MULTIPLICATION

TABLETS:

DERIVED FROM A THEOREM OF

S. SLONIMSKI.

THE TABLET ARRANGEMENT, &c.

BY

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WITH DIRECTIONS FOR USE.

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Remarks on the reconstruction

The tens carry is an important problem that had to be solved in the past by inventors of mechanical digital calculating aids as well as calculating machines. In the middle of the 19th century Hayyim Selig Slonimsky found with his theorem a sophisticated solution within multiplication tables and he used it to construct a moveable multiplication device with no gears. Adapted resp. generalized multiplication tables of that kind were calculated and published by August Leopold Crelle in 1846 and by Henry Knight in 1847. The latter used the title *Multiplication Tablets*.
For more information and literature about Slonimski's theorem and his calculating device see

> Weiss, Stephan: *Slonimsky's Multiplying Device, an impressive Example for Applied Mathematics.* (7/2010) http://www.mechrech.info section Publikationen

Knight's *Multiplication Tablets,* Birmingham 1847, is a very rare booklet whose reconstruction I based on a copy in the British Library – the only copy I found up to now.
Typography is approximately adapted to the original text, empty pages there are omitted in the reconstruction. All numbers in the tablets were compared with Crelle's Table and checked with a computer program written for this special purpose, so there should be no error now in the tablets. In my copy of Knight's original booklet I found three errors, they are in

- tablet 1, line 28,
- tablet 6, line 16,
- tablet 8, line 10.

Three errors in a small multiplication aid don't make it reliable. Maybe this is one of the reasons why the booklet is so hard to find nowadays.

Stephan Weiss, Dec. 28th 2010

PREFACE.

THE practical advantages to mathematical science which have been derived from the invention of logarithms and the use of logarithmic and other tables, are well known and appreciated; it is reasonable, therefore, to presume that any other efficient device for facilitating arithmetical computation will be favourably received and duly considered.

Of such a nature are the TABLETS now offered to public notice; they will be found to present greater facility for ascertaining the product arising from the multiplication of one number by another, however large those numbers may be, than any other method extant.

H. K.

Birmingham, March, 1847.

MULTIPLICATION TABLETS.

It has ever been deemed expedient that the operation of Multiplication, particularly of large numbers, should be facilitated by the construction of Tables exhibiting the proper figures to be extracted therefrom, and that actual computation and mental effort, should thereby be rendered unnecessary; but the apparently unlimited extent of Tables necessary to provide for every contingency has rendered it doubtful if advantage could be derived from the use of such extensive Tables. The apprehended obstacle has, however, been only imaginary.

These Tablets are derived from a Theorem of S. Slonimski, a distinguished Mathematician, of Bialystock, in Poland, developing a curions and important property of numbers which appears to have escaped the notice of other mathematicians. Far from contemplating the existence of such a property, men distinguished by scientific attainments have employed considerable time in computing the number of *books* that would be necessary for containing tables to exhibit the figures arising from the involutions or multiplications by each of the nine digits, of every sum composed, even of a limited number of figures.

The Theorem, however, of Mr. Slonimski, and its demonstration, not only remove uncertainty on this subject, but afford gratifying proof, that far from requiring a number of books, a single page of moderate extent will suffice for the purpose, without any limit as to the number or order of the figures of which a multiplicand may be composed.

The following is a translation of Mr. SLONIMSKI'S Theorem:—

THEOREM.

LET Z be any number whatever, and let the figures composing that number, in passing from the right hand to the left, be represented by z_1 , z_2 , z_3 , ... z_ε, ... If under the number Z be written its multiples 2Z , 3Z , 4Z , 5Z , 6Z , 7Z , 8Z , 9Z , in such order that the units, tens, hundreds, &c. appear in vertical lines, it is evident that the last vertical line, viz. that which appears under the last figure z1 , of the number Z , will contain the *second figures* of the products $2z_1$, $3z_1$, $4z_1$, $5z_1$, $6z_1$, $7z_1$, $8z_1$, and $9z_1$. But such will not be the case with respect to all the other vertical lines; that for example which is under z_ε, will not contain the series of *second figures* of the products $2z_\varepsilon$, $3z_\varepsilon$, $4z_\varepsilon$, $5z_\varepsilon$, $6z_\varepsilon$, $7z_\varepsilon$, $8z_\varepsilon$, $9z_\varepsilon$. To obtain the figures under this line, there requires to be added to the series of second figures of the multiples of z_ε , a COMPLEMENTARY SERIES, dependent on the figures which follow z_ε, in the number Z.

Now whatever may be these last mentioned figures, there exist but TWENTY-EIGHT DIFFERENT COMPLEMENTARY SERIES; and on adding to the series of *second figures* of the multiples of z_ε , that one of the twenty-eight complementary series which appertains to the figures which follow z_ε in Z, the figures in the vertical line z_ε will be obtained.

CONSTRUCTION OF THE TABLETS.

THE diffèrent COMPLEMENTARY SERIES predicated in Mr. SLONIMSKI'S THEOREM, and developed by its demonstration, constitute the first of these TABLETS, at the head of which is placed the character 0.

The figures of the several series on the other Tablets, 1 to 9 inclusive, are obtained by the addition of the *contingent complementary series* to the *second figures* of the respective products, as suggested in the Theorem.

Each Tablet is headed by its appropriate figure, denoting it also, to be the Tablet that must be used whenever any multiplicand is required to be multiplied by that particular number; and immediately over the several series in each Tablet are the relative figures 0 , 1 , 2 , 3 , 4 , 5 , 6 , 7 , 8 , 9 , which may there be termed Enumerators.

For convenience of reference corresponding Enumerators are placed at the foot of each Tablet.

The several series are consecutively numbered in red ink on the left band side of each Tablet; and on the right, in red ink, are numbers which indicate the particular series, on its appropriate Tablet, that must be used with the next multiplying figure.

DIRECTIONS FOR USING THE TABLETS.

To ascertain, by means of these Tablets, the product arising from the multiplication of one number by another. For example, of 78325946 by 5906637: take the Tablet corresponding with the first or units figure of the multiplier (7), and from the first series thereon write down the figures under those in the upper or enumeration row, which correspond respectively with the several figures of the multiplicand.

In the present example the figures to be extracted from the Tablet 7 are 96145382; and on the right of the series is found, in red ink, the number 20, indicating the series to be used on the next Tablet with the multiplier 3, in order to obtain the next product, which is found to be 59178342. The same course having been pursued with the remaining figures of the multiplier, the character 0 must then be considered as preceding the first or left hand figure of the multiplicand, and the series (17), on the Tablet 0 (as denoted by the Tablet last in hand), must be used in like manner as any other.

The sum of the products has then to be ascertained by simple addition.*

It will be observed, that in extracting the products from the Tablets, the operator may proceed from left to right, or from right to left, as most convenient. Also that the applicability and efficiency of the Tablets is not limited to a multiplicand of any given number of figures. The greater the number of such figures, the more will the utility of these Tablets be evident.

By the use of these Tablets the several products are ascertained with facility, and without mental effort ; whilst the time required will be found to be much less, and the risk of error much less, titan that by any tables heretofore devised, logarithmic tables certainly not excepted.

Whatever other benefits may be derived from the Theorem of Mr. **Slonimski**, its value and importance must be admitted from its development of a property of numbers, on which are established results so extensively useful as those now presented to the public.

Mr. Slonimski devoted several years to the invention of instruments for effecting arithmetical computations. By one of them the operations of addition and subtraction are effected with admirable facility.

Multiplication is with the greatest promptness performed by another.

* This example will be found in full at the close of these remarks.

Mr. SLONIMSKI'S researches with reference to such inventions probably led to the discovery of his peculiar Theorem, his very clever instrument for multiplication being founded thereon. One of the ADDITION INSTRUMENTS would be found an efficient adjunct to these Tablets, as the application of it would supersede the necessity for otherwise writing down, and adding together, the products derived from them.*

The editor of these pages had the advantage of receiving the Theorem, with other papers, from Mr. SLONIMSKI himself, and he has gratification in the endeavour to make that gentleman's scientific labours more extensively known, and in presenting such an arrangement of this particular result as will render it generally useful.

* These instruments have been patented in England, &c. by Mr. D. BARNETT, of Birmingham.

AN EXAMPLE

ILLUSTRATIVE OF THE MANNER OF USING THE

MULTIPLICATION TABLETS.

Multiplicand	78325946			
Multiplier	5906637			
1st Tablet Product	96145382	1	7	20
2nd	59178342	20	3	10
3rd	40921758	10	6	19
4th	63933969	19	6	19
5th	45113523	19	0	1
6th	32785161	1	9	28
7th	17719335	28	5	17
8th	44112523	17	0	1
Total Product	462642930703602			

0

	0	1	2	3	4	5	6	7	8	9	
1	0	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	0	0	1	1
3	0	0	0	0	0	0	0	0	1	1	1
4	0	0	0	0	0	0	0	1	1	1	1
5	0	0	0	0	0	0	1	1	1	1	1
6	0	0	0	0	0	1	1	1	1	1	1
7	0	0	0	0	0	1	1	1	1	2	1
8	0	0	0	0	1	1	1	1	2	2	1
9	0	0	0	0	1	1	1	2	2	2	1
10	0	0	0	1	1	1	2	2	2	3	1
11	0	0	0	1	1	1	2	2	3	3	1
12	0	0	0	1	1	2	2	2	3	3	1
13	0	0	0	1	1	2	2	3	3	3	1
14	0	0	0	1	1	2	2	3	3	4	1
15	0	0	1	1	2	2	3	3	4	4	1
16	0	0	1	1	2	2	3	3	4	5	1
17	0	0	1	1	2	2	3	4	4	5	1
18	0	0	1	1	2	3	3	4	4	5	1
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27	0	0	1	2	3	4	5	6	7	7	1
28	0	0	1	2	3	4	5	6	7	8	1
	0	1	2	3	4	5	6	7	8	9	

0

1

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3	0	1	2	3	4	5	6	7	9	0	2
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5	0	1	2	3	4	5	7	8	9	0	2
6	0	1	2	3	4	6	7	8	9	0	2
7	0	1	2	3	4	6	7	8	9	1	2
8	0	1	2	3	5	6	7	8	0	1	3
9	0	1	2	3	5	6	7	9	0	1	3
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27	0	1	3	5	7	9	1	3	5	6	5
28	0	1	3	5	7	9	1	3	5	7	5
	0	1	2	3	4	5	6	7	8	9	

1

2

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3	0	2	4	6	8	0	2	4	7	9	6
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9	0	2	4	6	9	1	3	6	8	0	7
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2

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3

4

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4

5

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23	0	5	1	7	3	8	4	0	6	2	17
24	0	5	1	7	3	9	4	0	6	2	17
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27	0	5	1	7	3	9	5	1	7	2	17
28	0	5	1	7	3	9	5	1	7	3	17
	0	1	2	3	4	5	6	7	8	9	

5

6

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20	0	6	3	0	6	3	0	6	3	0	20
21	0	6	3	0	6	3	0	7	3	0	20
22	0	6	3	0	7	3	0	7	4	0	20
23	0	6	3	0	7	3	0	7	4	1	20
24	0	6	3	0	7	4	0	7	4	1	20
25	0	6	3	0	7	4	1	7	4	1	20
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27	0	6	3	0	7	4	1	8	5	1	20
28	0	6	3	0	7	4	1	8	5	2	20
	0	1	2	3	4	5	6	7	8	9	

6

7

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10	0	7	4	2	9	6	4	1	8	6	21
11	0	7	4	2	9	6	4	1	9	6	21
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7

8

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8

9

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9