**Class 9 Maths Chapter 1- Number System**

## Exercise 1.1 Page: 5

**1. Is zero a rational number? Can you write it in the form p/q where p and q are integers and q ≠ 0?**

Solution:

Zero is a rational number.

Zero can be written in the form of $\frac{0}{1}, \frac{0}{2}, \frac{0}{3}$ and so on.. These are in the form of $\frac{p}{q}$, where p and q are integers

and q ≠ 0 ‘

**2. Find six rational numbers between 3 and 4.**

Solution:

$3 = 3 \times \frac{7}{7} = \frac{21}{7}$

$4 = 4 \times \frac{7}{7} = \frac{28}{7}$

*Therefore, the numbers in between* $\frac{21}{7}$ *and* $\frac{28}{7}$ *will the* **rational numbers between 3 and 4.**

**Hence, the required numbers are :**

$\frac{22}{7}, \frac{23}{7} \frac{24}{7}, \frac{25}{7} \frac{26}{7}, \frac{27}{7}$

**3 Find five rational numbers between 3/5 and 4/5.**

Solution:

$\frac{3}{5} = \frac{3\times6}{5\times6} = \frac{18}{30}$

$\frac{4}{5} = \frac{4\times6}{5\times6} = \frac{24}{30}$

Therefore, the rational numbers between $\frac{18}{30}$ and $\frac{24}{30}$ will be the rational numbers betwwen $\frac{3}{5}$ and $\frac{4}{5}$ .

Hence, the 5 rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$ are :

$\frac{19}{30}, \frac{20}{30}, \frac{21}{30}, \frac{22}{30}, \frac{23}{30}$

**4. State whether the following statements are true or false. Give reasons for your answers.**

**(i) Every natural number is a whole number.**

Solution:

**True**

Natural numbers= 1,2,3,4…

Whole numbers= 0,1,2,3…

So, Natural numbers are within the Whole numbers.

∴ Every natural number is a whole number,

**(ii) Every integer is a whole number.**

Solution:

**False**

We know., integers= {…-4,-3,-2,-1,0,1,2,3,4…}

Whole numbers= 0,1,2,3….

∴ Every integer is not a whole number.

**(iii) Every rational number is a whole number.**

Solution:

**False**

**Rational numbers include positive and negative integers and fractional numbers.**

**But whole numbers are positive integers only.**

**Hence, every rational number is not a whole number.**

**Class 9 Maths Chapter 1-** Exercise 1.2 Page: 8

**1.State whether the following statements are true or false. Justify your answers.**
**(i) Every irrational number is a real number.**

Solution:
**True**
Irrational Numbers - A number is said to be irrational, if it **cannot** be written in the p/q, where p and q are integers and $q \neq 0$.
i.e., Irrational numbers = √2, √5, π,.

Real numbers - The collection of both rational and irrational numbers are known as real numbers. i.e., Real numbers = √2, √5, π, 0.102…
∴ Every irrational number is a real number, however, every real numbers

are not irrational numbers.

**(ii) Every point on the number line is of the form √m where m is a**

**natural number.**

Solution:
**False**

**The value of $\sqrt{m}$ , where m is a natural number, is always positive.**
**But a number line has both positive and negative numbers.**
**So, the statement 'Every point on the number line is of the form √m where m is a natural number' is False.**

**(iii) Every real number is an irrational number.**

Solution:
**False**
The statement is false, the real numbers include both irrational and rational numbers. Therefore, every real number cannot be an irrational number.
∴ Every irrational number is a real number, however, every real number is not irrational.

**2. Are the square roots of all positive integers irrational? If not, give an example of the square root of a number that is a rational number.**

Solution:

No, the square roots of all positive integers are not irrational.

For example,

$\sqrt{4} = 2$ is rational.

$\sqrt{9} = 3$ is rational.

Hence, the square roots of positive integers 4 and 9 are not irrational.

**3. Show how $\sqrt{5}$ can be represented on the number line.**

Solution:

Step 1: Let line AB be of 2 unit on a number line.

Step 2: At B, draw a perpendicular line BC of length 1 unit.

Step 3: Join CA

Step 4: Now, ABC is a right-angled triangle. Applying Pythagoras theorem,

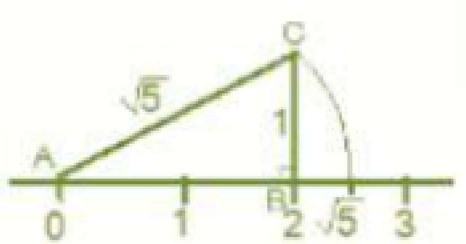
$AB^2+BC^2 = CA^2$

$2^2+1^2 = CA^2 \Rightarrow CA^2 = 5$

$\Rightarrow CA = \sqrt{5}$. Thus, CA is a line of length $\sqrt{5}$ unit.

Step 5: Taking CA as a radius and A as a center draw an arc touching the number line. The point at which number line get intersected by arc is at $\sqrt{5}$ distance from 0 because it is a radius of the circle whose center was A.

Thus, $\sqrt{5}$ is represented on the number line as shown in the figure.




**4. Classroom activity (Constructing the 'square root spiral') : Take a large sheet of paper and construct the 'square root spiral' in the following fashion. Start with a point O and draw a line segment OP1 of unit length. Draw a line segment P1P2 perpendicular to $OP_1$ of unit length (see Fig. 1.9). Now draw a line segment $P_2P_3$ perpendicular to $OP_2$. Then draw a line segment $P_3P_4$ perpendicular to $OP_3$. Continuing in Fig. 1.9 :**

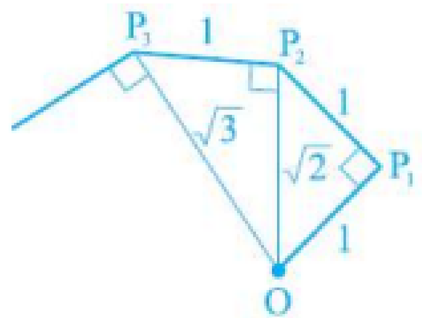
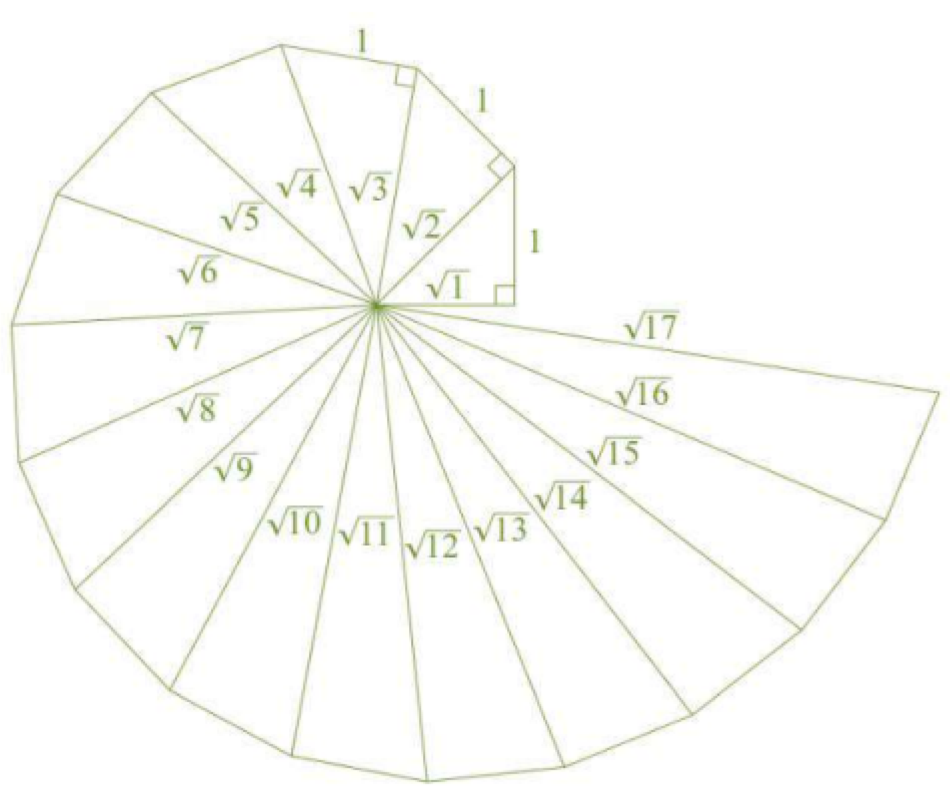



Fig. 1.9 : Constructing square root spiral

**Constructing this manner, you can get the line segment $P_{n-1}Pn$ by square root spiral drawing a line segment of unit length perpendicular to $OP_{n-1}$. In this manner, you will have created the points $P_2$, $P_3$,....,Pn,... ., and joined them to create a beautiful spiral depicting √2, √3, √4, ...**

Solution:




Step 1: Mark a point O on the paper. Here, O will be the center of the square root spiral. Step 2: From O, draw a straight line, OA, of 1cm horizontally.

Step 3: From A, draw a perpendicular line, AB, of 1 cm.

Step 4: Join OB. Here, OB will be of √2

Step 5: Now, from B, draw a perpendicular line of 1 cm and mark the end point C.

Step 6: Join OC. Here, OC will be of √3

Step 7: Repeat the steps to draw √4, √5, √6….

## Exercise 1.3 Page: 14

**1. Write the following in decimal form and say what kind of decimal expansion each has :**

**(i)** $\frac{36}{100}$

Solution:

100 ) 360 ( 0.36
300
600
600
0

Therefore,

$\frac{36}{100}$ = 0.36 (Terminating)

(ii) 1/11

Solution:

11 ) 100 ( 0.0909
99
100
99
1

$\frac{1}{11}$ = 0.0909.. = $0.\overline{09}$ (Non-terminating, repeating)

(iii) $4\frac{1}{8}$

$= \frac{33}{8}$

$$
\begin{array}{r|l}
8 & 33 \;\; (4.125 \\
 & 32 \\ \hline
 & 10 \\
 & 8 \\ \hline
 & 20 \\
 & 16 \\ \hline
 & 40 \\
 & 40 \\ \hline
 & 0
\end{array}
$$

$4\frac{1}{8} = 4.125$ (terminating)

(iv) $\frac{3}{13}$

Solution:

$$
\begin{array}{r|l}
 & 0.230769 \\ \hline
13 & 30 \\
 & 26 \\ \hline
 & 40 \\
 & 39 \\ \hline
 & 100 \\
 & 91 \\ \hline
 & 90 \\
 & 78 \\ \hline
 & 120 \\
 & 117 \\ \hline
 & 3
\end{array}
$$

$\frac{3}{13} = 0.\overline{230769}$ (non-terminating, repeating)

(v) $\frac{2}{11}$

Solution:

```
        0.18
     ________
11 ) 20
     11
     ----
      90
      88
     ----
       2
```

$\frac{2}{11}$ = 0.181818….. = $0.\overline{18}$ (non-terminating,recurring)

(vi) 329/400

Solution:

```
         0.8225
      _________
400 ) 3290
      3200
      -----
        900
        800
      -----
        1000
         800
      -----
         2000
         2000
      -----
            0
```

$\frac{329}{400}$ = 0.8225 (Terminating)

**2. You know that 1/7 = 0.1~~42857.~~ Can you predict what the decimal expansions of 2/7, 3/7, 4/7, 5/7, 6/7 are, without actually doing the long division? If so, how?**

**[Hint: Study the remainders while finding the value of 1/7 carefully.]**

Solution:

**3. Express the following in the form p/q, where p and q are integers and q ≠ 0.**

**(i)** $0.\overline{6}$

Solution:

Assume that x = 0.666...

Then,10x = 6.666...

10x = 6 + x

9x = 6

$x = \frac{\not{6}^{2}}{\not{9}_{3}} = \frac{2}{3}$

Therefore, $0.666... = \frac{2}{3}$

(ii) $0.4\overline{7}$

Solution:

Let, $x = 0.4777...$

or, $10x = 4.7777...$

Or, $100x = 47.777..$

Or, $90x = 43$

Or, $x = \frac{43}{90}$

So. $0.4777... = \frac{43}{90}$

(iii) $0.\overline{001}$

Solution:

Assume that x = 0.001001…

Then, $1000x$ = 1.001001…

or, $1000x - x = 1$

Or, $999x = 1$

Or, $x = \frac{1}{999}$

So, $0.\overline{001} = \frac{1}{999}$

**4. Express 0.99999.... in the form p/q . Are you surprised by your answer? With your teacher and classmates discuss why the answer makes sense.**

Solution:

Assume that $x$ = 0.9999….. Eq (a)

Multiplying both sides by 10,

$10x$ = 9.9999…. Eq. (b)

Eq.(b) – Eq.(a), we get

$10x$ = 9.9999…

<u>- $x$ = - 0.9999…</u>

$9x = 9$

$x = 1$

The difference between 1 and 0.999999 is 0.000001 which is negligible.

Hence, we can conclude that, 0.999 is too much near 1, therefore, 1 as the answer can be justified.

**5. What can the maximum number of digits be in the repeating block of digits in the decimal expansion of 1/17? Perform the division to check your answer.**

Solution:

1/17

Dividing 1 by 17:

$$
\begin{array}{r}
0.0588235294117647 \\
17 \overline{)\,1\,} \\
\underline{0} \\
10 \\
\underline{0} \\
100 \\
\underline{85} \\
150 \\
\underline{136} \\
140 \\
\underline{136} \\
40 \\
\underline{34} \\
60 \\
\underline{51} \\
90 \\
\underline{85} \\
50 \\
\underline{34} \\
160 \\
\underline{153} \\
70 \\
\underline{68} \\
20 \\
\underline{17} \\
30 \\
\underline{17} \\
130 \\
\underline{119} \\
110 \\
\underline{102} \\
80 \\
\underline{68} \\
120 \\
\underline{119} \\
1
\end{array}
$$

∴ There are 16 digits in the repeating block of the decimal expansion of 1/17.

**6. Look at several examples of rational numbers in the form p/q (q ≠ 0), where p and q are integers**

**with no common factors other than 1 and having terminating decimal representations (expansions). Can you guess what property q must satisfy?**

Solution:

We observe that when q is 2, 4, 5, 8, 10… Then the decimal expansion is terminating. For example:

1/2 = 0. 5, denominator $q = 2^1$

7/8 = 0. 875, denominator $q = 2^3$

4/5 = 0. 8, denominator $q = 5^1$

We can observe that the terminating decimal may be obtained in the situation where prime factorization of the denominator of the given fractions has the power of only 2 or only 5 or both.

**7. Write three numbers whose decimal expansions are non-terminating non-recurring.** Solution:

We know that all irrational numbers are non-terminating non-recurring. ∴ three numbers with decimal expansions that are non-terminating non-recurring are:

a) √3 = 1.732050807568

b) √26 = 5.099019513592

c) √101 = 10.04987562112

**8. Find three different irrational numbers between the rational numbers 5/7 and 9/11.**

Solution:

∴ Three different irrational numbers are:

a) 0.73073007300073000073...

b) 0.75075007300075000075…

c) 0.76076007600076000076...

**9. Classify the following numbers as rational or irrational according to their type:**

(i)√23

Solution:

√23 = 4.79583152331…

Since the number is non-terminating non-recurring therefore, it is an irrational number.

(ii)√225

√225 = 15 = 15/1

Since the number can be represented in p/q form, it is a rational number.

**(i) 0.3796**

Solution:

Since the number,0.3796, is terminating, it is a rational number.

**(ii) 7.478478**

Solution:
The number,7.478478, is non-terminating but recurring, it is a rational number.

**(iii) 1.101001000100001…**

Solution:
Since the number,1.101001000100001…, is non-terminating non-repeating (non-recurring), it is an irrational number.

## Exercise 1.4 Page: 18

**1. Visualise 3.765 on the number line, using successive magnification.**
Solution:


**NCERT Solutions for Class 9 Maths Chapter 1- Number System**

# Exercise 1.5 Page: 24

**1. Classify the following numbers as rational or irrational:**

**(i)2 –√5**

Solution:

We know that, √5 = 2.2360679…

Here, 2.2360679…is non-terminating and non-recurring.

Now, substituting the value of √5 in 2 –√5, we get,

2-√5 = 2-2.2360679… = -0.2360679

Since the number, – 0.2360679…, is non-terminating non-recurring, 2 –√5 is an irrational number.

**(ii)(3 +√23) - √23**

Solution:

(3 +√23) –√23 = 3+√23–√23

= 3

= 3/1

Since the number 3/1 is in p/q form, **(3 +√23)- √23** is rational.

**(iii)2√7/7√7**

Solution:

2√7/7√7 = (2/7)× (√7/√7)

We know that (√7/√7) = 1

Hence, (2/7)× (√7/√7) = (2/7)×1 = 2/7

Since the number, 2/7 is in p/q form, 2√7/7√7 is rational.

**(iv)1/√2**

Solution:

Multiplying and dividing numerator and denominator by √2 we get,

(1/√2) ×(√2/√2)= √2/2 ( since √2×√2 = 2)

We know that, √2 = 1.4142…

Then, √2/2 = 1.4142/2 = 0.7071..

Since the number, 0.7071..is non-terminating non-recurring, 1/√2 is an irrational number.

**(v)2π**

Solution:

We know that, the value of π = 3.1415

Hence, 2π = 2×3.1415.. = 6.2830…

Since the number, 6.2830…, is non-terminating non-recurring, 2π is an irrational number.

**2. Simplify each of the following expressions:**

**(i) $(3+\sqrt{3})(2+\sqrt{2})$**

Solution:

$(3+\sqrt{3})(2+\sqrt{2})$

$= (3\times2)+(3\times\sqrt{2})+(\sqrt{3}\times2)+(\sqrt{3}\times\sqrt{2})$

$= 6+3\sqrt{2}+2\sqrt{3}+\sqrt{6}$

**(ii) $(3+\sqrt{3})(3-\sqrt{3})$**

Solution:

$(3+\sqrt{3})(3-\sqrt{3}) = 3^2-(\sqrt{3})^2 = 9-3$

$= 6$

**(iii) $(\sqrt{5}+\sqrt{2})^2$**

Solution:

$(\sqrt{5}+\sqrt{2})^2 = \sqrt{5}^2+(2\times\sqrt{5}\times\sqrt{2})+\sqrt{2}^2$

$= 5+2\times\sqrt{10}+2$

$= 7+2\sqrt{10}$

**(iv) $(\sqrt{5}-\sqrt{2})(\sqrt{5}+\sqrt{2})$**

Solution:

$(\sqrt{5}-\sqrt{2})(\sqrt{5}+\sqrt{2}) = (\sqrt{5}^2-\sqrt{2}^2)$

$= 5-2$

$= 3$

**3. Recall, $\pi$ is defined as the ratio of the circumference (say c) of a circle to its diameter, (say d). That is, $\pi = c/d$. This seems to contradict the fact that $\pi$ is irrational. How will you resolve this contradiction?**

Solution:

There is no contradiction. When we measure a value with a scale, we only obtain an approximate value. We never obtain an exact value. Therefore, we may not realize whether c or d is irrational. The value of $\pi$ is almost equal to 22/7 or 3.142857…

**4. Represent $(\sqrt{9.3})$ on the number line.**

Solution:

Step 1: Draw a 9.3 units long line segment, AB. Extend AB to C such that BC=1 unit.
Step 2: Now, AC = 10.3 units. Let the centre of AC be O.
Step 3: Draw a semi-circle of radius OC with centre O.
Step 4: Draw a BD perpendicular to AC at point B intersecting the semicircle at D. Join OD.
Step 5: OBD, obtained, is a right angled triangle.

Here, OD 10.3/2 (radius of semi-circle), OC = 10.3/2 , BC = 1

OB = OC – BC

$\Longrightarrow$ (10.3/2)-1 = 8.3/2

Using Pythagoras theorem,

We get, $BD^2+OB^2$

$OD^2=$

$\Longrightarrow (10.3/2)^2 = BD^2+(8.3/2)^2$

$\Longrightarrow BD^2 = (10.3/2)^2-(8.3/2)^2$

$\Longrightarrow (BD)^2 = (10.3/2)-(8.3/2)(10.3/2)+(8.3/2)$

$\Longrightarrow BD^2 = 9.3$

$\Longrightarrow BD = \sqrt{9.3}$

Thus, the length of BD is √9.3 units.

Step 6: Taking BD as radius and B as centre draw an arc which touches the line segment. The point where it touches the line segment is at a distance of √9.3 from O as shown in the figure.

**5. Rationalize the denominators of the following:**

**(i) 1/√7**

Solution:

Multiply and divide 1/√7 by √7

(1×√7)/(√7×√7) = √7/7

**(ii) 1/(√7-√6)**

Solution:

Multiply and divide 1/(√7-√6) by (√7+√6)

[1/(√7-√6)]×(√7+√6)/(√7+√6) = (√7+√6)/(√7-√6)(√7+√6)

= $(\sqrt{7}+\sqrt{6})/\sqrt{7}^2-\sqrt{6}^2$ [denominator is obtained by the property, $(a+b)(a-b) = a^2-b^2$]

= (√7+√6)/(7-6)

= (√7+√6)/1

= √7+√6

**(iii) 1/(√5+√2)**

Solution:

Multiply and divide 1/(√5+√2) by (√5-√2)

[1/(√5+√2)]×(√5-√2)/(√5-√2) = (√5-√2)/(√5+√2)(√5-√2)

= $(\sqrt{5}-\sqrt{2})/(\sqrt{5}^2-\sqrt{2}^2)$ [denominator is obtained by the property, $(a+b)(a-b) = a^2-b^2$]

= (√5-√2)/(5-2)

= (√5-√2)/3

**(iv) 1/(√7-2)**

Solution:

Multiply and divide 1/(√7-2) by (√7+2)

1/(√7-2)×(√7+2)/(√7+2) = (√7+2)/(√7-2)(√7+2)

= $(\sqrt{7}+2)/(\sqrt{7}^2-2^2)$ [denominator is obtained by the property, $(a+b)(a-b) = a^2-b^2$]

= (√7+2)/(7-4)

= (√7+2)/3

**NCERT Solutions for Class 9 Maths Chapter 1- Number System**

Exercise 1.6 Page: 26

**1. Find:**

**(i)** $64^{\frac{1}{2}}$

Solution:

$64^{\frac{1}{2}} = (8 \times 8)^{\frac{1}{2}}$

$= (8^2)^{\frac{1}{2}}$

$= 8^{(2\times\frac{1}{2})}$

$= 8^1$

$= \mathbf{8}$

**(ii)** $32^{\frac{1}{5}}$

Solution:

$32^{\frac{1}{5}} = = (2^5)^{\frac{1}{5}}$

$= 2^{(5\times\frac{1}{5})}$

$= 2^1$

$= \mathbf{2}$

**(iii)** $125^{\frac{1}{3}}$

Solution:

$(125)^{\frac{1}{3}} = (5\times5\times5)^{\frac{1}{3}}$

$= (5^3)^{\frac{1}{3}}$

$= 5^{(3\times\frac{1}{3})}$

$= 5^1$

$= 5$

**2. Find:**

**(i)**$9^{\frac{3}{2}}$

Solution:

$9^{\frac{3}{2}} = (3\times3)^{\frac{3}{2}}$

$= (3^2)^{\frac{3}{2}}$

$=3^{(2\times\frac{3}{2})}$

$=3^3$

$= 27$

**(ii)**$32^{\frac{2}{5}}$

Solution:

$32^{\frac{2}{5}} = (2\times2\times2\times2\times2)^{\frac{2}{5}}$

$= (2^5)^{\frac{2}{5}}$

$= 2^{(5\times\frac{2}{5})}$

$= 2^2$

$= 4$

**(iii)**$16^{\frac{3}{4}}$

Solution:

$16^{\frac{3}{4}} = (2\times2\times2\times2)^{\frac{3}{4}}$

$= (2^4)^{\frac{3}{4}}$

$= 2^{(4\times\frac{3}{4})}$

$= 2^3$

$= 8$

**(iv) $125^{-\frac{1}{3}}$**

$125^{-\frac{1}{3}} = (5\times5\times5)^{-\frac{1}{3}}$

$= (5^3)^{-\frac{1}{3}}$

$= 5^{3\times(-\frac{1}{3})}$

$=5^{-1}$

$= \frac{1}{5}$

**3. Simplify:**

**(i) $2^{2/3}\times2^{1/5}$**

Solution:

$2^{2/3}\times2^{1/5} = 2^{(2/3)+(1/5)}$ [Since, $a^m\times a^n=a^{m+n}$____ Laws of exponents]

$= 2^{13/15}$ [2/3 + 1/5 = (2×5+3×1)/(3×5) = 13/15]

**(ii) $(1/3^3)^7$**

Solution:

$(1/3^3)^7 = (3^{-3})^7$ [Since,$(a^m)^n = a^{m \times n}$____ Laws of exponents]

$= 3^{-27}$

**(iii)$11^{1/2}/11^{1/4}$**

Solution:

$11^{1/2}/11^{1/4} = 11^{(1/2)-(1/4)}$

$= 11^{1/4}$ [(1/2) - (1/4) = (1×4-2×1)/(2×4) = 4-2)/8 = 2/8 = ¼ ]

**(iv)$7^{1/2}\times8^{1/2}$**

Solution:

$7^{1/2}\times8^{1/2} = (7\times8)^{1/2}$ [Since, $(a^m\times b^m = (a\times b)^m$ ____ Laws of exponents

$= 56^{1/2}$