CHAPTER: Number System

Grade: **9**
Board: **CBSE**
Book: **NCERT**

1.

Chapter Summary and Placement

<Read through the following to understand how this chapter is connected with the previous and next grades and also the important concepts covered in it.>

1. *It connects to all number system chapters done till this grade [Set of natural numbers to set of rational numbers]*
2. *In this chapter it extends to set of irrational numbers*
3. *It connects to Real numbers chapter in next grade*

2.

LEARNING OUTCOMES

<On completion of the chapter, students will be able to:>

1. *Review representation of natural, whole, integers and rational numbers on number line.*
2. *Identify irrational numbers*
3. *Locate irrational numbers on number line*
4. *Define real number set*
5. *Classify a real number as rational or irrational*
6. *Write the decimal expansion of a number and vice versa*
7. *Express a number[integral or decimal] in p/q form*
8. *Represent real number on number line by successive magnification*
9. *Simplifies the given expression involving irrational number*
10. *Rationalise the denominator*
11. *Apply laws of exponents to real numbers*

4. TEACHING PLAN

Follow this section for getting ideas on teaching the content covered in the chapter. The subtopic given in the first column with the matching learning outcome can be explained using instructions and resources listed subsequently

Subtopic and Learning Objective #1

Subtopic: Representation of numbers on number line
LO:
Review representation of natural, whole, integers and rational numbers on number line.
1.To make the student recall representation of numbers on number line

Teacher Activity

1. *A quick recap can be done to recollect the set of natural, whole, integers and rationals with examples. Representation of these numbers on number line and properties of number line*
2. ***Resource 1** can be used for explanation*

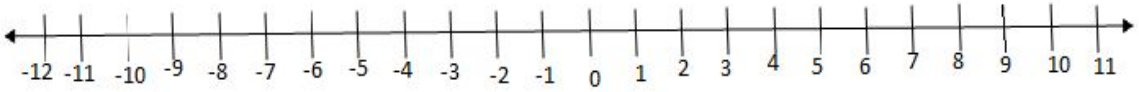
Check for understanding:

a) *As we move on to the right of any number line the value of number_____*
b) *713 lies between _____ and _____ on number line*
c) *To represent 37on a number line number of divisions to be made between 0 and 1 are_____*
d) *-257 lies between _____ and _____ on number line*
e) *Represent 25on number line*

Resources Suggested

Blackboard, pen and paper
Resource 1

Resource 1



Integers that are placed right to the zero are called positive integers and the integers that are placed left to the zero are negative integers.

As we move on right to the number line the value of number increases so, positive integers are greater in value than negative integers.[For comparison of integers analyse the position of integers on number line and can be compared easily]

Zero is neither positive nor negative

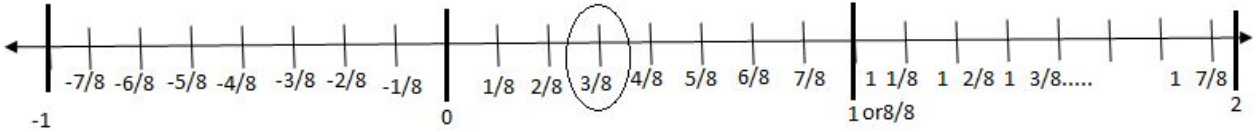
As we know fractions are rational numbers but rational numbers can not be fractions [since 0/2 is a rational number but it can not be a fraction]

Points to be remembered about rational numbers number line:

- *All proper fractions lie between 0 and 1 or 0 and -1*
- *Improper are to be converted to mixed fractions to know the position. All improper fractions lie between the whole number of mixed fraction and next whole number[325lies between 3 and 4, similarly -325lies between -3 and -4]*
- *Each main division must be subdivided as many divisions as in denominator of the fraction. Like to represent 38the number of subdivisions from 0 to 1 on the number line must be 8*

3/8 on number line as shown in figure

Resource 1



Represent -134 on number line



Subtopic and Learning Objective #1

Sub topic: Irrational numbers and representation on number line
***LO**: Identify irrational numbers*
1. To make students understand what an irrational number is

***LO:** Locate irrational numbers on number line*

2. To make students represent irrational number on number line.

Teacher Activity

1. *Do a quick recap of terminating, non terminating and repeating , non terminating and non repeating decimals with examples.*
2. ***Introduce rational number****[a number which can be written in the form of p/q. Eg: all natural, whole, integers,terminating decimals like 2.3, 0.485…; non terminating and repeating decimals like 2.333….,1.23454545…; numbers whose square roots are whole numbers like 4, 9,...]*
3. ***Introduce irrational numbers****[a number which cannot be written in the form of p/q. Eg.: Non terminating and non repeating decimals 2.3452135467089…., 1.2345436278……;whole numbers whose square root is not a whole number like 2,3,5,..]*
4. *Introduce representation of irrational numbers on number line*
5. ***Resource 1*** *can be used*

Check for understanding:

a) *Give an example each for terminating, non terminating and repeating, non terminating and non repeating decimals*
b) *2/5can be represented as _____ decimal*
c) *2/27can be represented as _____decimal*
d) *8 can be represented as _____ decimal*

Resources Suggested

Blackboard, pen and paper

Subtopic and Learning Objective #2

Sub topic: Real numbers

LO:
Define real number set
1. To help students understand real numbers
LO:
Classify real number as rational or irrational
2. To help students identify if a given real number is rational or irrational

Teacher Activity

1. *Introduce the real number set as union of rational and irrational numbers*
2. ***Activity** can be performed to get better understanding of number systems*
3. *Make student practice to classify the given real number as rational or irrational by checking the characteristics of the given number.[Like whether it is terminating or non terminating, recurring or non recurring, it has whole number as a square root or not]*

Check for understanding:

a) *Give an example each for rational and irrational number*
b) *In the square root of a number is not a whole number then the number is_____*
c) *Union of rational, irrational numbers together form the set of _____*
d) *_____is rational /irrational number[number can be teachers choice]*

Resources Suggested

Blackboard, pen and paper

Activity 1

Name of the activity- Sort out the given statements
Type of activity – individual
Use it for – Practice
Materials – pen and paper/ Flash cards of statements if resources permits
Procedure –
Instructions to the teachers:

1. *Ask the student to draw a table of 3 columns in their note book or an A4 sheet*
2. *The headings of the columns must be **Always true, Sometimes true, Never true***
3. *Now either write the below statements on the board or prepare flash cards with the statements below*
4. *Students must sort out the statements and write in the respective columns as they stay true*

Activity 1

1. *If a number contains a decimal places then it is an irrational number*
2. *If a number is a whole number then it is a natural number*
3. *If a number contains a decimal places then it is an integer*
4. *If a number is a whole number then it is a real number*
5. *If a number is a real number then it is a whole number*
6. *If a number is a repeating decimal then it is a irrational number*
7. *If a number is negative then it is an irrational number*
8. *If a number is a natural number then it is a real number*
9. *If a number is an natural number then it is an irrational number*
10. *If a number is a rational number then it is a real number*
11. *If a number is a real number then it is a rational number*
12. *If a number is even then it is an irrational number*
13. *If a number is an integer then it is a rational number*
14. *If a number is positive then it is a whole number*
15. *If a number is a real number then it is an irrational number*
16. *If a number contains π then it is a real number*
17. *If a number is rational then it is an integer*
18. *If a number is positive then it is a natural number*
19. *If a number is irrational then it is a natural number*

Activity 1


The Real Number System
Always, Sometimes, or Never
Card Sort Activity
Always True
4 If a number is a Whole number, then it is a Real number
8 If a number is a Natural number, then it is a Real Number
10 If a number is a Rational number, then it is a Real Number
13 If a number is an Integer, then it is a Rational number
16 If a number contains π, then it is a Real number
21 If a number is Irrational, then it is a Real Number
23 If a number is a Natural number, then it is a Whole number
24 If a number is a Natural number, then it is an Integer
Sometimes True
1 If a number contains decimal places, then it is an Irrational number
2 If a number is a Whole number, then it is a Natural number
5 If a number is a Real number, then it is a Whole number
7 If a number is negative, then it is an Irrational number
11 If a number is a Real Number, then it is a Rational number
14 If a number is positive, then it is a Whole number
15 If a number is a Real Number, then it is a Rational number
17 If a number is Rational, then it is an Integer
18 If a number is positive, then it is a Natural number
20 If a number is negative, then it is an Integer
Never True
3 If a number contains decimal places, then it is an Integer
6 If a number is a repeating decimal, then it is an Irrational number
9 If a number is an Integer, then it is an Irrational number
12 If a number is even, then it is an Irrational number
19 If a number is Irrational, then it is a Natural number
22 If a number is negative, then it is a Whole number
3
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Subtopic and Learning Objective #3

Sub topic:Decimal expansion of number
LO*:*
Write the decimal expansion of a number and vice versa
1. To make students write the decimal expansion of number
LO:
Express a number[integral or decimal] in p/q form
2. To make student to write given decimal in p/qform

Teacher Activity

1. *Introduce long division method to write decimal expansion of the given number specifically rational number*
2. *Introduce the method of writing a number in p/q form as given in NCERT text book*

Check for understanding:

a) *Write decimal form of 38*
b) *Write decimal form of 227*
c) *Write p/q form of 1.25*
d) *Write p/q form of 1.232323……...*
e) *Write p/q form of 2.133333……....*

Resources Suggested

Blackboard, pen and paper

Subtopic and Learning Objective #4

Sub topic: Representation of real number on number line
LO*:*
Represent real number on number line by successive magnification
1. To make student represent real number on number line

Teacher Activity

Introduce method of successive magnification to represent real number on number line as in NCERT text book

Check for understanding:

a) *Represent 1.234 on number line by successive magnification*
b) *Represent 1.23769……. On number line upto 3 decimal places*

Resources Suggested

Blackboard, pen and paper

Subtopic and Learning Objective #5

Subtopic:Simplification of given expression
LO*:*
Simplifies the given expression involving irrational number
1. To make student simplify the given expression

Teacher Activity

*Introduce the facts as in **Resource 2** that are to be used in simplification of irrational number*

Check for understanding:

a) *Simplify 3+23-53*
b) *Simplify 532*
c) *Simplify 284*
d) *Simplify 3+23-53*

Resources Suggested

Blackboard, pen and paper

Resource 2

The facts to be noted down while simplifying two irrational numbers

1. *The sum/difference of a rational and irrational number is irrational*
   2-2=2-1.414....=0.586.....which is irrational
   3+5=1.732.....+5=6.732.... which is irrational
2. *The product/quotient of a non zero rational and irrational number is irrational number*
   22=1.414.....2=2.828..... which is irrational
   32=1.73205080.....2=0.86602540.....which is irrational
3. *The sum, difference, product, quotient of two irrational numbers is either rational or irrational*
   25-5=5 which is irrational
   25+5=35 which is irrational
   255=25=10 which is rational
   255=2 which is rational

Subtopic and Learning Objective #6

Sub topic:Rationalising factor

***LO**:*
Rationalise the denominator

1. To make student to understand surds and rationalising factor of it

Teacher Activity

1. *Introduce the definition of surds and the method of rationalising*
2. ***Resource 3** can be used for explanation*

Check for understanding:

a) *Give an example of a surd*
b) *Rationalising factor of 7 is _____*
c) *Rationalising factor of 2+3 is _____*
d) *Rationalising factor of a-b is _____*
e) *Rationalise the denominator 53-2*

Resources Suggested

Blackboard, pen and paper

Teacher Activity

Surds *are numbers left in root form (√) to express its exact value. It has an infinite number of non-recurring decimals. Therefore, surds are irrational numbers.*
There are certain rules that we follow to simplify an expression involving surds. ***Rationalising the denominator*** *is one way to simplify these expressions. It is done by eliminating the surd in the denominator. This is shown in Rules 3, 5 and 6.*
It can often be necessary to find the ***largest perfect square factor*** *in order to simplify surds. The largest perfect square factor is found by looking at any possible factors of the number that is being square rooted. Let's say that you are looking at the square root of 242. Can you simplify this? Well, 2 x 121 is 242 and we can take the square root of 121 without leaving a surd (because we get 11). Since we cannot take the square root of a larger number that can be multiplied by another to give 242 then we say that 121 is the largest perfect square factor.*

Resource 3

Six Rules of Surds

Rule:1 *ab=a b*

Example:

Simplify18 :

Since 18=92=322=32

Rule:2 a b=ab

Example:

Simplify 12121=223112 =2 311

Rule:4 *By multiplying both the numerator and denominator by the denominator you can rationalise the denominator.*

Example:

Rationalise:

$$\frac{5}{\sqrt{7}} = \frac{5}{\sqrt{7}} \times \frac{\sqrt{7}}{\sqrt{7}}$$

multiply both numerator and denominator by $\sqrt{7}$

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

Resource 3

Rule:5 acbc=(ab)c

Example:

$$5\sqrt{6}+4\sqrt{6}=(5+4)\sqrt{6}$$

$$=9\sqrt{6}$$

using the rule $a\sqrt{c}\pm b\sqrt{c}=(a\pm b)\sqrt{c}$

Rule:6 a) *Following this rule enables you to rationalise the denominator.*

Ca+b nmultiply both numerator and denominator with a-bn

An Example:

Rationalise $\frac{3}{2+\sqrt{2}}=\frac{3}{2+\sqrt{2}}\times\frac{2-\sqrt{2}}{2-\sqrt{2}}$ multiply the numerator and denominator by $2-\sqrt{2}$

$$=\frac{6-3\sqrt{2}}{4-2}$$

$$=\frac{6-3\sqrt{2}}{2}$$

Rule:6 b) *Following this rule enables you to rationalise the denominator.*

ca-bnmultiply both numerator and denominator with a+bn and follow the same procedure as above

Subtopic and Learning Objective #7

Sub topic:Laws of exponents
LO*:*
Apply laws of exponents to real numbers

1. To make student know and apply laws of exponents

Teacher Activity

1. *Introduce laws of exponents with examples and specify 0^0 is not defined. Make sure that students memorize the laws*
2. ***Resource 4** can be used*

Check for understanding:

a) State the laws of exponents
b) To simplify
c) aman Powers are to be _____
d) When two real numbers with different powers are multiplied, to get the answer the powers are to be _____
e) To simplify qman Powers are to be _____
f) When two real numbers with different powers are divided, to get the answer the powers are to be _____
g) 0^0=_____

Ask one example specifying each law of exponent until the students are perfect in laws

Resources Suggested

Blackboard, pen and paper
***Resource 4** can be used*

Resource 4

For any real numbers a and b ; m and n are integers the following laws holds good

Law	Illustration
(1) $a^m a^n = a^{m+n}$	$2^3 \cdot 2^4 = 2^{3+4} = 2^7 = 128$
(2) $(a^m)^n = a^{mn}$	$(2^3)^4 = 2^{3\cdot 4} = 2^{12} = 4096$
(3) $(ab)^n = a^n b^n$	$(20)^3 = (2 \cdot 10)^3 = 2^3 \cdot 10^3 = 8 \cdot 1000 = 8000$
(4) $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$	$\left(\frac{2}{5}\right)^3 = \frac{2^3}{5^3} = \frac{8}{125}$
(5) (a) $\frac{a^m}{a^n} = a^{m-n}$	$\frac{2^5}{2^3} = 2^{5-3} = 2^2 = 4$
(b) $\frac{a^m}{a^n} = \frac{1}{a^{n-m}}$	$\frac{2^3}{2^5} = \frac{1}{2^{5-3}} = \frac{1}{2^2} = \frac{1}{4}$

Resource 4

Definition ($a \neq 0$)	Illustrations
$a^0 = 1$	$3^0 = 1, \quad (-\sqrt{2})^0 = 1$
$a^{-n} = \frac{1}{a^n}$	$5^{-3} = \frac{1}{5^3}, \quad (-3)^{-5} = \frac{1}{(-3)^5}$

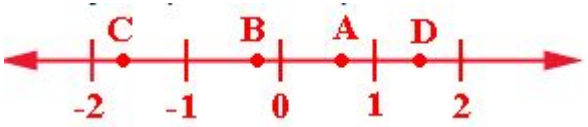
5. WORKSHEETS

Print or copy the worksheet questions on the blackboard and ask the students to attempt them. They can be given as homework or a class test as well.

Worksheet 1

Use it like: test after the chapter is complete, homework, class assignment

Answer the following:



Identify the point that represents
3/2on number line

a) A
b) B
c) C
d) D

Worksheet 1

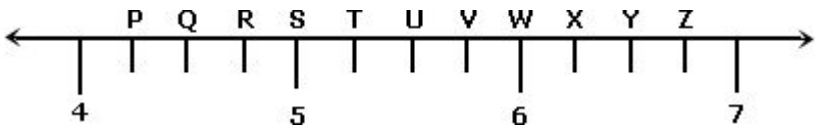
Which of the following is simultaneously a natural number, a whole number, a rational number and an integer?

a) -13
b) -9.5
c) 57
d) 36

3. Identify a true statement.

a) All rational numbers are whole numbers.
b) All natural numbers are rational numbers.
c) All integers are irrational numbers
d) All real numbers are integers.

Choose the letter that represents the mixed number6 1/2 on the number line.



Worksheet 2

Use it like: test after the chapter is complete, homework

Answer the following:

1. Identify the irrational number

a) 310

b) 36

c) 3

d) 35

2. Identify the irrational number.

a) 1.7

b) 2.23606797749. . .

c) 0.171717171717…

d) 0.51

3. Identify the rational number.

a) 121

b) 51 c) 11. d) 21

Worksheet 2

Identify the irrational number.

a) *5.12256556277689…*
b) *2*
c) *1/6*
d) *5/8*

5. Identify the irrational number.

a) *O.7*
b) *45*
c) *Root of 11*
d) *Root of 49*

Worksheet 3

Use it like: test after the chapter is complete, homework

Answer the following:

1. *Write 2.456 in p/q form*
2. *Write 2.343434…… in p/q form*
3. *Write 1.233333…… in p/q form*
4. *Write 56In decimal form*
5. *Write 245in decimal form*
6. *Write 423 in decimal form*

Worksheet 4

Use it like: test after the chapter is complete, homework

1. Simplify the following surds:

(a) $\sqrt{12}$ (b) $\sqrt{125}$ (c) $\sqrt{48}$ (d) $\sqrt{72}$

2. Expand and simplify the following expressions:

(a) $4(\sqrt{5}+3)$ (b) $\sqrt{2}(3+\sqrt{5})$

(c) $(8-\sqrt{2})(8+\sqrt{2})$ (d) $(5-\sqrt{2})(5+\sqrt{2})$

(e) $(\sqrt{3}+\sqrt{5})(\sqrt{3}+\sqrt{5})$

3. Rationalise the denominators of the following

(a) $\dfrac{1}{1+\sqrt{3}}$ (b) $\dfrac{1}{3-\sqrt{5}}$ (c) $\dfrac{\sqrt{2}}{6+\sqrt{2}}$

4. If $a=2+\sqrt{3}$, then find the value of $a-\dfrac{1}{a}$.

Worksheet 5

Use it like: test after the chapter is complete, homework

Simplify the following:

1. $(-2)^3 \cdot (-2)^1 \cdot (-2)^2 \cdot (-2)^6$
2. $\dfrac{9x^4y^5}{6x^2y^{10}}$
3. $(5x^3y^2)^0$
4. $(-3x^4y^2)^3$
5. $\dfrac{1}{a^{-1}b^{-1}}$ in positive powers

Worksheet 5

Simplify the following:

1) $\dfrac{4^5 \times 4^6}{4^3}$

2) $3^4 \times (3^5)^{-2} \times \left(\dfrac{3^2}{3^4}\right)^2$

3) $\dfrac{(5^{-3} \times 5^{-11})^4}{(5^{-4})^{10}}$

4) $\left(\left(6^3 \times \dfrac{6^7}{6^4 \times 6^2}\right)^{-4}\right)^{-2}$

5) $\dfrac{\left(\left(\dfrac{11}{20}\right)^4 \times \left(\dfrac{11}{20}\right)^{-8}\right)^5}{\left(\dfrac{11}{20}\right)^{-6}}$

6) If $a = \dfrac{3+\sqrt{5}}{2}$, then find the value of $a^2 + \dfrac{1}{a^2}$.

7) If $a = 5 + 2\sqrt{6}$ and $b = \dfrac{1}{a}$, then what will be the value of $a^2 + b^2$?

6. SOLUTIONS

This section gives you sample answers for activities and questions listed above.

Worksheet 1

1. *D*
2. *D*
3. *B*
4. *C*
5. *(a) Terminating*
6. *(b) Terminating*
7. *(c) Terminating*
8. *(d) Non-terminating*
9. *(e) Terminating*
10. *(f) Terminating*
11. *(g) Non-terminating*

Worksheet 2

1. *C*
2. *B*
3. *A*
4. *A*
5. *C*

Worksheet 3

1. 307/125
2. 23/299
3. 111/90
4. 0.833333……..
5. 2.8
6. 4.666666…….

Worksheet 4

1. *a) 23 b) 52 c) 43 d)62*
2. *a) 45+12 b) **32+10** **c) 62** **d) 23***
3. ***a) 3-12** **b) 3+54** **c) 32-117***
4. ***23***

Worksheet 5

1. -212
2. 3x22y5
3. 1
4. -27x12y6
5. ab

Worksheet 6

1. 48
2. 5-16
3. 3-10
4. 632
5. 1120-14
6. 21-35
7. 98

7. EXTRA RESOURCES

Carry out the following suggested activities/ tasks if you have the time and resources to do them

Teacher can use these videos if time and facilities permit:

1. *https://www.youtube.com/watch?v=dJkwEIt-mfM - Representation of real numbers on number line by successive magnification*
2. *https://www.youtube.com/watch?v=dQ9A-o3dUIM - Laws of exponents song*