International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-6, Issue-10, October 2020
ISSN: 2395-3470
www.ijseas.com

"A Novel Method of Multiplication" by the application of the Vedic Sutram – Urdhwa Tiryagbhyam

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Introduction

The method of multiplication, using the Vedic Sutram as described by Jagadguru Shankaracharya Shri Bharati Krishna Tirtha Maharaja using the Vedic Sutram "Urdhwa Tiryagbhyam", both from Right to Left and Left to Right is exemplified in this paper. The elegance, simplicity and less time consuming nature is crystal clear in comparision to the existing working. This is also called a one line method. An attempt is also made to express the working by using C^{++} Language. The method is confined to a column multiplication and is mainly of two types, Urdhwa (Vertical) and Tiryak (Cross wise)

Abstract

The details of the method of multiplication are explained in three different routes (A,B and C). For example, (A) from Right to Left (One line) (B) Left to Right and (C) Step method, which is clubbed with horizontal addition. This method is totally different from the existing method in the sense, that it is multiplication column wise and also in the placement of results and finalization to obtain the final value at different stages of working. But it is highly symmetrical, elegant and easy to perform and obtain the final result. The working starts with Urdhwa and ends with Urdhwa. All the three methods give the same result. Lert to Right is conceived for the first time by Swamiji. The methods are applicable to the multiplication of any digited number by any digited multiplier.

Method A for Right to Left

Let us consider the multiplication of the number 12546873(multiplicand) by 48032162 (multiplier). Swamiji has introduced two concepts. The multiplication is one digit of multiplier with one digit of multiplicand. He utilized pairs of columns and multiplies in the form of column wise. The sutram clearly explains that if the two digits belong to the same column, it is Urdhwa (Vertically) upwards and if one of the digits belong to different columns, it is a cross direction and is called "Tiryak" means across (cross) i.e. multiplication belongs to vertically disposed and crossly disposed column wise. The details are as given below between the given pairs of digits belonging to two categories; a and b.

8	7	6	5	4	3	2	1	←Column
10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0	
1	2	5	4	6	8	7	3	Multiplicand - a
4	8	0	3	2	1	6	2	Multiplier - b

The working details are clearly explained.

Method A (R →L)

Starting from Right hand and proceeding to the left extreme, the procedure is (on the top, the numbers indicate the number belonging to the columns)

First Step (10^0)

The first step is to start the multiplication in the first column and is $2 \times 3 =_0 6$. The first step is Urdhwa Type and indicated in the Figure-1. The part of the answer due to first step is written in one line as $_0 6$.

First Step (10^0)

3 ↑ 2	2 x 3 =$_0$ 6 6 - Answer Line 0 - Carrying suffix	

Fig – 1

Six in the Answer Line, the number on the left hand side belongs to its immediate higher position which is to be added to the result of the second step. The answer is in 10^0 units.

Second Step (10^1)

The First column should be now multiplied with the second column. While doing so, a cross multiplication will occur, giving two results belonging to the same unit and hence are to be added. For example

7 3 6 2	2 x 7 =14, 6 x 3 =18; 14 + 18 = 32 To this, the digit noted as suffix in the result of the first step is to be added, 32+0=32. This is shown as 2 6 - Answer Line 3 0 - Carrying suffix

Fig – 2

Third Step(10^2)

The working part to be considered as

8 7 3 1 6 2	Multiplication of the 1st column with, third column to obtain the result in the 3rd position i.e., belongs to 10^2. One has to multiply 2 x 8 =16, 1 x 3 =3 and also 6 x 7 = 42; When added, 16 + 3 + 42 =61. With a further addition to the previous suffix 3, becomes 64. Shown as 4 in answer line and 6 as its suffix. 4 2 6 – answer line 6 3 0 – Carrying Suffix

Fig – 3

Fourth Step (10^3)

One can easily follow the rest of the steps as 1st Column x 4th Column and proceed towards left upto the multiplication of the last column of the given problem as viewed from the Right end.
These are systematically shown in the figures, given in succession upto 1st Column x 8th Column.

6 8 7 3 2 1 6 2	2 x 6 =12, 2 x 3 = 6, 6 x 8 = 48, 1 x 7 = 7. When added, 12+6+48+7=73. Which when further added to the previous suffix 6, to become 79. 9 is in answer line and 7 in the carrying suffix line. 9 4 2 6 - answer line 7 6 3 0 – Carrying suffix

Fig – 4

Fifth Step (10^4)

For the fifth step, multiplication part is

4 6 8 7 3 3 2 1 6 2	2 x 4 = 8, 3 x 3 = 9, 6 x 6 = 36, 2 x 7 = 14, 1 x 8 =8, When added 8 + 9 + 36 + 14 + 8=75. Further, when added with the previous suffix 7, it is 82. 2 9 4 2 6 - Answer line 8 7 6 3 0 - Carrying Suffix

Fig – 5

Sixth Step (10^5)

5 4 6 8 7 3 0 3 2 1 6 2	2 x 5 =10, 0 x 3 = 0, 6 x 4 = 24, 3 x 7 = 21, 1 x 6 = 6, 2 x 8 =16. When added, 10+0+24+21+6+16=77. When Further added to the previous suffix 8, it is 85 5 2 9 4 2 6 - Answer Line 8 8 7 6 3 0 - Carrying Suffix

Fig – 6

Seventh Step (10^6)

2 5 4 6 8 7 3 8 0 3 2 1 6 2	2 x 2 = 4, 8 x 3 = 24, 6 x 5 = 30, 0 x 7 =0, 1 x 4 =4, 3 x 8 = 24, 2 x 6 = 12. When added, 4+24+30+0+4+24+12=98. When further added to the previous suffix 8, it is 106 6 5 2 9 4 2 6 - Answer Line 10 8 8 7 6 3 0 - Carrying Suffix

Fig – 7

Eighth Step (10^7)

1 2 5 4 6 8 7 3 4 8 0 3 2 1 6 2	2 x 1 =2, 4 x 3 = 12, 6 x 2 = 12, 8 x 7 = 56, 1 x 5 = 5, 0 x 8 =0, 2 x 4 = 8, 3 x 6 =18. When added, 2+12+12+56+5+0+8+18=113. When further added to the previous suffix 10, it is 123 3 6 5 2 9 4 2 6 - Answer Line 12 10 8 8 7 6 3 0 – Caryying suffix

Fig – 8

As the multiplication of the 1st column with all the other columns is over, one has to start with the 2nd column with the 8th column continued individually by the other columns in succession i.e. 3rd column with 8th, 4th column with 8th, 5th column with 8th, 6th column with 8th, 7th column with 8th and finally 8th column by itself. One has to perform enbloc operation to cover the remaining 7 steps to get the final result.

Ninth Step (10^8) – Multiplication of 2nd column with 8th column (enbloc)

1 2 5 4 6 8 7 3 4 8 0 3 2 1 6 2	6 x 1 = 6, 4 x 7 = 28, 1 x 2 =2, 8 x 8 =64, 2 x 5 =10, 0 x 6 = 0, 3 x 4 =12. When added 6+28+2+64+10+0+12= 122. When further added to the previous suffix 12, it is 134 4 3 6 5 2 9 4 2 6 - Answer Line 13 12 10 8 8 7 6 3 0 - Carrying suffix

Fig – 9

Tenth Step (10^9) - Multiplication of 3rd column with 8th column (enbloc)

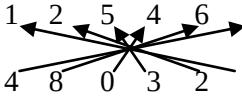
1 2 5 4 6 8 7 3  4 8 0 3 2 1 6 2	1 x 1 = 1, 4 x 8 = 32, 2 x 2 = 4, 8 x 6 = 48, 3 x 5 = 15, 0 x 4 = 0. When added, 1+32+4+48+15+0= 100. When further added to the previous suffix 13, it is 113. 3 4 3 6 5 2 9 4 2 6 - Answer line 11 13 12 10 8 8 7 6 3 0 - Carrying suffix

Fig – 10

Eleventh Step (10^{10}) Multiplication of 4th column with 8th column (enbloc)

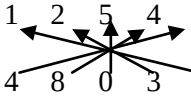
1 2 5 4 6 8 7 3  4 8 0 3 2 1 6 2	2 x 1 = 2, 4 x 6 = 24, 3 x 2 =6, 8 x 4 =32, 0 x 5 = 0. When added 2+24+6+32+0=64. On further addition to the previous suffix 11, it is 75 5 3 4 3 6 5 2 9 4 2 6 - Answer line 7 11 13 12 10 8 8 7 6 3 0 – Carrying Suffix

Fig – 11

Twelth Step (10^{11}) - Multiplication of 5th column with 8th column (enbloc)

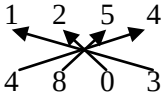
1 2 5 4 6 8 7 3  4 8 0 3 2 1 6 2	3 x 1 = 3, 4 x 4 = 16, 0 x 2 =0, 8 x 5 = 40. When added, 3+16+0+40 = 59. With further addition to the previous suffix 7, it is 66 6 5 3 4 3 6 5 2 9 4 2 6 - Answer line 6 7 11 13 12 10 8 8 7 6 3 0 - Carrying Suffix

Fig – 12

Thirteenth Step (10^{12}) - Multiplication of 6th column with 8th column (enbloc)

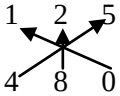
1 2 5 4 6 8 7 3  4 8 0 3 2 1 6 2	0 x 1 = 0, 4 x 5 = 20, 8 x 2 = 16. When added, 0+20+16 = 36. When further added to the previous suffix 6, it is 42 2 6 5 3 4 3 6 5 2 9 4 2 6 - Answer line 4 6 7 11 13 12 10 8 8 7 6 3 0 - Carrying suffix

Fig – 13

Fourteenth Step (10^{13}) - Multiplication of 7th column with 8th column (enbloc)

1 2 5 4 6 8 7 3  4 8 0 3 2 1 6 2	8 x 1 = 8, 4 x 2 =8. When added, 8 + 8 =16. When further added to the previous prefix 4, it is 20 0 2 6 5 3 4 3 6 5 2 9 4 2 6 - Answer line 2 4 6 7 11 13 12 10 8 8 7 6 3 0 - Carrying suffix

Fig – 14

Fifteenth Step (10^{14}) Multiplication of 8th column with 8th column (enbloc) – Urdhwa type

1 2 5 4 6 8 7 3  4 8 0 3 2 1 6 2	4 x 1 = 4. When added to the previous prefix, it is 6 6 0 2 6 5 3 4 3 6 5 2 9 4 2 6 - Answer line 0 2 4 6 7 11 13 12 10 8 8 7 6 3 0 - Carrying Suffix

Fig – 15

The answer is : 602653436529426

The first and the last are the Urdhwa type
The above method is one line method briefly it is as above (15 Figures)

It is noticed that for all even operations, the sub multiplications are only Tiryak , where as for the odd operations, with the exception of one Urdhwa, the others are Tiryak type.

A) R→L Multiplication (One line method) the entire calculation can be expressed as

							1	2	5	4	6	8	7	3	R→L
							4	8	0	3	2	1	6	2	
6	0	2	6	5	3	4	3	6	5	2	9	4	2	6	Answer Line
0	2	4	6	7	11	13	11	10	8	8	7	6	3	0	Carrying Suffix

Compare this with existing method

Answer : 602653436529426

B) L→R Multiplication

1	2	5	4	6	8	7	3								L→R
4	8	0	3	2	1	6	2								
4	6	6	9	4	0	2	3	8	7	5	3	1	2	6	↑
1	3	5	6	10	12	11	9	7	7	7	6	3	0		Add
6	0	2	6	5	3	4	3	6	5	2	9	4	2	6	

Answer : 602653436529426

Answer is Same

C) Step wise

The way of multiplication is as already given. The Corresponding identity is given.

R→L	**L→R**
Step 1	Step 15
Step 2	Step 14
Step 3	Step 13
Step 4	Step 12
Step 5	Step 11
Step 6	Step 10
Step 7	Step 9
Step 8	Step 8
Step 9	Step 7
Step 10	Step 6
Step 11	Step 5
Step 12	Step 4
Step 13	Step 3
Step 14	Step 2
Step 15	Step 1

The multiplication is carried out from L→R, starting with the 1st column in the left side in the same manner as in the R→L. After the first Urdhwa result from the result of each step value, the last digit has to be shown as in the answer line, but the others have to be placed under each previous value directly, so as to perform addition. But not as a suffix value as in the case of R→L multiplication.

On the addition, the result of multiplication L→R is found exactly as that of R→L multiplication.
The corresponding identity of the multiplications are drawn below. Resulting Number (R x L = L x R)
As **602653436529426**

C) Step Wise – Identity of the values

R→L		Step	
10^0	6	1st	↓ Vedic Addition
10^1	32	2nd	
10^2	61	3rd	
10^3	73	4th	
10^4	75	5th	
10^5	77	6th	
10^6	98	7th	
10^7	113	8th	
10^8	122	9th	
10^9	100	10th	
10^{10}	64	11th	
10^{11}	59	12th	
10^{12}	36	13th	
10^{13}	16	14th	
10^{14}	04	15th	

These are to be put in the horizontal manner, starting with 10^0 to 10^{14} from R→L to be clubbed with horizontal addition by Vedic Method This is a one line method.

L→R		Step	
10^{14}	04	1st	↑ Vedic Addition
10^{13}	16	2nd	
10^{12}	36	3rd	
10^{11}	59	4th	
10^{10}	64	5th	
10^9	100	6th	
10^8	122	7th	
10^7	113	8th	
10^6	98	9th	
10^5	77	10th	
10^4	75	11th	
10^3	73	12th	
10^2	61	13th	
10^1	32	14th	
10^0	06	15th	

This is a two line followed by addition.
The steps are to be arranged similarly for the Vedic Addition.

Vedic Addition (Horizontal)

The addition of several numbers in different powers are to be placed horizontally and in ascending order from R to L as shown. (Fig. Demo Vedic Addition-VA)

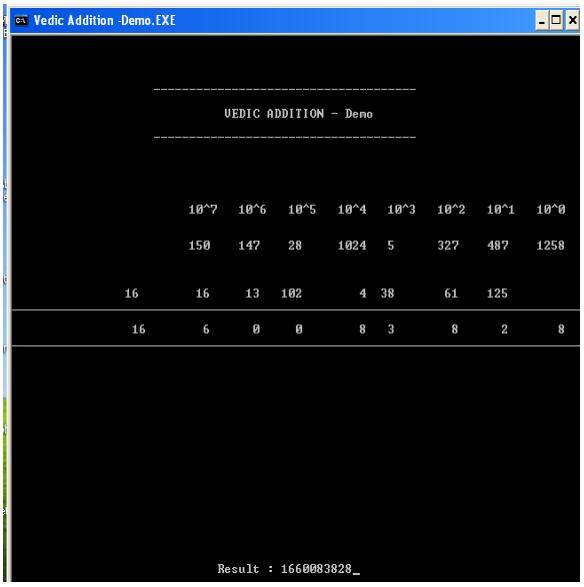
	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
	H	G	F	E	D	C	B	A
0	150	147	28	1024	5	327	487	1258
16	16	13	102	4	38	61	125	
16	6	0	0	8	3	8	2	8

The numbers to be added by Vedic Method should be arranged power wise and Horizontal wise HGFEDCBA In the summation, consider the last digit of the last number A as the last digit of the addition (result). The remaining digits of A should be shifted to the number B into the respective places of its position, for further addition with the given data. For example after the result in the 1st column as 8, the remaining 125 is placed under 487 and added the last digit is 2 and the rest is 61, which is shifted to the next. This is to be continued till one reaches the last number (H) to be added. One will thus observe the final result. This is the Vedic addition of the given numbers given in a systematic order of powers. This is clearly shown in the Figure.

The answer is **1660083828**.

This method is compared with the existing method which is given below.

International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-6, Issue-10, October 2020
ISSN: 2395-3470
www.ijseas.com



VA - This method is much simpler than the existing method, in operation

						1	2	5	8
						4	8	7	0
					3	2	7	0	0
						5	0	0	0
		1	0	2	4	0	0	0	0
			2	8	0	0	0	0	0
	1	4	7	0	0	0	0	0	0
1	5	0	0	0	0	0	0	0	0
1	**6**	**6**	**0**	**0**	**8**	**3**	**8**	**2**	**8**

Existing Method

Existing Method of Multiplication

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

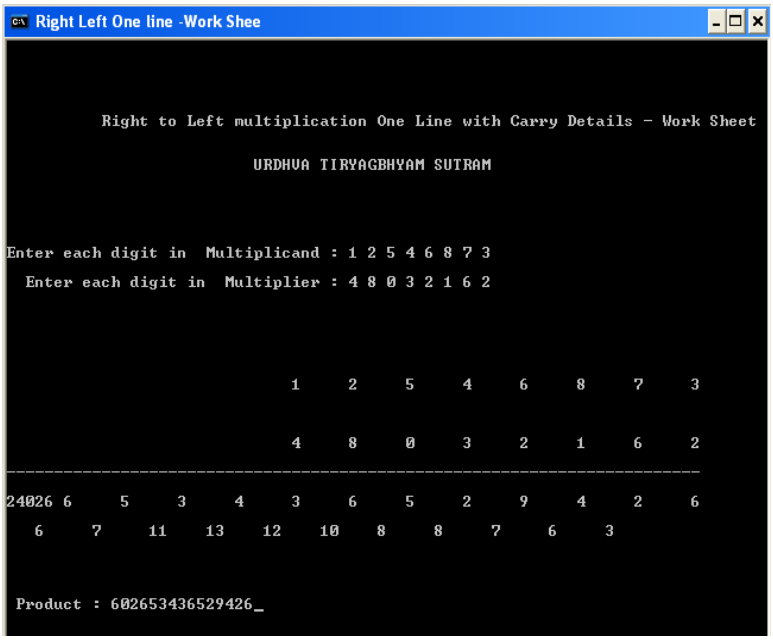
Compare this with R X L or L X R results Fig A1 and Fig B1 or R→L one line method, L→R multiplication method.

Vedic Method when applied to the Stepwise results obtained in R→L multiplication and L→R methods are given below. R→L method with stepwise components being added by Vedic Method. Refer to A and B methods. In this multiplication, we are familiar that, we have no idea of Left to Right Multiplication, as it gives a different Value. The Vedic Method L X R gives the same value as

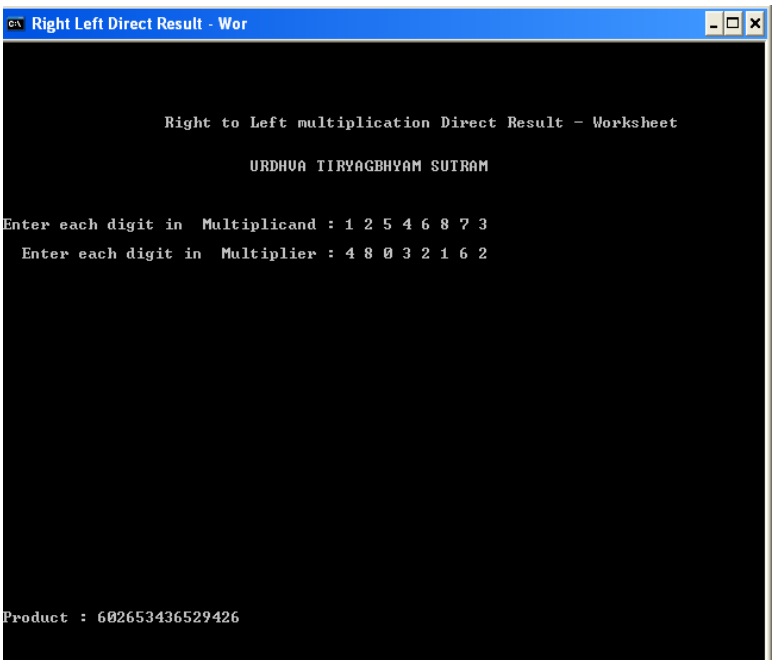
that of R X L under different placement using Vedic Principle showing that L X R is also possible – in giving the same value as that of R X L Value.

Figures

R→L Multiplication - One line with Carry Details (A1)



R→L Multiplication (Direct Result) (A)



R→L Step wise with Vedic Addition (A – 15 Figs)

International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-6, Issue-10, October 2020
ISSN: 2395-3470
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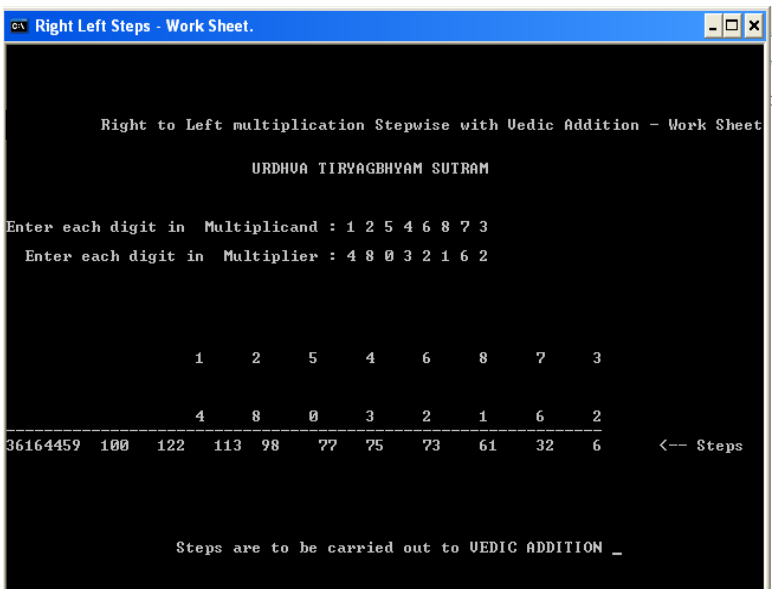

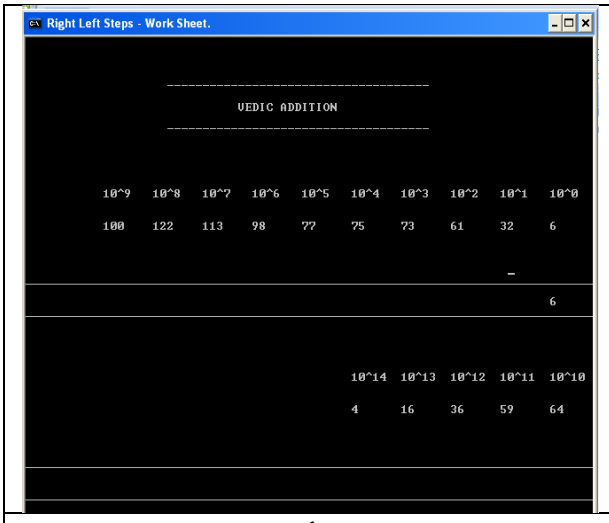

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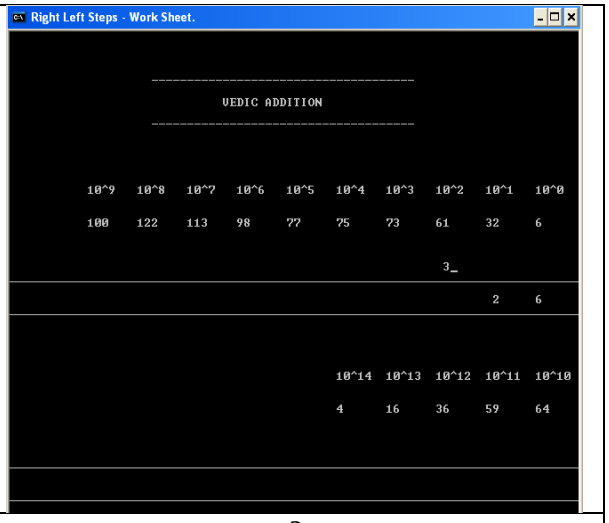

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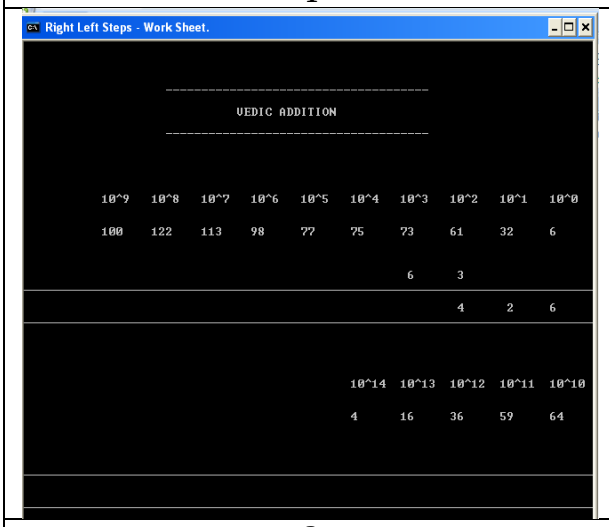

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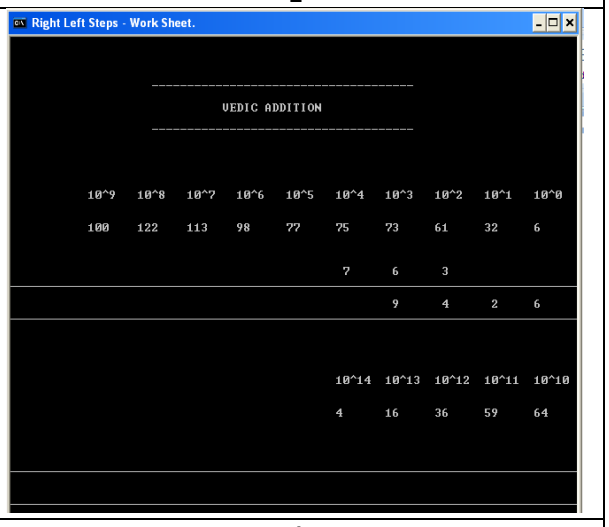

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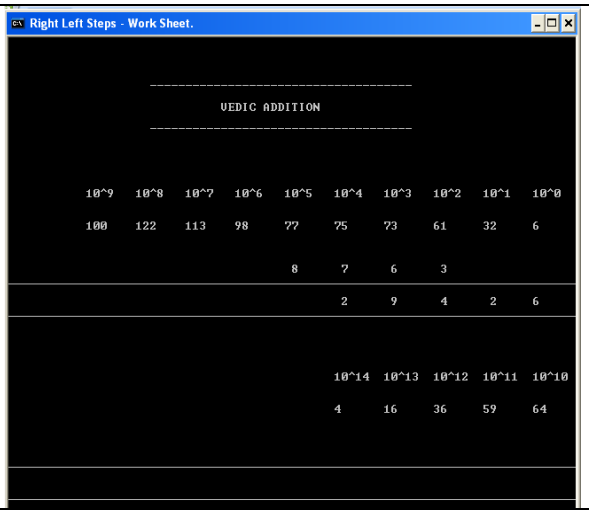
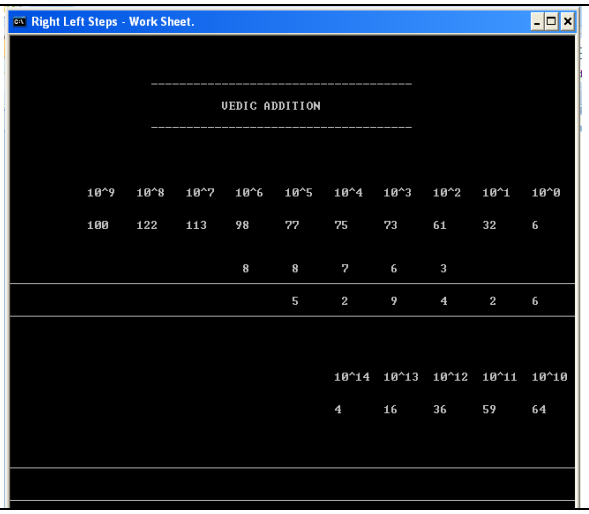
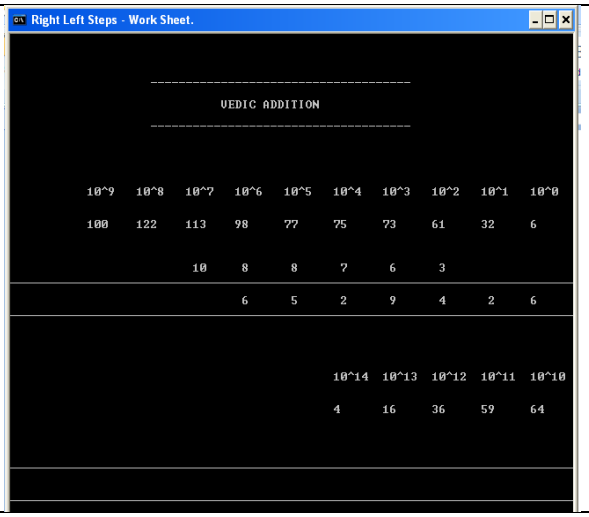

Right Left Steps - Work Sheet.
VEDIC ADDITION
10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2 10^1 10^0
100 122 113 98 77 75 73 61 32 6
8 7 6 3
2 9 4 2 6
10^14 10^13 10^12 10^11 10^10
4 16 36 59 64

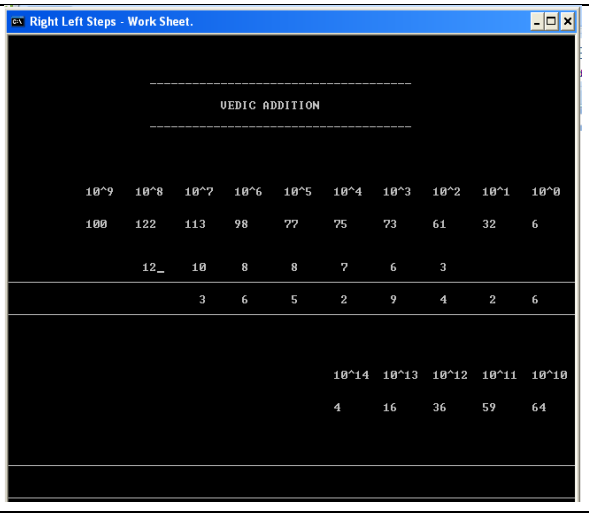
5


Right Left Steps - Work Sheet.
VEDIC ADDITION
10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2 10^1 10^0
100 122 113 98 77 75 73 61 32 6
8 8 7 6 3
5 2 9 4 2 6
10^14 10^13 10^12 10^11 10^10
4 16 36 59 64

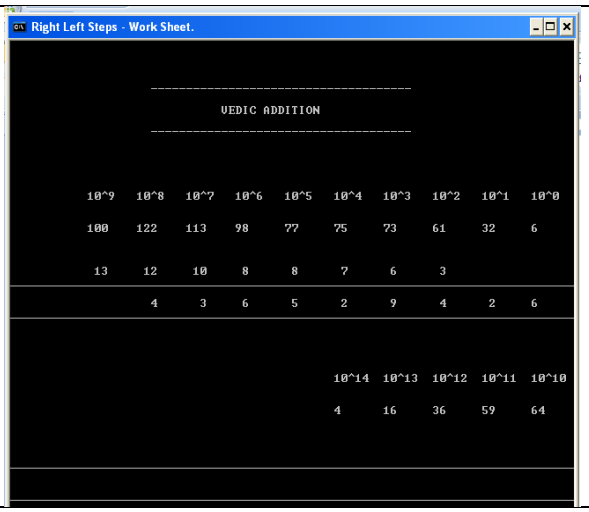
6


Right Left Steps - Work Sheet.
VEDIC ADDITION
10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2 10^1 10^0
100 122 113 98 77 75 73 61 32 6
10 8 8 7 6 3
6 5 2 9 4 2 6
10^14 10^13 10^12 10^11 10^10
4 16 36 59 64

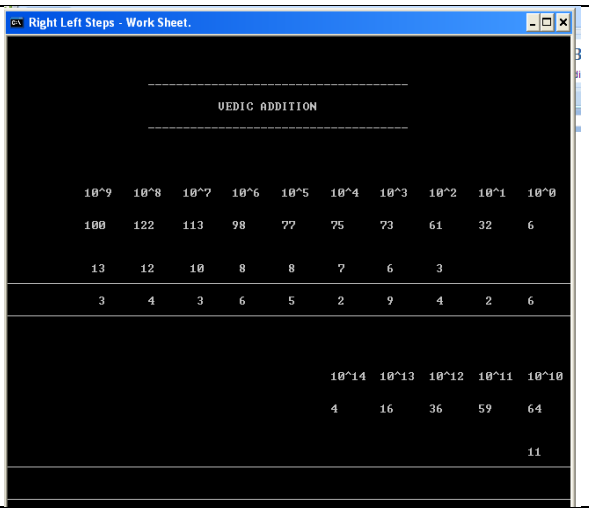
7


Right Left Steps - Work Sheet.
VEDIC ADDITION
10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2 10^1 10^0
100 122 113 98 77 75 73 61 32 6
12_ 10 8 8 7 6 3
3 6 5 2 9 4 2 6
10^14 10^13 10^12 10^11 10^10
4 16 36 59 64

8


Right Left Steps - Work Sheet.
VEDIC ADDITION
10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2 10^1 10^0
100 122 113 98 77 75 73 61 32 6
13 12 10 8 8 7 6 3
4 3 6 5 2 9 4 2 6
10^14 10^13 10^12 10^11 10^10
4 16 36 59 64

9


Right Left Steps - Work Sheet.
VEDIC ADDITION
10^9 10^8 10^7 10^6 10^5 10^4 10^3 10^2 10^1 10^0
100 122 113 98 77 75 73 61 32 6
13 12 10 8 8 7 6 3
3 4 3 6 5 2 9 4 2 6
10^14 10^13 10^12 10^11 10^10
4 16 36 59 64
11

10

International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-6, Issue-10, October 2020
ISSN: 2395-3470
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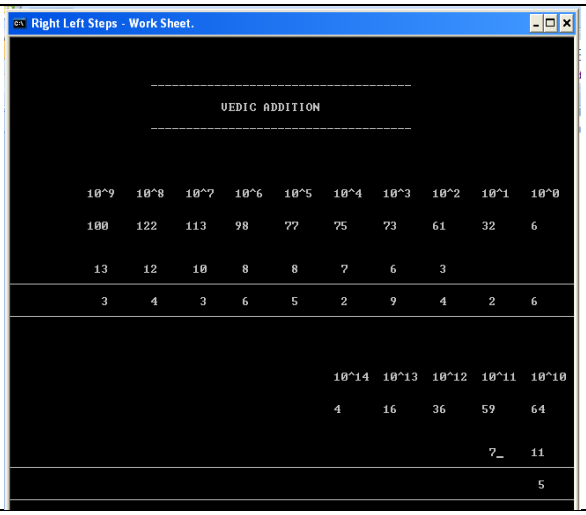

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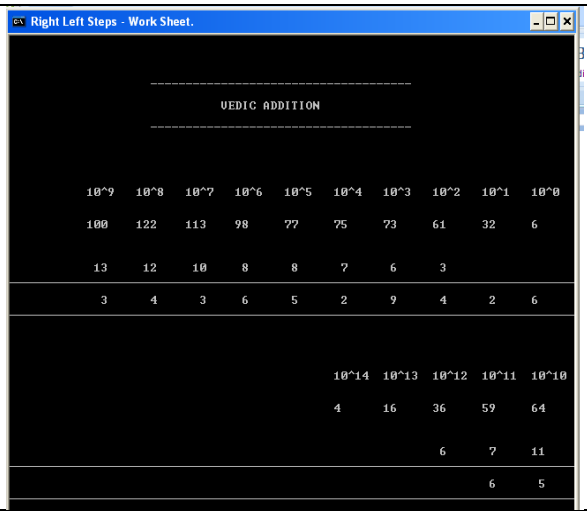

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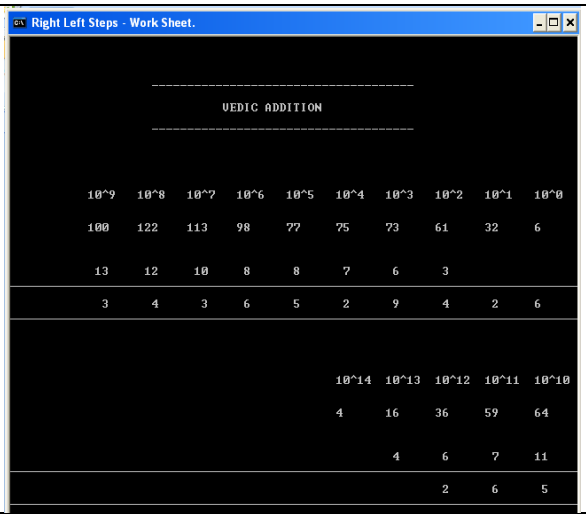

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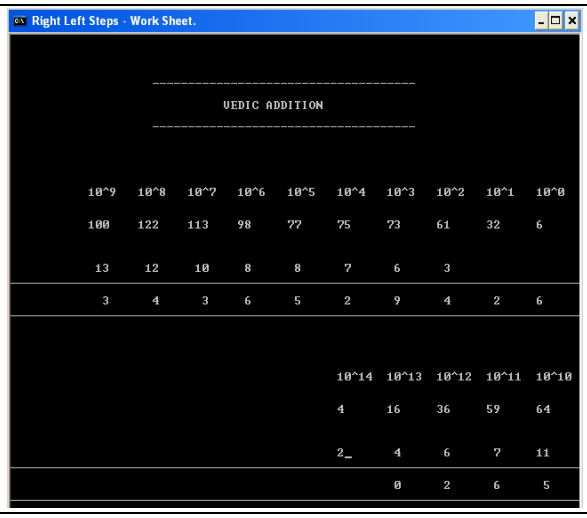

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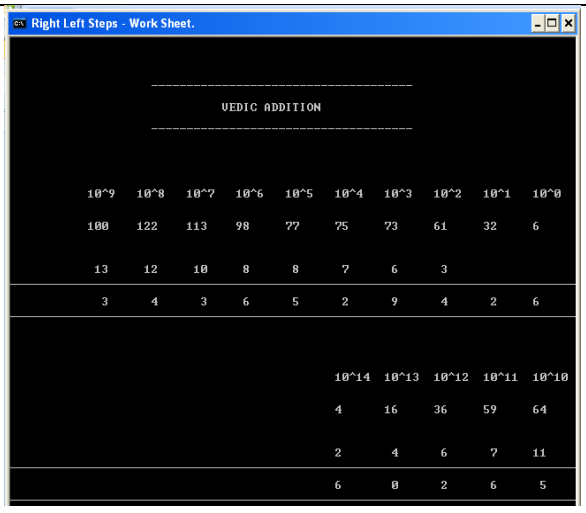

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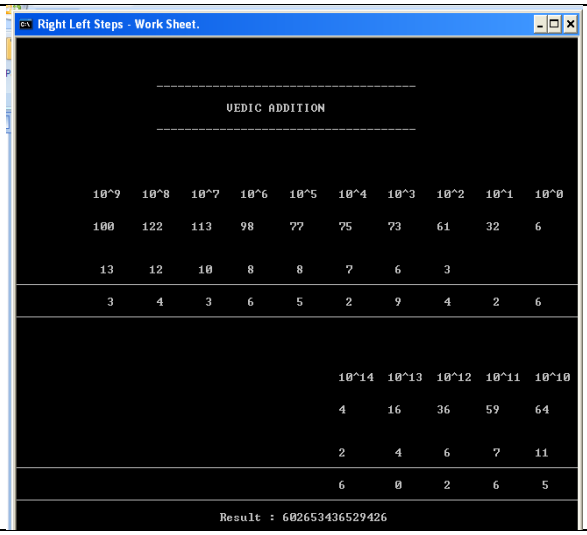

Final Answer

International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-6, Issue-10, October 2020
ISSN: 2395-3470
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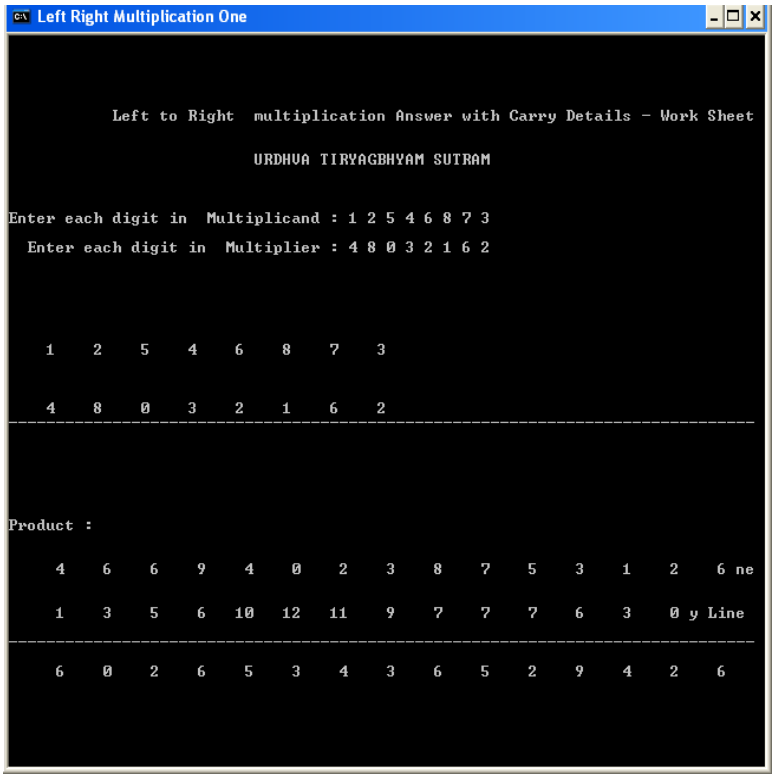
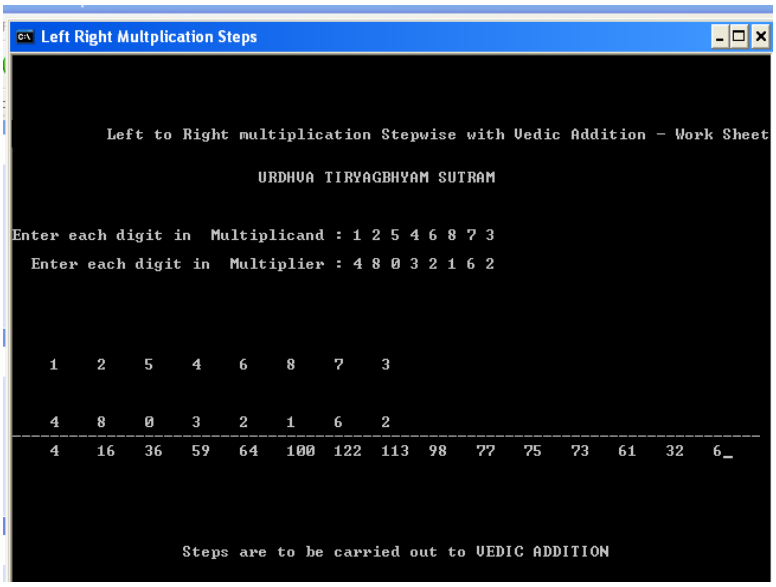
L→R Multiplication - Direct Result (B)

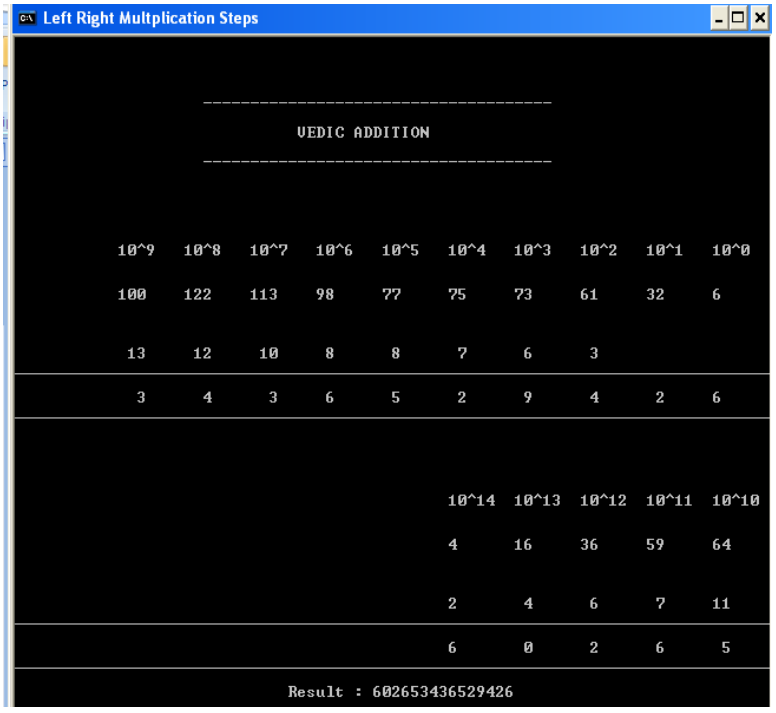
L→R Multiplication One line answer with carry details (B1)



Add

L→R Multiplication Step wise with Vedic Addition (C)





Acknowledgements

The author, is deeply indebted to Prof. GSN Raju, the Vice Chancellor of Centurion University of Technology and Management AP, Vizianagaram and also equally, acknowledges Prof. D.N.Rao, the Vice President of the Institution for his interest in this line of Investigation. The author extends her special thanks to Prof. Mukti Kanta Mishra, the President of the Institution for giving the position of Emeritus Professor in the Institution. The author is thankful to Dr. A. Ramakrishna Raju (Management Representative), Dr. Pallavi, Registrar of the University and also Prof. C.V. Gopinath, Principal of Baba College of Engineering for their appreciation of the work of the Indian Origin.

Special Note : I am profoundly grateful to the Tirumala Tirupathi Devestanam, Vedic University for the financial assistance and also to a very liberal contribution by prominent philanthropist, Dr. S. Vijay Kumar (once, my student at the Chemical Engineering Department, Andhra University) of Visakhapatnam for enabling

me to have the courtesy of possessing the Figures of the Workshop on Vedic Mathematics conducted by me, at the Andhra University, as the Director of the work and convener of the workshop.

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