COUNTING IN DOZENS

1	2	3	4	5	6	7	8	9	X	Ɛ	10
one	two	three	four	five	six	seven	eight	nine	dek	el	do

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

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

Place value is the whole key to dozenal arithmetic. Observe the following 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 you already know the 12-times table. Mentally convert the quantities into dozens, and set them down. For example, 7 times 9 is 63, *which is* 5 dozen and 3; so set down *53*. Using this "*which is*" step, you will be able to multiply and divide dozenal numbers without referring to the dozenal multiplication table.

Conversion of small quantities is obvious. By simple inspection, if you are 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     Answer: 265
```

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

Fractions may be similarly converted by using successive multiplications, 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 Table

1	2	3	4	5	6	7	8	9	X	Ɛ
2	4	6	8	X	10	12	14	16	18	1X
3	6	9	10	13	16	19	20	23	26	29
4	8	10	14	18	20	24	28	30	34	38
5	X	13	18	21	26	2Ɛ	34	39	42	47
6	10	16	20	26	30	36	40	46	50	56
7	12	19	24	2Ɛ	36	41	48	53	5X	65
8	14	20	28	34	40	48	54	60	68	74
9	16	23	30	39	46	53	60	69	76	83
X	18	26	34	42	50	5X	68	76	84	92
Ɛ	1X	29	38	47	56	65	74	83	92	X1

The Duodecimal Bulletin

Whole Number 1Ɛ

Volume Ɛ, No. 2
Dec. - 1955

THE DUODECIMAL SOCIETY OF AMERICA

20 Carlton 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.

The Duodecimal Bulletin is the official publication of the Duodecimal Society of America, Inc., 20 Carlton Place, Staten Island 4, New York. F. Emerson Andrews, Chairman of the Board of Directors. Kingsland Camp, President. Ralph H. Beard, Editor.

Separate subscriptions $2.00 a year, 50¢ a copy.

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The Duodecimal Bulletin

All figures in italics are duodecimal.

HERBERT SPENCER

1820 - 1903

In the fifty years that have passed since the death of Herbert Spencer, there has been a growing regard for the clarity of thought and the wisdom of this famous philosopher. Yet he was largely self educated. His father was a teacher, and the Methodist and Quaker background of his family determined his independence of thought. His association with the Economist and his many contributions to the Westminster Review afforded wide contact with the vital minds of his day. The impact of Darwin's "Origin of Species " led to his tremendous endeavor to apply the principles of evolution to all phases of life and thought, in a system of philosophy, economics, and ethics, which he called the Synthetic Philosophy.

Of his more than thirty major works, none is more important to Americans than his "Man versus the State." It is today as vital and as applicable to our problems as the day it was written - in its emphasis on freedom of thought and action for the individual, and the need to curtail the autonomous growth of bureaucracy.

But the name of Herbert Spencer occupies an especial niche among duodecimal pioneers because of his energetic opposition to the efforts of the propagandists of the French metric system to decimalize the English currency, and to supplant the English weights and measures, through compulsory legislation.

In the preface to his pamphlet, "Against the Metric System," he states:

> "During the Parliamentary Session of 1896 an association which has for some time past sought to establish the Metric System in England, has obtained from the Parliamentary Secretary of the Board of Trade, a promise that a Bill conforming to their desire should be presently introduced. Holding strongly the opinion that adoption of the Metric System is undesirable, I published in The Times, as special articles 'From a Correspondent,' four letters setting forth the reasons for this opinion; and immediately afterwards issued these letters in the form of a pamphlet, which was distributed to all members of the House of Commons and a few members of the House of Lords here, and also to members of the United States Congress, before which a Bill to establish the Metric System was pending."

In June 1903, six months before his death, Herbert Spencer added the following codicil to his will:

"If and when within ten years after my death a Bill should be introduced into Parliament for the compulsory adoption of the Metric System of Weights and Measures I desire that my pamphlet entitled 'Against the Metric System' shall be reprinted from the stereotype plates which were cast in February One thousand nine hundred and one and are now in the custody of Messieurs Harrison and Sons with such corrections as are indicated in a copy of the pamphlet which I have deposited in my safe and that such reprinted pamphlet shall be distributed gratis and at the expense of my estate among members of both Houses of Parliament and shall be put on sale by my publishers at a nominal price."

The original pamphlet was copyrighted in 1897. We have been unable to determine the dates of the English reprints. But D. Appleton and Company of New York issued a reprint in 1906, and there have been several others since.

A condensation of the material in the four letters to the Times has been carried as Appendix C, of the second edition of "New Numbers," by F. Emerson Andrews, published by Essential Books in 1944. In order that it may be more readily accessible, a reprint of that condensation will be found in the succeeding pages of this issue of the Duodecimal Bulletin.

An interesting duodecimal sidelight is the dinner conversation with Sir Isaac Pitman (1896) in which he reminded Spencer: "I formulated a Reckoning Reform on the basis of twelve, forty years ago, used it for three or four years, advocated it, and paged the Phonetic Journal in it. The phonetic alphabet was then on the anvil, and as I could not do justice to both reforms, I let the Reckoning Reform slide." The accounts of the Phonetic Society at Bath were for some years, about 1855, kept on a duodecimal basis.

For the Duodecimal Society, Herbert Spencer's memory will be forever green for the invocation, that "since a better system would facilitate both the thoughts and actions of men, and in so far diminish the frictions of life throughout the future, the task of establishing it should be undertaken."

AN EXCERPT FROM HERBERT SPENCER

(This material first appeared in a series of unsigned letters in the London Times. *This excerpt is condensed from the version later printed in the June, 1896, issue of Appleton's* Popular Science Monthly.)

Advocates of the metric system allege that all opposition to it results from 'ignorant prejudice.' This is far from being the fact. There are strong grounds for rational opposition. . . . Perhaps an imaginary dialogue will most conveniently bring out the various reasons for dissent. Let us suppose that one who is urging adoption of the metric system is put under cross-examination by a skeptical official. Some of his questions might run thus:

'What do you propose to do with the circle? At present it is divided into 360 degrees, each degree into 60 minutes, each minute into 60 seconds. I suppose you would divide it into 100 degrees, each degree into 100 minutes, and each of these into 100 seconds.'

'The French have decimalized the quadrant, but I fear their division will not be adopted. Astronomical observations throughout a long past have been registered by the existing mode of measurement, and works for nautical guidance are based upon it. It would be impracticable to alter this arrangement.'

'You are right. The arrangement was practically dictated by Nature. The division of the circle was the outcome of the Chaldean division of the heavens to fit their calendar: a degree being, within $\frac{1}{80}$th, equivalent to a day's apparent motion of the Sun on the ecliptic. And that reminds me that I do not find in your scheme any proposal for redivision of the year. Why do you not make 10 months instead of 12?'

'A partial decimalization of the calendar was attempted at the time of the French Revolution; a week of ten days was appointed, but the plan failed. Of course, the 365 days of the year do not admit of division into tenths; or, if ten months were made, there could be no tenths of these. Moreover, even were it otherwise, certain deeply-rooted customs stand in the way. Many trading transactions, especially the letting of houses and the hiring of assistants, have brought the quarter-year into such constant use that it would be very difficult to introduce a redivision of the year into tenths.'

'Just so; and it occurs to me that there is a deeper reason. Ignoring the slight ellipticity of the earth's orbit, a quarter of a year is the period in which the Earth describes a fourth of its annual journey around the Sun, and the seasons are thus determined—the interval between the shortest day and the vernal equinox, between that and the longest day, and so on with the other divisions.'

'The order of Nature is doubtless against us here.'

'It is against you here in a double way. Not only the behavior of the Earth, but also the behavior of the Moon conflicts with your scheme. By an astronomical accident it happens that there are 12 full moons or approximately 12 synodic lunations in the year; and this, first recognized by the Chaldeans, originated the 12-month calendar, which civilized peoples in general have adopted after compromising the disagreements in one or other way. But there is another division of time in which you are not so obviously thus restrained. You have not, so far as I see, proposed to substitute 10 hours for 12, or to make the day and night 20 hours instead of 24. Why not?'

'Centuries ago it might have been practicable to do this; but now that timekeepers have become universal we could not make such a redivision. We might get all the church clocks altered, but people would refuse to replace their old watches by new ones.'

'I fancy conversatism will be too strong for you in another case—that of the compass. The divisions of this are, like many other sets of divisions, made by halving and rehalving and again halving until 32 points are obtained. Is it that the habits of sailors are so fixed as to make hopeless the adoption of decimal division?'

'Another reason has prevented—the natural relation of the cardinal points. The intervals included between them are necessarily four right angles, and this precludes a division into tenths.'

'Just so. Here, as before, Nature is against you. The quadrant results from space-relations which are unchangeable and necessarily impose, in this as in other cases, division into quarters. Nature's lead has been followed by mankind in various ways. Beyond the quarter of a year we have the moon's four quarters. The quarter of an hour is a familiar division, and also the quarter of a mile. Though the yard is divided into feet and inches, yet in every draper's shop yards are measured out in halves, quarters, eighths, and sixteenths or nails. Then we have a wine merchant's quarter-cask, we have the fourth of a gallon or quart, and, beyond that, we have for wine and beer, the quarter of a quart or half-pint. Even that does not end the quartering of measures, for at the bar of a tavern quarterns of gin, that is quarter pints of gin, are sold. Evidently we must have quarters. What do you do about them? Ten will not divide by four.'

'The Americans have quarter dollars.'

'And are inconsistent in having them. Just as in France, notwithstanding the metric system, they speak of a quarter of a litre and a quarter of a livre, so in the United States they divide the dollars into quarters, and in so doing depart from the professed mode of division in the very act of adopting it—depart in a double way. For the tenths of a dollar play but an inconspicuous part. They do not quote prices in dollars and dimes. I continually see books advertised at 25¢, 75¢, \$1.25¢, \$1.75¢, and so forth, but I do not see any advertised as \$1.3 dimes or 4 dimes, etc. So that, while not practically using the division theoretically appointed, they use the division theoretically ignored.'

'It may be somewhat inconsistent, but there is no practical inconvenience.'

'I beg you pardon. If they had a 12-division of the dollar, instead of a 10-division, these prices \$1.25 and \$1.75 would be \$1..3 and \$1..9. And not only would there be a saving in speech, writing, and printing, but there would be a saving in calculation. Only one column of figures would need adding up where now there are two to add up; and, besides decreased time and trouble, there would be fewer mistakes. But leaving this case of the dollar, let us pass to other cases. Are we in all weights, all measures of length, all areas and volumes, to have no quarters?'

'Quarters can always be marked as .25.'

'So that in our trading transactions of every kind we are to make this familiar quantity—a quarter—by taking two-tenths and five-hundredths? But now let me ask a further question. What about thirds? In our daily life, division by three often occurs. Not uncommonly there are three persons to whom equal shares of property have to be given. Then in talk about wills of intestates one hears of widows' thirds; and in Acts of Parliament the two-thirds majority often figures. Occasionally a buyer will say—"A half is more than I want and a quarter is not enough; I will take a third." Frequently, too, in medicines where half a grain is too much or not enough, one-third of a grain or two-thirds of a grain is ordered. Continually thirds are wanted. How do you arrange? Three threes do not make ten.'

'We cannot make a complete third.'

'You mean we must use a makeshift third, as a makeshift quarter is to be used?'

'No; unfortunately that cannot be done. We signify a third by .3333, etc.'

'That is to say, you make a third by taking 3 tenths, *plus* 3 hundredths, *plus* 3 thousandths, *plus* 3 ten-thousandths, and so on to infinity!'

'Doubtless the method is unsatisfactory, but we can do no better.'

'Nevertheless, you really think it desirable to adopt universally for measurements of weight, length, area, capacity, value, a system which gives us only a makeshift quarter and no exact third.'

'These inconveniences are merely set-offs against the great conveniences'

'Set-offs, you call them! To me it seems that the inconveniences outweigh the conveniences.'

'But surely you cannot deny those enormous evils entailed by our present mixed system which the proposed change would exclude.'

'I demur to your assertion. I have shown you that the mixed system would in large part remain. You cannot get rid of the established divisions of the circle and the points of the compass. You cannot escape from those quarters which the order of Nature in several ways forces on us. You cannot change the divisions of the year and the day and the hour. It is impossible to avoid all these incongruities by your method, but there is another method by which they may be avoided.'

'You astonish me. What else is possible?'

'I will tell you. We agree in condemning the existing arrangements under which our scheme of numeration and our modes of calculation based on it proceed in one way, while our various measures of length, area, capacity, weight, value, proceed in other ways. Doubtless, the two methods of procedure should be unified, but how? You assume that, as a matter of course, the measure system should be made to agree with the numeration system; but it may be contended that, conversely, the numeration system should be made to agree with the measure system—with the dominant measure system, I mean.'

'I do not see how that can be done.'

'Perhaps you will see if you join me in looking back upon the origins of these systems. Unable to count by giving a name to each additional unit, men fell into the habit of counting by groups of units and compound groups. Ten is a bundle of fingers, as you may still see in the Roman numerals, where the joined fingers of one hand and the joined fingers of the two hands are symbolized. Then, above these, the numbering was continued by counting two tens, three tens, four tens, etc., or 20, 30, 40, as we call them, until ten bundles of ten had been reached. Proceeding similarly, these compound bundles of tens, called hundreds, were accumulated until there came a doubly compound bundle of a thousand; and so on. Now this process of counting by groups and compound groups, tied together by names, is equally practicable with other groups than 10. We may form our numerical system by taking a group of 12, then 12 groups of 12, then 12 of these compound groups; and so on as before. The 12-group has an enormous advantage over the 10-group. Ten is divisible only by 5 and

2. Twelve is divisible by 2, 3, 4, and 6. If the fifth in the one case and the sixth in the other be eliminated as of no great use, it remains that the one group has three times the divisibility of the other. Doubtless it is this great divisibility which has made men in such various cases fall into the habit of dividing into twelfths. For beyond the 12 divisions of the zodiac and the originally associated twelve-month, and beyond the twelfths of the day, and beyond those fourths —submultiples of 12—which in sundry cases Nature insists upon and which in so many cases are adopted in trade, we have 12 ounces to the pound troy, 12 inches to the foot, 12 lines to the inch, 12 sacks to the last; and of multiples of 12 we have 24 grains to the pennyweight, 24 sheets to the quire. Moreover, large sales of small articles are habitually made by the gross(12 times 12) and great gross (12X12X12). Again, we have made our multiplication table go up to 12 times 12, and we habitually talk of dozens. Now, though these particular 12-divisions are undesirable, as being most of them arbitrary and unrelated to one another, yet the facts make it clear that a general systems of twelfths is called for by trading needs and industrial needs: and such a system might claim something like universality, since it would fall into harmony with those natural divisions of twelfths and fourths which the metric system necessarily leaves outside as incongruities.'

'But what about the immense facilities which the method of decimal calculations gives us? You seem ready to sacrifice all these?'

'Not in the least. It needs only a small alteration in our method of numbering to make calculation by groups of 12 exactly similar to calculation by groups of 10; yielding just the same facilities as those now supposed to belong only to decimals. This seems a surprising statement; but I leave you to think about it, and if you cannot make out how it may be I will explain presently.'

[The promised explanation.] Of course I do not call in question the great advantages to be derived from the ability to carry the method of decimal calculation into quantities and values, and of course I do not call in question the desirableness of having some rationally originated unit from which all measures of lengths, weights, forces, etc., shall be derived. That as promising to end the present chaos the metric system has merits goes without saying. But I object to it on the ground that it is inconvenient for various purposes of daily life, and that the conveniences it achieves may be achieved without entailing any inconveniences.

One single fact should suffice to give us pause. This fact is that, notwithstanding the existence of the decimal notation, men have in so many cases fallen into systems of division at variance with it, and especially duodecimal division. Numeration by tens and multiples of ten has prevailed among civilized races from early times. What then has made them desert this mode of numeration in their tables of weights, measures and

and values? They cannot have done this without a strong reason. The strong reason is conspicuous—the need for easy division into aliquot parts. . . .

Above all, men have gravitated toward a 12-division, because 12 is more divisible into aliquot parts than any other number—halves, quarters, thirds, sixths—and their reason for having in so many cases adopted the duodecimal division is that this divisibility has greatly facilitated their transactions. When counting by twelves instead of by tens, they have been in far fewer cases troubled by fragmentary numbers. There has been an economy of time and mental effort. These practical advantages are of greater importance than the advantages of theoretical completeness. Thus, even were there no means of combining the benefits achieved by a method like that of decimals with the benefits achieved by duodecimal division, it would still be a question whether the benefits of the one with its evils were or were not to be preferred to the benefits of the other with its evils—a a question to be carefully considered before making any change.

But now the important fact, at present ignored, and to which I draw your attention, is that it is perfectly possible to have all the facilities which a method of notation like that of decimals gives, along with all the facilities which duodecimal division gives. It needs only to introduce two additional digits for 10 and 11 to unite the advantages of both systems. The methods of calculation which now go along with the decimal system of numeration would be equally available were 12 made the basic number instead of 10. In consequence of the association of ideas established in them in early days and perpetually repeated throughout life, nearly all people suppose that there is something natural in a method of calculation by tens and compounding of tens. But I need hardly say that this current notion is utterly baseless. The existing system has resulted from the fact that we have five fingers on each hand. If we had had six on each there would never have been any trouble. No man would ever have dreamt of numbering by tens, and the advantages of duodecimal division with a mode of calculation like that of decimals would have come as a matter of course. . . .

Now it seems to me that the two facts—first, that in early days men diverged from the decimal division into modes of division which furnished convenient aliquot parts, and, second, that where, as in America, the decimal system has been adopted for coinage, they have in the focus of business fallen into the use of aliquot parts in spite of the tacit governmental dictation—not only prove the need for this mode of division, but imply that, if the metric system were universally established, it would be everywhere traversed by other systems. To ignore this need, and to ignore the consequences of disregarding it, is surely unwise. Inevitably the result must be a prevention of the desired unity of method; there will be perpetural inconveniences from the conflict of two irreconcilable systems.

I fully recognize the difficulties that stand in the way of making such changes as those indicated—difficulties greater than those implied by the changes which adoption of the metric system involves. The two have in common to overcome the resistance to altering our tables of weights, measures, and values; and they both have the inconvenience that all distances, quantities, and values named in records of the past must be differently expressed. But there would be further obstacles in the way of a 12-notation system. To prevent confusion different names and different symbols would be needed for the digits, and to acquire familiarity with these, and with the resulting multiplication table, would, of course, be troublesome; perhaps not more troublesome, however, than learning the present system of numeration and calculation as carried on in another language. There would also be the serious evil that, throughout all historical statements, the dates would have to be differently expressed; though this inconvenience, so long as it lasted, would

be without great difficulty met by inclosing in parentheses in each case the equivalent number in the old notation.

But, admitting all this, it may still be reasonably held that it would be a great misfortune were there established for all peoples and for all time a very imperfect system when with a little more trouble a perfect system might be established. . . .

Do I think this system will be adopted? Certainly not at present—certainly not for many generations. In our days the mass of people, educated as well as uneducated, think only of immediate results; their imaginations of remote consequences are too shadowy to influence their acts. Little effect will be produced upon them by showing that, if the metric system should be established universally, myriads of transactions every day will for untold thousands of years be impeded by a very imperfect system. But it is, I think, not an unreasonable belief that further intellectual progress may bring the conviction that since a better system would facilitate both the thoughts and actions of men, and in so far diminish the friction of life throughout the future, the task of establishing it should be undertaken.

A NOTE ABOUT POWERS OF NUMBERS

That power of a number ends again in the same figure when the number is expressed on any prime base and raised to that power; i.e., 3^7 on Base VII ends 3, and this is true for the 7th power of all numbers on that base. For composite bases the repetition is governed by some one of the factors and related elements.

For Base II	All powers repeat original endings.
III	Odd powers repeat.
IV	Repetition is stopped by $2^2 = 10$.
V	Fifth powers repeat.
VI	Odd powers repeat as for Base III.
VII	Seventh powers repeat.
VIII	Repetition is stopped by $2^3 = 10$.
IX	Repetition is stopped by $3^2 = 10$.
X	Fifth powers repeat as for Base V.
XI	Eleventh powers repeat.
XII	Repetition is stopped by $6^2 = 30$.

A corollary is that in the (B-1) power, in the case of the prime bases, all numbers but B's end in 1.

MATHEMATICAL RECREATIONS

One of the major purposes of this Recreations section, is to lead your thoughts into explorations of the possibilities and advantages of duodecimals. For instance, let your mind dwell on the following equations.

$$3^2 + 4^2 = 5^2$$

$$3^3 + 4^3 + 5^3 = 6^3$$

Are there further constructions of this type possible?

F. Emerson Andrews sends us a teaser, every once in a while. The following are good examples.

> Find a duodecimal number ending in 2 which would be doubled if you shifted the 2 over to be the first figure.
>
> Do the same thing for a decimal number.
>
> Multiply 1 2 3 4 5 6 7 8 9 £ by any multiple of £ up to 𝒳1. E.g. -

```
    1 2 3 4 5 6 7 8 9 £
                    1 𝒳
    -------------------
    £ 𝒳 9 8 7 6 5 4 3 2
  1 2 3 4 5 6 7 8 9 £
  ---------------------
  2 2 2 2 2 2 2 2 2 2 2
```

From Eugene Scifres we get occasional items too. But his are usually geometrical, and we hesitate as to how welcome they might be to you. If you'd like them, let us know. But the last one was a nice little problem in number theory.

> Find an arithmetical series A + NB, where A and B are constant integers, and N takes each integral value 0, 1, 2, 3, etc., to infinity; so that no term in the series is a square, a cube, or any higher power of any number.

William C. Schumacher enjoyed Mary Lloyd's last arithmocrypt so much that he sent us one that he composed himself.

```
                  H E N
AARON ) P H A R A O H
        A A R O N
          O O Y P O
          B B N Y C
          A E Y D N H
          A C E P H H
            E R P Z C
```

And Mary Lloyd sent us two new ones.

```
DUO ) D E C I M A L
      D U O
        O I I
        O L D
          Z A M
          Z P Z
            E A A
            E L G
              N C L
              N P C
                  A
```

It's a sneaky trick to leave out the quotient. And this one is no pushover, either.

```
                    I B
BTMXA ) R B O S E U
        T O D X A
          E E E E U
          E B I A A
            I B E U
```


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