



Exercise 1.1

Question 1:

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

$$\frac{p}{q}, \text{ where p and q are}$$

Answer:

Yes. Zero is a rational number as it can be represented as

$$\frac{0}{1} \text{ or } \frac{0}{2} \text{ or } \frac{0}{3} \text{ etc.}$$

Question 2:

Find six rational numbers between 3 and 4.

Answer:

There are infinite rational numbers in between 3 and 4.

3 and 4 can be represented as $\frac{24}{8}$ and $\frac{32}{8}$ 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 $\frac{3}{5}$ and $\frac{4}{5}$.

Answer:

There are infinite rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$.

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

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

Therefore, rational numbers between $\frac{3}{5}$ and $\frac{4}{5}$ are



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

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.

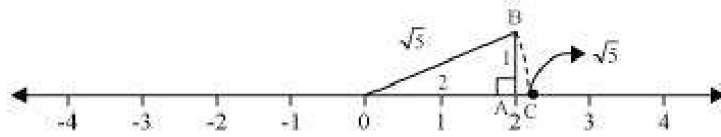
Question 3:

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

Answer:

We know that, $\sqrt{4} = 2$

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



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 $\sqrt{5}$.



Exercise 1.3

Question 1:

Write the following in decimal form and say what kind of decimal expansion each 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

Question 2:



You know that $\frac{1}{7} = 0.\overline{142857}$. Can you predict what the decimal expansion of $\frac{2}{7}, \frac{3}{7}, \frac{4}{7}, \frac{5}{7}, \frac{6}{7}$ 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.

$$\frac{2}{7} = 2 \times \frac{1}{7} = 2 \times 0.\overline{142857} = 0.\overline{285714}$$

$$\frac{3}{7} = 3 \times \frac{1}{7} = 3 \times 0.\overline{142857} = 0.\overline{428571}$$

$$\frac{4}{7} = 4 \times \frac{1}{7} = 4 \times 0.\overline{142857} = 0.\overline{571428}$$

$$\frac{5}{7} = 5 \times \frac{1}{7} = 5 \times 0.\overline{142857} = 0.\overline{714285}$$

$$\frac{6}{7} = 6 \times \frac{1}{7} = 6 \times 0.\overline{142857} = 0.\overline{857142}$$

Question 3:

Express the following in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$.

(i) $0.\overline{6}$ (ii) $0.4\overline{7}$ (iii) $0.00\overline{1}$

Answer:

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

Let $x = 0.666\ldots$

$$10x = 6.666\ldots$$

$$10x = 6 + x$$

$$9x = 6$$



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

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

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

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

$$10x = 7.777...$$

$$10x = 7 + x$$

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

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

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

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

$$1000x = 1.001001...$$

$$1000x = 1 + x$$

$$999x = 1$$

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

Question 4:

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

Answer:

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

$$10x = 9.9999...$$

$$10x = 9 + x$$



$$9x = 9$$

$$x = 1$$

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 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:

Find three different irrational numbers between the rational numbers

$$\frac{5}{7} \text{ and } \frac{9}{11}.$$

Answer:

$$\frac{5}{7} = 0.\overline{714285}$$

$$\frac{9}{11} = 0.\overline{81}$$

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) $7.478478 \dots = \overline{7.478}$

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.



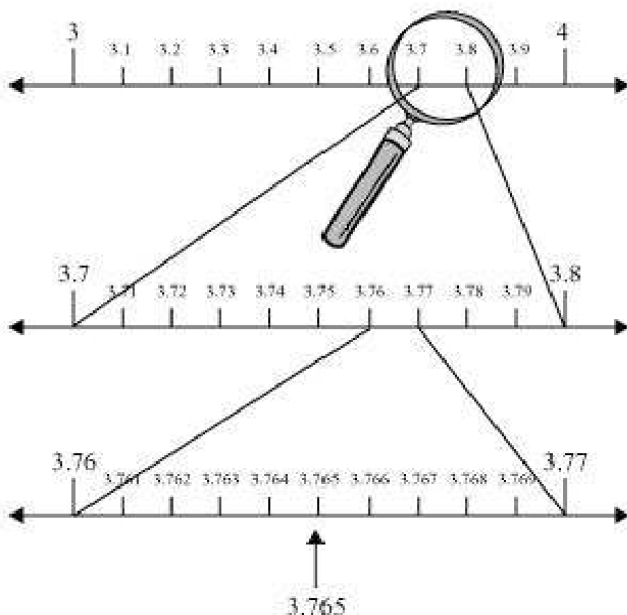
Exercise 1.4

Question 1:

Visualise 3.765 on the number line using successive magnification.

Answer:

3.765 can be visualised as in the following steps.

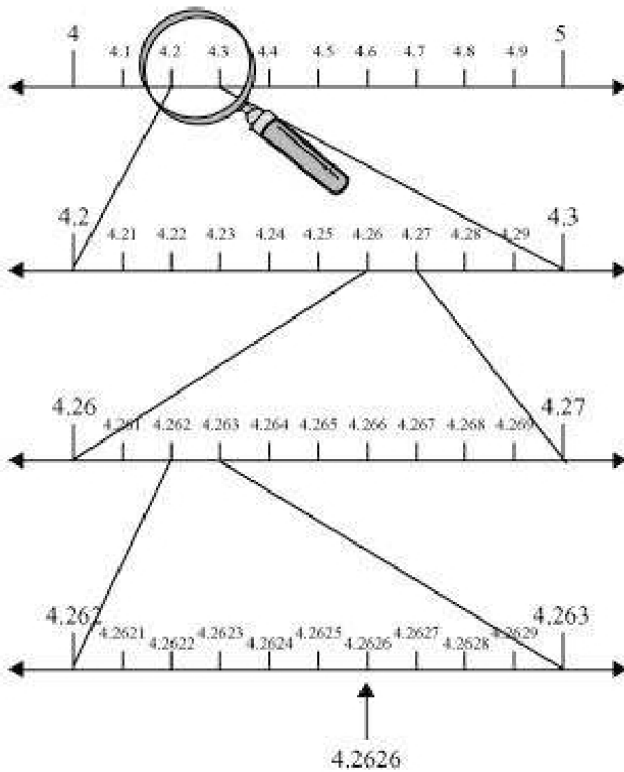
**Question 2:**

Visualise $4.\overline{26}$ on the number line, up to 4 decimal places.

Answer:

$$4.\overline{26} = 4.2626\ldots$$

4.2626 can be visualised as in the following steps.





Exercise 1.5

Question 1:

1. Classify the following numbers as rational or irrational:

(i) $2 - \sqrt{5}$ (ii) $(3 + \sqrt{23}) - \sqrt{23}$ (iii) $\frac{2\sqrt{7}}{7\sqrt{7}}$

(iv) $\frac{1}{\sqrt{2}}$ (v) 2π

Answer:

(i) $2 - \sqrt{5} = 2 - 2.2360679...$
 $= -0.2360679...$

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

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

As it can be represented in $\frac{p}{q}$ form, therefore, it is a rational number.

(iii) $\frac{2\sqrt{7}}{7\sqrt{7}} = \frac{2}{7}$

As it can be represented in $\frac{p}{q}$ form, therefore, it is a rational number.

(iv) $\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2} = 0.7071067811...$

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

(v) $2\pi = 2(3.1415 ...)$
 $= 6.2830 ...$



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, π 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 π 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,

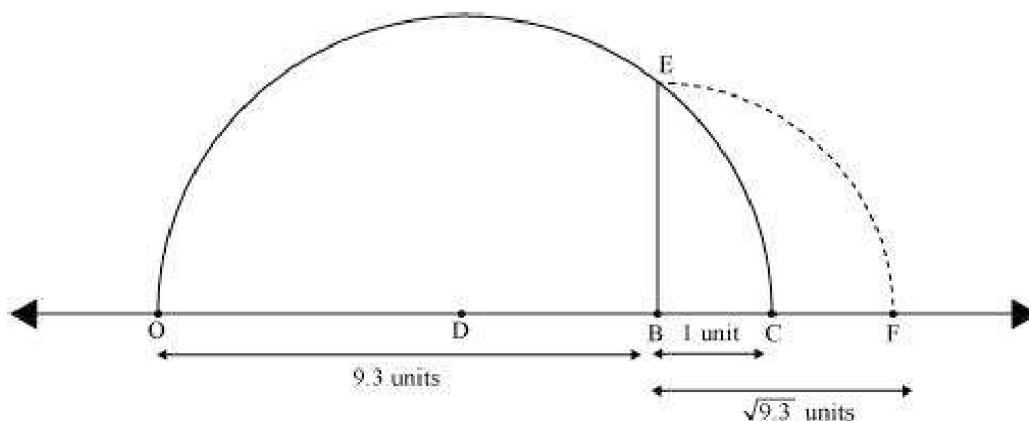
the fraction $\frac{c}{d}$ is irrational. Hence, n is irrational.

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

(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:

(i) $\frac{1}{\sqrt{7}} = \frac{1 \times \sqrt{7}}{1 \times \sqrt{7}} = \frac{\sqrt{7}}{7}$



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

$$\begin{aligned} \text{(iii)} \quad \frac{1}{\sqrt{5}+\sqrt{2}} &= \frac{1}{(\sqrt{5}+\sqrt{2})(\sqrt{5}-\sqrt{2})} \\ &= \frac{\sqrt{5}-\sqrt{2}}{(\sqrt{5})^2-(\sqrt{2})^2} = \frac{\sqrt{5}-\sqrt{2}}{5-2} \\ &= \frac{\sqrt{5}-\sqrt{2}}{3} \end{aligned}$$

$$\begin{aligned} \text{(iv)} \quad \frac{1}{\sqrt{7}-2} &= \frac{1}{(\sqrt{7}-2)(\sqrt{7}+2)} \\ &= \frac{\sqrt{7}+2}{(\sqrt{7})^2-(2)^2} \\ &= \frac{\sqrt{7}+2}{7-4} = \frac{\sqrt{7}+2}{3} \end{aligned}$$



Exercise 1.6

Question 1:

Find:

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

Answer:

(i)

$$\begin{aligned} 64^{\frac{1}{2}} &= (2^6)^{\frac{1}{2}} \\ &= 2^{6 \times \frac{1}{2}} & \left[(a^m)^n = a^{mn} \right] \\ &= 2^3 = 8 \end{aligned}$$

(ii)

$$\begin{aligned} 32^{\frac{1}{5}} &= (2^5)^{\frac{1}{5}} \\ &= (2)^{5 \times \frac{1}{5}} & \left[(a^m)^n = a^{mn} \right] \\ &= 2^1 = 2 \end{aligned}$$

(iii)

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

Question 2:

Find:

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

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

Answer:



(i)

$$\begin{aligned}9^{\frac{3}{2}} &= (3^2)^{\frac{3}{2}} \\&= 3^{2 \times \frac{3}{2}} \\&= 3^3 = 27\end{aligned}$$

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

(ii)

$$\begin{aligned}(32)^{\frac{2}{5}} &= (2^5)^{\frac{2}{5}} \\&= 2^{5 \times \frac{2}{5}} \\&= 2^2 = 4\end{aligned}$$

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

(iii)

$$\begin{aligned}(16)^{\frac{3}{4}} &= (2^4)^{\frac{3}{4}} \\&= 2^{4 \times \frac{3}{4}} \\&= 2^3 = 8\end{aligned}$$

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

(iv)

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

$$\left[a^{-m} = \frac{1}{a^m} \right]$$

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



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)

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