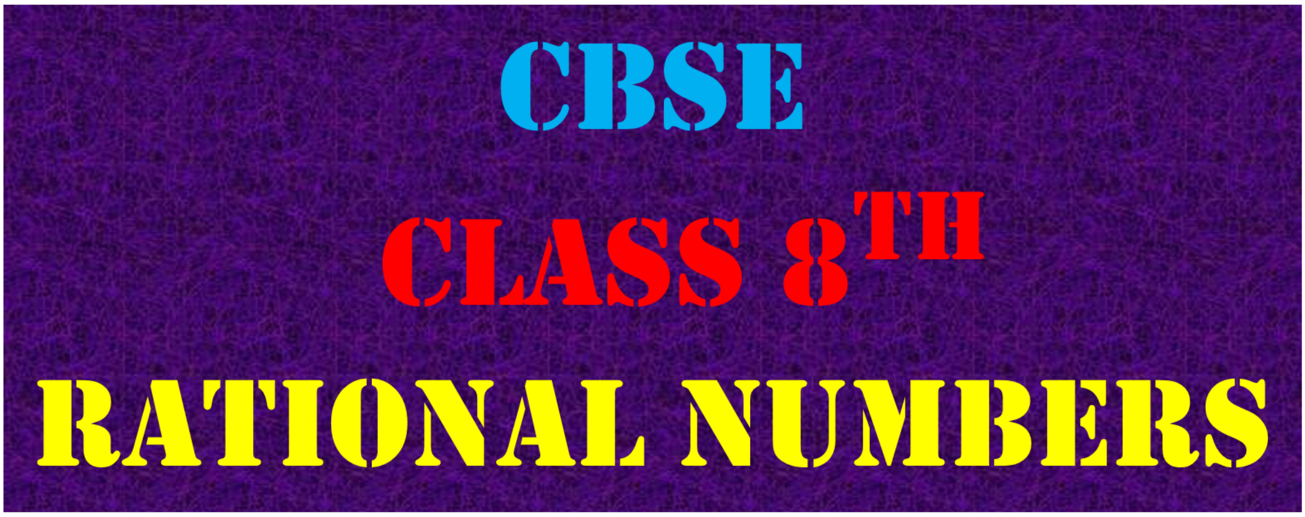
CBSE Class 8 Rational Numbers



AMAN RAJ 25/06/2016 CBSE Class 8, Latest Announcement 0

RATIONAL NUMBERS

1.1 Definition of Rational Numbers:

Question:

What are rational numbers?

Answer:

A number that can be written as $\frac{p}{q}$, where p and q are integers and q $\neq$ 0, is known as **Rational Number.**

Example: $\frac{2}{3}, \frac{4}{5}, -\frac{9}{11}$, 12, -18 etc.

If the signs of numerator and denominator are either both positive or both negative, the rational number is known as **Positive Rational Number**.

Example: $\frac{-2}{-7}, \frac{14}{25}$ etc.

If the signs of numerator and denominator are opposite to each other, the rational number is known as **Negative Rational Number.**

Example: $\frac{-2}{9}, \frac{4}{-17}$ etc.

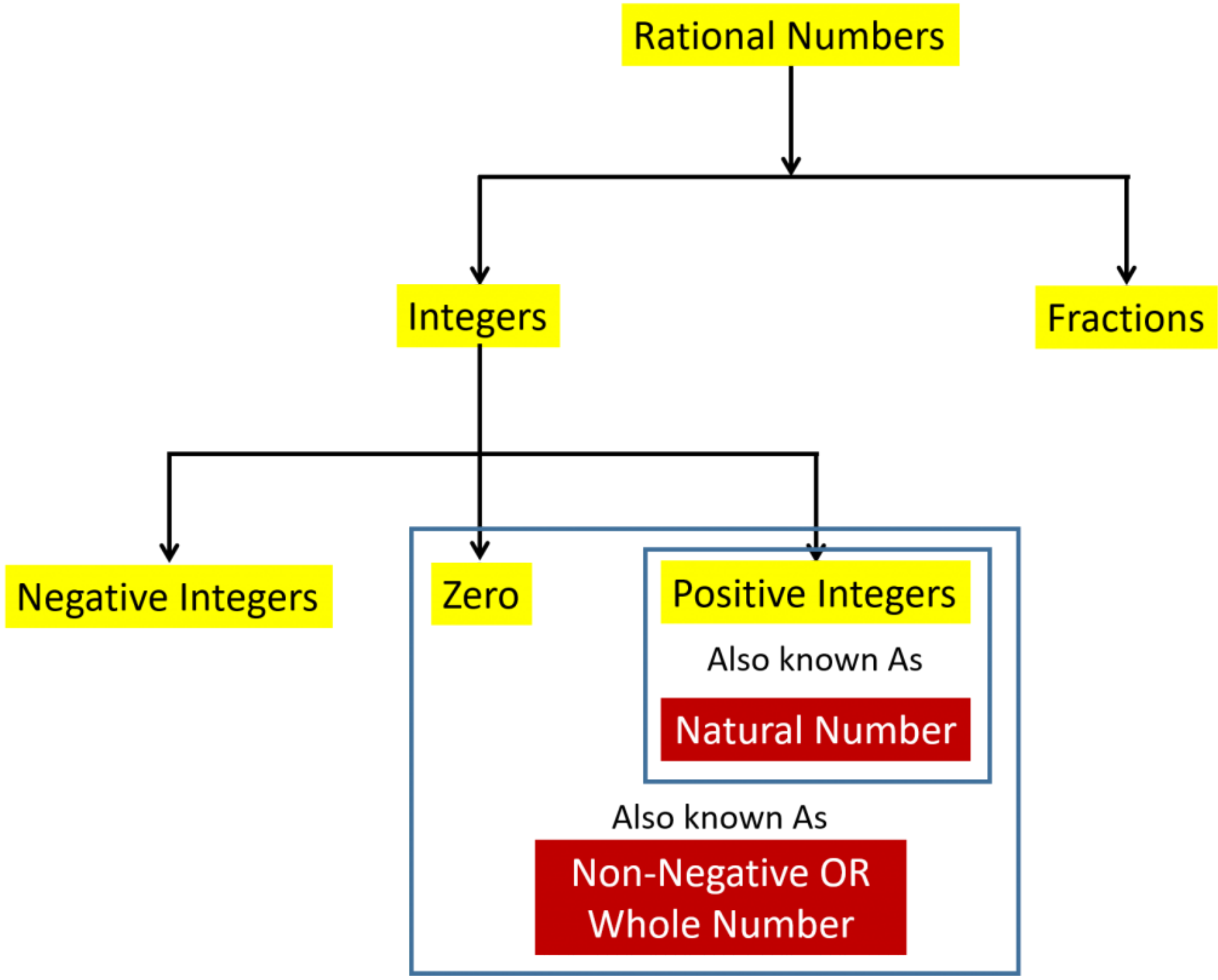
1.2 Types of Rational Numbers:

Question:

How many types of rational numbers?

Answer:

There are following types of rational numbers.



Integers:

All the natural numbers, 0 (zero) and the negative of all the natural numbers from the set of **INTEGERS**. Its set is represented by are denoted by Z or I.

Therefore, Z = {-3, -2, -1, 0,1,2,3,…} is the set of integers.

Now, we observe that both the set of natural numbers N = {1, 2, 3, 4, 5, 6, 7, 8, 9, …} and the whole numbers W = {0, 1, 2, 3, 4, 5, 6…} are the subset of integers Z = {-3, -2, -1, 0,1,2,3,…}. Thus, $N \subseteq Z$ and $W \subseteq Z \Rightarrow N \subseteq W \subseteq Z$.

Fractions:

A number that can be written in the form of p/q, q $\neq$ 0 where p and q are whole numbers known as fractions.

A fraction is part of whole. A fraction is always positive where as a rational number can be positive or negative.

Natural Numbers:

All the counting numbers are called **NATURAL NUMBERS**. Its set is represented by N. Therefore, N = {1, 2, 3, 4, 5, 6, 7, 8, 9, …} is the set of natural numbers.

The number of natural number is infinite. The natural numbers are also known as Positive Integers.

Whole Numbers:

All counting numbers including 0 (zero) form the set of **WHOLE NUMBERS**. Its set is represented by W. Therefore, W = {0, 1, 2, 3, 4, 5, 6…} is the set of the whole numbers.

Now, on comparing the set of natural numbers N = {1, 2, 3, 4, 5, 6, 7, 8, 9, …} is the subset of the whole numbers W = {0, 1, 2, 3, 4, 5, 6…}. Thus, N $\subseteq$ W. The whole numbers are also known as Non-Negative integers.

Rational Numbers:

We know that a number that can be written as $\frac{p}{q}$, where p and q are integers and q $\neq$ 0, is known as **RATIONAL NUMBERS**. Thus, the set of the rational numbers contains all integers and fractions. The set of rational numbers is denoted by Q. Therefore, N $\subseteq$ W $\subseteq$ Z $\subseteq$ Q.

1.3 Decimal Representation of Rational Numbers:

Question:

How do we represent the rational number in decimal form?

Answer:

To represent a rational number p/q, q $\neq$ 0, in decimal form, we divide the numerator p by the denominator q, and then we do the division upto 2 or 3 decimal places as required.

For example: 1/8 = 0.125

Question:

What are the terminating, non-terminating and recurring decimal?

Answer:

In the division of a rational number $\frac{p}{q}$, when we get the remainder at any step is zero, then that decimal representation is known as **TERMINATING DECIMAL** and when the remainder is not zero, then that decimal representation is known as **NON-TERMINATING DECIMAL.**

Now, in the non-terminating decimal, either the decimal part is repeating, recurring or no repeat, non-recurring. When the decimal part is recurring, then that decimal number is known as **RECURRING DECIMAL** and when the decimal part is non-recurring, then that decimal representation is known as **NON-RECURRING DECIMAL**.

Example: $\frac{1}{8} = 0.125$, $\frac{1}{2} = 0.5$, $\frac{1}{25} = 0.04$ etc are known as **terminating decimal**. In the division of these rational numbers, we get the remainder zero after a finite steps.

Whereas, $\frac{1}{3} = 0.33333\ldots$, $\frac{9}{11} = 0.81818181\ldots$. etc are known as recurring decimal. In the division of these rational numbers, we don't get the remainder zero after any finite steps and its decimal part is recurring. The recurring decimal numbers are also represented as

$$\frac{1}{3} = 0.333\ldots = 0.\bar{3}\ (\text{Read as } 0.3 \text{ bar})$$
$$\frac{9}{11} = 0.818181\ldots = 0.\overline{81}(\text{Read as } 0.81 \text{ bar})$$

Question:

How do we identify that the fraction is terminating or non-terminating decimal numbers without performing division?

Answer:

In the rational number or fraction $\frac{p}{q}$, if the prime factorization of the denominator q is in the form of $2^m \times 5^n$, it means, the prime factors of the denominator q are 2 or 5 or both. Otherwise, the fraction is non-terminating decimal.

Example:

In $\frac{1}{8}$, we have q =8 = $2^3 \times 5^0$. Thus, $\frac{1}{8}$ is terminating decimal and $\frac{1}{8}$ = 0.125.

In $\frac{1}{25}$, we have q = 25 = $2^0 \times 5^2$. Thus, $\frac{1}{25}$ is terminating decimal and $\frac{1}{25}$ = 0.04.

In $\frac{8}{15}$, we have q = 15 = $3^1 \times 5^1$. Thus, $\frac{8}{15}$ is non-terminating decimal.

Question:

How do we express the recurring decimal as fraction?

Answer:

To express the recurring decimal number in a fraction, we use a formula as below,

$$ABC.D\overline{EF} = \frac{ABCDEF - ABCD}{990}$$

where 999… as many times as the number recurring digits and 000… as many times as the number non-recurring digits after decimal point. In the following, the number of recurring digits (E and F) is 2, we write 9 as two times and the number of non-recurring digits (D) after decimal point is 1, we write 0 as one time.

For example:

$$135.65\overline{489} = \frac{13565489 - 13565}{99900} = \frac{13551924}{99900}$$

1.4 Comparison of Rational Numbers:

Question:

How do we compare two or more rational numbers?

Answer:

To compare two or more rational numbers, we do the following steps:

Step 1: Express each of the rational numbers with the positive denominator.

Step 2: Find the LCM of these positive denominators.

Step 3: Express each of the rational number with this LCM as the common denominator.

Step 4: The numerator having the greater numerator is greater.

Question:

Arrange the numbers $\frac{-3}{5}$, $\frac{7}{-10}$ and $\frac{-5}{8}$.

Answer:

We are given $\frac{-3}{5}$, $\frac{7}{-10} = \frac{-7}{10}$ and $\frac{-5}{8}$. LCM of (5, 10 and 8) = 40

$$\frac{-3}{5} = \frac{-3\times8}{5\times8} = -\frac{24}{40}$$

$$\frac{-7}{10} = \frac{-7\times4}{10\times4} = -\frac{28}{40}$$

$$\frac{-5}{8} = \frac{-5\times5}{8\times5} = -\frac{25}{40}$$

Thus, we get $\frac{-28}{40} < \frac{-25}{40} < \frac{-24}{40} \Rightarrow \frac{-7}{10} < \frac{-5}{8} < \frac{-3}{5}$.

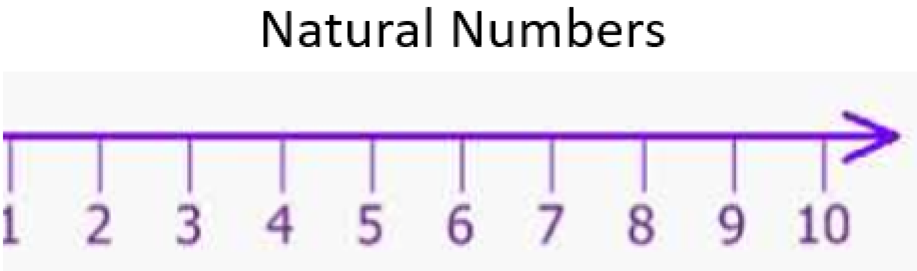
1.5 Representation of Rational Numbers on Number Lines:

Question:

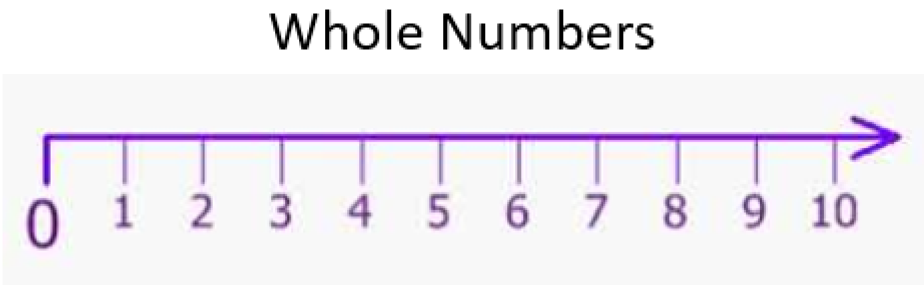
How do we represent the rational numbers on number line?

Answer:

Natural Numbers: To represent natural numbers on the number line, we draw a line and mark natural numbers 1, 2, 3, … on it as below. The line extends indefinitely only to the right side of 1. There is no number to the left of 1.



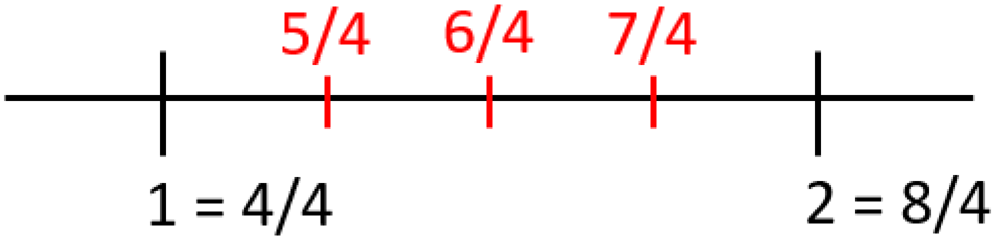
Whole Numbers: To represent whole numbers on the number line, we draw a line and mark whole numbers 0, 1, 2, 3, … on it as below. The line extends indefinitely only to the right side of 0. There is no number to the left of 0.



Rational Numbers: To represent a rational number, let 7/4, we first get the two positive integers in which the given rational number lies, means 7/4 lies between 1 and 2 as 1 < 7/4 < 2.

Now, we mark 1 and 2 on the number line. Since the denominator of 7/4 is 4, then we divide the gap between 1 and 3 into 4 equal parts by marking three lines at equal gap between 1 and 2.

Hence, 1 = 4/4, first mark is 5/4, second mark is 6/4, third mark is 7/4 and 2 = 8/4. We get that the third mark represents 7/4.



1.6 Addition of Rational Numbers

Question:

How to add two rational numbers if the given rational numbers have same denominator?

Answer:

When the given rational numbers have same denominator, then we use the method as $\frac{a}{b}+\frac{c}{b}=\frac{a+c}{b}$.

Question:

Add the rational numbers, $\frac{-7}{9}+\frac{11}{9}$.

Answer:

$\frac{-7}{9}+\frac{11}{9}=\frac{-7+11}{9}=\frac{4}{9}$

Question:

How to add two rational numbers if the given rational numbers have different denominator?

Answer:

When the given rational numbers have same denominator, then we take the LCM of their denominators and express each of the given numbers with this LCM as the common denominator. Now, we add these numbers as $\frac{a}{b}+\frac{c}{b}=\frac{a+c}{b}$.

Question:

Find the sum $\frac{-5}{6}+\frac{4}{9}$.

Answer:

The denominator of the given numbers are 6 and 9. LCM of (6, 9) = 18. Thus, $\frac{-5}{6}=\frac{-5\times3}{6\times3}=\frac{-15}{18}$ and $\frac{4}{9}=\frac{4\times2}{9\times2}=\frac{8}{18}$.

Now, $\frac{-5}{6}+\frac{4}{9}=\frac{-15}{18}+\frac{8}{18}=\frac{-15+8}{18}=\frac{-7}{18}$.

1.7 Properties of Addition of Rational Numbers

Question:

What are the properties of addition of rational numbers?

Answer:

There are following properties of addition of rational numbers:

Property 1: The sum of two rational numbers is always a rational number. It means, if $\frac{a}{b}$ and $\frac{c}{d}$ are numbers, then $\left(\frac{a}{b}+\frac{c}{d}\right)$ are rational number. This property is known as **CLOSURE PROPERTY**.

Property 2: Two rational numbers can be added in any order. It means, if $\frac{a}{b}$ and $\frac{c}{d}$ are numbers, then $\left(\frac{a}{b}+\frac{c}{d}\right) = \left(\frac{c}{d}+\frac{a}{b}\right)$. This property is known as **COMMUTATIVE PROPERTY**.

Property 3: While adding three rational numbers, they can be grouped in any order. It means, if $\frac{a}{b}$, $\frac{c}{d}$ and $\frac{e}{f}$ are three numbers, then $(\frac{a}{b} + \frac{c}{d}) + \frac{e}{f}$

$= \frac{a}{b} + (\frac{c}{d} + \frac{e}{f})$. This property is known as **ASSOCIATIVE PROPERTY**.

Property 4: 0 (zero) is a rational number such that the sum of any rational number and 0 (zero) is the rational number itself. Thus, $(\frac{a}{b} + 0) = (0 + \frac{a}{b}) = \frac{a}{b}$. This property is known as **EXISTENCE OF ADDITIVE IDENTITY** and 0 (zero) is known as **ADDITIVE IDENTITY** for rational number.

Property 5: For any rational number $\frac{a}{b}$, there exist a rational number $\frac{-a}{b}$ such that $(\frac{a}{b} + \frac{-a}{b}) = 0$. This property is known as **EXISTENCE OF ADDITIVE INVERSE** and $\frac{-a}{b}$ is known as **ADDITIVE INVERSE** of $\frac{a}{b}$.

1.8 Subtraction of Rational Numbers

Question:

How to subtract two rational numbers?

Answer:

For rational number $\frac{a}{b}$ and $\frac{c}{d}$, we subtract as $(\frac{a}{b} - \frac{c}{d}) = (\frac{a}{b} + \frac{-c}{d}) = (\frac{a}{b} +$ Additive Inverse of $\frac{c}{d}$).

Question:

Subtract $\frac{3}{4}$ from $\frac{2}{3}$

Answer:

$\frac{2}{3} - \frac{3}{4} = \frac{2}{3} + \frac{-3}{4} = \frac{8+(-9)}{12} = \frac{-1}{12}$.

1.9 Properties of Subtraction of Rational Numbers

Question:

What are the properties of subtraction of rational number?

Answer:

There are following properties of subtraction of rational number:

Property 1: The subtraction of two rational numbers is always a rational number. It means, if $\frac{a}{b}$ and $\frac{c}{d}$ are rational numbers, then ($\frac{a}{b} - \frac{c}{d}$) is rational number. This property is known as **CLOSURE PROPERTY**.

Property 2: Two rational numbers **cannot** be subtracted in any order. It means, if $\frac{a}{b}$ and $\frac{c}{d}$ are numbers, then $(\frac{a}{b} - \frac{c}{d}) \neq (\frac{c}{d} - \frac{a}{b})$. It means, the subtraction **does** **not** follow the rule **COMMUTATIVE PROPERTY** as in addition. Similarly, the subtraction does not follow **ASSOCIATIVE PROPERTY**.

1.10 Multiplication of Rational Numbers

Question:

How do we multiply two rational numbers?

Answer:

For two rational numbers $\frac{a}{b}$ and $\frac{c}{d}$, we get the multiplication as $\frac{a}{b} \times \frac{c}{d} = \frac{a \times c}{b \times d}$.

Question:

Multiply $\frac{-3}{7} \times \frac{14}{5}$

Answer:

We multiply as $\frac{-3}{7}\times\frac{14}{5}=\frac{-6}{5}$.

1.11 Properties of Multiplication of Rational Number

Question:

What are the properties of multiplication of rational number?

Answer:

There are following properties of multiplication of rational number:

Property 1: The multiplication or the product of two rational number is always a rational number. It means, if $\frac{a}{b}$ and $\frac{c}{d}$ are numbers, then $\frac{a}{b}\times\frac{c}{d}$ is rational number. This property is known as **CLOSURE PROPERTY**.

Property 2: Two rational number can be multiplied in any order. It means, if $\frac{a}{b}$ and $\frac{c}{d}$ are numbers, then $\frac{a}{b}\times\frac{c}{d}$ $=\frac{c}{d}\times\frac{a}{b}$. This property is known as **COMMUTATIVE PROPERTY**.

Property 3: While multiplying three rational numbers, they can be grouped in any order. It means, if $\frac{a}{b}$, $\frac{c}{d}$ and $\frac{e}{f}$ are three numbers, then ($\frac{a}{b}\times\frac{c}{d}$) $\times\frac{e}{f}=\frac{a}{b}\times$ ($\frac{c}{d}\times\frac{e}{f}$) . This property is known as **ASSOCIATIVE PROPERTY**.

Property 4: 1 (one) is a rational number such that the product of any rational number and 1 is the rational number itself. Thus, ($\frac{a}{b}\times$ 1) =(1 $\times\frac{a}{b}$)= $\frac{a}{b}$. This property is known as **EXISTENCE OF MULTIPLICATIVE IDENTITY** and 1 is known as **MULTIPLICATIVE IDENTITY** for rational number.

Property 5: For any rational number $\frac{a}{b}$, there exist a rational number $\frac{b}{a}$ such that $(\frac{a}{b} \times \frac{b}{a}) = 1$. This property is known as **EXISTENCE OF MULTIPLICATIVE INVERSE** and $\frac{b}{a}$ is known as **MULTIPLICATIVE INVERSE or RECIPROCAL** of $\frac{a}{b}$. Note that 0 (zero) has no reciprocal, because $\frac{1}{0}$ is not defined. The reciprocal of 1 is 1 and the reciprocal of (-1) is (-1).

Property 6: For any three numbers $\frac{a}{b}$, $\frac{c}{d}$ and $\frac{e}{f}$, we have $\frac{a}{b} \times (\frac{c}{d} + \frac{e}{f}) = (\frac{a}{b} \times \frac{c}{d}) + (\frac{a}{b} \times \frac{e}{f})$. This property is known as **DISTRIBUTIVE LAW OF MULTIPLICATION OVER ADDITION PROPERTY**.

Property 7: If we multiply any rational number with 0 (zero), then the result is always 0 (zero). It means, $(\frac{a}{b} \times 0) = (0 \times \frac{a}{b}) = 0$. This property is known as **MULTIPLICATIVE PROPERTY OF 0 (ZERO).**

1.12 Division of Rational Numbers

Question:

How do we divide two rational number?

Answer:

If $\frac{a}{b}$ and $\frac{c}{d}$ are two numbers such that $\frac{c}{d} \neq 0$, then the division of $\frac{a}{b}$ by $\frac{c}{d}$ is defined as $(\frac{a}{b} \div \frac{c}{d}) = (\frac{a}{b} \times \frac{d}{c})$. It means, when $\frac{a}{b}$ is divided by $\frac{c}{d}$, then $\frac{a}{b}$ is known as dividend and $\frac{c}{d}$ is known as divisor and the product/result is known as the quotient of the division.

Question:

Divide $\frac{9}{16}$ by $\frac{5}{8}$.

Answer:

$\frac{9}{16} \div \frac{5}{8} = \frac{9}{16} \times \frac{8}{5} = \frac{9}{10}$.

1.13 Properties of Division of Rational Numbers

Question:

What are the properties of division of rational number?

Answer:

There are following properties of division of rational number:

Property 1: If $\frac{a}{b}$ and $\frac{c}{d}$ are two numbers such that $\frac{c}{d} \neq 0$, then $(\frac{a}{b} \div \frac{c}{d})$ is also a rational number. This property is known as **CLOSURE PROPERTY**.

Property 2: For every rational number, we have then $(\frac{a}{b} \div 1) = \frac{a}{b}$. This property is known as **PROPERTY OF 1**.

Property 3: For every rational number, we have then $(\frac{a}{b} \div \frac{b}{a}) = 1$. Here, $\frac{a}{b}$ and $\frac{b}{a}$ are **RECIPROCAL TO EACH OTHER**.

1.14 Finding more than one Rational Number between two Rational Numbers

Question:

How do we find a rational number between two rational number?

Answer:

If *x* and *y* are two rational numbers such that x < y, then $\frac{x+y}{2}$ is the rational number between *x* and *y*.

Question:

Find a rational number between $\frac{1}{3}$ and $\frac{1}{2}$.

Answer:

Required Number = $(\frac{1}{3}+\frac{1}{2})/2=(\frac{5}{6})/2=\frac{5}{12}$.

Question:

Find three rational numbers between 3 and 5.

Answer:

First number between 3 and 5 = $\frac{3+5}{2}=4$

Second number between 3 and 4 = $\frac{3+4}{2}=\frac{7}{2}$

Third number between 4 and 5 = $\frac{4+5}{2}=\frac{9}{2}$

Thus, the three rational number between 3 and 5 are 4, 7/2, 9/2.

Question:

Find 9 rational number between 1 and 2.

Answer:

Since 1 = $\frac{10}{10}$ and 2 = $\frac{20}{10}$, the nine rational number between 1 and 2 are

$\frac{11}{10},\frac{12}{10},\frac{13}{10},\frac{14}{10},\frac{15}{10},\frac{16}{10},\frac{17}{10},\frac{18}{10},\frac{19}{10},$

Question:

What are equivalent ratios?

Answer:

Let a ratio as a/b. When we multiply a non-zero number (m) in the numerator and the denominator, we get another ratio as am/bm or when divide the numerator (a) and denominator (b) by a non-zero number (n), we get another ratio as (a/n)/(b/n).

Thus, the ratios am/bm and (a/n)/(b/n) are known as the equivalent ratios of a/b.

For example: the equivalent ratio of 16/15 = (16 x 2)/(15 x 2) = 32 / 30 and equivalent ratio of 25/45 = (25/5) / (45/5) = 5 / 9

Question:

What is absolute value of a number?

Answer:

An absolute value of a number represents the distance between the zero (0) and the number on the number line. The absolute value of a number is always positive and it is represented in the MODULUS sign (|x|).

The absolute value of a number (x) is defined as below.

$| x | = x$, when $x > 0$,

$| x | = 0$, when $x = 0$ and

$| x | = -x$, when $x < 0$. For example: $| 5 | = 5$ and $| -7 | = -(-7) = 7$.

It means, the distance between 0 and 5 on the number line is 5. Thus, the absolute value of 5 is $| 5 | = 5$ and the distance between 0 and -7 on the number line is 7. Thus, the absolute value of -7 is $| -7 | = 7$.

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