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MathsWiz

A course in Mathematics

BOOK 8

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A course in Mathematics

Book 8

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Preface

MathsWiz, a series of nine textbooks for KG to 8 is a course based on the National Curriculum Framework and the guidelines provided therein.

The content of the series is student-centred and activity-based with emphasis on developing problem-solving skills, encouraging the child to think creatively and work independently. The methodology facilitates the teacher, the student and the parent to ensure full involvement of the child in the classroom and at home.

All the mathematical concepts are presented in a very simple and easy-to-understand form. The concepts are explained by taking examples from our daily life situations. The examples and problems also make use of modern tools, gadgets and technology commonly used. An abundant use of visual tools such as diagrams, illustrations, cartoons, tables and charts makes learning fun and helps in greater retention. The approach helps create passion for mathematics in children rather than fear for the subject. It encourages them to enquire, explore and discover rather than only learn by rote.

Each book of the series is accompanied by an interactive **student CD** to help concept-building by showing its application in daily life. The CD also supplements the book content through visuals, interactive practice and additional information.

Teacher's Manuals with extensive teaching ideas and solutions are also available separately.

Web Support includes interactive tests, worksheets, term-wise updated papers, unit-wise test papers to support classroom teaching.

The salient features of the series are

- ***Test Your Understanding*** exercises for immediate practice have been given almost after every topic.
- ***Exercises*** have been designed to include all types of questions, especially the ***Multiple Choice Questions*** **(MCQs)** and ***Higher Order Thinking Skills*** **(HOTS)**.
- ***Chapter Assessment*** provided at the end of each chapter to assess the child's understanding of the concepts given therein.
- ***Maths Lab Activities*** as per CBSE guidelines have been incorporated.
- ***Formative Assessment*** is a part of the on-going scholastic evaluation of the child. It is a kind of Unit Test – A ***Self-assessment*** of the concepts taught in the class.
- ***Mental Maths*** exercises have been given to develop skills in rapid calculations.
- ***Maths Alert*** to warn against likely mistakes and misconceptions.
- ***Summative Assessment*** at the end of each term has been skillfully prepared incorporating all types of questions such as:
  - (i) Very Short Answer Type Questions (Concept Review, True-False, Matching Questions)
  - (ii) Short Answer Type Questions
  - (iii) Multiple Choice Questions (MCQs)
  - (iv) Higher Order Thinking Skills (HOTS)

We are thankful to the management and the editorial team of S. Chand And Company Pvt. Ltd., New Delhi, for their help and support in the publication of the books of this series.

Suggestions and feedback for the improvement of this newly introduced series from the principals, teachers, students and parents would be most welcome. You may write in at **anubhutigangal@hotmail.com**

Authors

Syllabus

UNIT I: NUMBER SYSTEM (Periods 50)

(i) *Rational Numbers*

- Properties of rational numbers. (including identities). Using general form of expression to describe properties
- Consolidation of operations on rational numbers
- Representation of rational numbers on the number line
- Between any two rational numbers there lies another rational number (Making children see that if we take two rational numbers then unlike for whole numbers, in this case you can keep finding more and more numbers that lie between them)
- Word problems (higher logic, two operations, including ideas like area)

(ii) *Powers*

- Integers as exponents
- Laws of exponents with integral powers

(iii) *Squares, Square roots, Cubes, Cube roots*

- Square and Square roots
- Square roots using factor method and division method for numbers containing (a) no more than total 4 digits and (b) no more than 2 decimal places
- Cubes and cubes roots (only factor method for numbers containing at most 3 digits)
- Estimating square roots and cube roots. Learning the process of moving nearer to the required number

(iv) *Playing with numbers*

- Writing and understanding a 2- and 3-digit number *in generalised form* ($100a + 10b + c$, where a, b, c can be only digit 0-9) and engaging with various puzzles concerning this. (Like finding the missing numerals represented by alphabets in sums involving any of the four operations.) Children to solve and create problems and puzzles.
- Number puzzles and games
- Deducing the divisibility test rules of 2, 3, 5, 9, 10 for a two or three-digit number expressed in the general form

UNIT II: ALGEBRA (Periods 20)

Algebraic Expressions

- Multiplication and division of algebraic expression (Coefficient should be integers)
- Some common errors (e.g. $2 + x \neq 2x$, $7x + y \neq 7xy$)
- Identities $(a \pm b)^2 = a^2 \pm 2ab + b^2$, $a^2 - b^2 = (a - b)(a + b)$
- Factorisation (simple cases only) as examples the following types
  $a(x + y)$, $(x \pm y)^2$, $a^2 - b^2$, $(x + a).(x + b)$
- Solving linear equations in one variable in contextual problems involving multiplication and division (word problems) (avoid complex coefficient in the equations)

UNIT III: RATIO AND PROPORTION **(Periods 25)**

- Slightly advanced problems involving applications on percentages, profit and loss, overhead expenses, discount, tax
- Difference between simple and compound interest (compounded yearly up to 3 years or half-yearly up to 3 steps only), Arriving at the formula for compound interest through patterns and using it for simple problems
- Direct variation – Simple and direct word problems
- Inverse variation – Simple and direct word problems
- Time and work problems– Simple and direct word problems

UNIT IV: GEOMETRY **(Periods 40)**

(i) *Understanding Shapes*

- Properties of quadrilaterals – Sum of angles of a quadrilateral is equal to 360^0 (By verification)
- Properties of parallelogram (By verification)
  - (i) Opposite sides of a parallelogram are equal
  - (ii) Opposite angles of a parallelogram are equal
  - (iii) Diagonals of a parallelogram bisect each other. [Why (iv), (v) and (vi) follow from (ii)]
  - (iv) Diagonals of a rectangle are equal and bisect each other
  - (v) Diagonals of a rhombus bisect each other at right angles
  - (vi) Diagonals of a square are equal and bisect each other at right angles

(ii) *Representing 3D in 2D*

- Identify and Match pictures with objects [more complicated e.g. nested, joint 2D and 3D shapes (not more than 2)]
- Drawing 2D representation of 3D objects (Continued and extended)
- Counting vertices, edges and faces and verifying Euler's relation for 3D figures with flat faces (cubes, cuboids, tetrahedrons, prisms and pyramids)

(iii) *Construction:*

Construction of Quadrilaterals

- Given four sides and one diagonal
- Three sides and two diagonals
- Three sides and two included angles
- Two adjacent sides and three angles

UNIT V: MENSURATION **(Periods 15)**

(i) Area of a trapezium and a polygon

(ii) Concept of volume, measurement of volume using a basic unit, volume of a cube, cuboid and cylinder.

(iii) Volume and capacity (measurement of capacity)

(iv) Surface area of a cube, cuboid, cylinder

UNIT VI: DATA HANDLING **(Periods 15)**

(i) Reading bar-graphs, ungrouped data, arranging it into groups, representation of grouped data through bar-graphs, constructing and interpreting bar-graphs

(ii) Simple Pie charts with reasonable data numbers

(iii) Consolidating and generalising the notion of chance in events like tossing coins, dice etc. Relating it to chance in life events. Visual representation of frequency outcomes of repeated throws of the same kind of coins or dice

Throwing a large number of identical dice/coins together and aggregating the result of the throws to get large number of individual events. Observing the aggregating numbers over a large number of repeated events. Comparing with the data for a coin. Observing strings of throws, notion of randomness

Introduction to graphs **(15 hrs)**

PRELIMINARIES

(i) Axes (Same units), Cartesian Plane

(ii) Plotting points for different kind of situations (perimeter vs length for squares, area as a function of side of a square, plotting of multiples of different numbers, simple interest vs number of years etc.)

(iii) Reading off from the graphs

- Reading of linear graphs
- Reading of distance vs time graph

Contents

UNIT 1 : NUMBER SYSTEM

1 Rational Numbers

Revision

Whole Numbers, Integers and Rational Numbers

From your study in the earlier classes, you know that as a result of our wish to find a suitable number system, we extended the number system several times. We first considered the system of **natural numbers** or **counting numbers** (positive or non-negative integers). For example,

$N = \{1, 2, 3, 4, 5, ...\}$

To this we added zero and designated the new system as the system of **whole numbers:**

$W = \{0, 1, 2, 3, 4, 5, ...\}$

Then we extended this system to include the negative of each positive integer and obtained the complete set of **integers:**

I or $Z = \{... -3, -2, -1, 0, 1, 2, 3, ...\}$

***The positive integers are* 1, 2, 3, ...** ***The negative integers are* – 1, – 2, – 3, ...**

Zero is neither positive nor negative.

Next, fractions were considered and we developed the system of **rational numbers.**

$Q = \{$Numbers which can be expressed in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0\}$.

p is called the **numerator** and q is called the **denominator.**

All these are rational numbers: $-7, \frac{8}{4}, 0, 73\%, 3.84, \sqrt{25}, \sqrt[3]{-8}$

But a number as $\frac{5}{0}$ or $-\frac{6}{0}$ is not defined and hence is not a rational number.

Note that

1. Every natural number n can be written as $\frac{n}{1}$ which is a rational number, but a rational number such as $\frac{1}{n}$ need not be a natural number.
2. Zero is a rational number, as it can be expressed as $\frac{0}{q}$ where q is any non-zero integer.
3. Every fraction is a rational number, but a rational number need not be a fraction. A number like $\frac{5}{-6}$ is a rational number but not a fraction.

Positive and Negative Rational Numbers

1. A rational number is said to **positive** if its numerator and denominator are both positive or both negative.

   For example: $\frac{3}{4}, \frac{-29}{-110}$

2. A rational number is said to be **negative** if its numerator and denominator are such that, one of them is a positive integer and the other is a negative integer.

   Example: $\frac{-9}{43}, \frac{78}{-215}$

Equivalent Rational Numbers

If $\frac{p}{q}$ is a rational number and n is a non-zero integer, then $\frac{p}{q} = \frac{p \times n}{q \times n}$.

Example: $\frac{-2}{5} = \frac{(-2) \times 2}{5 \times 2} = \frac{(-2) \times 3}{5 \times 3} = \frac{(-2) \times 4}{5 \times 4} = \ldots$

i.e., $\frac{-2}{5} = \frac{-4}{10} = \frac{-6}{15} = \frac{-8}{20} = \ldots$

All these rational numbers are ***equivalent rational numbers***.

Also, if $\frac{p}{q}$ is a rational number, and n is a common divisor of p and q, then $\frac{p}{q} = \frac{p \div n}{q \div n}$.

Example: $\frac{-32}{48} = \frac{(-32) \div 2}{48 \div 2} = \mathbf{\frac{-16}{24}}$, $\frac{-32}{48} = \frac{(-32) \div 4}{48 \div 4} = \mathbf{\frac{-8}{12}}$,

$\frac{-32}{48} = \frac{(-32) \div 8}{48 \div 8} = \mathbf{\frac{-4}{6}}$, $\frac{-32}{48} = \frac{(-32) \div 16}{48 \div 16} = \mathbf{\frac{-2}{3}}$

As we can see $\frac{-2}{3}$ is in its **lowest terms**. It is also called the ***standard form***.

Standard Form of a Rational Number

A rational number is said to be in standard form if it is in its lowest terms.

To express a given rational number in standard form:

Step I. *If already not so, make the denominator of the given rational number positive.*
Step II. *Divide both the numerator and denominator by their HCF.*

Example: To express $\frac{45}{-70}$ in standard form, proceed as follows:

Step I. *Make denominator positive:* $\frac{45}{-70} = \frac{-45}{70}$.

Step II. *Divide both numerator and denominator by the HCF of 45 and 70, i.e., 5.*

$\therefore \quad \frac{-45}{70} = \frac{(-45) \div 5}{70 \div 5} = \mathbf{\frac{-9}{14}}$.

Comparison of Rational Numbers

Method I.
Step 1. *Express each rational number with a positive denominator.*
Step 2. *Find the LCM of the positive denominators.*
Step 3. *Express each of the given rational numbers with this LCM as common denominator.*
Step 4. *Then number having greater numerator is greater.*

Ex. 1. Compare: $\mathbf{\frac{-8}{9}}$ **and** $\mathbf{\frac{4}{-5}}$.

Sol. $\frac{-8}{9} = \frac{-8}{9}$ and $\frac{4}{-5} = \frac{-4}{5}$ — Express in standard form

LCM of 9 and 5 is 9 × 5 = 45.

$$\therefore \frac{-8}{9} = \frac{-8\times 5}{9\times 5} = \frac{-40}{45}, \quad \frac{-4}{5} = \frac{-4\times 9}{5\times 9} = \frac{-36}{45}$$

Express each rational number with LCM as denominator

Since –40 < –36

$$\therefore \frac{-40}{45} < \frac{-36}{45} \Rightarrow \frac{-8}{9} < \frac{-4}{5} \Rightarrow \mathbf{\frac{-8}{9} < \frac{4}{-5}}.$$

Compare the numerators

Method II.

If a and b are integers and c and d are positive integers, then

$\frac{a}{c} > \frac{b}{d}$, *if and only if ad > bc.*

$\frac{a}{c} < \frac{b}{d}$, *if and only if ad < bc.*

$\frac{a}{c} = \frac{b}{d}$, *if and only if ad = bc.*

$\frac{a}{c} \times \frac{b}{d}$

a and b are any integers c and d are positive integers.

Ex. 2. Compare: $\frac{9}{-11}$ **and** $\frac{5}{-17}$**.**

Sol. $\frac{9}{-11} = \frac{-9}{11}$ and $\frac{5}{-17} = \frac{-5}{17}$

First express the given rational number with positive denominator

On cross multiplication

$\frac{-9}{11} \times \frac{-5}{17}$

–9 × 17 = –153 and –5 × 11 = –55

$\because -153 < -55 \qquad \therefore \frac{-9}{11} < \frac{-5}{17} \Rightarrow \mathbf{\frac{9}{-11} < \frac{5}{-17}}.$

Ex. 3. Arrange $\frac{-4}{5}, \frac{9}{-15}, \frac{-2}{3}$ **in descending order.**

Sol. Writing each rational number with a positive denominator, we have $\frac{-4}{5}, \frac{-9}{15}, \frac{-2}{3}$.

LCM of 5, 15 and 3 is 15

5	5, 15, 3
3	1, 3, 3
	1, 1, 1

∴ The given rational numbers are:

$$\therefore \frac{-4}{5} = \frac{(-4)\times 3}{5\times 3} = \frac{-12}{15}; \quad \frac{-9}{15}; \quad \frac{-2}{3} = \frac{(-2)\times 5}{3\times 5} = \frac{-10}{15}$$

Since –9 > –10 > –12, therefore,

$$\therefore \frac{-9}{15} > \frac{-10}{15} > \frac{-12}{15} \Rightarrow \frac{-9}{15} > \frac{-2}{3} > \frac{-4}{5}.$$

Hence, the rational numbers in descending order are $\frac{-9}{15}, \frac{-2}{3}, \frac{-4}{5}$, *i.e.*, $\frac{9}{-15}, \frac{-2}{3}, \frac{-4}{5}$.

Absolute Value of a Rational Number

For a rational number x,

$$|x| = \begin{cases} x & \text{if } x > 0 \\ 0 & \text{if } x = 0 \\ -x & \text{if } x < 0 \end{cases}. \text{ Thus, } \left|\frac{5}{7}\right| = \frac{5}{7}, \left|\frac{-12}{19}\right| = -\left(-\frac{12}{19}\right) = \frac{12}{19} \text{ and } |0| = 0.$$

Ex. 4. Find the absolute value of

(a) $\frac{7}{11}$ (b) $\frac{-15}{17}$ (c) $\left(\frac{-1}{3} \times \frac{7}{-3}\right)$ (d) $\left(\frac{-5}{4} \div \frac{35}{16}\right)$ (e) $\left(\frac{1}{3} - \frac{5}{6}\right)$

Sol. (a) $\left|\frac{7}{11}\right| = \frac{7}{11}$ (b) $\left|\frac{-15}{17}\right| = \frac{15}{17}$ (c) $\left|\frac{-1}{3} \times \frac{7}{-3}\right| = \left|\frac{-1}{3} \times \frac{-7}{3}\right| = \left|\frac{7}{9}\right| = \frac{7}{9}$

(d) $\left|\frac{-5}{4} \div \frac{35}{16}\right| = \left|\frac{-5}{4} \times \frac{16}{35}\right| = \left|\frac{-4}{7}\right| = \frac{4}{7}$ (e) $\left|\frac{1}{3} - \frac{5}{6}\right| = \left|\frac{2-5}{6}\right| = \left|-\frac{3}{6}\right| = \left|-\frac{1}{2}\right| = \frac{1}{2}$

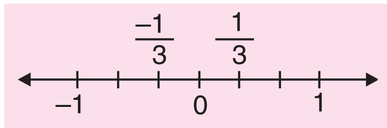
Ex. 5. Compare $\left|\frac{-4}{3} + \frac{5}{8}\right|$ **and** $\left|\frac{-4}{3}\right| + \left|\frac{5}{8}\right|$**.**

Sol. $\left|\frac{-4}{3} + \frac{5}{8}\right| = \left|\frac{-32+15}{24}\right| = \left|\frac{-17}{24}\right| = \frac{17}{24}$, $\left|\frac{-4}{3}\right| + \left|\frac{5}{8}\right| = \frac{4}{3} + \frac{5}{8} = \frac{32+15}{24} = \frac{47}{24}$.

Obviously, $\frac{47}{24} > \frac{17}{24}$, therefore, $\left|\frac{-4}{3}\right| + \left|\frac{5}{8}\right| > \left|\frac{-4}{3} + \frac{5}{8}\right|$.

Ex. 6. Find two rational numbers whose absolute value is $\frac{1}{3}$**.**

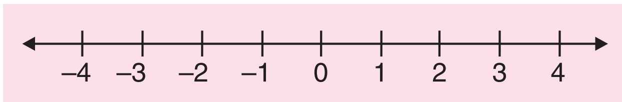
Sol. Since $\left|-\frac{1}{3}\right| = \frac{1}{3}$ and $\left|\frac{1}{3}\right| = \frac{1}{3}$, the two rational numbers whose absolute value is $\frac{1}{3}$ are $\frac{-1}{3}$ and $\frac{1}{3}$. They are the two equidistant numbers on opposite sides of zero.



Presentation of a Rational Number on a Number Line

Every rational number has a corresponding point representing it on the number line.

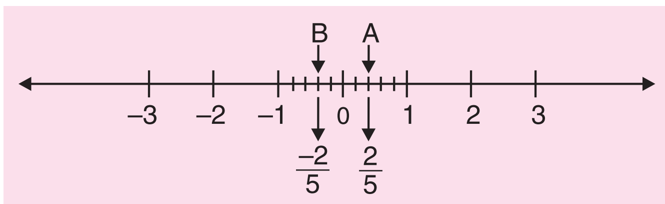
We have already learnt that integers can be represented by taking *positive integers to the right of the point 0* and *negative integers to the left of the point 0*. Let us consider the length between two successive integers to be unit length. As we know integers are also rational numbers with denominator 1.



■ **To represent a rational number of the form** $\frac{p}{q}$ **where** $p < q$**.**

Ex. 7. Represent $\frac{2}{5}$ **and** $-\frac{2}{5}$ **on the number line.**

Sol. To represent $\frac{2}{5}$ on the number line we divide the unit length between 0 and 1 into 5 equal parts and take 2 out of the 5 parts. Then *A* represents $\frac{2}{5}$.



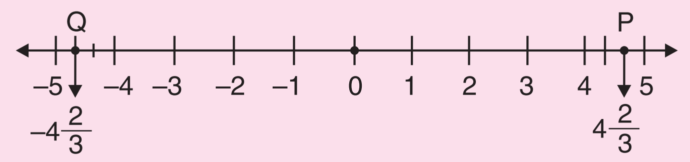
Similarly $-\frac{2}{5}$ can be represented by taking the unit length between 0 and –1 and dividing it into 5 equal parts.

■ **To represent a rational number of the form $\frac{p}{q}$ where $p > q$.**

Ex. 8. Represent $\frac{14}{13}$ and $-\frac{14}{13}$ on the number line.

Sol. $\frac{14}{3} = 4\frac{2}{3}$ and $-\frac{14}{3} = -\left(4\frac{2}{3}\right) = -\left(4+\frac{2}{3}\right) = -4+\left(-\frac{2}{3}\right)$.

To represent $\frac{14}{3}$ or $4\frac{2}{3}$.

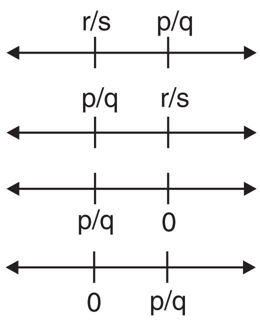


Start from 0 and take 4 full units. Divide the unit length between 4 and 5 into 3 equal parts.

Take two out of 3 parts. Then the point P represents $\frac{14}{3}$ or $\left(4+\frac{2}{3}\right)$. Similarly, point Q represents $-\frac{14}{3}$ or $-\left(4+\frac{2}{3}\right)$ on the left side of 0.

Order Relation

1. Two equal rational numbers correspond to the same point on the number line.
2. If $\frac{p}{q}$ lies to the right of $\frac{r}{s}$, then $\frac{p}{q} > \frac{r}{s}$.
3. If $\frac{p}{q}$ lies to the left of $\frac{r}{s}$, then $\frac{p}{q} < \frac{r}{s}$.
4. All rational numbers lying to the left of 0 are negative.
5. All rational numbers lying to the right of 0 are positive.



EXERCISE 1 (A)

1. Fill in the blanks:

(i) $\frac{7}{-8}$, expressed as a rational number with denominater 24 = ...

(ii) $\frac{-4}{7}$ .... $\frac{4}{-11}$ (<, >, =)

(iii) The absolute value of $\frac{-16}{-19}$ = ...

(iv) The rational numbers whose absolute value is $\frac{11}{13}$ are ....

(v) The rational number which is neither positive nor negative is ....

2. Answer True (T) or False (F).

(i) Every rational number is a whole number.

(ii) 0 is the smallest rational number.

(iii) Every fractional number is a rational number.

(iv) $\frac{4}{0}$ is a rational number.

(v) $|x| = -x$ if $x < 0$.

3. Write four rational numbers equivalent to each of the following rational numbers:

(i) $\frac{2}{5}$ (ii) $\frac{-5}{9}$ (iii) $\frac{8}{-11}$ (iv) $\frac{-12}{13}$

4. Which of the symbols <, = or > should replace the blank space?

(i) $\frac{8}{7} \ldots\ldots \frac{12}{9}$ (ii) $\frac{-2}{3} \ldots\ldots \frac{4}{-7}$ (iii) $\frac{13}{-15} \ldots\ldots \frac{10}{-11}$ (iv) $0 \ldots\ldots \frac{-3}{-8}$

5. Write the absolute value of:

(i) $\frac{5}{8}$ (ii) $\frac{-7}{10}$ (iii) 0 (iv) $\frac{11}{-12}$

Multiple Choice Questions (MCQs)

6. $-\frac{28}{84}$ expressed as a rational number with numerator 4 is

(a) $\frac{4}{12}$ (b) $\frac{4}{7}$

(c) $\frac{4}{-7}$ (d) $\frac{4}{-12}$

7. Which of the following set of rational numbers is arranged in ascending order?

(a) $-\frac{1}{2}, \frac{-3}{7}, \frac{-5}{14}, \frac{-25}{28}$

(b) $-\frac{25}{28}, -\frac{1}{2}, -\frac{3}{7}, -\frac{5}{14}$

(c) $-\frac{25}{28}, \frac{-5}{14}, \frac{-3}{7}, -\frac{1}{2}$

(d) $-\frac{5}{14}, -\frac{25}{28}, -\frac{3}{7}, -\frac{1}{2}$

Higher Order Thinking Skills (HOTS)

8. Find the absolute value of

$-1 \div \frac{-1}{5} \div \frac{1}{-5} \div \frac{-1}{-5}$

Remember. Operate from left to right

Operations on Rational Numbers

■ **Case I.** *If* $\frac{p}{q}$ *and* $\frac{r}{q}$ *are any two rational numbers with the common denominator q, then* $\frac{p}{q} + \frac{r}{q} = \frac{p+r}{q}$.

Note that

For addition we should convert each rational number into a rational number with positive denominator.

Example : $\frac{6}{13} + \frac{-2}{13} = \frac{6+(-2)}{13} = \mathbf{\frac{4}{13}}$.

$$\frac{11}{-20} + \frac{-9}{20} = \frac{-11}{20} + \frac{-9}{20} = \frac{(-11)+(-9)}{20} = \frac{-20}{20} = \mathbf{-1}.$$

■ **Case II.** *For rational numbers* $\frac{p}{q}$ *and* $\frac{r}{s}$ *with different denominators, we take the LCM of the denominators and express the given rational numbers with this LCM as the common denominator.*

Now add as in **Case I**.

In particular, $\frac{p}{q} + \frac{r}{s} = \frac{ps+rq}{qs}$, when HCF of q and s is 1.