Vedic Mathematics Tricks and Shortcuts

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Vedic Mathematics is a system of mathematics which was invented by Indian mathematician **Jagadguru Shri Bharathi Krishna Tirthaji Maharaj** in the period between A.D. 1911 and 1918.

It consists of 16 Sutras (methods) and 13 sub-sutras (Sub methods). Vedic Mathematics's methods are highly efficient when it comes to calculation of regular arithmetics like subtraction, multiplication, division of numbers and polynomials, squares, square roots, cubes, cube roots, solving equation, partial fractions, derivatives, conics, etc.

Vinculum Numbers / Vinculum Process:

Vinculum Process forms the very basic requisites for Vedic Mathematics.
Vinculum is a Sanskrit word which means a line i.e. bar over number i.e. negative digits. Vinculum numbers are numbers which have atleast 1 digit as a negative digit.
Vinculum numbers/digits are also called as Bar numbers/digits.

Eg: Vinculum number converted to normal number using Place Value concept.

$$234\bar{5} = 2000+300+40-5 = 2335$$

$$23\bar{4}5 = 2000+300-40+5 = 2265$$

$$23\overline{45} = 2000+300-40-5 = 2255$$

Another Method of **Conversion of Vinculum number to Normal number**:
Follow R -> L approach.

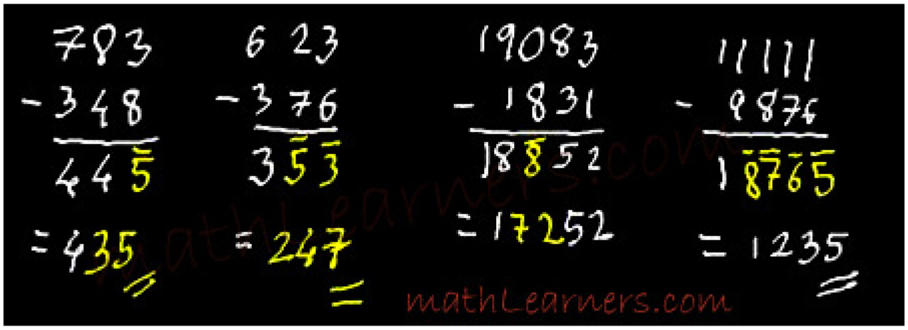
1. Find 1st Bar digit and takes is 10's complement.
2. a) If next digit is again Bar digit then take its 9's complement. Continue taking 9's complement till non-bar digit is obtained.
   b) Decrement non-bar digit by 1.
1. Continue (1) & (2) till complete number is covered.

Conversion of Normal number to Vinculum number:
Follow R -> L approach.

1. Find 1st digit > 5 & take its 10's complement with a bar over it.
2. a) If next digit is again >= 5, take its 9's complement with a bar over it & continue this till a digit <5 is obtained.
   b) Increment <5 digit by 1.
1. Continue (1) & (2) till complete number is covered.

Conversion of Vinculum numbers to Normal numbers and vice versa is very important for other concepts of Vedic Mathematics.

Subtraction using Vinculum:



(More examples on http://mathlearners.com/vedic-mathematics/basic-requisites/)

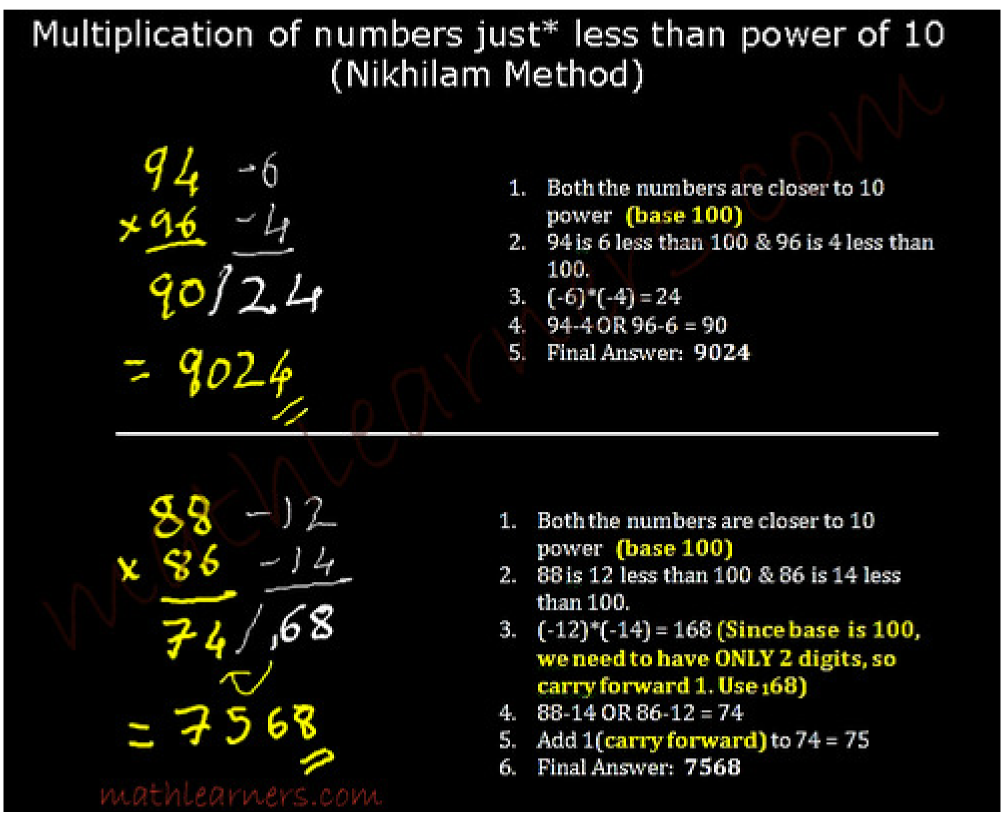
Nikhilam Navatascaramam Dastah:

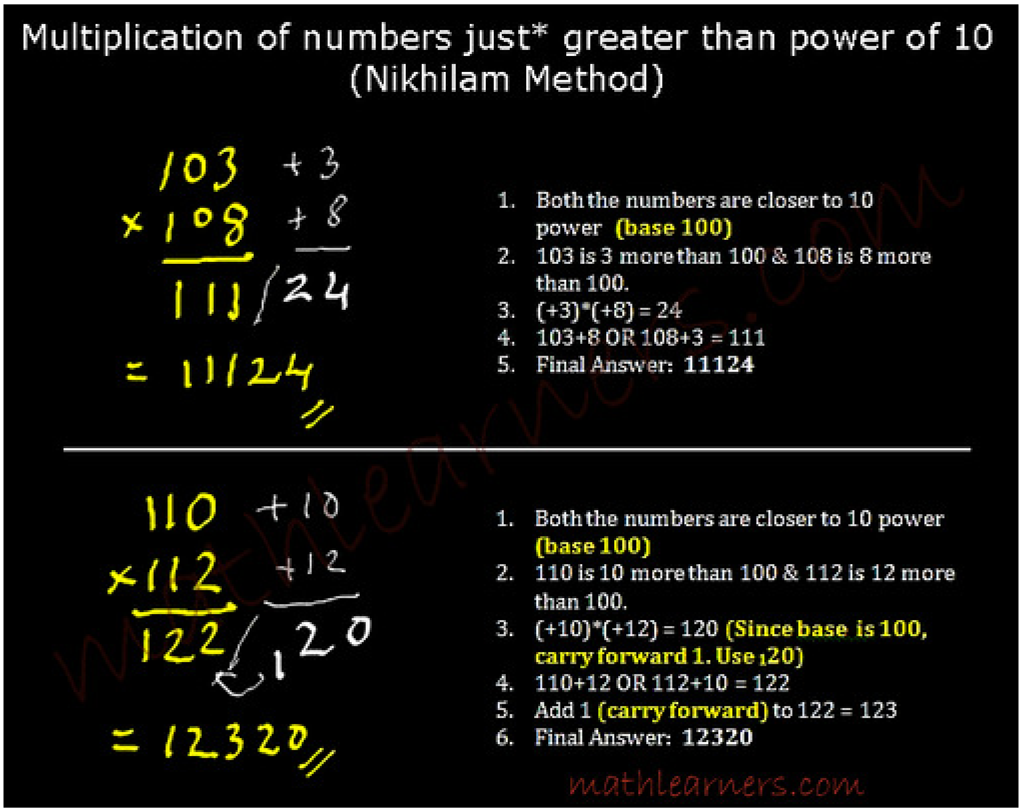
Popularly called as **Nikhilam** Sutra and English it means as 'All from 9 and last from 10'.

Nikhilam Sutra in Multiplication is used whenever the numbers are closer to power of 10 i.e. 10, 100, 1000, ...

This creates 3 groups:

1. Numbers are less than power of 10 i.e. 10, 100, 1000, ...
2. Numbers are more than power of 10 i.e. 10, 100, 1000, ...
3. Numbers are present on either side of power of 10 i.e. 10, 100, 1000, ...





Multiplication of numbers just* greater than power of 10 (Nikhilam Method)
103 +3
×108 +8
111/24
= 11124
1. Both the numbers are closer to 10 power (base 100)
2. 103 is 3 more than 100 & 108 is 8 more than 100.
3. (+3)*(+8) = 24
4. 103+8 OR 108+3 = 111
5. Final Answer: 11124
110 +10
×112 +12
122/₁20
= 12320
1. Both the numbers are closer to 10 power (base 100)
2. 110 is 10 more than 100 & 112 is 12 more than 100.
3. (+10)*(+12) = 120 (Since base is 100, carry forward 1. Use ₁20)
4. 110+12 OR 112+10 = 122
5. Add 1 (carry forward) to 122 = 123
6. Final Answer: 12320
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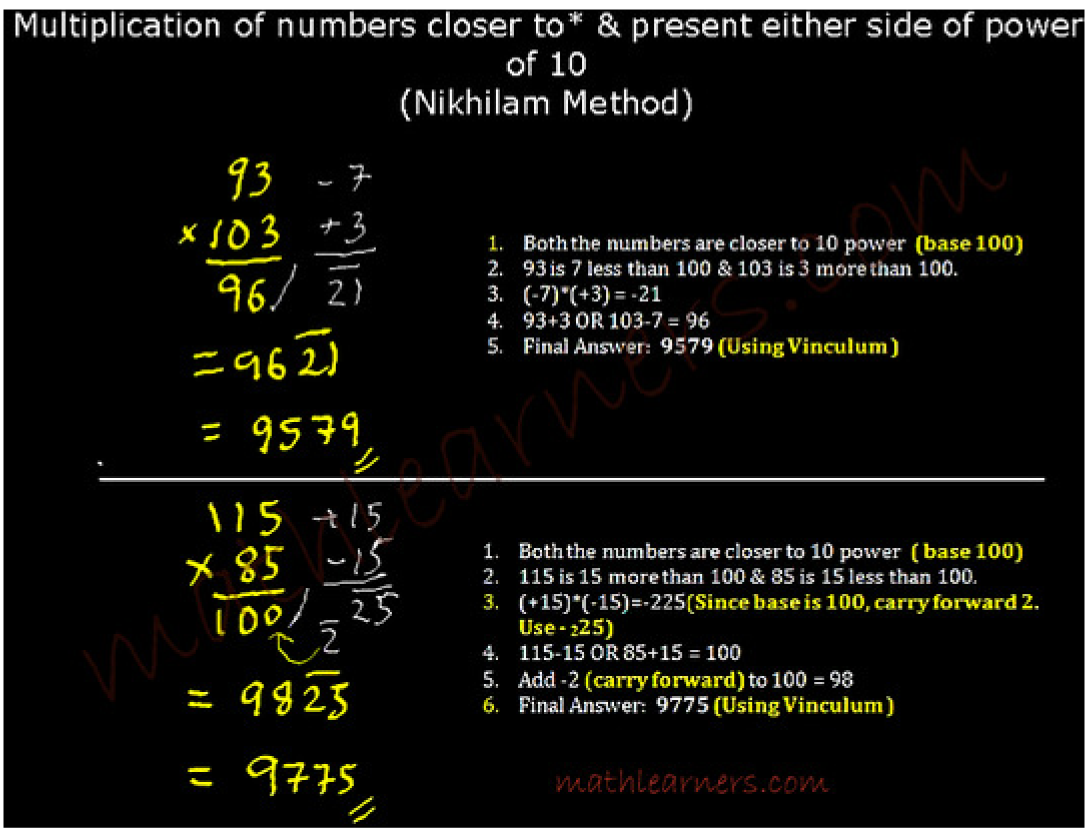

Multiplication of numbers closer to* & present either side of power of 10 (Nikhilam Method)
93 -7
×103 +3
96/ $\overline{21}$
= 96$\overline{21}$
= 9579
1. Both the numbers are closer to 10 power (base 100)
2. 93 is 7 less than 100 & 103 is 3 more than 100.
3. (-7)*(+3) = -21
4. 93+3 OR 103-7 = 96
5. Final Answer: 9579 (Using Vinculum)
115 +15
× 85 -15
100/ $\overline{2}\overline{25}$
= 98$\overline{25}$
= 9775
1. Both the numbers are closer to 10 power (base 100)
2. 115 is 15 more than 100 & 85 is 15 less than 100.
3. (+15)*(-15)=-225(Since base is 100, carry forward 2. Use -₂25)
4. 115-15 OR 85+15 = 100
5. Add -2 (carry forward) to 100 = 98
6. Final Answer: 9775 (Using Vinculum)
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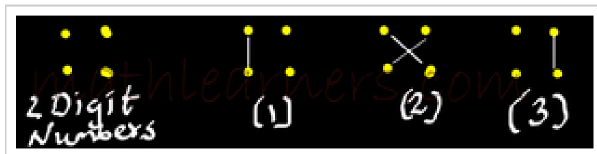
Urdhva Tiryakbhyam (Vertically and Crosswise):

Commonly called as Urdhva Tiryak Sutra used in multiplication and its a General method which can be applied to any types of numbers.

Multiplication of Two 2digit numbers

Process: (Left -> Right)

1. Vertical Multiplication of 1st digits of 2 numbers.
2. Crosswise Addition (Crosswise Multiplication and adding them).
3. Vertical Multiplication of last digits of 2 numbers.



Formula :

$$(ax+b)(cx+d) = acx^2 + (ad+bc)x + bd$$

Multiplication of Two 3digit numbers

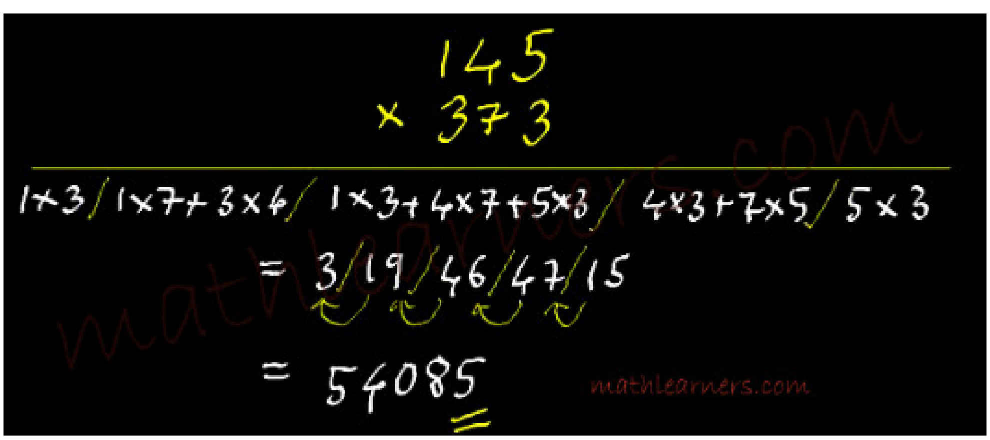
Process: (Left -> Right)

1. Vertical Multiplication of 1st digits of 2 numbers.
2. Crosswise Addition of 1st 2 digits 2 numbers.
3. Crosswise Addition of all 3 digits of both the numbers.
4. Crosswise Addition of last 2 digits 2 numbers.
5. Vertical Multiplication of last digits 2 numbers.

Formula :

$$(ax^2+bx+c)(dx^2+ex+f) = adx^4 + (ae+bd)x^3 + (af+be+cd)x^2 + (bf+ce)x + cf$$

Example:



Nikhilam Sutra:

Nikhilam Sutra in Division is applied when divisor is closer to and slightly lesser than power of 10.

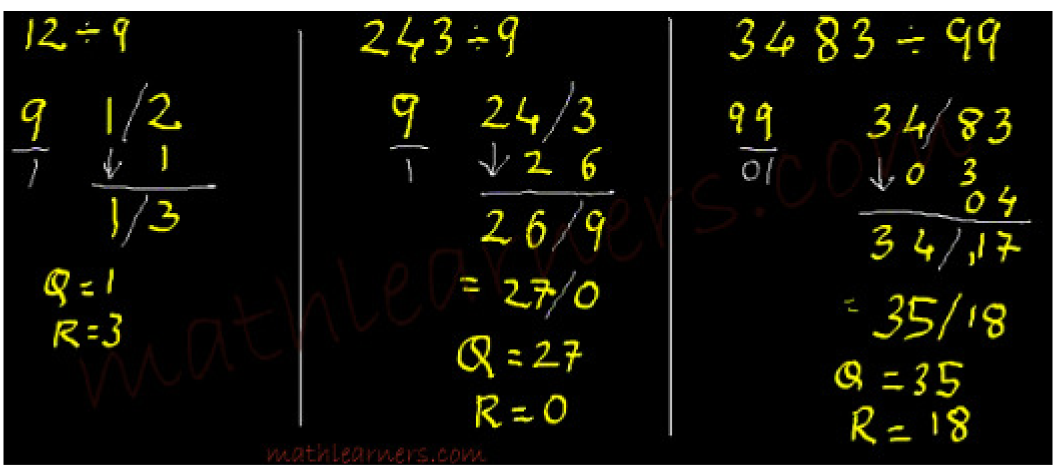
Examples:

12/9 (See Below)

1. 9 is 1(deficiency) less than 10(nearest power of 10).
2. Split Dividend in 2 parts (Quotient & Remainder) in such a way Remainder to have same digits as that of Divisor. In this case its 1.
3. Take 1 as it is down.
4. Multiply the above deficiency (1) with the 1 and put below 2 and add them column wise.
5. Thus Quotient=1 & Remainder=3.

3483/99 (See Below)

1. 99 is 01(deficiency) less than 100(nearest power of 10).
2. Split Dividend in 2 parts (Quotient & Remainder) in such a way Remainder to have same digits as that of Divisor. In this case its 2.
3. Take 3 as it is down.
4. Multiply the above deficiency (01) with the 3 and put them below 4 and 8(as shown), add 1st column (4+0=4).
5. Multiply the above deficiency (01) with the 4 now and put in next columns (as shown), add 1st column (8+3+0=11).
6. Repeat this process till a number comes in last column. In this example a number (4) has appeared in last column so stop here.
7. Thus Quotient=35 & Remainder=18.



Also, if deficiency has bigger digits like 6, 7, 8 and 9 then apply Vinculum and then apply Nikhilam Sutra on that.

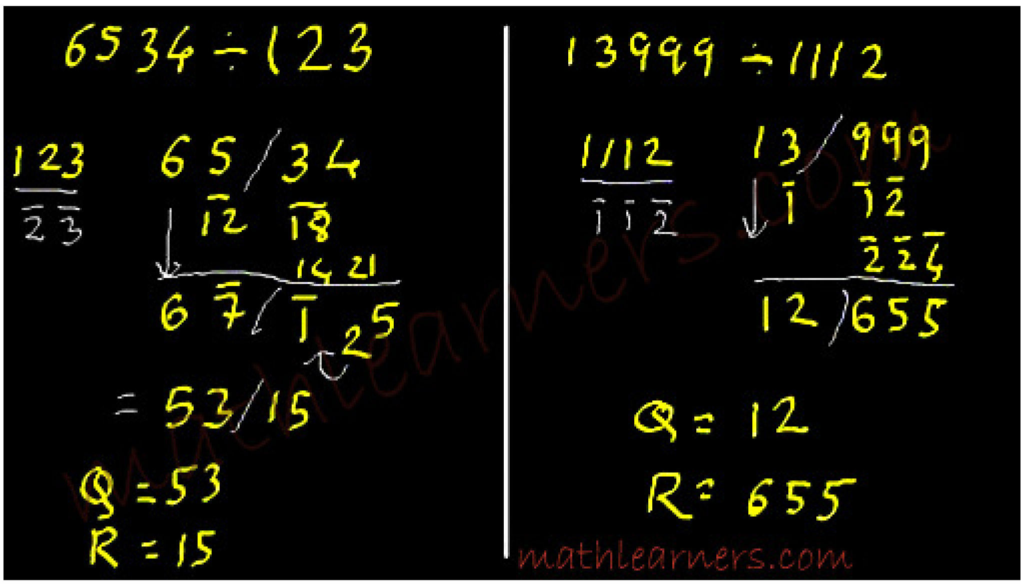
Instead of Quotients and Remainders, division answers can be obtained in decimal format as well.

Paravartya Yogayat Sutra (Transpose and Apply):

Paravartya Sutra can be applied for division whenever divisor is closer and slightly greater than power of 10.

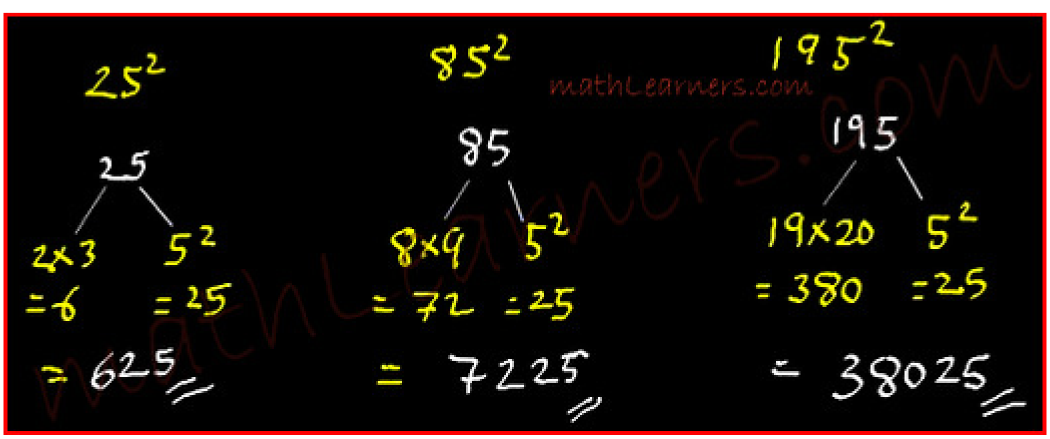
Process almost remains same as that of Division's Nikhilam Sutra except 1st digit of divisor is discarded and other digits are transposed.

Example:



Ekadhikena Purvena Sutra:

Ekadhikena Purvena is used to find square of number which end with 5.

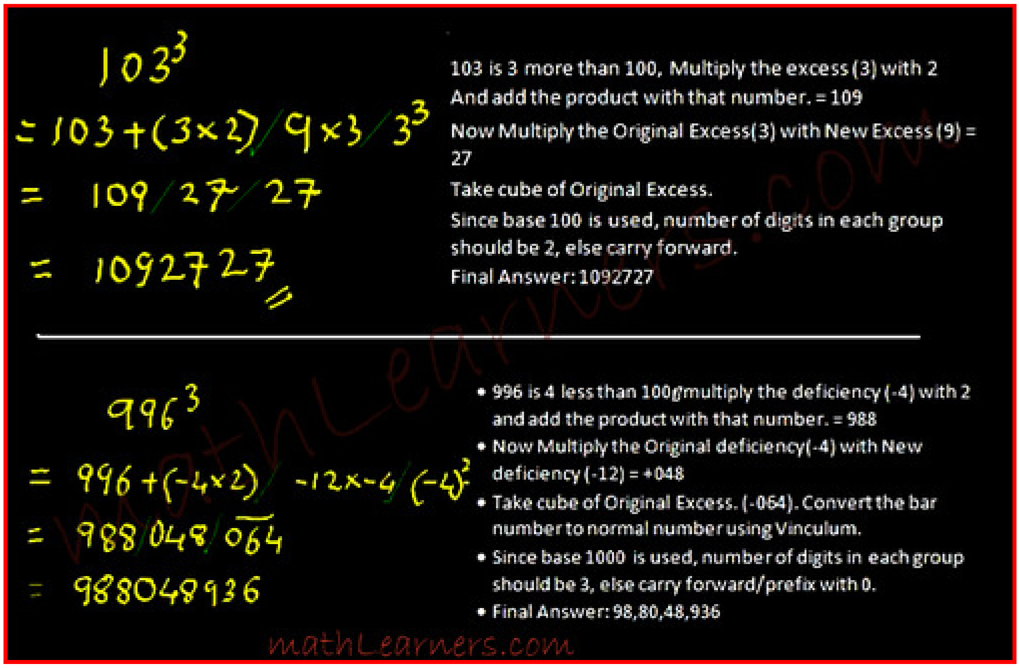


Yavadunam Sutra:

Yavadunam is used to find square of a number which is closer to power of 10.

- $93^2 = (93\text{-}7)/7^2 = 86/49 = 8649$
- $89^2 = (89\text{-}11)/11^2 = 78/121 = 7921$
- $113^2 = (113+13)/13^2 = 126/169 = 12769$
- $1002^2 = (1002+2)/2^2 = 1004/004 = 1004004$

Yavadunam can be used find cube of a number but condition remains same i.e. number should be closer to power of 10.



Square root of a perfect Square:

Examples:

Square root of 2209

1. Number ends with 9, Since it's a perfect square, square root will end with 3 or 7.
2. Need to find 2 perfect squares (In Multiplies of 10) between which 2209 exists. Numbers are 1600(40^2) and 2500(50^2).
3. Find to whom 2209 is closer. 2209 is closer to 2500. Therefore squareroot is nearer to 50 Now from Step 2, possibilities are 43 or 47 out of which 47 is closer to 50
4. Hence squareroot = 47.

Square root of 7056

1. Number ends with 6, So square root ends with 4 or 6.
2. Perfect squares (In Multiplies of 10) between which 7056 exists are $6400(80^2)$ and $8100(90^2)$. 7056 is closer to 6400. Therefore squareroot is nearer to 80
3. Now from Step 2, possibilities are 84 or 86 out of which 84 is closer to 80
4. Hence squareroot = 84.

Cube Root of a Perfect Cube (Max 6 digits):

Cubes from 1- 10:

Number	Cube	Cube ends with	
1	1	**1**	Thus as seen cubes have distinct ending, there is no overlapping. Thus, if the given number is perfect cube, then the last digit will help to find the cube root.
2	8	**8** (Compliment of 2)	
3	27	**7** (Compliment of 3)	
4	64	**4**	
5	125	**5**	
6	216	**6**	
7	343	**3** (Compliment of 7)	
8	512	**2** (Compliment of 8)	
9	729	**9**	
10	1000	**0**	

Cube root of 1728:

1. Group the numbers from R -> L in the group of 3. So we have 1,728.
2. Last group (728) ends with 8, so cube root will end in 2.
3. 1^{st} group is 1. Find perfect cube root <= 1 i.e. 1 and its cube root is 1.
4. Answer is 12.

Cube root of 300763:

1. Group the numbers from R -> L in the group of 3. So we have 300,763.
2. Last group (763) ends with 3, so cube root will end in 7.
3. 1^{st} group is 300. Find perfect cube <= 300 i.e. 216 and its cube root is 6.
4. Answer is 67.