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Research Paper

A New Concept of Multiplication of Any Large Number with the Help of a New Series of Algebraic Formulas

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ABSTRACT

In this article, we introduce a new concept of multiplication with the help of Algebraic formulas (Digital Algebraic formulas). These formulas are newly introduced and act as multipurpose use to find faster result of any number. The new formulas maintain the rule of adjustment of decimal point after multiplication and indicate the negative concept of neglecting zero or zeroes before the number. This series of formulas are the best even to multiply any large number in the world of multiplication. We can apply these formulas to multiply large numbers using multi-digit as single digit.

Keywords: Multiplication with algebraic formulas, Digital Algebraic formulas, Multiplication of any large number, multiplication of decimal numbers.

INTRODUCTION

In the mathematical world of multiplication, we apply various formulas or methods such as long multiplication method, Lattice method, Vedic method, box method and so many other methods or formulas to multiply the numbers. We find accurate result applying these methods but application of Algebraic formulas for multiplication of any number, how much large it may be, is probably the first step in the history of basic mathematics.

These formulas are newly introduced, so we discuss the main points about the formulas and thereafter write them-

The new formulas are named as Digital Algebraic formulas and these formulas are obtained by long multiplication method by keeping exact place value using block symbol. The terms of these formulas are equal to the terms of the general algebraic formulas. We can apply single digit as a digit and also can apply multi-digit as single digit in these formulas.

The new series of formulas – We can categorized the series into- 1. Formulas of squares and 2. Formulas of finding cubes and higher power of any number.

1. Formulas of Squares:

$(ab)^2 = a^2/2ab/b^2$

$(abc)^2 = a^2/2ab/b^2+2ac/2bc/b^2$

$(abcd)^2 = a^2/2ab/b^2+2ac/2bc+2ad/c^2+2bd/2cd/d^2$

$(abcde)^2 = a^2/2ab/b^2+2ac/2bc+2ad/c^2+2bd+2ae/2be+2cd/d^2+2ce/2de/e^2$

And so on.

2. Formulas of cubes, 4th and higher power-

$(ab)^3 = a^3/3a^2b/3ab^2/b^3$

$(ab)^4 = a^4/4a^3b/6a^2b^2/4ab^3/b^4$

$(ab)^5 = a^5/5a^4b/10a^3b^2/10a^2b^3/5ab^4/b^5$

And so on.

$(abc)^3=a^3/3a^2b/3ab^2+3a^2c/b^3+6abc/3ac^2+3b^2c/3bc^2/b^3$.

$(abcd)^3=a^3/3a^2b/3ab^2+3a^2c/b^3+3a^2d+6abc/3ac^2+3b^2c+6abd/3bc^2+3b^2d+6acd/c^3+3ad^2+6bcd/3bd^2+3c^2d/3cd^2/d^3$.

And so on.

Application of the formulas-

Here, we discuss about the application of these formulas under two headings, namely-

1. General Application and 2. Special Application

1. General Application- We generally use these formulas for finding squares, cubes and also for higher power of any number. We can apply single digit as a digit or also multi-digit as single digit to find the result of any numbers. Here, we apply multi digit as single digit to find the result of large numbers.

Rules for General Application-

1. We split the number taking equal number of vertical digits for each part from the right part to left except thinking of last part.
2. We split the number according to our choiceful formula and apply multi-digit as single digit.
3. We maintain the rule of adjustment of decimal point after multiplication as per as possible.

It is better to understand this application with the help of examples-

Example: Find $(2545)^2$ or multiply 2545 by 2545 using 2 digits formula.

We split or pair the number 2545 as 25 and 45.

We know, $(ab)^2 = a^2/2ab/b^2$

Applying above formula, we find, where a=25, b=45.

$(2545)^2 = (25)^2/2.25.45/(45)^2$

= 0625/2250/2025

= 0647/70/25 (2 digit in each block)

= 06477025 (withdrawing block symbols)

Example: Find $(2340{\cdot}07)^2$ or multiply 2340·07 by 2340·07 using two digits formula.

We split the number 2340.07 as 234 and 007 ignoring decimal point.

We know, $(ab)^2 = a^2/2ab/b^2$

Applying above formula, we find, where a=234, b=007.

$(2340{\cdot}07)^2 = (234)^2/2{\cdot}234{\cdot}007/(007)^2$

= 054756/003276/000049

= 054759/276/049 (3 digits in each block)

= 05475927.6049 (withdrawing block symbols& putting decimal point)

Example: Find $(10101)^2$ or multiply 10101 by 10101 using 3 digit formula.

We split the number 10101 as 1, 01 and 01

We know $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$

Applying above formula, we find, where a=1, b=01, c=01

$(10101)^2 = 1^2/2{\cdot}1{\cdot}01/(01)^2+2{\cdot}1{\cdot}01/2{\cdot}01{\cdot}01/(01)^2$

= 01/002/0001+002/0002/0001

= 01/002/003/0002/0001

= 01/02/03/02/01

= 0102030201

Example: Find $(23456{\cdot}789)^2$ or multiply 23456·789 by 23456·789 using 3 digit formula.

We split the number 23456789 as 23, 456 and 789.

We know, $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$

Applying above formula, we find, where a=23, b=456, c=789.

$(23456.789)^2$

$=(23)^2/2{\cdot}23{\cdot}456/(456)^2+2{\cdot}23{\cdot}789/2{\cdot}456{\cdot}789/(789)^2$

=0529/20976/207936+36294/719568/622521

= 0529/20976/244230/719568/622521

= 0550/220/950/190/521

= 0550220950·190521

Example: Find $(23456789)^2$ or multiply 23456789 by 23456789 using 4 digit formula.

We split the number 23456789 as 23, 45, 67 and 89

We know, $(abcd)^2 = a^2/2ab/b^2+2ac/2bc+2ad/c^2+2bd/2cd/d^2$

Applying above formula, we find, where a=23, b=45, c=67, d=89.

$(23456789)^2$

$=(23)^2/2{\cdot}23{\cdot}45/(45)^2+2{\cdot}23{\cdot}67/2{\cdot}45{\cdot}67+2{\cdot}23{\cdot}89/(67)^2+2{\cdot}45{\cdot}89/2{\cdot}67{\cdot}89/(89)^2$

=0529/2070/2025+3082/6030+4094/4489+8010/11926/7921

=0529/2070/5107/10124/12499/11926/7921

= 0550/22/09/50/19/05/21

= 0550220950190521

Now, we apply the formulas of cubes, 4th power and other higher power-

Example: Find $(2345)^3$ or multiply 2345x2345x2345 using 2 digit formula.

We split the number 2345 as 23 and 45

We know, $(ab)^3 = a^3/3a^2b/3ab^2/b^3$

Applying above formula, we find, where a=23, b=45.

$(2345)^3 = (23)^3/3.(23)^2.45/3.23.(45)^2/(45)^3$

= 01267/3.529.45/3.23.2025/091125

= 012167/071415/139725/091125

= 012895/21/36/25 (2 digit in each block)

= 012895213625

Example: Find $(2345)^4$ or multiply $2345 \times 2345 \times 2345 \times 2345$ using 2 digits formula.
We split the number 2345 as 23 and 45
We know, $(ab)^4 = a^4/4a^3b/6a^2b^2/4ab^3/b^4$
Applying above formula, we find, where a=23, b=45
$(2345)^4=(23)^4/4.(23)^3.45/6.(23)^2.(45)^2/4.23.(45)^3/(45)^4$
=279841/4.12167.45/6.529.2025/4.23.91125/4100625
=279841/2190060/6427350/8383500/4100625
= 302392/75/95/06/25
= 30239275950625

Example: Find $(2345)^5$ using 2 digit formula
We split the number 2345 as 23 and 45
We know, $(ab)^5 = a^5/5a^4b/10a^3b^2/10a^2b^3/5ab^4/b^5$
Applying above formula, we find, where a=23, b=45
$(2345)^5$
$=(23)^5/5.(23)^4.45/10.(23)^3.(45)^2/10.(23)^2.(45)^3/5.23.(45)^4/(45)^5$
=6436343/5.279841.45/10.12167.2025/10.529.91125/5.23.4100625/184528125
=6436343/62964225/246381750/482051250/471571875/184528125
= 7091110/21/04/21/56/25 (2 digit in each block)
= 70911102104215625

Example: Find $(123456)^3$ or multiply $123456 \times 123456 \times 123456$ using 3 digit formulas.
We split the number 123456 as 12, 34 and 56
We know,
$(abc)^3 = a^3/3a^2b/3ab^2+3a^2c/b^3+6abc/3ac^2+3b^2c/3bc^2/b^3$
Applying above formula, we find, where a=12, b=34, c=56
$(123456)^3$
$=(12)^3/3.(12)^2.34/3.12.(34)^2+3.(12)^2.56/(34)^3+6.12.34.56/3.12.(56)^2+3.(34)^2.56/3.34.(56)^2/(56)^3$
=1728/3.144.34/36.1156+3.144.56/39304+72.34.56/36.3136+3.56.1156/3.34.3136/175616
=1728/14688/41616+24192/39304+137088/112896+194208/319872/175616
=1728/14688/65808/176392/307104/319872/175616
= 1881/64/02/95/20/28/16 (2 digit in each block)
= 1881640295202816

2. Special Application- We can use these formulas for various purposes but here we apply these formulas for general multiplication and multiplication of decimal numbers.

We can apply the formulas of squares for general multiplication and multiplication of decimal numbers of any digit. How we can use these formulas- In case of finding squares, the multiplicand and multiplier are the same number or simply to say, vertical digits are same but in general multiplication or multiplication of decimal numbers, the multiplicand and the multiplier may be different types of number i.e, unsimilar number or one may have larger digits than the other.

We know that in case of finding squares, vertical digits are same number so we generally use (a, a), (b, b), (c, c) etc. and find the vertical product or result as a^2, b^2, c^2 etc. and crosswise or horizontal product as ab+ab= 2ab, ac+ac = 2ac, bc+bc = 2bc etc. and so on. Thus, we may seem (apply vertical digits as (a, a), (b, b), (c, c) etc. or if we apply (a_1, a_2), (b_1, b_2), (c_1, c_2) etc. then also we seem (write) the vertical product as a^2, b^2, c^2 etc. or crosswise product as $a_1b_2+a_2b_1$= 2ab, $a_1c_2+a_2c_1$= 2ac, $b_1c_2+b_2c_1$=2bc, etc. ignoring the product as a_1a_2, b_1b_2, c_1c_2 or $a_1b_2+a_2b_1$, $a_1c_2+a_2c_1$, $b_1c_2+b_2c_1$ etc. for balancing with the formulas.

Rules for application –
1. If there is dissimilarities between the number of digits of the multiplicand and multiplier, then we put zero or zeroes if necessary, before or after (decimal number) the numbers to equalise vertical digits or aligning the digits for easy application of the formulas. When we put zero or zeros before or after the number it must be cancelled from the result.
2. If we apply multi-digit as single digit then we must take equal number of vertical digits for each part from the extreme right to left except last part of the left which is depend

only on the rest number of the digits of the number taken or given.

3. We must keep equal number of digits which are taken in each block from right side when we add the results of the blocks as per rule.

Now, we apply our formulas for general multiplication with the help of examples-

Example: We multiply 24 by 26 using 2 digits formula.

We split the number 24 as 2, 4 and 26 as 2, 6

We know, $(ab)^2 = a^2/2ab/b^2$

Applying above formula, we find, $a_1= 2$, $a_2= 2$, $b_1 = 4$, $b_2= 6$.

24×26 = 2.2/2.6+2.4/4.6
= 04/12+08/24
= 04/20/24
= 06/2/4
= 0624

Example: We multiply 32457 by 3546 using 2 digits formula.

We split the numbers 32457 as 324, 57 and 3546 as 35, 46.

We know, $(ab)^2 = a^2/2ab/b^2$ (or) $(a_1b_1 \times a_2b_2) = a_1a_2/a_1b_2+a_2b_1/b_1b_2$

Applying above formula, we find, where $a_1= 324$, $a_2= 35$, $b_1= 57$, $b_2= 46$.

32457×3546 = 324.35/324.46+35.57/57.46.
= 11340/14904+1995/2622
= 11340/16899/2622
= 11509/25/22
= 115092522

Example: We multiply 324560 by 304256 using 2 digit formula.

We split the numbers 324560 as 324, 560 and 304256 as 304, 256

We know, $(ab)^2 = a^2/2ab/b^2$ (or) $(a_1b_1 \times a_2b_2) = a_1a_2/a_1b_2+a_2b_1/b_1b_2$

Applying above formula, we find, where $a_1 = 324$, $a_2= 304$, $b_1= 560$, $b_2= 256$.

324560×304256 = 324.304/324.256+304.560/560.256
= 098496/082944+170240/143360
= 098496/253184/143360
= 098749/327/360
= 098749327360

Example: We multiply 526 by 437 using 3 digits formula.

We split the numbers 526 as 5, 2, 6 and 437 as 4, 3, 7.

We know, $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$

Applying above formula, we find, where $a_1 = 5$, $a_2= 4$, $b_1= 2$, $b_2= 3$, $c_1= 6$, $c_2= 7$.

526×437 = 5.4/5.3+4.2/2.3+5.7+4.6/2.7+3.6/6.7.
= 20/15+08/06+35+24/14+18/42
= 20/23/65/32/42
= 22/9/8/6/2
= 229862

Example: We multiply 32458 by 2587 using 3 digit formulas.

We rewrite the number 32458×02587 and split the numbers 32458 as 3, 24, 58 and 02587 as 0, 25 and 87.

We know, $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$

Applying above formula, we find, where $a_1 = 3$, $a_2= 0$, $b_1= 24$, $b_2= 25$, $c_1= 58$, $c_2= 87$.

32458×02587
=3.0/3.25+0.24/24.25+3.87+0.58/24.87+25.58/58.87.
= 0/75+0/600+261+0/2088+1450/5046
= 0/75/861/3538/5046
= 0/83/96/88/46
= 083968846

Example: We multiply 324560 by 304256 using 3 digit formula

We split the numbers 324560 as 32, 45, 60 and 304256 as 30, 42, 56

We know, $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$

Applying above formula, we find, where $a_1 = 32$, $a_2= 30$, $b_1= 45$, $b_2= 42$, $c_1= 60$, $c_2= 56$.

324560×304256
=32.30/32.40+30.45/45.42+32.56+30.60/45.56+42.60/60.56.
=0960/1344+1350/1890+1792+1800/2520+2520/3360
= 0960/2694/5482/5040/3360
= 0987/49/32/73/60
= 098749327360

Example: Multiply 6235789004 by 523063007 using 2 digit formula.

We split the numbers 6235789004 as 62357, 89004 and 523063007 as 5230, 63007

We know, $(ab)^2 = a^2/2ab/b^2$

Applying above formula, we find, where $a_1 = 62357$, $a_2= 5230$, $b_1= 89004$, $b_2= 63007$.

6235789004×523063007
=62357.5230/62357.63007+5230.89004/89004.63007
=326127110/3928927499+465490920/5607875028
= 326127110/4394418419/5607875028

= 326171054/74497/75028
= 3261710547449775028

Example: Multiply 6235789004 by 523063007 using 4 digit formula.
We split the numbers 6235789004 as 6235, 78, 90, 04 and 523063007 as 523, 06, 30, 07
We know, $(abcd)^2 = a^2/2ab/b^2+2ac/2bc+2ad/c^2+2bd/2cd/d^2$
Applying above formula, we find, where $a_1 = 6235$, $a_2= 523$, $b_1= 78$, $b_2= 06$, $c_1=90$, $c_2= 30$,
$d_1= 04$, $d_2 = 07$.
6235789004x523063007
=6235.523/6235.06+523.78/78.06+6235.30+523.90/6235.07+523.04+78.30+06.90/90.30+78.07+06.04/90.07+30.04/04.07
=3260905/37410+40794/468+187050+47070/43645+2092+2340+0540/2700+0546+0024/630+120/0028
=3260905/78204/234588/48617/3270/750/0028
= 3261710/54/74/49/77/50/28
= 3261710547449775028

Multiplications of Decimal Numbers- We apply our formulas to multiply decimal numbers with examples.

Example: We multiply the decimal numbers 25.20 by 12.40 using 2 digits formulas.
We split the numbers 25.20 as 25, 20 and 12.40 as 12, 40 ignoring decimal point.
We know, $(ab)^2 = a^2/2ab/b^2$
Applying above formula, we find, where $a_1 = 25$, $a_2= 12$, $b_1= 20$, $b_2= 40$.
25.20x12.40 = 25.12/25.40+12.20/20.40
= 0300/1000+0240/0800
= 0300/1240/0800
= 0312/48/00
= 0312.4800 (putting decimal point)

Example: We multiply the decimal numbers 1025.31 by 2515.5 using 3 digits formula.
We rewrite the number as 1025.31x2515.50 and split the numbers 1025.31 as 10, 25, 31 and
2515.50 as 25, 15, 50 ignoring decimal point.
We know, $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$

Applying above formula, we find, where $a_1 = 10$, $a_2= 25$, $b_1= 25$, $b_2= 15$, $c_1= 31$, $c_2= 50$,
1025.31 x 2515.50
=10.25/10.15+25.25/25.15+10.50+25.31/25.50+15.31/31.50
=0250/0150+0625/0375+0500+0775/1250+0465/1550
= 0250/0775/1650/1715/1550
= 0257/91/67/30/50
= 02579167.3050 (putting decimal point)
= 02579167.305 (withdrawing zero)

Example: We multiply 257.253 by 321.5 using 3 digits formula.
We rewrite the numbers 257.253x321.500
We split the numbers 257.253 as 25, 72, 53 and 321.500 as 32, 15, 00 ignoring decimal point.
We know, $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$
Applying above formula, we find, where $a_1 = 25$, $a_2= 32$, $b_1= 72$, $b_2= 15$, $c_1= 53$, $c_2= 00$,
257.253x321.500 = 25.32/25.15+32.72/72.15+25.00+32.53/72.00+15.53/53.00
=0800/0375+2304/1080+0000+1696/0000+0795/0000
= 0800/2679/2776/0795/0000
= 0827/06/83/95/00
= 082706.839500 (putting decimal point)
= 082706.8395 (withdrawing zeroes)

Multiplication of large numbers-

We can apply these formulas to multiply any number. Suppose, we have a calculator of 12 digits number and we have to multiply 12 digits by 12 digits number. In this case, we have to apply 3 digits, 4 digits, or 5 digits formula. We cannot apply 2 digits formula because we have to find the product of 2ab which may create 13 digits number. If we apply our 2 digits formula, we must take 1 digit lesser than the limit of the calculator.

It is easier to verify our above statements with the help of examples-

Example 1: Multiply 987654321345 by 987654321345 or find $(987654321345)^2$ using 2 digit formula-
We split the number 987654321345 as 987654, 321345.
We know, $(ab)^2 = a^2/2ab/b^2$

Applying above formula, we find, where a= 987654, b= 321345

$(987654321345)^2$
$= (987654)^2/2.987654.321345/(321345)^2$
$=975460423716/2.317377674630/103262609025$
$=975460423716/634755349260/103262609025$
$= 975461058471/350292/609025$
$= 975461058471350292609025$

Example 2: Multiply 824567891456 by 824567891456 or find $(824567891456)^2$ using 2 digit formula-

We split the number 824567891456 as 824567, 891456.

We know, $(ab)^2 = a^2/2ab/b^2$

Applying above formula, we find, where a= 824567, b= 891456

$(824567891456)^2 = (824567)^2/2.\ 824567.\ 891456/(891456)^2$
$=679910737489/2.735065199552/794693799936$
$=679910737489/1470130399104/794693799936$
$= 679912207620/193797/799936$
$= 679912207620193797799936$

In the above example 2, we cannot multiply 2ab at a time with this calculator because it creates 13 digit number.

Example 3: Find $(824567891456)^2$ using 3 digit formula-

We split the number 824567891456 as 8245, 6789 and 1456

We know, $(abc)^2 = a^2/2ab/b^2+2ac/2bc/c^2$

Applying above formula, we find, where a=8245, b=6789, c=1456

$(824567891456)^2$
$=(8245)^2/2.8245.6789/(6789)^2+2.8245.1456/2.6789.1456/(1456)^2$
$=67980025/111950610/46090521+24009440/19769568/2119936$
$=67980025/111950610/70099961/19769568/2119936$
$= 67991220/7620/1937/9779/9936$
$= 679912207620193797799936$

CONCLUSION

These formulas are very useful to multiply any large number within a short time. The formula will be very beneficial for the students, teachers, scholars and especially for the mankind.

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