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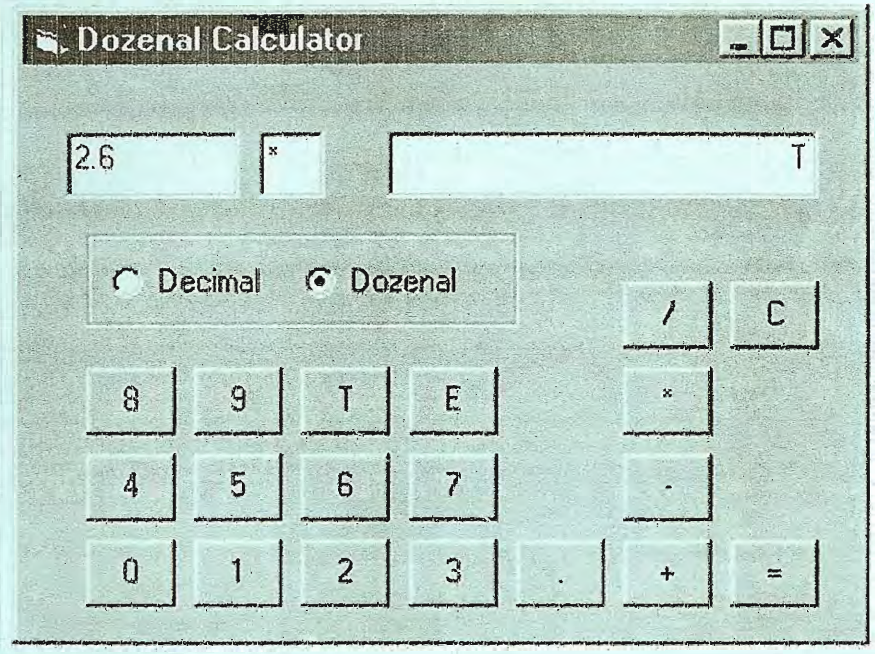

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THE DOZENAL SOCIETY OF AMERICA
c/o Math Department
Nassau Community College
Garden City LI NY 11530-6793

= Annual Meeting: See Page Dek =

THE DOZENAL SOCIETY OF AMERICA

(Formerly: The Duodecimal Society of America)

is a voluntary, non profit, educational corporation, organized for the conduct of research and education of the public in the use of base twelve in numeration, mathematics, weights & measures, & other branches of pure & applied science.

Membership dues are $12 (US) for one calendar year. Student Membership is $3 (US) per year, and a life Membership is $144 (US).

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IN DEFENSE OF NATURAL MEASURES

Arthur Whillock, Information Secretary
The Dozenal Society of Great Britain

Ever since the introduction of place-value numeration into Europe some six hundred years ago, Mathematicians and Philosophers have recognized that the poorly divisible counting scale of ten was not suitable as a means of communication with our material environment. Structures of the world around us, our understanding of and dealings with it, and one another, are governed by twos, threes and fours with their unit fractions. So it follows that the arithmetic required to formalize all such relationships should contain the above values as aliquot parts and be able to express their fractions as concisely as possible. Dozenal Societies exist to affirm this view and seek ways of explaining and advancing them in order that the place-value system could attain its full potential.

There has been no lack of ideas as to how numerical reform could be achieved, nor an acceptance of the difficulties involved, particularly over the introduction of single symbols for values now known as 'ten' and 'eleven'. Information on this can be had from several books, and papers published by us and The *Dozenal Society of America*. Suffice it to mention now that The Dozenal Society of Great Britain uses the Isaac Pitman inversions (by rotation) of two and three, ↊ & ↋. For good reasons of their own, *DSA* have adopted the Bell telephone symbols ✱ & #, first used in a math book in the '40s and now familiar to the public.

The Pitman solution could well have been used for the hexadecimal scale, as an inverted one has been for work in balanced ternary as it's negative, and there would have been mnemonic advantages. It was a lost opportunity to establish a complete numbering scale that would serve all needs for the foreseeable future instead of meekly using A to F. However, it does seen unreasonable to accept that there never, ever, will be any additions to the overworked set of alphanumeric symbols we have now. Anything new will be seized upon for all manner of purposes.

The immediate need is the preservation of our existing well understood measures with practical sized divisible units that are dealt with in small numbers and simple fractions. They are far mare suitable for social use and exchanges than any artificial committee designed arrangement with narrow objectives. Our measures have evolved down the ages to be best suited to their purpose — convenience in use — as this paper attempts to explain. Nobody, however learned or eminent, has any entitlement to lay our perceptions and needs onto a Procrustean bed to be stretched or shortened so that they will fit into their own restrictive ideas. Least of all, destroy something that is part of our history and culture which we have not yet been allowed to use properly.

For the past four dozen years, ever since it became clear that no expense would be spared, or deception deemed unworthy, to insinuate artificial metric into all of our affairs as well as reducing traditional measures by a 'salami-slice' procedure, *DSGB* has been warning of the danger and outcome, and producing information to counter it including references to historic measures, their origin and principles. This was in addition to the contention that a primitive finger-counting scale with its limited divisibility inherited from a remote past, when there was no conception of any higher use, was not competent to deal with the objective world in the clearest manner possible. Even the mathematics required for this would benefit if the primary numbers on which it relies — 2, 3 & 4 were allowed to take their rightful place in the pantheon of important numbers.

We have also supported the groups that sprang up along the downward slope from decimalized currency to overall metrication. (Decimalized time is yet to come, and ultimate cacophony can be achieved with a ten-tone music scale!) Most were simply anti the 'threat-of-the-moment', without realizing that by the time an official denial was issued It was too late. Similarly, smooth assurances of 'no compulsion' given by all Governments only served to emphasize the real intention. Without an understanding of the principles that should be embodied in a social metrology — human sized manageable units that could be dealt with by small numbers and simple fractions, there is no staying power.

The *British Weights and Measures Association* has a broad base, It was formed in 1995 in response to the attempt at a final demise of the weights and measures that have served us so well for the past fourteen hundred years, starting in October of that year. Under the guidance of Vivian Linacre, they have tackled all aspects of the situation, particularly the political and have attracted support from several MP's. They have also received public approval from many well known people. A team of dedicated members collect evidence of the inadequacies arid illogicalities of metric for ordinary use, an ensure a supply of material for their *Yardstick*, published twice yearly to inform members of developments and act as a forum for their views.

BWMA are entirely dedicated to retaining our traditional measures for ordinary use. There are no objections to metric for technical purposes, and criticisms of it are directed to explaining its unsuitability for social usages. The requirements for these are quite different from those for scientific, even technical work, when size-order can be more important than actual size. By their direct, simplified approach; they have attracted a wide spectrum of opinion, and articulated the unease felt by many that something valuable is being lost by default of sufficient opposition.

DSGB has been expounding the essential details required by working measures, as distinct from analytical, ever since it has been obvious that there was an undeclared intention to impose metrication upon us with lofty disregard of all objections voiced in the past or present, Our policy, in cooperation with the *DSA*, was inclined to be theoretical and technical, with references to past experiences and future needs, and mathematical justifications. All of which a bemused and small c conservative public would regard as unimportant. The present dispute over measurement is, at heart, one over arithmetic notation. It will not be properly resolved until the benefits of, divisibility acquired out of necessity by the former is allowed for the latter. The place-value system of notation can then achieve its full potential and allow a unification of scientific and social practices.

We are, of course, concerned with the current attempt to force metric into all our social transactions, with its inadequate and clumsy means of expressing simple relationships we now take for granted and by right of usage. Aristotle said that some things are so obvious that they are never noticed (or appreciated until lost). Metric processes require different patterns of thought to those in which we normally make judgements regarding distances, lengths, quantities or values which are conducted by means of simple fractions — halves, thirds, quarters, two thirds, three quarters, In the less divisible scale of ten we are restricted to halves and fifths, with this last rarely needed; all others become rows of meaningless figures.

As Napoleon put it in one of his criticisms of metric: "They suppressed all complex numbers (i.e. common fractions). Nothing is more contrary to an organization of the mind, of the memory, and of the imagination."

The facility of these much used proportions was embedded in early measures over their working range. Large quantities dealt with by merchants and administrators could proceed in multiples of tens since the need for divisions never arose. Working units of length, weight, and volume were also selected to be comprehensible and suited to practical needs. These were evolved from precursors found to be useful long before records became available,

All measures throughout Europe were based on those of Rome, either for convenience in trade or imposed by conquest, but changes to local forms were not great; the same principles having been followed. The Romans in turn had theirs from Greece, who were indebted to Egypt, particularly for those of length, and Egypt had connections with Harappa in the Indus valley.

There were minor variations between Principalities and independent City States. The two most influential were those of France and England. Paris measures were a revision by Charlemagne in the eighth century up to the imposition of metric. Ours date from Saxon times and King Athelstan, but were not legalized until Edward I early in the fourteenth. Statistical studies of historic buildings show that our foot has not varied by more than half a percent since then.

These 'Natural' measures, so called because of their human compatibility, and, with their binary and ternary structures, correspond not only to the instinctive ways we use to make judgements of relationships and proportions but the manner in which things arrange themselves to best advantage. The single half and fifth of a decimal scale seems stultifying by comparison. Yet it is just this unfortunate combination of nonergonomic sizes rigidly embedded into a poorly divisible arithmetic framework that Governments with any color of shirt were intent on forcing into our everyday affairs to further their political and commercial purposes.

A specious reason is that metric is more 'scientific'. By being a system, integrated with a numbering scale, it is convenient for abstract technical work dealing with concepts outside ordinary experience for which rows of figures bracketed with lots of zeros are acceptable. Even desirable as an appearance of "pecuniary reputability', requiring that a great deal of time and money must be expended on a project to receive maximum approval.

The present dispute over measurement is, at the core, one over the ability of arithmetical notation to respond to its needs. It can not be fully and properly resolved until the essential benefits of divisibility acquired by necessity by the former is achieved by the latter. The place-value system of calculation, which many think is the property of just one numbering scale, could then be operated with clarity.

There is no doubt that a so called 'rationalization' of measures is politically and commercially motivated, as it was at the beginning; the two go 'hand in glove', but opinions vary as to which is which: It will most certainly help the management and control of such activities, with a further advantage of rendering them less overt to us. More importantly, we become detached from our past, and further alienated from the natural objective world when it is presented in a — human sized measures expressed in rows of meaningless figures into which we are at risk of becoming submerged ourselves.

It has been well noted that "because systems of measurement express the attitudes of the cultures that created them, they tend to resist change until the culture changes (the French revolution was an abrupt transfer of power from a feudal to a mercantile class) . . . The right to determine measures is also symbolic of sovereignty". Those who are claiming to direct our destiny are likely to have realized that this could be a two-way process — enforced changes in metrology could be a means of changing the culture. Metric restricts freedom of choice, and thus inculcates more obedience vs. the differing patterns of thought mentioned earlier.

"One dimensional Man", with no history or memory (Time) will be responsive only to the latest advert or edict. Without'perspective on his surroundings (Space) nor any feel for then (Matter) will himself be reduced to a three figure paper abstraction as seen on a packet of 'food', and as readily adjusted to suit whatever economic policy is in vogue for the store or government.

If *BWMA* musters enough support to prevent the total loss of our national measures, or arose sufficient public concern that will oblige Authority to tolerate their use in nontechnical matters, they will be performing a valuable service for the future everywhere. Canada and Australia/New Zealand are operating a mixed-measures arrangement, and the United States certainly will have to as individual states are zealous for their rights and resist any interference by the 'Feds'. Many. have lately reverted completely back to traditional means and methods.

Dozenal Societies, and others concerned with natural metrology, will (must) continue to assure an anxious public that their age-old measures are not so unscientific as they are being led to believe. With their binary and ternary structures they are potentially more so than the artificial / primitive counting system intended to replace them to fulfill an authoritarian need for overall uniformity. They have recognizable identities besides history, which adds meaning to their uses, and with roots going back to the earliest attempts on some meaningful relationship with our material surroundings. 'Man' can be appropriately defined as a 'Measuring Animal' to distinguish him from the others who also make and use tools and body related sizes would inevitably have been used. Post holes recently found in Japan have been dated at half a million years ago. With their equidistance spacings, they seem to have been paced out purposefully.

Were we to Lose our measures it will be all the more difficult to explain the principles on which they have been founded, and the benefits they afford. However, there is very little that is new to be said on the subject, only circumstances and needs change so it is necessary to fit fresh words to these. The

opinion of John Quincy Adams, Secretary of State, later President, of the U.S.A., when advising Congress on the metrication question is well worth repeating: "The decimal principle can be applied only with many qualifications to any general system of metrology; that its natural application is only to numbers; and that time, space, gravity and extension inflexibly rejects its sway . . . Decimal arithmetic is a contrivance of man for computing numbers and not a property of Time, Space or Matter, Nature has no partialities for the number Ten, and the attempt to shackle her freedom with it will forever prove abortive."

THE EASIEST, MOST CONFUSING THING - MORE METRICS

by Arlene Glaser, Age Dek

Everyone who understands the metric system, says
"Good-bye inches and feet,"
"You're all so confusing unlike the metric system,
which is really neat,"
"Inches and feet are so uncool."
(But I don't agree, and when they say metrics are
easy, I feel like a first class fool!)

They say once I learn it, I'll like it better,
without a doubt.
Anyone who likes metrics, should get their head
checked out!
In my mind this system is very inferior,
Anyone who likes it should be sent to Siberia!

I still say metrics is very "confusin",
I'd pick inches over centimeters, if I could
be "choosin"!
The only good thing I found,
Every kilogram I weigh, is less than every pound!

*[Thanks to **Dick Trelfa 159;** who challenged Arlene with the dozenal system]*

CALCULATOR

Hi there. I've been interested in dozenal notation for a little while, and heard about the Dozenal Societies of America & Great Britain. I got a lot out of both web sites. I especially found the *TGM* system of metrics interesting.

Anyway, for my own amusement, I wrote this little calculator thing that works both in decimal and dozenal, so I thought I would share it with you. Please feel free to distribute it to whomever you choose. It is written for Windows, and should work for most versions of Windows. If you would like the source code (in Visual Basic), I don't mind sharing that as well.

For this calculator, I used the letters T and E for ten and eleven. Numbers can be entered by clicking the buttons on the calculator or using the computer keyboard. Also two important shortcut keys are M and Z to switch between deciMal and doZenal representation.

Enjoy, and feel free to contact me with any questions. Harvey Kramer Hawks, Seattle, WA, hhawks@solucient.com kramerhawks@attbi.com

(Harvey included a 40KB program, DozenCalc.exe. I simply ran the program and it was great! - Editor)

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ANNUAL MEETING TO BE HELD IN MANHATTAN

After three dozen years the DSA will once again hold an Annual meeting in Manhattan, the scene of its birth. (We had planned to do last year when the unfortunate events of 9-11 caused us to move the meeting Long Island.) Our Secretary, Christina D'Aiello has arranged for us to convene at her place of employment, Bank Street College , 610 West 112th Street between Broadway and Riverside Drive.

You can take the number 1/9 train to 110th street, walk 2 blocks north to 112th street and you will see the Bank Street Bookstore. Turn down that block and the next building is us.

We gather on Friday 4 October 11XX. The time is (tentatively) set for 1 pm. Please try to attend.

For details contact either:

Christina at 212 875 4789 or at cscalise@bnkst.edu or

Gene at 631 669 0273 or at genezirk@mindspring.com.

*, *, *, *, *, *, *, *, *, *, *, ❖ or X?

The asterisk has often been used as the numeral for dek (ten). Many asterisks have 6 spokes such as the Times New Roman font (∗). However some fonts have only 5 spokes such as the Arial asterisk (*) while Amaze has 8 (✳).

In addition most of those with 6 spokes are composed of the letter X crossed by a vertical line. Very few use a horizontal line.

Henry Churchman, former Board Chair of our Society and former editor of this *Bulletin* was fond of saying of the symbol for dek, "It's not ten. It's a Roman Ten crossed out." Thus we prefer the horizontal line such as found in the Basque font (*).

Furthermore, when word processing or typing the asterisk appears as a superscript and much smaller than the other numerals as: 89*#0. To compensate for this, an author needs to advance the asterisk down, insert a larger font, and then advance back up. Thus 89∗#0 is obtained in dek point type by advancing down and then up 0.065inches and using 14; point type. Notice however, that the use of 14; point type caused the entire line to drop down leaving an unsightly space. To correct this one needs to put an additional advance up at the beginning of the line obtaining 89∗#0. This required an advance up of 0.1 inches.

Of course, any editing such as inserting or deleting words might cause the beginning of the line to change and would necessitate changing this last advance.

These are, to say the least, very onerous for the dozenal typist!

For these reasons we have switched to *cap X and strike out* (X)as a symbol for dek. It is much, much easier for the volunteer. What are your thoughts about this change?

□ □ □

OBITUARY: STEPHEN JAY GOULD

Stephen Jay Gould, the author of *The Panda's Thumb*, passed away on 18; May 11XX. In one of his essays in the Museum of Natural History's magazine, *Natural History*, he pointed out that the panda has 6 "fingers". It was this disclosure that led the DSA to adopt the panda as its mascot.

A MOST UNUSUAL SOCIAL SECURITY NUMBER
A "Mega-Clue" Problem

Jay Schiffman and Eric Milou Rowan University

[REPRINTED FROM *THE NEW JERSEY MATHEMATICS TEACHER*, VOL. 58, NO. 1, FALL 2000. THIS ARTICLE ANSWERS A QUESTION RAISED BY JEAN KELLY IN "AN EXTENSION OF A FAMILIAR PROBLEM" IN THIS *BULLETIN*, WN 85, VOL. 42; NO. 2; PP16;-1X;]

The text by Billstein, Libeskind, and Lott entitled *Mathematics For Elementary School Teachers*, Fifth Edition, poses the following *Brain Teaser* on Page 231:

> *Dee has an extraordinary Social Security Number. Its nine digits contain all the numbers from 1 through 9. They also form a number with the following characteristics: When read from left to right, its first two digits form a number divisible by 2, its first three digits form a number divisible by 3, its first four digits form a number divisible by 4, and so on, until the complete number is divisible by 9. What is Dee's Social Security Number?*

The National Council of Teachers of Mathematics (NCTM) in the *Curriculum and Evaluation Standards for School Mathematics* (1989) state that in grades 5-8, students should develop and apply number theory concepts in mathematical problem situations (p. 91). The purpose of this article is twofold. First, the article shows how a single problem can provide the basis for some excellent mathematical investigations, and, at the same time inspire a class of pre-service teachers and their instructor to delve deeply into some excellent mathematics. Secondly, the article explores number-theoretic and combinatorial ideas needed to furnish a solution to the stated problem as well as to demonstrate the uniqueness of the solution. These concepts are easily accessible to the majority of students at the middle school level.

The problem was presented in an undergraduate mathematics course that prepares pre-service elementary school teachers at a university in a rural setting in the Northeast. The students quickly observed that nine digits can be arranged in $9! = 362{,}880$ ways. (However, there are restrictions on the digits which greatly reduces the number of possibilities based upon the given information.) Also, we reviewed the following tests for divisibility of an integer N by each of the integers from one through nine respectively which we denote by D1-D9. (D7 caused quite a few puzzled looks from the students as many had not experienced the rule before.)

D1: N is always divisible by 1.

D2: N is divisible by 2 if, and only if, the units digit of N is even.

D3: N is divisible by 3 if, and only if, the number consisting of the sum of the digits of N is divisible by 3.

D4: N is divisible by 4 if, and only if, the number consisting of the ten's digit and the unit's digit of N is divisible by 4.

D5: N is divisible by 5 if, and only if, the unit's digit of N is 0 or 5.

D6: N is divisible by 6 if, and only if, N is divisible by both 2 and 3.

D7: N is divisible by 7 if, and only if, the number formed by taking the unit's digit plus three times the ten's digit plus twice the hundred's digit minus the thousand's digit minus three times the ten thousand's digit minus twice the hundred thousand's digit plus the million's digit, etc. of N is divisibly by 7 where we proceed from right to left. (Other tests for the divisibility of an integer N by 7 are known.)

D8: N is divisible by 8 if, and only if, the number consisting of the hundred's digit, ten's digit, and unit's digit of N is divisible by 8.

D9: N is divisible by 9 if, and only if, the number consisting of the sum of the digits of N is divisible by 9.

The students were placed in groups of four for 30 minutes to explore the problem. The entire class then came together to discuss their findings. What follows is the discussion that ensued over the course of two class periods.

Initially, by the constraints of the problem, it was clear to the students that the even places in the SSN (the second, fourth, sixth, and eighth) must contain a different even digit, while the odd places (the first, third, fifth, seventh, and ninth) must contain a distinct odd digit. In addition, the digit in the fifth place is restricted to being a 5 by virtue of D5. Moreover, the digit in the fourth place could either be a 2 or a 6, since utilizing D4, only 12, 32, 72, 92, 16, 36, 76 and 96 are two digit integers that are divisible by 4. Thus, the students claimed they knew the following:

1. The fifth digit must be a 5.

2. The first digit can be any odd digit apart from 5, namely 1, 3, 7 or 9.

3. The third digit can be any odd digit except 5 and the one used for the first digit, leaving three choices.

4. The seventh digit can be one of the two remaining odd digits (other than 5 and the two odd digits employed for the first and third places).

5. The ninth digit can be filled with the lone odd digit remaining.

6. The fourth digit can be the even digit 2 or 6. leaving the second digit to be one of the three remaining even digits.

7. The sixth digit can be occupied by any even digit other than those employed for the second and fourth digits, a total of two.

8. Finally, the eighth digit can occupy the sole available even digit.

Hence we had a reduced list containing 4 x 3 x 3 x 2 x 1 x 2 x 2 x 1 x 1 = 288 possibilities (by The Fundamental Principle of Counting). The students were excited to see that the list of possibilities had dwindled from 362,880 to 288. But they still knew there was much work to be done. With some prodding from the professor, the students generated a list of twelve schemes (marked SI to S12) each having two dozen (4! = 24) outcomes:

__	2	__	6	5	4	8	__	S1
__	2	__	6	5	8	4	__	S2
__	4	__	6	5	2	8	__	S3
__	4	__	6	5	8	2	__	S4
__	8	__	6	5	2	4	__	S5
__	8	__	6	5	4	2	__	S6
__	6	__	2	5	4	8	__	S7
__	6	__	2	5	8	4	__	S8
__	4	__	2	5	6	8	__	S9
__	4	__	2	5	8	6	__	S10
__	8	__	2	5	4	6	__	S11
__	8	__	2	5	6	4	__	S12

Our next task was to examine each of our dozen schemes with the sixth through eighth digits and examine D8 (divisibility by 8).

Scheme S1 was impossible as 418, 438, 478, or 498 were NOT divisible by 8 (where the seventh slot was filled with one of the odd integers 1, 3 , 7, or 9).

Scheme S2 was impossible as 814, 834, 874, or 894 were NOT divisible by 8.

Scheme S3 was impossible as 218, 238, 278. or 298 were NOT divisible by 8.

Scheme S5 was impossible as 214, 234, 274, and 294 were NOT divisible by 8.

Scheme S7 was impossible as 418, 438, 478, and 498 were NOT divisible by 8.

Scheme S8 was impossible as 814, 834, 874, and 894 were NOT divisible by 8.

Scheme S9 was impossible as 618, 638, 678, and 698 were NOT divisible by 8.

Scheme S12 was impossible as 614, 634, 674, and 694 were NOT divisible by 8.

This left us with Schemes S4, S6, S10, and S11.

Now, we examined the seventh digit of the remaining schemes and D8:

Scheme S4 worked when the seventh digit was a 3 or a 7; for 832 and 872 were divisible by 8.

Scheme S6 was feasible when the seventh digit was likewise a 3 or a 7; for 432 and 472 were divisible by 8.

Scheme S10 held when the seventh digit was a 1 or a 9; for 816 and 896 were divisible by 8.

Scheme S11 was satisfied when the seventh digit was either a 1 or a 9; for 416 and 496 were divisible by 8.

Therefore, our 288 possibilities have been reduced to 48. As for each of our four possible schemes, there are two choices for the seventh digit and three choices for the first digit, two choices for the third digit and one choice for the ninth digit. Thus there are 2 x 3 x 2 x 1 = 12 possibilities for each of the four schemes, a total of 48. We were now in a position to make a list and examine each of our four schemes.

We first examined Scheme S4: __ 4 __ 6 5 8 __ 2 __. The 12 possibilities written in the usual SSN format were as follows:

147-65-8329	941-65-8327	341-65-8729
149-65-8327	947-65-8321	349-65-8721
741-65-8329	143-65-8729	941-65-8723
749-65-8321	149-65-8723	943-65-8721

The students quickly eliminated all of these possibilities because they either failed test D3 or test D6. Now, they examined Scheme S6: __ 8 __ 6 5 4 __ 2 __. The 12 possibilities were as follows:

187-65-4329	981-65-4327	381-65-4729
189-65-4327	987-65-4321	389-65-4721
781-65-4329	183-65-4729	981-65-4723
789-65-4321	189-65-4723	983-65-4721

187-65-4329, 781-65-4329, 389-65-4721 and 983-65-4721 failed the D3 test; leaving 8 possible solutions. They then examined the 12 possibilities of Scheme S10: __ 4 __ 2 5 8 __ 6 __. All but 147-25-8963 and 741-25-8963 failed test D3. Now a total of 10 possibilities remained. Finally they examined Scheme S11: __ 8 __ 2 5 4 __ 6.

All failed either test D3 or test D6; thus the following ten cases remained and this final enumeration followed:

189-65-4327	183-65-4729	981-65-4723
789-65-4321	189-65-4723	147-25-8923
981-65-4327	381-65-4729	741-25-8963
987-65-4321		

It was agreed that D7 was now the deciding factor. The students quickly found that of the above ten candidates, only 381-65-4729 satisfied Property D7 for its initial seven digits (3,816,547). Applying D7 to the first seven digits, note that

$7+(3\cdot 4)+(2\cdot 5)-6-(3\cdot 1)-(2\cdot 8)+3 = 7$ and clearly 7 is divisible by 7. (Most students disregarded the property and instead turned to their calculators and found that $3816547 / 7 = 545221$.) In all other cases, the number consisting of the first seven digits was not evenly divisible by 7. Finally, note that any nine-digit integer whose digits consist of all the initial nine counting integers each employed once and only once is divisible by 9. (The digital sum in such case is 45 and 45 is evenly divisible

by 9 regardless of order.) We concluded that the SSN:

381-65-4729 is indeed unique and possesses the special properties required of our problem.

The students felt genuinely proud of their accomplishment. However, they wondered does anyone actually have such a social security number? Thus, this problem took a new turn. We researched the issuance of social security numbers (COMAP, 1994) and found that the first three digits of Social Security Numbers showed the locale where the number was applied for. The person possibly holding our number (first three digits 381) most likely applied for it in the state of Michigan. (However, changes in population have forced some numbers to be moved or assigned out of sequence over the years.) A call to the Social Security Administration confirmed that if the first three digits of a SSN lie in the range 362-386, Michigan was the place of origination.

Furthermore, we investigated the middle (fifth) digit. We analyzed a sample of social security numbers from courses during the years 1993-1997 comprising 602 students and found that ONLY 52 of them or roughly 8.6% had SSN's with an odd middle digit. Of these 52, 19 applied in Puerto Rico (range 581-584), 10 applied in The District of Columbia (the initial three digits being in the range 577-579), 5 applied in California (range 545-573), 4 each applied in Maryland (range 212-220) and Florida (range 261-267), 2 each acquired their number in either Puerto Rico or The Virgin Islands (range 580), Virginia (range 223-231) or North Carolina (range 247-251) and 1 each in Mississippi (range 425-428), Arkansas (range 429-432), South Carolina (range 247-251), and Colorado (range 521-524). This investigation involved data analysis and statistical calculations. This problem now was involving the whole class in many mathematical areas.

We also discovered that 9 is not utilized as the first digit in any SSN and the range 700-728 through July 1, 1963 was reserved for railroad employees. Moreover, unlike the SSN in our problem the digit 0 is permissible, as are repetitions of digits. (See Table 1 for a breakdown of social security numbers by state.)

In conclusion, the solution to the problem is neat from a mathematical standpoint to view the marriage of combinatorics and number-theoretic considerations, and to further illustrate the many connections that the problem led to. This paper's goal was to furnish a useful application of number theory together with combinatorial considerations, and to illustrate that challenging but accessible problems from number theory can be easily formulated and explored by all students (NCTM, 1989). It was a wonderful experience to see the students excited, stimulated, and pushing their professor to find out even more than even we had expected.

REFERENCES

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Table 1

BREAKDOWN OF SOCIAL SECURITY NUMBERS BY STATE

New Hampshire	001-003	Oklahoma	440-448
Maine	004-007	Texas	449-467
Vermont	008-009	Minnesota	468-477
Massachusetts	010-034	Iowa	478-485
Rhode Island	035-039	Missouri	486-500
Connecticut	040-049	North Dakota	502
New York	050-134	South Dakota	503-504
New Jersey	135-158	Nebraska	505-508
Pennsylvania	159-211	Kansas	509-515
Maryland	212-220	Montana	516-517
Delaware	221-222	Idaho	518-519
Virginia	223-231	Wyoming	520
West Virginia	232-236	Colorado	521-524
North Carolina	232,237-246	New Mexico	525,585
South Carolina	247-251	Arizona	526-527,600-601
Georgia	252-260	Utah	528-529
Florida	261-267,589-595	Nevada	530
Ohio	268-302	Washington	531-539
Indiana	303-317	Oregon	540-544
Illinois	318-361	California	545-573,602-626
Michigan	362-386	Alaska	574

Wisconsin	387-399	Hawaii	575-576
Kentucky	400-407	Dist. of Columbia	577-579
Tennessee	408-415	Virgin Islands	580
Alabama	416-424	Puerto Rico	580-584,596-599
Mississippi	425-428,587-588	Guam	586
Arkansas	429-432	American Samoa	586
Louisiana	433-439	Philippines	586

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8. Click: Continue
9. At next page, if correct Click: Send Money

That's all there is to it!

PROBLEM CORNER

1. Consider the famous Fibonacci Sequence FIB(N) which is recursively defined as follows:

$$FIB(1) = FIB(2) = 1 \text{ and } FIB(N) = FIB(N-2) + FIB(N-1)\ N \geq 3.$$

Thus FIB(3) = 2 and FIB(4) = 3. Show that every dozenth term of the sequence is divisible by and twelve (and hence by 2, 3, 4 and 6).

2. The Lucas Numbers are a Fibonacci-like sequence. LUC(N) is recursively defined as follows:

$$LUC(1) = 1,\ LUC(2) = 3\ \&\ LUC(N) = LUC(N-2) + LUC(N-1) \text{ for } N \geq 3.$$

Thus LUC(3) = 4 and LUC(4) = 7. Show that no Lucas Number is a multiple of 5, 8, X; or 10;.

3. Show that the periods of the units digits of the Fibonacci and Lucas sequences in Base Dek are respectively five dozen and one dozen while in Base Twelve, the units digits of each sequence is two dozen.

SOLUTION TO A PREVIOUS PROBLEM:

In base dek the cryptarithm $E^2 = DE$ has 2 solutions: $5^2 = 25$ or $6^2 = 36$. Hence E = 5 or 6 and D = 2 or 3 respectively.

In base do, $E^2 = DE$ has a unique solution for D and E. Furthermore if

$$L^2 = ED$$
$$EA - OE = DZ$$
$$O \times Z = A$$
$$O + Z = N$$
$$Z - O = D$$

find the values of all the digits represented by letters and place them in numerical order.

Solution:

From $E^2 = DE$ we have E = 4 and D = 1and hence $L = \sqrt{41} = 7$.

4A - O4 = 1Z yields these possibilities:

A	Z	O
0	8	2
3	#	2
6	2	3
8	5	3
X	6	3

but since O x Z = A we have A = 6 and O = 2 or 3 while Z = 3 or 2. Either way N = 5. Finally Z - O = 1 yields Z = 3 and O = 2.

Putting the digits in order gives 1, 2, 3, 4, 5, 6, 7 and the word DOZENAL! ✷

△ △ △ △

JOTTINGS

Life member **DICK TRELFA** 159; sent us this clipping from *The Sunday Telegraph* of 21 October 2001, page 33.

READERS RALLY, Funds flow in for metric martyrs

Neil Herron, the Sunderland businessman who runs the Metric Martyrs Defence Fund, reports an amazing response to my emergency appeal last week for more financial support. This was made because of Sunderland council's belated move to press for costs in a bid to head off the great metrication case before its full hearing in the London high court on November 19. "Hundreds of cheques have flooded in," says Herron, "including one for £1,000 from one of our leading industrialists who said he and his wife were 'outraged' at the way these small traders are being persecuted."

Another reader said that he was sending £25, and a further £250 on behalf of his brother who had already contributed to the fund last April but died during the summer. Mr Herron says he and his small staff cannot thank all these contributors individually, but the "the wonderful response of *Sunday Telegraph* readers has given us a fantastic boost".

• • •

We welcome our newest members:

MARGARET CALDERÓN 36# from Madison WI

SKYLER WILLIAM ROSS 370 from Columbia TN

ANDREW KIRK 371 from Roslindale MA

KATHRYN BRUMMER 372 from Massapequa Park NY

ANDREW is a teacher. He suggests an inverted U for dek and a J shaped figure for el. He writes: I developed them as easy to write quickly and unlikely to confuse. ∩ is the Egyptian ten, and J is the Arabic Alphabetic thirty. Admittedly, it looks like a "j" but seems to work.

KATHRYN is the recipient of the student scholarship donated by **CHARLES MARSCHNER** 270.

• • •

Received from **PROFESSOR BILL LAURITZEN** 330;

Please consider linking to my web site: www.earth360.com which has information on numbers and dozenals, or even more specifically to my article: "Versatile Economics" at http://earth360.com/math-versatile.html.

□ □ □

ERRATA

The pages in our last issue were correctly marked Volume 43; Number 1, but the front cover was incorrectly marked as Number 2. This is Volume 43; Number 2.

WHICH REPUNITS ARE PRIME?

by Jay Schiffman & Gene Zirkel

Repunits are numerals which are composed entirely of ones such as *1, 11, 111, 1111, 11111,* etc.

In the table below we have converted the values of the first four repunits in bases 2 through 14; into dozenals. Thus we show that *111* in base two equals 7 in duodecimals while *11* in base eleven (#) equals one dozen (10).

Repunits:	*1*	*11*	*111*	*1111*
BASE				
2	1	$\underline{3}$	$\underline{7}$	13
3	1	4	$\underline{11}$	34
4	1	$\underline{5}$	19	71
5	1	6	$\underline{27}$	110
6	1	$\underline{7}$	$\underline{37}$	197
7	1	8	49	294
8	1	9	$\underline{61}$	409
9	1	X	77	584
X	1	$\underline{\#}$	93	787
#	1	10	#1	X20
10	1	$\underline{11}$	$\underline{111}$	1111
11	1	12	133	1464
12	1	13	$\underline{157}$	1863
13	1	14	$\underline{181}$	2114
14	1	$\underline{15}$	1X9	2641

The primes in this table have been underlined. The question we wish to investigate is: Which repunits are prime numbers in bases binary through hexadecimal?

To answer this question, we note that a repunit in base b is a geometric series of the form $1 + b + b^2 + b^3 + b^4 + \ldots + b^k$ which, in turn, is equal to

$$\frac{b^{k+1} - 1}{b-1}$$

Note that k+1 equals the number of ones in the repunit.

For example, in base five we have *1111* = $5^3 + 5^2 + 5 + 1$ = *5 + 21 + 5 + 1 = 110; and $\frac{5^4 - 1}{5-1} = \frac{440}{4}$ is also 110 as seen in the table above. This is not prime since 2 x 2 x 3 x 11 are its factors.

Using the computer program, *MATHEMATICA*, and the formula given above for the sum of a geometric series we generated 3 gross outputs for each base from 2 through 14; and tested to see which ones were prime. For example, the first dozen outputs in base 2 are listed in the first column below. These correspond to the first dozen rep units in the second column where False indicates the repunit is not a prime and True indicates that it is prime. Since these are binary numerals, we convert them to dozenals in column 3.

False	*1*	1	unity: neither prime nor composite
True	*11*	3	prime
True	*111*	7	prime
False	*111 1*	13	3 x 5
True	*111 11*	27	prime
False	*111 111*	53	3 x 3 x 7
True	*111 111 1*	*7	prime
False	*111 111 11*	193	3 x 5 x 15
False	*111 111 111*	367	7 x 61
False	*111 111 111 1*	713	3 x # x 27
False	*111 111 111 11*	1227	1# x 75
False	*111 111 111 111*	2453	3 x 3 x 5 x 7 x11

The final results for the first 3 gross repunits in each base were as follows where k is the number of digits in the rep unit

Base:	k:
2	2, 3, 5, 7, 11, 15, 17, 27, 51, 75, 8#, *7
3	3, 7, 11, 5#, 87
4	2
5	3, 7, #, 11, 3#, *7, 105, 131
6	2, 3, 7, 25, 5#, *7, 1*7
7	5, 11, *#, 105
8	3
9	none
*	2, 17, 1#, 225
#	15, 17, 61, #7
10	2, 3, 5, 17, 81, 91, 225, 255
11	5, 7, #5, 1#7
12	3, 7, 17, 27, 35
13:	3, 37, 61
14:	2

Thus in hexadecimals among the repunits consisting of anywhere from a single 1 to three gross 1s, only repunit *11* (15;) is prime! On the other hand, among the first three gross of repunits in dozenals 8 are prime including *11, 111, 11 111*, ... up to the repunit consisting of 255; ones! Only the binary repunits have more primes among these first three gross repunits.

IN APPRECIATION

Life member **DICK TRELFA** of Lisbon New Hampshire, member number 159; recently spent a lot of time designing our new membership cards. After much back and forth correspondence patiently designing, editing and correcting several possible variations he has come up with a beautiful finished product.

Our Treasurer Professor Alice Berridge has informed us that she has just received a packet of beautiful membership cards from Dick: "They look very good indeed! I have sent him the first card for the new DSA year. In addition to producing the cards at his own expenses, he sent us a generous donation of a gross of dollars. Not only has he donated many hours of his time for the cards but he is generous with his money too!"

When you next pay your dues and you receive your new membership card, thank Dick.

WHY CHANGE?

This same question was probably rife in Europe between the years 1000 and 1500, when the new Hindu-Arabic numerals were slowly making their inching progress in displacing the comfortable and familiar Roman numerals then universally used.

Yet, although it took D years, and despite much opposition--("Who needs a symbol for nothing?")--the new notation did come into popular use. Released from the drag of Roman notation, people's thinking leapt forward dramatically, and mathematicians discovered a new dimension in mathematical symbolism. Working with Hindu-Arabic numeration, they found that the new system better accommodated mathematical statements and facilitated the working out of ideas. Re-examining their fundamental concepts of numbers, they made advances in arithmetic, algebra, logarithms, analytic geometry and calculus, and thus contributed to the explosion of human thought which later became known as the Renaissance. Then, in a related development, people awoke to the fact that different number bases could be used.

A parallel to today seems tenable. The notation of the dozen base better accommodates mathematical statement and facilitates ideation. It, too, is a step forward in numerical symbolism. The factorable base is preferred for the very same advantages which led the carpenter to divide the foot into twelve inches, the baker and the grocer (one who deals in *grosses*) to sell in dozens, the chemist and the jeweler to subdivide the Troy pound into twelve ounces. And 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**FACTOR**y because it has **NOT ENOUGH FACTORS**.

Then should we change? Yes, but no change should be forced, and we urge no mandated change. All the world counts in tens. But people of understanding should learn to use duodecimals to facilitate their thinking, their computations and their measurings. Base twelve should be man's second mathematical language. It should be taught in all the schools. In any operation, the most advantageous base should be used, the one best suited to the task at hand. (Similar to computer scientists use of binary, hexadecimal or octal - whichever is most convenient.) If this were done, duodecimals would progressively earn their way into general popularity because they simplify the all-important problem of the correlation of weights and measures, the expansion of fractions (1/3 = 0;4) and give an advantage in calculations involving time and our twelve-month calendar. 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 more convenient base.

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 erroneously 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 most cordially invited ✷

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Please include on a separate sheet your particular duodecimal interests, comments, and other suggestions.

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