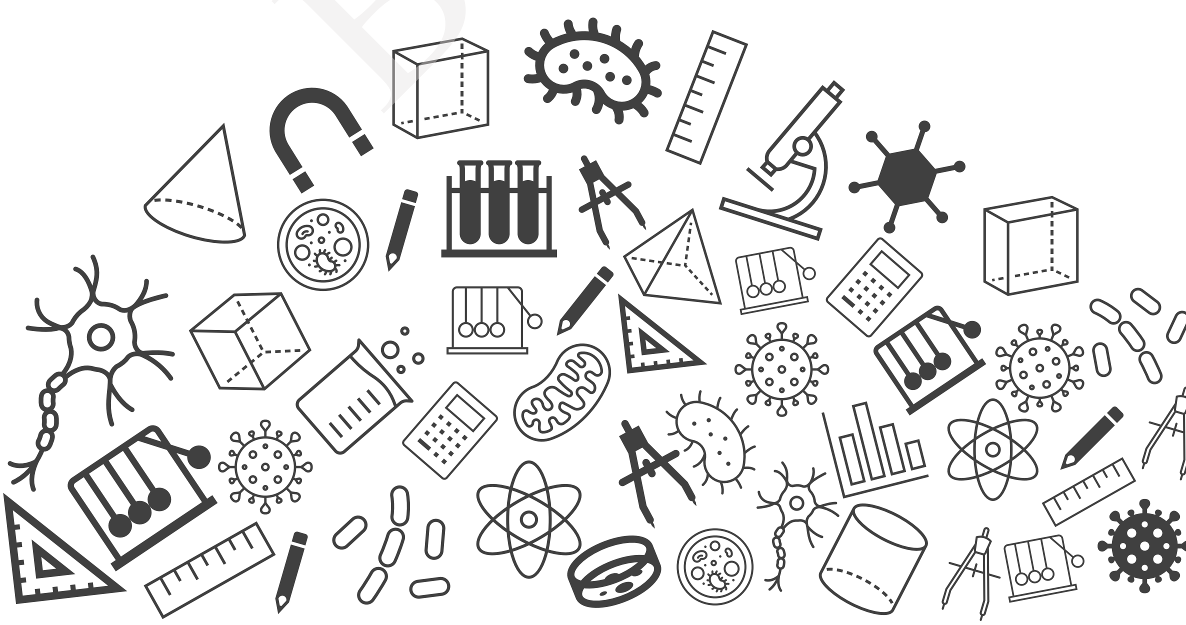
Grade 09
Mathematics Chapter Notes



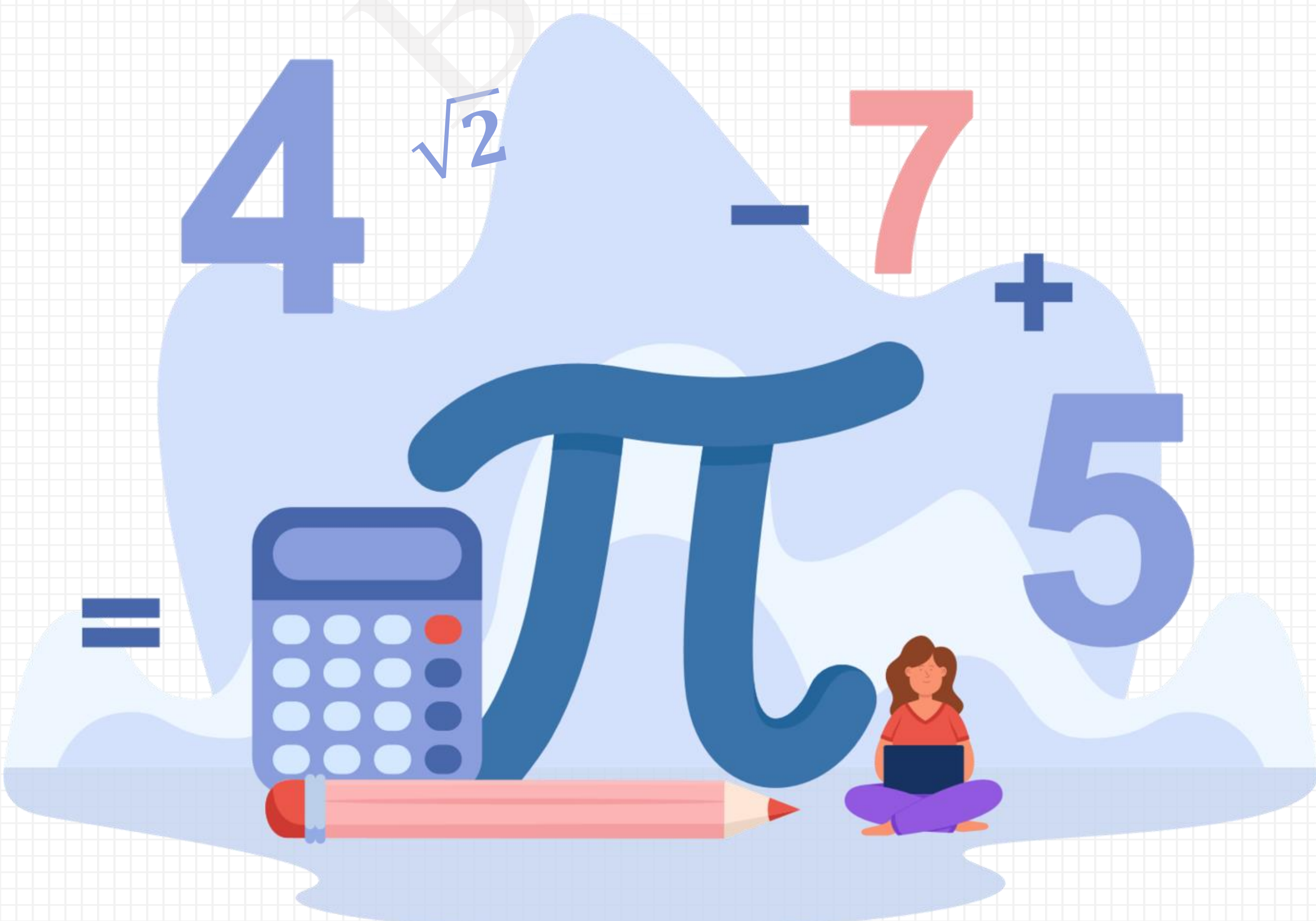
BYJU'S

Classes

CHAPTER NOTES

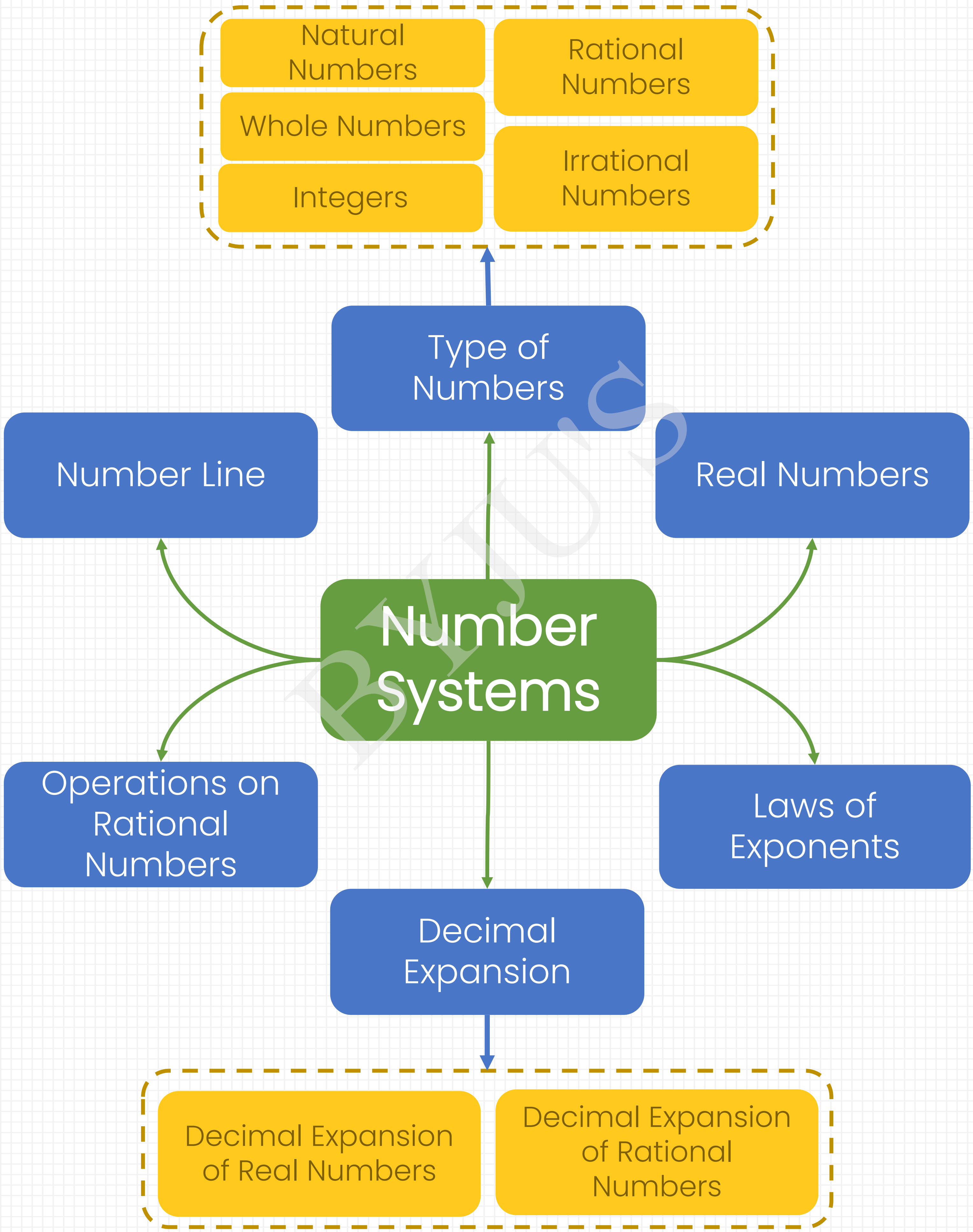
Number Systems

Grade 9



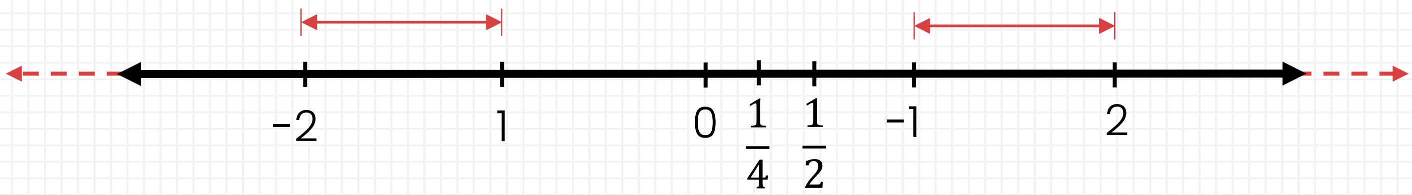
Topics

Mind Map



Natural Numbers
Whole Numbers
Integers
Rational Numbers
Irrational Numbers
Type of Numbers
Number Line
Real Numbers
Number Systems
Operations on Rational Numbers
Laws of Exponents
Decimal Expansion
Decimal Expansion of Real Numbers
Decimal Expansion of Rational Numbers

1. Number Line



A number line is a straight line with numbers placed at equal intervals along its length. It can be extended infinitely in any direction and is usually represented horizontally

2. Types of Numbers

2.1 Natural Numbers

Natural numbers are also called counting numbers.

They start with 1 and end at infinity.

Example:
1, 2, 3, ...

2.2 Whole Numbers

Whole numbers include all the natural numbers and zero.

They start with 0 and end at infinity.

Example:
0, 1, 2, 3, ...

2.3 Integers

Integers are whole numbers that can be positive, negative or zero.

Example:
..., −2, −1, 0, 1, 2, ...

All the natural numbers are whole numbers but the vice versa is not true.

2.4 Rational Numbers

A rational number can be expressed as $\frac{p}{q}$, where p and q are integers and $q \neq 0$

Example: $\frac{1}{2}, \frac{3}{4}, -\frac{1}{2}, \ldots$

1, 2, 3, ...can be written in the $\frac{p}{q}$ form as $\frac{2}{1}, \frac{3}{1}, \ldots$ Hence, all the integers are rational numbers but the vice versa is NOT true.

2.5 Equivalent Rational Numbers

Rational numbers do not have a unique representation in the form $\frac{p}{q}$.

Example: $\frac{1}{2} = \frac{2}{4} = \frac{12}{24}$, and so on

These are **equivalent rational numbers**.

There are infinitely many rational numbers between two rational numbers

2.6 Irrational Numbers

Irrational numbers can NOT be expressed as $\frac{p}{q}$, where p and q are integers and $q \neq 0$

Example: $\sqrt{2}, \sqrt{3}, \sqrt{15}, \pi$

When we use the symbol $\sqrt{\ }$, we assume that it is the positive square root of the number.

So, $\sqrt{4} = 2$, though both 2 and -2 are square roots of 4.

There are infinitely many irrational numbers between two numbers.

3. Real Numbers

Rational Numbers

$$\ldots, -\frac{5}{2}, 0, 0.8, 1, 2, \frac{7}{3}, \ldots$$

Integers

$$\ldots, -1, 0, 1, 2, 3, 4, \ldots$$

Whole Numbers

$$0, 1, 2, 3, 4, \ldots$$

Natural Numbers

$$1, 2, 3, 4, \ldots$$

Irrational Numbers

$$\ldots, \sqrt{5}, \sqrt{7}, \pi, \ldots$$

4. Decimal Expansion of Real Numbers

4.1 Terminating

RECURRING

2.345

Rational Number

4.2 Non – Terminating

RECURRING

2.3333...

Rational Number

NON-RECURRING

1.23464...

Irrational Number

We often take the approximate value of π as $\frac{22}{7}$, but $\pi \neq \frac{22}{7}$

5. Decimal Expansion of Rational Numbers $\left(\frac{p}{q}\right)$

5.1 Terminating

The denominator, q has factors in the form of

$\mathbf{2^n, 5^m}$ or $\mathbf{2^n \times 5^m}$

Example:

$\frac{1}{25}$

5.2 Non – Terminating Recurring

The denominator, q DOES NOT have factors in the form of

$\mathbf{2^n, 5^m}$ or $\mathbf{2^n \times 5^m}$

Example:

$\frac{1}{27}$

6. Operations on Real Numbers

6.1 Rational & Rational

$+ - \times \div$

Rational Number

Example:

$3 \div 4 = \frac{3}{4}$

6.2 Rational & Irrational

$+ - \times \div$

Irrational Number

Example:

$3 \times \sqrt{2} = 3\sqrt{2}$

6.3 Irrational & Irrational

$+ - \times \div$

Rational/Irrational

Example:

$3 \times \sqrt{2} = 3\sqrt{2}$

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

If r is rational and s is irrational, then $r + s$ and $r - s$ are irrational numbers, $r \neq 0$.

If r is rational and s is irrational, then $r \times s$ and $\frac{r}{s}$ are irrational numbers, $r \neq 0$.

6.4 Identities on Real Numbers

1. $\sqrt{ab} = \sqrt{a}\sqrt{b}$

2. $\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$

3. $\left(\sqrt{a} - \sqrt{b}\right)\left(\sqrt{a} + \sqrt{b}\right) = a - b$

4. $\left(a + \sqrt{b}\right)\left(a - \sqrt{b}\right) = a^2 - b$

5. $\left(\sqrt{a} + \sqrt{b}\right)^2 = a + b + 2\sqrt{ab}$

6. $\left(\sqrt{a} - \sqrt{b}\right)^2 = a + b - 2\sqrt{ab}$

6.5 Rationalisation

Rationalisation of the denominator means removing any radical term or surds from the denominator and expressing the fraction in a simplified form.

Denominator		Rationalising Factor		Simplified Form
$a+\sqrt{b}$	$\times$	$a-\sqrt{b}$	$=$	a^2-b
$a-\sqrt{b}$	$\times$	$a+\sqrt{b}$	$=$	a^2-b
$\sqrt{a}+\sqrt{b}$	$\times$	$\sqrt{a}-\sqrt{b}$	$=$	$a-b$

Steps for Rationalisation

Step 1: Find the conjugate or rationalising factor of the denominator.

Step 2: Multiply the numerator and denominator by the conjugate.

Step 3: Simplify the expression.

7. Laws of Exponents

1. $a^m \times a^n = a^{m+n}$
2. $(a^m)^n = a^{mn}$
3. $\frac{a^m}{a^n} = a^{m-n}$
4. $a^m \times b^m = (ab)^m$
5. $a^0 = 1$
6. $\frac{1}{a^n} = a^{-n}$
7. $\sqrt[n]{a} = a^{\frac{1}{n}}$
8. $\sqrt[n]{a^m} = a^{\frac{m}{n}}$