting a minus sign over them: $\overline{187}$. They can be very useful at times. Using them to write $\frac{1}{7}$ we get: $0;\overline{187}\overline{187}$ which is easier to remember than $0;\overline{186235}$. If you think of 1 from 8 leaves 7, you'll have no difficulty at all in writing the seventh straight down in zenimals.

To turn it into all positive digits, all you have to do is: 0.187000

(4) Multiply *187 by (a) 2, (b) 3, (c) 4, (d) 5, (e) 6.

(5) Compose zenimals from the results obtained in (4) by the method just shown. Turn them into all positive digits (come on! You can do it in your head! No need to write it in full!). Compare the results with the answers you got in (2).

You do not always have to get rid of negative digits. They can be put straight into a column of figures to be added up. You then subtract them instead of adding, and find that you have less carry-over figures!

The SYMMETRICAL FORM (0;187187) can be done with almost all repeating zenimals (and decimals: $0.142\ 857 = 0.143\ \overline{143}$). $1/5 = 0.252\overline{5}$.

WARNING: If you try to get the zenimals of 2, 3, 4, 5, 6 sevenths by straight-away doubling-up, beware the number 6. For $\frac{3}{5}$ we said twice 3 is 6 put 7, but for $\frac{3}{7}$ if we say twice 3 is 6 put 5--twice 5 is only 10 (no 1 to come off the 6). Put 6, then twice 6 is *10 put 2:-

$$3/7 = 0.\overset{\circ}{6}\overset{\circ}{\Sigma}9\overset{\circ}{6}\overset{\circ}{\Sigma}9 = 0.\overset{\circ}{5}186\overset{\circ}{7}3$$

ONEZEN-FIRSTS or ONEZEN-ONETHS (Thirteenthths).

*11 into zen goes 1 and 1 over. So $\frac{1}{11} = 0;111111... = 0;0\Omega 0\Omega 0\Omega...$
 $\frac{2}{11} = 0;22222... = 0;1\bar{2}1\bar{2}1\bar{2}...$ $\frac{3}{11} = 0;33333333... = 0;292929...$

For short of course these are written: $0;0\bar{2}$, $0;1\bar{2}$, $0;2\bar{9}$. Think of the pairs as onezen minus one, twozen minus two, threezen minus three, and you cannot go wrong.

(6) You write down the others up to $\frac{10}{11}$.

RECURRING ZENIMALS are caused through dividing 1 by a number that is not a factor of *10, *100, *1000, etc. That is precisely why they go on and on. Notice that the divisors we used were 5, 7, 2, *11--the one-ups and one-downs. (In decimal 3, 6, 7, 9, 11, 12, 13 give recurrers).

FINITE ZENIMALS (that come to an end) are due to dividing 1 by factors of *10, *100, *1000, etc. e.g. 2, 3, 4, 6, 8, 9, *10, *14, *16.

MIXED ZENIMALS (when one or more of the first digits do not take part in the repeating sequence) occur from dividing by factors and non-factors, e.g. tenths (halves of fifths or fifths of halves) $0;1249\bar{7}$.

A FRACTIONAL SHORTHAND. I am a lazy chap, and don't always bother to write out zenimals in full. Instead, I use a sort of shorthand that goes like this:- $\frac{1}{5} = 0;2\bar{x}$ $\frac{1}{2} = 0;1\bar{x}$ $\frac{2}{5} = 0;4\bar{x}$ $\frac{1}{7} = 0;2\bar{2}$

The digit immediately after the semicolon is your first digit.

$\frac{2}{x}$ means each succeeding digit to be obtained by doubling the one before it.

$\frac{2}{-}$ means ditto but subtract every second digit.

They can be multiplied or divided in this form. Compare $\frac{1}{2}$ and $\frac{2}{5}$ with $\frac{1}{5}$. Halving or doubling the first digit automatically halves or doubles all the succeeding ones. Do NOT adjust for carry figures in this form: $\frac{9}{2}$ is $0;9\bar{x}$ NOT $0;2\bar{x}$ --the extra 1 comes in when you do the doubling indicated: $0;29724$.

I mention this system because, if you can toy around and get acquainted with it between now and the next instalment, it will help me to present the more complex zenimals concisely and lucidly without the need for long-winded explanations.

Any vulgar fraction can be turned into this form and they can be used in decimal. First: divide 1 by the denominator e.g. 5 into 1 is $0;2$ and 2 to carry. Put $0;2\bar{x}$. Second: multiply the first digit by the numerator, e.g. for $\frac{3}{5}$ put $0;6\bar{x}$.

2 into 1 is $0;1\bar{x}$, so $\frac{9}{2}$ is $0;9\bar{x}$ (= $0;999999...$).

3 into 1 is $0;4\bar{x}$ ($\bar{x}$ makes all further digits 0. A sort of zenimal full stop.)

* * * * *

Answers:-

- (1) $\frac{3}{2} = 0;37249$ $\frac{7}{2} = 0;84972$ $\frac{9}{2} = 0;29724$
 (2) (a) $0;35186\bar{2}$ (b) $0;51862\bar{3}$ (c) $0;62351\bar{8}$ (d) $0;86235\bar{1}$ (e) $0;23518\bar{6}$
 (3) They all consist of the same sequence of digits (but start at different points of the cycle).
 (4) (a) 352 (b) 519 (c) 624 (d) 862 (e) 236
 (5) $\frac{352}{0;35186\bar{2}}$ $\frac{519}{0;51862\bar{3}}$ $\frac{624}{0;62351\bar{8}}$ $\frac{862}{0;86235\bar{1}}$ $\frac{236}{0;23518\bar{6}}$
 (6) $\frac{4}{11} = 0;3\bar{8}$ $\frac{5}{11} = 0;4\bar{7}$ $\frac{6}{11} = 0;5\bar{6}$ $\frac{7}{11} = 0;6\bar{5}$ $\frac{8}{11} = 0;7\bar{4}$
 $\frac{9}{11} = 0;8\bar{3}$ $\frac{2}{11} = 0;9\bar{2}$ $\frac{2}{11} = 0;2\bar{1}$ $\frac{10}{11} = 0;2\bar{0}$

BOOK REVIEW : Megalithic Sites in Britain.

AFW

(Professor A. Thom, Oxford University Press 1967, 70/-)

The idea that our early ancestors were a bunch of savages who lived in fear of natural events (that came later) is slowly being dispelled by the work of people from disciplines not handicapped by any assumption that the intelligence of homo sapiens was a late development.

In Professor Thom's survey of some 600 stone circles throughout the British Isles he found that their setting out accuracy was sometimes better than his portable theodolite. Applying statistical analysis to their distortions by time and inexpert repairs it was determined that not only was a standard unit of length used, but the properties of 'pythagorean' triangles used to ensure that integral multiples of this unit could be fitted into ellipses and flattened circles of various shapes.

This unit of length (the Megalithic Yard) had a mean value of $\sqrt{2.72}$ Imperial feet with divisions of halves and quarters. The large Avebury circles were built with a multiple of ten yards, with its quarter of 2.5. The word yard is derived from wooden stick or rod. In French it is verge and Spanish vara. The latter is still used in the Spanish speaking world with the following values:

Burgos	2.766	Texas and California	2.778
Madrid	2.743	Peru	2.75
Mexico	2.749		

A fair assumption is that megalithic people occupied the Atlantic coast of Europe and migrated to Britain. Thom's deductions have recently been found to fit the stone monuments in Brittany. (In the opinion of this reviewer a study of naturally evolved units of length would do much to aid the study of population movements).

The positions of the stones and their alignment with sighting stones or natural features suggest that the year was divided into eight (at least) and probably sixteen periods of 22-23 days. Knowledge of the passage of the seasons was vital to an agrarian economy to organise planting and reaping of crops. Synchronisation of the calendars posed a problem and it is suggested that messengers could count the days as they travelled about.

A correspondent elsewhere on the subject thought that the Beltane or mid-summer fires could be a survival of signals that were sent on the determined day from a central point, perhaps Stonehenge. There is a tradition of fires of Silbury Hill nearby, and traces of ash have been found. This practice,

along with the associated monuments, might have degenerated into sacrificial excesses: Christian missionaries did their best to destroy both. Nevertheless they were rooted in real needs. The modern decimal/metric priesthood is also eager to extirpate our remaining contacts with reality in favour of their abstract theology.

FACTORS

S. Ferguson.

Because twelve has more factors than ten, its powers and multiples also contain more factors. The table below lists the factors of the powers of ten and twelve.

<u>Number(dec or doz)</u>	<u>divisible by(dec)</u>	<u>divisible by(doz)</u>
ends -0	2 5 10	2 3 4 6 10
ends -00	2 4 5 10 20 50 100	2 3 4 6 8 9 10 14 16
ends -000	2 4 5 8 10 20 25 50 100 125 200 250 500 1000	20 30 40 60 100
ends -0000	2 4 5 8 10 16 20 25 40 50 80 100 125 200 250 400 500 1000 1250 2000 2500 5000 10,000	2 3 4 6 8 9 10 14 16 20 23 28 30 40 46 54 60 80 90 100 140 160 200 300 400 600 1000 1600 2000 3000 4000 6000 10,000.

In total (all figures decimal)

<u>Ending:</u>	<u>total factors:</u>	<u>total factors:</u>
-0	3	5
-00	8	14
-000	14	27
-0000	23	44

(Note: 1 has not been counted as a factor).

Comments: Members of the DSA, who also receive this Review, are invited to submit any comments to the Secretary, 69 Scotby Road, Scotby, Carlisle, CA4 8BG, England.

DECIMAL-DOZENAL POINTS...

Decimal division is not a special property of space, time or matter and its use inhibits our conception of these entities. Ordinary packaging emphasises the need for a divisible number as an aid to defining spatial relationships.

Denary grouping was selected for its primitive function of counting long before men capable of considering the mathematical implications arrived on the scene.

The primary ratios - halves, thirds and quarters - form the framework of all forms of contact with our environment. Decimal arithmetic is incapable of a concise expression of these proportions.

Point-position arithmetic - the key to numerical manipulation - would be more readily grasped by children if it were related to visual processes. The intractable nature of base ten is responsible for the blockage in arithmetic that is so common.

Base twelve comprises all the arithmetical relationships in their simplest forms that are needful for our daily affairs and social exchanges. Dozenal tables are easier to learn and recall than decimal, and the arithmetic more often exhibits recognisable patterns. It can be performed in two-thirds the time.

Decimal arithmetic is incompatible with the binary scale used by computers. Its extension to coinage at this late stage is thus particularly inept. Ternary computer units could enable binary (scientific) and dozenal (social) arithmetic to be interchangeable.

Now that the principles of numeration are being taught in schools the fact that the symbols 10 can stand for any number is no longer cause for surprise. Avoidance of the dozen scale has been a matter of conscious policy although the interest it arouses in children is admitted by educationalists.

Few ancient systems of weight, money or measures made much use of ten as a base, more convenient group numbers being chosen as the need arose.

Measuring systems have always incorporated units that are in accord with our physical needs and perception. Those derived from the artificial metre are either too large or too small for practical purposes.

The metric system was instituted without regard to long established practices. It is an unfortunate combination of non-ergonomic units to an indivisible base that does not permit the formation of more acceptable sizes.

Legal compulsion has been required in all countries where the metric system is extant. Where its use is permissive this has not extended beyond specialist technical work with conceptions that cannot be related to experience.

(to be continued in Review *27)

The **Duodecimal Society Of Great Britain** provides a centre for all who consider that naturally developed methods of conducting our daily affairs - largely based on divisible groups of twelve - are superior to those restricted to an inflexible decimal progression. The Society aims to counsel the public in the principles of numeration and measurement, and study the application of base twelve arithmetic to all social and scientific purposes.

With the co-operation of other organisations, we afford a channel of informed resistance against any proposal intended to restrict our thinking to inept and out-moded methods.

Membership of the D.S.G.B. is open to all who have an interest in the development of arithmetic as an essential tool of science that will also allow a broader understanding of the ways in which the physical world is described and regulated. Members receive copies of this Review free, plus the Duodecimal Bulletin of the Duodecimal Society of America. An occasional Newsletter is also issued for internal affairs. Non-members may purchase copies of the Review at 1/6d each.

The numeration in this journal is dozenal with the sequence 1 2 3 4 5 6 7 8 9 ζ ε 10 11 12 13 14 15 16 . . . In some instances decimal notation is used. Unless clear from the text, dozenal numbers are prefixed with a star (*) and decimal with a dagger (†) e.g. $*100 = †144$ or $1000 = *6ε4$.

The generally accepted sign for the dozenal point is a semi-colon (;) e.g. $2\frac{1}{2} = 2;6$ or $\frac{3}{4} = 0;9$. Any special notation used by authors should be described at the beginning.

Articles and letters are welcomed for publication; both members and non-members being invited to contribute. Although the majority of articles are concerned with base twelve and have a mathematical bias, discussion of any topic with arithmetical connections, and work in other bases, will interest our readers.

The Editor reserves the right to shorten any article, but will take care not to alter its conclusions. Contributions should be sent to: Editor, Duodecimal Review, 69 Scotby Road, Scotby, Carlisle CA4 8BG