**NCERT MATHEMATICS** Grade VIII **MATHS NOTES -PART 3** **APRIL 2020**

## Chapter 6- SQUARES AND SQUARE ROOTS(Exercise 6.3 & 6.4)

In this session of the chapter, we shall learn the following :

I. Square root - Methods of finding square root of a number

(i) For small numbers
- a) Table of Squares
- b) Repeated Subtraction method

(ii) For large numbers
- a) Prime Factorization method
- b) Division method
- c) Estimation method

II. To find the smallest factor to be multiplied /divided to get a perfect square.(By Prime Factorization Method)

III. To find the smallest number to be added / subtracted to get a perfect square.(By Division Method)

IV. To find the smallest square number which is divisible by the given factors

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NOTE TO STUDENTS- ONLY EXERCISES TO BE DONE IN NOTE BOOK

SQUARE ROOTS

Let us recall that a square is a number which is the product of any number with itself.

The number which is repeated is called the square root. In other words, square root is the inverse operation of squaring.

Eg. 4 x 4 = 16

The number repeated here is 4. Therefore, square root of 16 is 4.

It is denoted as $\sqrt{16} = 4$

Similarly, $\sqrt{25} = 5$

# METHODS OF FINDING SQUARE ROOTS

## Table of Squares

For small numbers, the table of squares written in inverse order will be of help. Given below are the square roots of numbers from 1 to 100.

| Statement | Inference |
|---|---|
| $1^2 = 1$ | $\sqrt{1} = 1$ |
| $2^2 = 4$ | $\sqrt{4} = 2$ |
| $3^2 = 9$ | $\sqrt{9} = 3$ |
| $4^2 = 16$ | $\sqrt{16} = 4$ |
| $5^2 = 25$ | $\sqrt{25} = 5$ |

| Statement | Inference |
|---|---|
| $6^2 = 36$ | $\sqrt{36} = 6$ |
| $7^2 = 49$ | $\sqrt{49} = 7$ |
| $8^2 = 64$ | $\sqrt{64} = 8$ |
| $9^2 = 81$ | $\sqrt{81} = 9$ |
| $10^2 = 100$ | $\sqrt{100} = 10$ |

Memorizing the table of squares will be a useful tool in finding the square roots of large numbers by the other methods.

From the above table, we find some interesting observations as tabulated below:

| IF Square ends with the digit… | THEN Square root ends with the digit…. |
|---|---|
| 1 | 1 or 9 |
| 4 | 2 or 8 |
| 5 | 5 |
| 6 | 4 or 6 |
| 9 | 3 or 7 |

Eg. 79744**9** is a square number and its one's digit is 9.

Then the one's digit of its square root will be either 1 or 9

Eg.15876 is a square number and its one's digit is 6.

Then the one's digit of square number will be 4 or 6

**Exercise 6.3**

## QUESTION 1

Ex 6.3 Class 8 Maths Question 1.
What could be the possible 'one's' digits of the square root of each of the following numbers?
(i) 9801
(ii) 99856
(iii) 998001
(iv) 657666025
Solution:
(i) One's digit in the square root of 9801 maybe 1 or 9.
(ii) One's digit in the square root of 99856 maybe 4 or 6.

## Q1.( iii) & ( iv) for HW

QUESTION 2.( as explained in Exercise 6.1)

Without doing any calculation, find the numbers which are surely not perfect squares.

(i) 153

(ii) 257

(iii) 408

(iv) 441

Solution:

We know that the numbers ending with 2, 3, 7 or 8 are not perfect squares.

(i) 153 is not a perfect square number. (ending with 3)

(ii) 257 is not a perfect square number. (ending with 7)

Q2.( iii) & ( iv) for HW

REPEATED SUBTRACTION METHOD

This is again applicable for small numbers only.

We shall apply a rule which we learnt earlier, that is,

THE SUM OF THE FIRST '**n** 'ODD NUMBERS IS ' $\mathbf{n^2}$'

Let us find the square root of 81 by this method

Method: Subtract the number with odd numbers starting from 1 as shown below:

1) 81 – 1 = 80
2) 80 – 3 = 77
3) 77 – 5 = 72
4) 72 – 7 = 65
5) 65 – 9 = 56
6) 56 – 11 = 45
7) 45 – 13 = 32
8) 32 – 15 = 17
9) 17 – 17 =0

We observe that we repeatedly subtract odd numbers starting from 1, NAMELY 1,3,5,7,…till the difference becomes 0.

The number of subtraction steps involved gives the square root of the number.

Here there are 9 steps to reduce value to 0

**Therefore square root of 81 is 9**

**Ans:** $\sqrt{81}$**= 9**

QUESTION 3 (HW)

Find the square roots of 100 and 169 by the method of repeated subtraction.

## PRIME FACTORISATION

For LARGE SQUARE NUMBERS, the square root can be found by the method of Prime factorisation.

You have learnt Prime factorisation in grade VI & VII. The same can be applied in finding the square roots of a number.

Example 1 : **256**

By Prime Factorisation , the factors of 256 are as follows:

$$256 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$$

By pairing the prime factors we get,

$$256 = \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{2 \times 2} \times \underline{2 \times 2} = (2 \times 2 \times 2 \times 2)^2$$

Therefore, $\sqrt{256} = 2 \times 2 \times 2 \times 2 = 16$

| | |
|---|---|
| 2 | 256 |
| 2 | 128 |
| 2 | 64 |
| 2 | 32 |
| 2 | 16 |
| 2 | 8 |
| 2 | 4 |
| | 2 |

Example 2: **324**

By Prime Factorisation , the factors of 324 are as follows:

324 = 2 x 2 x 3 x 3 x 3 x 3

By pairing the prime factors we get,

324 = $\underline{2 \text{ x } 2}$ x $\underline{3 \text{ x } 3}$ x $\underline{3 \text{ x } 3}$

Therefore $\sqrt{324}$ = 2 x 3 x 3

$\sqrt{324}$ = **18**

Imp Note: Each pair is represented by only one number in its square root

| | |
|---|---|
| 2 | 324 |
| 2 | 162 |
| 3 | 81 |
| 3 | 27 |
| 3 | 9 |
| | 3 |

QUESTION 4 (HW)

Find the square roots of the following numbers by the Prime Factorisation Method.

(i) 729 (ii) 400 (iii) 1764 (iv) 4096

(v) 7744 (vi) 9604 (vii) 5929 (viii) 9216

(ix) 529 (x) 8100

## METHOD TO FIND THE SMALLEST FACTOR TO BE MULTIPLIED / DIVIDED TO GET A PERFECT SQUARE.

(By Prime Factorization Method)

Is the number 2352 a perfect square?(No, because it ends with digit 2)

Let us check its factors…

2352 = 2 x 2 x 2 x 2 x 3 x 7 x 7

Pairing them we get,

2352 = 2 x 2 x 2 x 2 x **3** x 7 x 7

IT IS NOT A PERFECT SQUARE BECAUSE 3 DOES NOT HAVE A PAIR.

To make 2352 a perfect square, we should **multiply** or **divide** 2352 with the factor 3 .

Case 1:The **Smallest factor** to be multiplied with 2352 **is 3**.

The **perfect square** thus obtained is 2352 x 3 = **7056**

The **square root** of 7056 is 2 x 2 x 3 x 7 = **84**

( Do we have to do the prime factorisation again to find $\sqrt{7056}$?

Think about it…….)

Case 2 : The **Smallest factor** to be divided with 2352 **is 3**.

The **perfect square** thus obtained is 2352 ÷ 3 = **784**

The **square root** of 7056 is 2 x 2 x 7 = **28**

Solutions to Question 5 and 6 will make the two cases very clear.

| | |
|---|---|
| 2 | 2352 |
| 2 | 1176 |
| 2 | 588 |
| 2 | 294 |
| 3 | 147 |
| 7 | 49 |
| | 7 |

QUESTION 5

For each of the following numbers, find the smallest whole number by which it should be **multiplied** so as to get a perfect square number. Also find the square root of the square number so obtained. (i) 252 (ii) 180 (iii) 1008 (iv) 2028 (v) 1458 (vi) 768

Q5 (i) and (iii) have been done for you. Follow the same steps to solve the other sums.

(i) 252

Solution:

(i) Prime factorisation of 252 is

$252 = 2 \times 2 \times 3 \times 3 \times 7$

Here, the prime factorisation is not in pair. 7 has no pair.

Thus, 7 is the smallest whole number by which the given number is multiplied to get a perfect square number.

The new square number is $252 \times 7 = 1764$

Square root of 1764 is

$\sqrt{1764} = 2 \times 3 \times 7 = 42$

| | |
|---|---|
| 2 | 252 |
| 2 | 126 |
| 3 | 63 |
| 3 | 21 |
| 7 | 7 |
| | 1 |

(iii) 1008

(iii) Prime factorisation of 1008 is

$1008 = 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 7$

Here, 7 has no pair.

New square number $= 1008 \times 7 = 7056$

Thus, 7 is the required number.

Square root of 7056 is

$\sqrt{7056} = 2 \times 2 \times 3 \times 7 = 84$

| | |
|---|---|
| 2 | 1008 |
| 2 | 504 |
| 2 | 252 |
| 2 | 126 |
| 3 | 63 |
| 3 | 21 |
| 7 | 7 |
| | 1 |

QUESTION 6

For each of the following numbers, find the smallest whole number by which it should be **divided** so as to get a perfect square. Also find the square root of the square number so obtained. (i) 252 (ii) 2925 (iii) 396 (iv) 2645 (v) 2800 (vi) 1620

Q6 (ii) & (iii) have been done for you. Follow the same steps to solve the other sums.

(ii) 2925

(ii) Prime factorisation of 2925 is

$2925 = 3 \times 3 \times 5 \times 5 \times 13$

Here, 13 has no pair.

13 is the smallest whole number by which 2925 is divided to get a square number.

New square number = $2925 \div 13 = 225$

Thus $\sqrt{225} = 15$

| | |
|---|---|
| 3 | 2925 |
| 3 | 975 |
| 5 | 325 |
| 5 | 65 |
| 13 | 13 |
| | 1 |

(iii) 396

(iii) Prime factorisation of 396 is

$396 = 2 \times 2 \times 3 \times 3 \times 11$

Here 11 is not in pair.

11 is the required smallest whole number by which 396 is divided to get a square number.

New square number = $396 \div 11 = 36$

Thus $\sqrt{36} = 6$

| | |
|---|---|
| 2 | 396 |
| 2 | 198 |
| 3 | 99 |
| 3 | 33 |
| 11 | 11 |
| | 1 |

QUESTION 7 (WORD PROBLEMS ON SQUARE NUMBERS)

The students of Class VIII of a school donated Rs 2401 in all, for Prime Minister's National Relief Fund. Each student donated as many rupees as the number of students in the class. Find the number of students in the class.

It is given that each student donated as many rupees as the number of students of the class. Number of students in the class will be the square root of the amount donated by the students of the class.

The total amount of donation is Rs 2401.

Number of students in the class = $\sqrt{2401}$

$2401 = \underline{7 \times 7} \times \underline{7 \times 7}$

$\therefore \sqrt{2401} = 7 \times 7 = 49$

Hence, the number of students in the class is 49.

QUESTION 8 (HW)

**8.** 2025 plants are to be planted in a garden in such a way that each row contains as many plants as the number of rows. Find the number of rows and the number of plants in each row.

## METHOD TO FIND THE SMALLEST SQUARE NUMBER WHICH IS DIVISIBLE BY THE GIVEN FACTORS

Let us take an example

Find the smallest square number which is divisible by each of the numbers 6, 9 ,15

METHOD

*Step 1*: Find the LCM of 6,9,15

LCM = 2 x 3 x 3 x 5 = 90

*Step 2* : Make the LCM a perfect square by multiplying with suitable factors

Here Prime factors of the LCM 90 = 2 x 3 x 3 x 5

To make it a perfect square, we need a pair for its factors. We see that only 3 has a pair. 2 and 5 do not have a pair.

Let us multiply the factors of 90 with 2 and 5

2 x 3 x 3 x 5 **x 2 x 5**….now rearrange in order

2 x 2 x 3 x 3 x 5 x 5 = **900**

900 is the smallest square number which is divisible by each of the numbers 6, 9 ,15

QUESTION 9 & 10 (HW)

**9.** Find the smallest square number that is divisible by each of the numbers 4, 9 and 10.

**10.** Find the smallest square number that is divisible by each of the numbers 8, 15 and 20.

# METHOD OF FINDING SQUARE ROOTS BY ESTIMATION

This method is used when the number is not a perfect square.

Example : 125

Step 1 : We must place bars on every pair of digits starting from the unit place.

$\overline{1}\,\overline{25}$…There are 2 bars on 125, therefore $\sqrt{125}$ has 2 digits.

Step 2 : From the table of squares, 125 lies between the perfect squares 121 and 144

Step 3: Therefore $\sqrt{125}$ lies between $\sqrt{121}$ and $\sqrt{144}$

Step 4: $\sqrt{125}$ lies between 11 and 12 (because $\sqrt{121}$ and $\sqrt{144}$ is 11 and 12 respectively

Step 5: : $\sqrt{125}$ is approximately 11 because 125 is closer to 121 than 144.

**Answer: $\sqrt{125}$ = 11 (approx..)**

Estimate the value of the following to the nearest whole number.

(i) $\sqrt{80}$ (ii) $\sqrt{1000}$ (iii) $\sqrt{350}$ (iv) $\sqrt{500}$

# METHOD OF FINDING SQUARE ROOTS BY DIVISION

Let us take the example of 529

**Step 1** Place a bar over every pair of digits starting from the digit at one's place. If the number of digits in it is odd, then the left-most single digit too will have a bar.

Thus we have, $\overline{5}\,\overline{29}$.

**Step 2** Find the largest number whose square is less than or equal to the number under the extreme left bar ($2^2 < 5 < 3^2$). Take this number as the divisor and the quotient with the number under the extreme left bar as the dividend (here 5). Divide and get the remainder (1 in this case).

| | 2 |
|---|---|
| 2 | $\overline{5}\,\overline{29}$ |
| | – 4 |
| | 1 |

| | 2 |
|---|---|
| 2 | $\overline{5}\,\overline{29}$ |
| | – 4 |
| | 1 29 |

**Step 3** Bring down the number under the next bar (i.e., 29 in this case) to the right of the remainder. So the new dividend is 129.

**Step 4** Double the divisor and enter it with a blank on its right.

| | 2 |
|---|---|
| 2 | $\overline{5}\,\overline{29}$ |
| | – 4 |
| 4_ | 129 |

**Step 5** Guess a largest possible digit to fill the blank which will also become the new digit in the quotient, such that when the new divisor is multiplied to the new quotient the product is less than or equal to the dividend.

In this case $42 \times 2 = 84$.

As $43 \times 3 = 129$ so we choose the new digit as 3. Get the remainder.

| | 23 |
|---|---|
| 2 | $\overline{5}\,\overline{29}$ |
| | – 4 |
| 43 | 1 29 |
| | -129 |
| | 0 |

**Step 6** Since the remainder is 0 and no digits are left in the given number, therefore, $\sqrt{529} = 23$.

*Example* 2 : $\sqrt{4096}$

```
     6
   ______
6 | 40 96
  |-36
  ------
  |  4
```

**Step 1** Place a bar over every pair of digits starting from the one's digit. ($\overline{40}\ \overline{96}$).

**Step 2** Find the largest number whose square is less than or equal to the number under the left-most bar ($6^2 < 40 < 7^2$). Take this number as the divisor and the number under the left-most bar as the dividend. Divide and get the remainder i.e., 4 in this case.

```
     6
   ______
6 | 40 96
  | -36
  ------
  |  496
```

**Step 3** Bring down the number under the next bar (i.e., 96) to the right of the remainder. The new dividend is 496.

```
      6
    ______
 6 | 40 96
   | -36
 ---------
 12_| 496
```

**Step 4** Double the divisor and enter it with a blank on its right.

**Step 5** Guess a largest possible digit to fill the blank which also becomes the new digit in the quotient such that when the new digit is multiplied to the new quotient the product is less than or equal to the dividend. In this case we see that $124 \times 4 = 496$.

So the new digit in the quotient is 4. Get the remainder.

```
       64
     ______
  6 | 40 96
    | -36
  ---------
124 |  496
    | -496
  ---------
    |    0
```

**Step 6** Since the remainder is 0 and no bar left, therefore, $\sqrt{4096} = 64$.

**Estimating the number**

We use bars to find the number of digits in the square root of a perfect square number.

$$\sqrt{\overline{5}\,\overline{29}} = 23 \qquad \text{and} \qquad \sqrt{\overline{40}\,\overline{96}} = 64$$

Use the above method to solve the following in Qs.1

## EXERCISE 6.4

1. Find the square root of each of the following numbers by Division method.

| | | | |
|---|---|---|---|
| (i) 2304 | (ii) 4489 | (iii) 3481 | (iv) 529 |
| (v) 3249 | (vi) 1369 | (vii) 5776 | (viii) 7921 |
| (ix) 576 | (x) 1024 | (xi) 3136 | (xii) 900 |

2. Find the number of digits in the square root of each of the following numbers (without any calculation).

| | | | |
|---|---|---|---|
| (i) 64 | (ii) 144 | (iii) 4489 | (iv) 27225 |
| (v) 390625 | | | |

*Method*: As explained under estimation , the number of digits can be found by putting a bar on each pair of digits starting from unit place .

<u>*Alternate method*</u> : If the number of digits in the number is **n** and is even, then the number of digits in its square root is $\frac{n}{2}$

If the number of digits in the number **n** is odd, then the number of digits in its square root is $\frac{n+1}{2}$

For example : 64 has a square root with number of digits 1

144 has a square root with number of digits 2

Q2 ( iii) , (iv) and (v) as HW

# METHOD OF FINDING SQUARE ROOTS OF DECIMAL NUMBERS

Consider $\sqrt{17.64}$

**Step 1** To find the square root of a decimal number we put bars on the integral part (i.e., 17) of the number in the usual manner. And place bars on the decimal part (i.e., 64) on every pair of digits beginning with the first decimal place. Proceed as usual. We get $\overline{17}.\overline{64}$.

4
4 | $\overline{17}.\overline{64}$
– 16
1

**Step 2** Now proceed in a similar manner. The left most bar is on 17 and $4^2 < 17 < 5^2$. Take this number as the divisor and the number under the left-most bar as the dividend, i.e., 17. Divide and get the remainder.

4
4 | $\overline{17}.\overline{64}$
– 16
8_ | 1 64

**Step 3** The remainder is 1. Write the number under the next bar (i.e., 64) to the right of this remainder, to get 164.

4.
4 | 17.64
– 16
82 | 164

**Step 4** Double the divisor and enter it with a blank on its right. Since 64 is the decimal part so put a decimal point in the quotient.

**Step 5** We know $82 \times 2 = 164$, therefore, the new digit is 2. Divide and get the remainder.

4.2
4 | 17.64
–16
82 | 164
– 164
0

**Step 6** Since the remainder is 0 and no bar left, therefore $\sqrt{17.64} = 4.2$.

QUESTION 3 ( Apply the above method)

3. Find the square root of the following decimal numbers.
   (i) 2.56 (ii) 7.29 (iii) 51.84 (iv) 42.25
   (v) 31.36

Example

Find the least number that must be subtracted from 5607 so as to get a perfect square. Also find the square root of the perfect square.

**Solution:** Let us try to find $\sqrt{5607}$ by long division method. We get the remainder 131. It shows that $74^2$ is less than 5607 by 131.
This means if we subtract the remainder from the number, we get a perfect square.
Therefore, the required perfect square is $5607 - 131 = 5476$. And, $\sqrt{5476} = 74$.

74
7 | $\overline{56}\overline{07}$
– 49
144 | 707
–576
131

QUESTION 4 to be done using above method

Example

Find the least number that must be added to 1300 so as to get a perfect square. Also find the square root of the perfect square.

**Solution:** We find $\sqrt{1300}$ by long division method. The remainder is 4.
This shows that $36^2 < 1300$.
Next perfect square number is $37^2 = 1369$.
Hence, the number to be added is $37^2 - 1300 = 1369 - 1300 = 69$.

36
3 | $\overline{13}\overline{00}$
– 9
66 | 400
– 396
4

QUESTION 5 to be done using above method

**5.** Find the least number which must be added to each of the following numbers so as to get a perfect square. Also find the square root of the perfect square so obtained.
(i) 525 (ii) 1750 (iii) 252 (iv) 1825
(v) 6412

## <u>APPLICATIONS OF SQUARE ROOTS IN WORD PROBLEMS</u>

**6.** Find the length of the side of a square whose area is 441 $m^2$.

Solution:

Let the length of the side of the square be x m.

Area of the square = $(\text{side})^2 = x^2\ m^2$

$x^2 = 441 \Rightarrow x = \sqrt{441} = 21$

```
       21
    ______
 2 | 4 41
   | 4
   |-----
41 |   41
   |   41
   |-----
   |    0
```

Thus, x = 21 m.

Hence the length of the side of square = 21 m.

**7.** In a right triangle ABC, ∠B = 90°.
(a) If AB = 6 cm, BC = 8 cm, find AC (b) If AC = 13 cm, BC = 5 cm, find AB

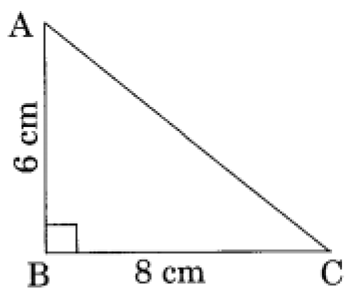
In a right triangle ABC, ∠B = 90°.

(a) If AB = 6 cm, BC = 8 cm, find AC

(b) If AC = 13 cm, BC = 5 cm, find AB

Solution:

(a) In right triangle ABC




$AC^2 = AB^2 + BC^2$ [By Pythagoras Theorem]

$\Rightarrow AC^2 = (6)^2 + (8)^2 = 36 + 64 = 100$

$\Rightarrow AC = \sqrt{100} = 10$

Thus, AC = 10 cm.

7 (b) to be done as HW

8. A gardener has 1000 plants. He wants to plant these in such a way that the number of rows and the number of columns remain same. Find the minimum number of plants he needs more for this.

Solution:

Let the number of rows be x.

And the number of columns also be x.

Total number of plants = $x \times x = x^2$

$x^2 = 1000 \Rightarrow x = \sqrt{1000}$

| | 31 |
|---|---|
| 3 | $\overline{10}\,\overline{00}$ |
| | 9 |
| 61 | 100 |
| | 61 |
| | 39 |

Here the remainder is 39

So the square of 31 is less than 1000.

Next number is 32 and $32^2 = 1024$

Hence the number to be added = 1024 − 1000 = 24

Thus the minimum number of plants required by him = 24.

QUESTION 9 (to be done as HW)

9. There are 500 children in a school. For a P.T. drill they have to stand in such a manner that the number of rows is equal to number of columns. How many children would be left out in this arrangement.

REFERENCE LINKS

FOR SOLUTIONS https://www.learncbse.in/ncert-solutions-for-class-8-maths-squares-and-square-roots-ex-6-3/

FOR TEXT BOOK https://www.ncertbooks.guru/ncert-books-class-8-maths

FOR DIVISION METHOD https://youtu.be/qyedV7JbXKk

FOR ESTIMATION METHOD https://youtu.be/vBtjLhletxc

FOR PRIME FACTORIZATION METHOD https://youtu.be/cyEpGWGaBlA

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