

# Class IX Chapter 1 –

## Number Systems Maths

### Exercise 1.1 Question

Is zero a rational number? Can you write it in the form  $\frac{p}{q}$ , where p and q are integers  $\neq 0$ ?

and q

Answer:

Yes. Zero is a rational number as it can be represented as  $\frac{0}{1}$  or  $\frac{0}{2}$  or  $\frac{0}{3}$  etc.

### Question 2:

Find six rational numbers between 3 and 4.

Answer:

There are infinite rational numbers in between 3 and 4.

$$\frac{24}{8} \text{ and } \frac{32}{8}$$

3 and 4 can be represented as respectively.

Therefore, rational numbers between 3 and 4 are

$$\frac{25}{8}, \frac{26}{8}, \frac{27}{8}, \frac{28}{8}, \frac{29}{8}, \frac{30}{8}$$

### Question 3:

Find five rational numbers between Answer:

$$\frac{3}{5} \text{ and } \frac{4}{5}$$

numbers

There are infinite between .

rational numbers

$$\frac{3}{5} = \frac{3 \times 6}{5 \times 6} = \frac{18}{30}$$

$$\frac{4}{5} = \frac{4 \times 6}{5 \times 6} = \frac{24}{30}$$

$$\frac{3}{5} \text{ and } \frac{4}{5}$$

$$\frac{3}{5} \text{ and } \frac{4}{5}$$

numbers between

Therefore, rational are

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

Question 4:

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

- (i) Every natural number is a whole number.
- (ii) Every integer is a whole number.
- (iii) Every rational number is a whole number.

Answer:

- (i) True; since the collection of whole numbers contains all natural numbers.
- (ii) False; as integers may be negative but whole numbers are positive. For example:  $-3$  is an integer but not a whole number.

- (iii) False; as rational numbers may be fractional but whole numbers may not be. For

example:  $\frac{1}{5}$  is a rational number but not a whole number.

Exercise 1.2 Question 1:

State whether the following statements are true or false. Justify your answers.

- (i) Every irrational number is a real number.
- (ii) Every point on the number line is of the form  $\sqrt{m}$ , where  $m$  is a natural number.
- (iii) Every real number is an irrational number.

Answer:

- (i) True; since the collection of real numbers is made up of rational and irrational numbers.
- (ii) False; as negative numbers cannot be expressed as the square root of any other number.
- (iii) False; as real numbers include both rational and irrational numbers. Therefore, every real number cannot be an irrational number.

Question 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.

Answer:

If numbers such as  $\sqrt{4} = 2$ ,  $\sqrt{9} = 3$  are considered,  
Then here, 2 and 3 are rational numbers. Thus, the square roots of all positive integers are not irrational.

Question 3:

$$\sqrt{5}$$

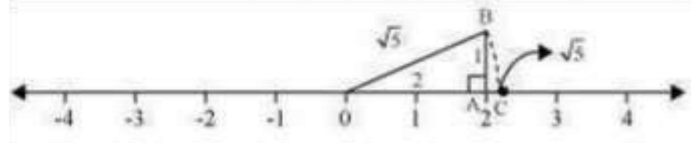
Answer:

$$\sqrt{4} = 2$$

We know that,

$$\sqrt{5} = \sqrt{(2)^2 + (1)^2}$$

Show how And, can be represented on the number line.



Mark a point 'A' representing 2 on number line. Now, construct AB of unit length perpendicular to OA. Then, taking O as centre and OB as radius, draw an arc intersecting number line at C.

C is representing  $\sqrt{5}$ .

has:

$$(i) \frac{36}{100} \quad (ii) \frac{1}{11} \quad (iii) 4\frac{1}{8}$$

$$(iv) \frac{3}{13} \quad (v) \frac{2}{11} \quad (vi) \frac{329}{400}$$

Answer:

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

Terminating

$$(ii) \frac{1}{11} = 0.090909..... = 0.\overline{09}$$

Non-terminating repeating

$$(iii) 4\frac{1}{8} = \frac{33}{8} = 4.125$$

Terminating

$$(iv) \frac{3}{13} = 0.230769230769.... = 0.\overline{230769}$$

Non-terminating repeating

$$(v) \frac{2}{11} = 0.18181818..... = 0.\overline{18}$$

Non-terminating repeating

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

Terminating

$$\frac{1}{7} = 0.142857$$

Question 2:

You know that

$$\frac{2}{7}, \frac{3}{7}, \frac{4}{7}, \frac{5}{7}, \frac{6}{7}$$

Exercise 1.3 Question 1:

Write the following in decimal form and say what kind of decimal expansion each . Can you predict what the decimal expansion of are, without actually doing the long division? If so, how?

[Hint: Study the remainders while finding the value of  $\frac{1}{7}$  carefully.] Answer:

Yes. It can be done as follows.

$$\begin{aligned}\frac{2}{7} &= 2 \times \frac{1}{7} = 2 \times 0.\overline{142857} = 0.\overline{285714} \\ \frac{3}{7} &= 3 \times \frac{1}{7} = 3 \times 0.\overline{142857} = 0.\overline{428571} \\ \frac{4}{7} &= 4 \times \frac{1}{7} = 4 \times 0.\overline{142857} = 0.\overline{571428} \\ \frac{5}{7} &= 5 \times \frac{1}{7} = 5 \times 0.\overline{142857} = 0.\overline{714285} \\ \frac{6}{7} &= 6 \times \frac{1}{7} = 6 \times 0.\overline{142857} = 0.\overline{857142}\end{aligned}$$

, where p and q are integers and  $q \neq 0$ .

$$10x = 6 + x$$

$$9x = 6$$

$$x = \frac{2}{3}$$

$$(ii) \quad 0.\overline{47} = 0.4777\ldots$$

$$= \frac{4}{10} + \frac{0.777}{10}$$

Question 3:

Express the following in the form  $\frac{p}{q}$

$$(i) \quad 0.\overline{6} \quad (ii) \quad 0.\overline{47} \quad (iii) \quad 0.\overline{001}$$

Answer:

$$(i) \quad 0.\overline{6} = 0.666\ldots$$

$$\text{Let } x = 0.666\ldots$$

$$10x = 6.666\ldots$$

$$\text{Let } x = 0.777\ldots$$

$$10x = 7.777\ldots$$

$$10x = 7 + x$$

$$x = \frac{7}{9}$$

$$\begin{aligned}\frac{4}{10} + \frac{0.777\ldots}{10} &= \frac{4}{10} + \frac{7}{90} \\ &= \frac{36 + 7}{90} = \frac{43}{90}\end{aligned}$$

$$(iii) \quad 0.\overline{001} = 0.001001\ldots$$

$$\text{Let } x = 0.001001\ldots$$

$$1000x = 1.001001\ldots$$

$$1000x = 1 + x$$

$$999x = 1$$

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

Question 4:

Express  $0.99999\ldots$  in the form  $\frac{p}{q}$ . Are you surprised by your answer? With your teacher and classmates discuss why the answer makes sense.

Answer:

$$\text{Let } x = 0.9999\ldots$$

$$10x = 9.9999\ldots$$

$$10x = 9 + x$$

$$9x = 9 \times =$$

1

Question 5:

What can the maximum number of digits be in the repeating block of digits in the decimal expansion of  $\frac{1}{17}$ ? Perform the division to check your answer.

Answer:

It can be observed that,

$$\frac{1}{17} = 0.0588235294117647$$

There are 16 digits in the repeating block of the decimal expansion of  $\frac{1}{17}$ .

Question 6:

Look at several examples of rational numbers in the form  $\frac{p}{q}$  ( $q \neq 0$ ), 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?

Answer:

Terminating decimal expansion will occur when denominator  $q$  of rational number  $\frac{p}{q}$  is either of 2, 4, 5, 8, 10, and so on...

$$\frac{9}{4} = 2.25$$

$$\frac{11}{8} = 1.375$$

$$\frac{27}{5} = 5.4$$

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

Question 7:

Write three numbers whose decimal expansions are non-terminating non-recurring.  
Answer:

3 numbers whose decimal expansions are non-terminating non-recurring are as follows.

0.505005000500005000005...

0.7207200720007200007200000... 0.080080008000080000080000008...

Question 8:

$$\frac{5}{7} \quad \frac{9}{11}$$

Find three different irrational numbers between the rational numbers  $\frac{5}{7}$  and  $\frac{9}{11}$ .  
Answer:

$$\frac{5}{7} = 0.714285$$

$$\frac{9}{11} = 0.81$$

3 irrational numbers are as follows.

0.73073007300073000073...

0.75075007500075000075... 0.79079007900079000079...

Question 9:

Classify the following numbers as rational or irrational:

(i)  $\sqrt{23}$  (ii)  $\sqrt{225}$  (iii) 0.3796

(iv) 7.478478 (v) 1.101001000100001...

(i)  $\sqrt{23} = 4.79583152331 \dots$

As the decimal expansion of this number is non-terminating non-recurring, therefore, it

is an irrational number.

(ii)  $\sqrt{225} = 15 = \frac{15}{1}$

It is a rational number as it can be represented in  $\frac{p}{q}$  form.

(iii) 0.3796

As the decimal expansion of this number is terminating, therefore, it is a rational number.

(iv) 7.478478 ...  $= 7.\overline{478}$

As the decimal expansion of this number is non-terminating recurring, therefore, it is a rational number.

(v) 1.10100100010000 ...

As the decimal expansion of this number is non-terminating non-repeating, therefore, it is an irrational number.

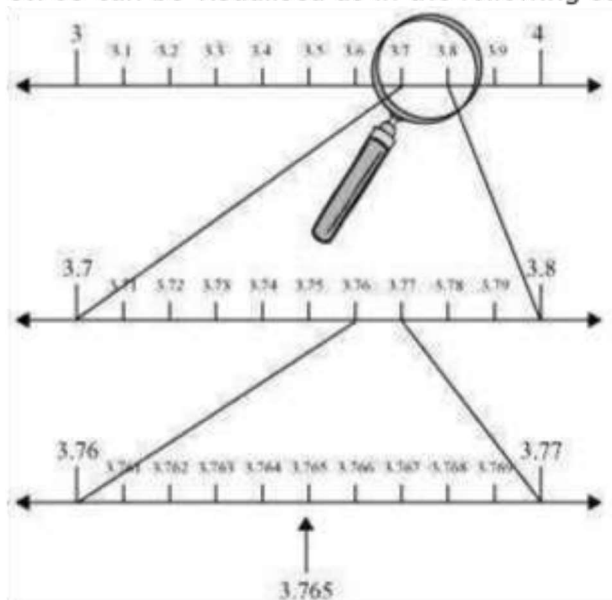
### Exercise 1.4 Question

1:

Visualise 3.765 on the number line using successive magnification.

Answer:

3.765 can be visualised as in the following steps.



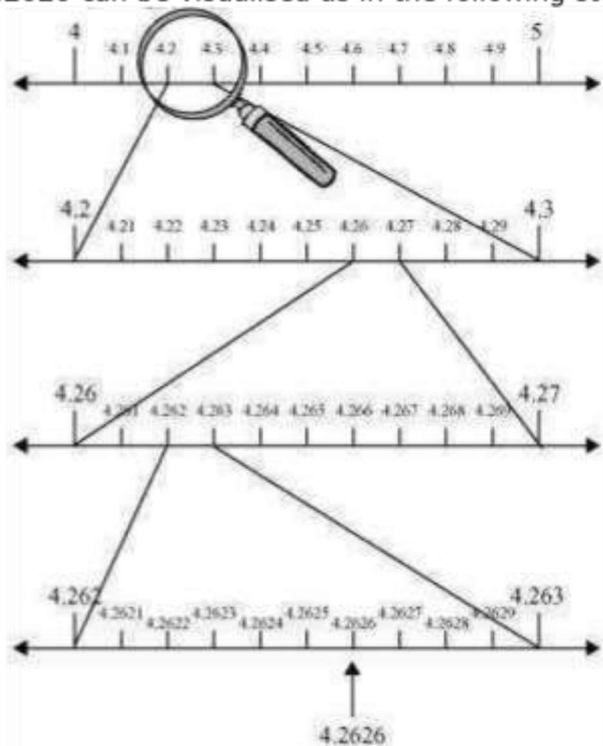
Question 2:

Visualise  $\overline{4.26}$  on the number line, up to 4 decimal places.

Answer:

$$\overline{4.26} = 4.2626\ldots$$

4.2626 can be visualised as in the following steps.



Exercise 1.5 Question 1:

1 Classify the following numbers as rational or irrational:

$$\begin{array}{lll} \text{(i)} & 2 - \sqrt{5} & \text{(ii)} \quad (3 + \sqrt{23}) - \sqrt{23} \quad \text{(iii)} \quad \frac{2\sqrt{7}}{7\sqrt{7}} \\ & \frac{1}{\sqrt{2}} & \\ \text{(iv)} & & \text{(v)} \quad 2n \end{array}$$

Answer:

$$\begin{aligned} \text{(i)} \quad 2 - \sqrt{5} &= 2 - 2.2360679... \\ &= -0.2360679... \end{aligned}$$

As the decimal expansion of this expression is non-terminating non-recurring, therefore, it is an irrational number.

number. form, therefore, it is a rational

$$(ii) \quad (3 + \sqrt{23}) - \sqrt{23} = 3 = \frac{3}{1}$$

rational number.

As it can be represented in  $\frac{p}{q}$

$$\frac{2\sqrt{7}}{7\sqrt{7}} = \frac{2}{7}$$

(iii)

As it can be represented in  $\frac{p}{q}$

$$\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2} = 0.7071067811...$$

(iv)

irrational number. (v)  $2\pi = 2(3.1415 \dots)$

As the decimal expansion of this expression is non-terminating non-recurring,

therefore,  
it is an

= 6.2830 ...

As the decimal expansion of this expression is non-terminating non-recurring, therefore,  
it is an irrational number.

Question 2:

Simplify each of the following expressions:

$$(i) \quad (3 + \sqrt{3})(2 + \sqrt{2}) \quad (ii) \quad (3 + \sqrt{3})(3 - \sqrt{3})$$

$$(iii) \quad (\sqrt{5} + \sqrt{2})^2 \quad (iv) \quad (\sqrt{5} - \sqrt{2})(\sqrt{5} + \sqrt{2})$$

Answer:

$$(i) \quad (3 + \sqrt{3})(2 + \sqrt{2}) = 3(2 + \sqrt{2}) + \sqrt{3}(2 + \sqrt{2}) \\ = 6 + 3\sqrt{2} + 2\sqrt{3} + \sqrt{6}$$

$$(ii) \quad (3 + \sqrt{3})(3 - \sqrt{3}) = (3)^2 - (\sqrt{3})^2 \\ = 9 - 3 = 6$$

$$(iii) \quad (\sqrt{5} + \sqrt{2})^2 = (\sqrt{5})^2 + (\sqrt{2})^2 + 2(\sqrt{5})(\sqrt{2}) \\ = 5 + 2 + 2\sqrt{10} = 7 + 2\sqrt{10}$$

$$(iv) \quad (\sqrt{5} - \sqrt{2})(\sqrt{5} + \sqrt{2}) = (\sqrt{5})^2 - (\sqrt{2})^2 \\ = 5 - 2 = 3$$

Question 3:

Recall,  $\pi$  is defined as the ratio of the circumference (say  $c$ ) of a circle to its diameter

(say  $d$ ). That is,  $\pi = \frac{c}{d}$ . This seems to contradict the fact that  $\pi$  is irrational. How will you resolve this contradiction?

Answer:

There is no contradiction. When we measure a length with scale or any other instrument, we only obtain an approximate rational value. We never obtain an exact value. For this reason, we may not realise that either  $c$  or  $d$  is irrational. Therefore,

the fraction  $\frac{c}{d}$  is irrational. Hence,  $n$  is irrational.

Question 4:

Represent  $\sqrt{9.3}$  on the number line. Answer:

Mark a line segment  $OB = 9.3$  on number line. Further, take  $BC$  of 1 unit. Find the midpoint

$D$  of  $OC$  and draw a semi-circle on  $OC$  while taking  $D$  as its centre. Draw a

- (i)  $\frac{1}{\sqrt{7}}$  (ii)  $\frac{1}{\sqrt{7}-\sqrt{6}}$   
 (iii)  $\frac{1}{\sqrt{5}+\sqrt{2}}$  (iv)  $\frac{1}{\sqrt{7}-2}$

Answer:

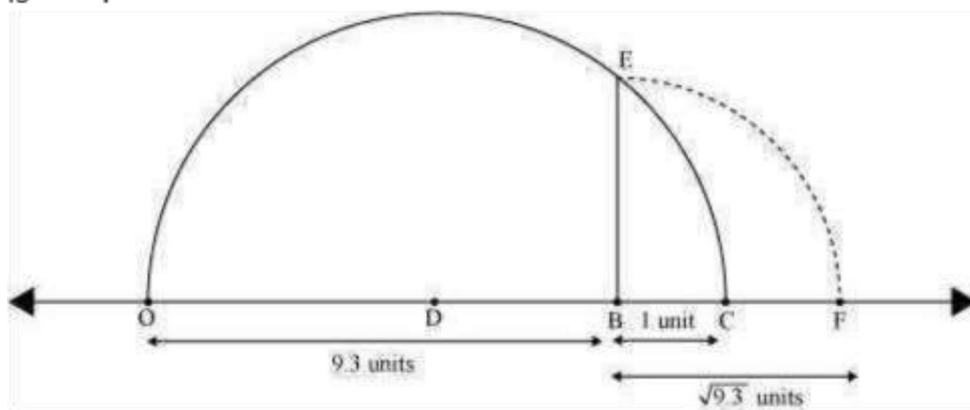
$$\frac{1}{\sqrt{7}} = \frac{1 \times \sqrt{7}}{1 \times \sqrt{7}} = \frac{\sqrt{7}}{7}$$

(i)

perpendicular to line  $OC$  passing through point  $B$ . Let it intersect the semi-circle at  $E$ .

Taking  $B$  as centre and  $BE$  as radius, draw an arc intersecting number line at  $F$ .  $BF$

is  $\sqrt{9.3}$ .



Question 5:

Rationalise the denominators of the following:

$$\frac{1}{\sqrt{7}-\sqrt{6}} = \frac{1}{(\sqrt{7}-\sqrt{6})(\sqrt{7}+\sqrt{6})} (\sqrt{7}+\sqrt{6})$$

(ii)

$$\begin{aligned} &= \frac{\sqrt{7}+\sqrt{6}}{(\sqrt{7})^2 - (\sqrt{6})^2} \\ &= \frac{\sqrt{7}+\sqrt{6}}{7-6} = \frac{\sqrt{7}+\sqrt{6}}{1} = \sqrt{7}+\sqrt{6} \end{aligned}$$

$$\frac{1}{\sqrt{5}+\sqrt{2}} = \frac{1}{(\sqrt{5}+\sqrt{2})(\sqrt{5}-\sqrt{2})} (\sqrt{5}-\sqrt{2})$$

(iii)

$$\begin{aligned} &= \frac{\sqrt{5}-\sqrt{2}}{(\sqrt{5})^2 - (\sqrt{2})^2} = \frac{\sqrt{5}-\sqrt{2}}{5-2} \\ &= \frac{\sqrt{5}-\sqrt{2}}{3} \end{aligned}$$

$$\frac{1}{\sqrt{7}-2} = \frac{1}{(\sqrt{7}-2)(\sqrt{7}+2)} (\sqrt{7}+2)$$

(iv)

$$\begin{aligned} &= \frac{\sqrt{7}+2}{(\sqrt{7})^2 - (2)^2} \\ &= \frac{\sqrt{7}+2}{7-4} = \frac{\sqrt{7}+2}{3} \end{aligned}$$

Exercise 1.6 Question 1:

Find:

(i)  $64^{\frac{1}{2}}$       (ii)  $32^{\frac{1}{5}}$       (iii)  $125^{\frac{1}{3}}$

Find:

(i)  $9^{\frac{3}{2}}$  (ii)  $32^{\frac{2}{5}}$  (iii)  $16^{\frac{3}{4}}$

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

Answer:

Answer:

(i)

$$\begin{aligned} 64^{\frac{1}{2}} &= (2^6)^{\frac{1}{2}} \\ &= 2^{6 \times \frac{1}{2}} \\ &= 2^3 = 8 \end{aligned}$$

$$\left[ (a^m)^n = a^{mn} \right] \text{ (iii)}$$

(ii)

$$\begin{aligned} 32^{\frac{1}{5}} &= (2^5)^{\frac{1}{5}} \\ &= (2)^{5 \times \frac{1}{5}} \\ &= 2^1 = 2 \end{aligned}$$

$$\left[ (a^m)^n = a^{mn} \right] \text{ (iv)}$$

(iii)

$$\begin{aligned} (125)^{\frac{1}{3}} &= (5^3)^{\frac{1}{3}} \\ &= 5^{3 \times \frac{1}{3}} \\ &= 5^1 = 5 \end{aligned}$$

$$\left[ (a^m)^n = a^{mn} \right]$$

(i)

$$\begin{aligned} 9^{\frac{3}{2}} &= (3^2)^{\frac{3}{2}} \\ &= 3^{2 \times \frac{3}{2}} \\ &= 3^3 = 27 \end{aligned} \quad \left[ (a^m)^n = a^{mn} \right]$$

(ii)

$$\begin{aligned} (32)^{\frac{2}{5}} &= (2^5)^{\frac{2}{5}} \\ &= 2^{5 \times \frac{2}{5}} \\ &= 2^2 = 4 \end{aligned} \quad \left[ (a^m)^n = a^{mn} \right]$$

(iii)

$$\begin{aligned} (16)^{\frac{3}{4}} &= (2^4)^{\frac{3}{4}} \\ &= 2^{4 \times \frac{3}{4}} \\ &= 2^3 = 8 \end{aligned} \quad \left[ (a^m)^n = a^{mn} \right]$$

(iv)

$$\begin{aligned} (125)^{-\frac{1}{3}} &= \frac{1}{(125)^{\frac{1}{3}}} \\ &= \frac{1}{(5^3)^{\frac{1}{3}}} \\ &= \frac{1}{5^{3 \times \frac{1}{3}}} \\ &= \frac{1}{5} \end{aligned} \quad \left[ a^{-m} = \frac{1}{a^m} \right] \quad \left[ (a^m)^n = a^{mn} \right]$$

Question 2:

Question 3:

Simplify:

$$(i) 2^{\frac{2}{3}} \cdot 2^{\frac{1}{5}} \quad (ii) \left(\frac{1}{3^3}\right)^7 \quad (iii) \frac{11^{\frac{1}{2}}}{11^{\frac{1}{4}}}$$

$$(iv) 7^{\frac{1}{2}} \cdot 8^{\frac{1}{2}}$$

Answer:

(i)

$$\begin{aligned} 2^{\frac{2}{3}} \cdot 2^{\frac{1}{5}} &= 2^{\frac{2}{3} + \frac{1}{5}} & [a^m \cdot a^n = a^{m+n}] \\ &= 2^{\frac{10+3}{15}} = 2^{\frac{13}{15}} \end{aligned}$$

(ii)

$$\begin{aligned} \left(\frac{1}{3^3}\right)^7 &= \frac{1}{3^{3 \times 7}} & [(a^m)^n = a^{mn}] \\ &= \frac{1}{3^{21}} \\ &= 3^{-21} & \left[\frac{1}{a^m} = a^{-m}\right] \end{aligned}$$

(iii)

$$\begin{aligned} \frac{11^{\frac{1}{2}}}{11^{\frac{1}{4}}} &= 11^{\frac{1}{2} - \frac{1}{4}} & \left[\frac{a^m}{a^n} = a^{m-n}\right] \\ &= 11^{\frac{2-1}{4}} = 11^{\frac{1}{4}} \end{aligned}$$

(iv)

$$\begin{aligned} 7^{\frac{1}{2}} \cdot 8^{\frac{1}{2}} &= (7 \times 8)^{\frac{1}{2}} & [a^m \cdot b^m = (ab)^m] \\ &= (56)^{\frac{1}{2}} \end{aligned}$$