GOVERNMENT OF TAMILNADU

STANDARD - IX

MATHEMATICS

TERM - I

TEACHER'S HAND BOOK

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PREFACE

Dear Teachers,

The ideal objective of the education system is to provide the society as a whole the fundamental skills, life skills and global perspective.

The newly developed textbook resources children who were learning by rote and sows seeds for global child centered learning activity. Teacher's Handbook not only serves as an additional material for transacting the textbook effectively but also as a guide.

Each unit of the Teachers' Handbook has been designed with the following headings.

- Important component
- Application in daily life
- Learning objectives
- Learning outcomes
- Planning for taking one of the topics of the content to students.
- Web resources
- Recommended activities for teacher and student activities
- Additional information based on the heading for Teacher professional development
- Additional activities
- Additional problems for Competitive examinations
- Self – assessment and
- Consolidation

Teachers are advised to keep the Handbook as a model and transform the classroom into lively. You need to make them feel the need and necessity of learning mathematics, alleviate the mathematical phobia and enrich their mathematical knowledge and understanding.

With wishes

Textbook Development Team

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CONTENT

1 How to use the book?

1.1. INTRODUCTION

Mathematics text book is for mathematics teachers working in secondary schools. This book will help teachers to improve the quality of mathematical education among children. Our state government developed Tamil Nadu State Curriculum Frame Work (TNSCF2017) in accordance with NCF 2005 and RTE 2009 which recommends that children's life at schools must be linked to the life outside the school. Hence it is mandatory to develop new syllabus and text books involving the children to participate, discuss and take an active part in the class room teaching learning processes includes content related activities , key points, projects and problem solving. Thus the new Text Books for class IX were developed in a phased manner with a national perspective to prepare the students with a strong base of Mathematics. Teaching learning strategies were given in accordance with New Curriculum. In this position, the teachers have to revise their Teaching Strategies to involve into the new processes. Based on this thee new Term-wise Mathematics Text Book was developed by SCERT for IX Standard in the year 2018.

1.2. AIM OF THIS BOOK

The book will help Mathematics Teachers:

- Text book aims to focus on the two new dimensions as mathematical modelling and mathematics for digital era.
- Present text book aims to assess the student's process skill such as ability to visualise to abstract to change representations to search for counter examples to provide arguments.
- This book aims to develop teacher professionalism is using online resources and reference materials.
- Find new and successful ways of Teaching Mathematics.
- Makes Mathematics more interesting and relevant to their studies.
- Understands some of the language and cultural issues of the students.

Above all we hope this book will contribute in improving the quality of Mathematics Education and to raise the standards of achievement.

1.3 .WAYS TO ACHIEVE THE OBJECTIVES:

The new text book focuses on;

TEACHING METHODS

This book gives detailed introduction of the concept, which connects knowledge to everyday life activities. This book gives more of activities examples and ideas for using many different methods in the class.

1.4 RESOURCES AND TEACHING AIDS

Students learn a lot by doing activities – investigating, thinking, analysing, self assessing and constructing ideas. There are many ways of using low cost and locally available resources so that the students can learn by doing and demonstrating. This book shows

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how to teach more effectively using resources such as Web Resources, ICT Corner and References.

1.5 CHAPTERISATION OF UNITS:

Text book consists of ten chapters. Each chapter in the text book contains;

- Introduction about Mathematician
- Learning outcomes
- Introduction TO UNIT

Activities to enrich the content

- Sub topics
- Definitions
- Properties
- Solved examples
- Exercises
- Notes related to the topic
- Thinking corner
- Important points in the box
- Progress check
- ICT corner
- QR codes
- Points to remember and
- Answers for the exercise problems.

1.6 Web Technology – Application

The URL link has beed provided for each unit of the textbook to enhance the understanding of the content of learners through the application of technology. This would facilitate motivating the students and learning the content with interest. Besides, each unit of the textbook has been provided with QR Code. The Scan app can be downloaded free of cost and the content imaged on the screen by scanning the QR code can be taught to the students.

1.7 Topic of Term I:

The contents in the Mathematics text book are divided into Trimester Pattern. The first Term book deals with the following chapters:

- Set language
- Real numbers
- Algebra
- Geometry
- Co ordinate geometry

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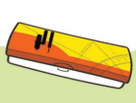
UNIT SYNOPSIS :

MONTH	WEEK	TOPIC	DURATION	UNIT	LEARNING OUTCOME
JUNE	I	SET LANGUAGE	7	1.1 – 1.3.3	Description of a set, Representation of a set (Descriptive form, Set Builder form and Roster form)
	II		7	1.4.1 – 1.5.6	Identifies the types of set. Understands and perform set operations
	III		7	1.6 and Revision	Usage of Venn diagrams to represent sets and its operations. Solving life oriented simple word problems
	IV	REAL NUMBERS	7	2.1 – 2.3.5	Concept of rational numbers. Existence of infinitely many rational numbers between any two rational numbers. Denote a rational number on a number line. Represent a rational number as terminating decimal.
JULY	I		7	2.3.6 – 2.4.2, Revision	Express an irrational number in the decimal form. Locating an irrational number on a number line. Visualizing the real number on the number line.
	II	ALGEBRA	7	3.1 -3.3.3	Understands a polynomial in one variable. Classification of polynomial based on degree and terms. Performing addition, subtraction and multiplication operations in polynomials.
	III		7	3.4 – 3.5.1	Understands the zeros and the roots of the polynomial. Division of a polynomial and Division algorithm.
	IV		7	3.6 and revision	Understands the remainder theorem





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AUG	I	GEOMETRY	7	4.1 – 4.3.4	Understands the theorem on linear pair and vertically opposite angles. Understands the concepts of parallel lines with the transversal. Understands the angle sum property of triangles. Classification of a quadrilateral and its special names. Types of quadrilateral. properties of quadrilateral.
	II		1 1	4.3.5 – 4.4.2,Rev	Parallelogram and its properties and theorems. Construction of circum-centre and ortho-centre
					Understands the Cartesian coordinate system Abscissa and Ordinate on the coordinate plane. Plotting points in a Cartesian plane
	IV		1 2	5.3 – 5.3.3, Revision	Understands the distance between any two points through the real life situation. Find the distance between any two points. Properties of distances.
SEP	I	REVISION			Revision for SA I







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2.1 2. Chapters Set Language

Teaching / Learning tools

textbook, blackboard, pictures, charts, paper folding, paper cuttings, electronic gadgets, and others

Mon	Tue	Wed	Thu	Fri

Spotlight

- Learning about sets and where and how it is used.
- Understanding that everything in real life can be divided into sets based on some criteria that make them similar or dissimilar.

  Example:
  - a group of people form a set
  - rainbow colours form finite sets and stars in the sky from infinite sets
  - food, fitness, and exercise
  - parenting and grandparenting

Learning Objectives

At the end of the lesson, students will be able to

- define a set and its descriptions
- differentiate descriptive form, set builder form, and roster form
- identify different types of sets
- understand set operations
- represent sets through Venn diagrams and set operations
- solve word problems based on real life situations

Learning Outcomes

Through the course of the lesson, students will be able to

- describe a set
- represent sets in descriptive form, set builder form, and roster form
- study the elements in a set and name the type of set
- perform set operations
- use Venn diagrams to represent sets and set operations
- apply concepts to real life situations

2.1.1. Introduction, Set

Transactional Strategy

Teaching-Learning method

Warm up

- Share the list of examples on collection (textbook, page 3) to help students understand sets.

00:30

Classroom Situation

- Give examples of commonly used items in daily life for a better understanding of sets.

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Teaching-Learning method

✧ Use examples to explain what a set is.

Example:

- Ask students to list out the subjects they had learnt in Class VIII. Ask the question, 'Shall we group the subjects under a set and name it, *The set of subjects studied in VIII standard*?'

  {Tamil, English, Mathematics, Science, and Social Science}

- Ask students to name some Indian men cricket players whom they know of. Ask them, 'Shall we group the names in a set and name it, *The set of Indian men cricket players?'*

  {Yuvraj Singh, Virat Kohli, M.S. Dhoni, R. Ashwin, Suresh Raina, and Dinesh Karthik}

✧ Guide students to differentiate between sets and subsets.

✧ Jumble up details and ask students to identify which set will a particular detail belong to and put it in the correct column (form of sets).

✧ Explain the type of sets with various examples.

✧ One or more transactional methods given below can be followed.

observatory, self-learning, learning by doing, inductive and deductive method, simulation method, flow chart method, and so on

✧ One or more transactional strategies given below can be followed.

teacher activity, individual activity, group activity, paired activity, or any other

Note: The aim of warm up activities is to get students to talk about the topic that is going to be taken up.

https://youtu.be/tyDKR4FG3Yw
https://youtu.be/GbkHzgVZKzg
www.coolmath.org
(videos: introduction to sets)

Classroom Situation

Step 1: Students in the class are divided into small groups.

Step 2: Each group is provided with a set of adequate flash cards as given below.

{2, 4, 6, 8, 10,...}	{set of vowels in the English alphabet}	{x / x is a multiple of 5}	{green, white, saffron, blue}

Step 3: Students from each group are called forward and asked to read the given flash card. Then, he/she is asked to drop the card into the respective box. Activity to be continued till all the students in each group get a turn.

✧ Play the given weblinks to show videos about sets.

Assessment

Which of the following are sets?

1. The set of intelligent students in the classroom.
2. The set of multiples of 5.

You can follow the questions given in the textbook.

Note: Revise the chapter topics to bring more clarity to students who find the concepts difficult to understand.

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2.1.2 Representation of a Set

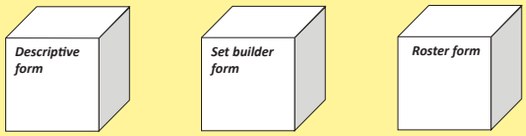
Transactional Strategy

Teaching-Learning method

Explain the types of sets and how they are represented.

Classroom Situation

You can explain different types of sets with the help of the following pictures.



Descriptive form

- Example:

  A set of numbers greater than 30 and smaller than 55.
- Play the given weblink to show a video on descriptive form.

https://youtu.be/_CJ2gI5O-pw (video: descriptive form)

Set builder form or Rule form

- Example:

  Let P be a set of counting numbers greater than 12;

  The set P in set builder form is written as:

  P = {x: x is a counting number and greater than 12}

  or

  P = {x | x is a counting number and greater than 12}

  This will be read as 'P is the set of elements x such that x is a counting number and is greater than 12'.
- Play the given weblink to show a video on set builder form or rule form.

https://youtu.be/6wrn-2xabEg (video: set builder form)

Roster form or Tabular form

- Example:

  The set of all odd numbers less than 9.

  Therefore, X = {1, 3, 5, 7}
- Play the given weblink to show a video on roster form.

https://youtu.be/muxfpFFRmWY (video: roster form)

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Assessment

Answer the following.

Express A = {1, 3, 5, 7, 9, 11} in set builder form.

Express B = {the set of planets in the solar system} in roster form.

Activity

Read today's newspaper and write the names of sports persons given in it. Create sets for players of cricket, hockey, badminton, volleyball, and so on.

Practise problems 1, 2, 4, 5 and 6 given under Exercise 1.1 in the textbook.

Note: Revise the chapter topics to bring more clarity to students who find the concepts difficult to understand.

2.1.3 Types of Sets

Transactional Strategy

Teaching-Learning method

Explain the types of sets with various examples.

Classroom Situation

Empty set or Null set

- Example:
  a. The set of whole numbers less than 0.
  b. Clearly, there is no whole number less than 0.
     Therefore, it is an empty set.
  c. N = {x: x ∈ N, 3 < x < 4}
- Play the given weblink to show a video on empty sets or null sets.

https://youtu.be/5qfv5iY05tc (video: empty sets or null sets)

Singleton set

- Example:
  B = {x: x is a whole number, x < 1}
  This set contains only one element 0 and is a singleton set.
- Play the given weblink to show a video on singleton set.

https://youtu.be/0qQwNzvnImg (video: singleton set)

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Teaching-Learning method

Classroom Situation

Finite set

- Example:

  The set of colours in the rainbow.

  N = {x: x ∈ N, x < 7}

- Play the given weblink to show a video on finite set.

https://youtu.be/Oesb5xaMYjo (video: finite set)

Infinite set

- Examples:

  The set of all points in a plane.

  The set of all prime numbers.

- Play the given weblink to show a video on infinite set.

https://youtu.be/BydchiZ8t6o (video: infinite set)

Equivalent set

Example:

A = {1, 2, 3} Here, *n* (A) = 3 (i) Same cardinal number

B = {p, q, r} Here, *n* (B) = 3 (ii) Different Elements

Therefore, *n* (A) = *n* (B). therefore, A and B are Equivalent sets

Equal set

Example:

A = {p, q, r, s} (i) Same cardinal number

B = {p, s, r, q} (ii) Same Elements

Therefore, A = B. therefore, A and B are Equal sets

Subset

- Example:

  Let, A = {2, 4, 6}

  B = {6, 4, 8, 2}

  Here A is a subset of B. Since, all the elements of set A are contained in set B.

  However, B is not the subset of A. Since, all the elements of set B are not contained in set A.

- Play the given weblink to show a video on subsets.

https://youtu.be/_9Wvu-R04go (video: subsets)

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Teaching-Learning method

Classroom Situation

Proper subset

- Example:

  If A={1,3,5} and B={1,5}, then B={1,5} is a proper subset of A.

  If set C= {1, 3, 5}, then C= {1, 3, 5} is a subset of A, but it is not a proper subset of A since C=A.

  If set D= {1, 4}, then D= {1, 4} is not even a subset of A, since 4 is not an element of A.

- Play the given weblink to show a video on proper subsets.

https://youtu.be/FNcbW_ja9Qo (video: proper subsets)

Power set

- Example:

  For the set S={a,b,c}

  - the empty set {} is a subset of {a,b,c}
  - these are subsets: {a}, {b}, and {c}
  - these are also subsets: {a,b}, {a,c}, and {b,c}

  and {a,b,c} is a subset of {a,b,c}

  Altogether, they make the power set

  P(S) = { {}, {a}, {b}, {c}, {a,b}, {a,c}, {b,c}, {a,b,c} }

- Play the given weblink to show a video on power set.

https://youtu.be/1obxIn-WD3A (video: power set)

Assessment

You can follow the questions given in the textbook.

2.1.4 Set Operations

Transactional Strategy

Teaching-Learning method

- Discuss all the set operations.
- Talk about the differences between sets.

Classroom Situation

Universal set

- Example:

  We have to determine the sets.

  M = {x / x are the multiples of 3}

  N = {x / x are the multiples of 5}

- Play the given weblink to show a video on universal set.

https://youtu.be/8innwDI1bv8 (video: universal set)

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Teaching-Learning method

Classroom Situation

Complement of a set

- Example:
  Let U = { orange, **apricot**, pineapple, banana, **mango**, apple, **kiwifruit**}
  Let B = { orange, pineapple, banana, apple}
  We show in bold all elements in U, but not in B.
  B^c = { apricot, mango, kiwifruit}
- Play the given weblink to show a video on finding complement of a set.

https://youtu.be/vmhssot-DAY (video: finding complement of a set)

Union of two sets

- We write A ∪ B to denote union of two sets A and B.
  We find A ∪ B by putting all the elements of A and B together.
  Example:
  Let A = { orange, pineapple, banana, apple} and
  B = { spoon, knife, fork}
  A ∪ B = { orange, pineapple, banana, apple, spoon, knife, fork}
- Play the given weblink to show a video on finding union of two sets.

https://youtu.be/DHA4EkVyT4w (video: union of two sets)

Intersection of two sets

- Example:
  If X = {a, b, c} and Y = { }. Find intersection of two given sets X and Y.
  Solution
  X ∩ Y = { }
- Play the given weblink to show a video on finding intersection of two sets.

https://youtu.be/8v3-EIFOmFg (video: intersection of two sets)

Difference between two sets

- Example:
  A = {1, 2, 3} and B = {4, 5, 6}.
  Find the difference between the two sets.
  a. A and B
  b. B and A
  Solution
  The two sets are disjoint as they do not have any elements in common.
  a. A - B = {1, 2, 3} = A
  b. B - A = {4, 5, 6} = B
- Play the given weblink to show a video on finding difference between two sets.

https://youtu.be/f2UT59j-Y1o (video: difference between two sets)






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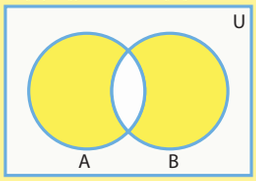
Teaching-Learning method

Classroom Situation

Symmetric difference between sets

- Example:

  If A = {1, 2, 3, 4, 5, 6, 7, 8} and B = {1, 3, 5, 6, 7, 8, 9}, then A – B = {2, 4}, B – A = {9} and A Δ B = {2, 4, 9}.



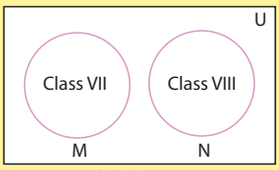
A△B

- Play the given weblink to show a video on finding symmetric difference between sets.

https://youtu.be/iyu-Ds0XeXc (video: symmetric difference between sets)

Disjoint sets

- Example:



Disjoint sets

2.1.5 Cardinality and Practical Problems on Set Operations

Transactional Strategy

Teaching-Learning method

- Explain cardinality with the help of types of sets.
- Solve practical sums with the help of Venn diagram.

Classroom Situation

- Example:

  'The number of elements in a set.'

  Let *A* be a set.

a. If A = Ø(the empty set), then the cardinality of A is 0.
b. If *A* has exactly *n* elements, *n* a natural number, then the cardinality of *A* is *n*.
c. The set *A* is a *finite set*.
d. Otherwise, *A* is an *infinite set.*

- Play the given weblink to show a video on cardinality.

https://youtu.be/kQAto-SgQ0c (video: cardinality)

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Assessment

Activity 1

In a classroom, take a survey among your friends and draw a Venn diagram for how many of them like to take ice cream or chocolate or biscuit or, ice cream and biscuit, biscuit and chocolate, or chocolate and ice cream.

Activity 2

Find the value in the table.

S.No.	Value of A-B	Value of B-A	Find the value
1.	ø	B	A = ...
2.	ø	ø	A = ...
3.	**A**	B	A∩B = ...

Activity 3

Which one of the following Venn diagram represent (A Δ B)' and (A ∪ B)'? Justify.

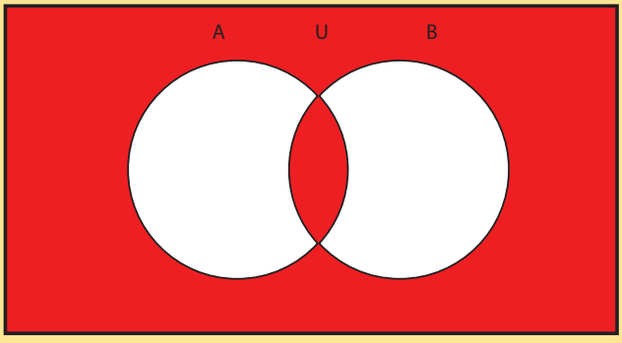

Fig 1

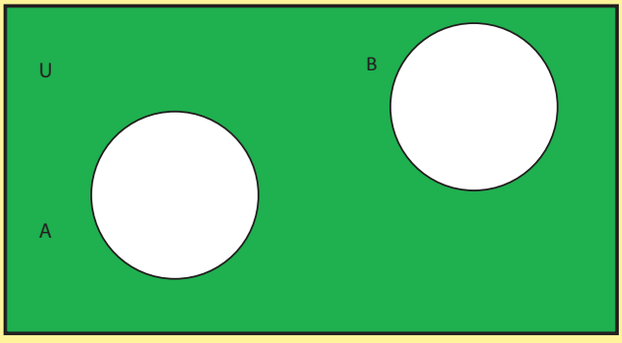

Fig 2

Activity 4

Think & answer

S.No.	Question	Answer
1.	If A and B are not empty sets, then (A-B) ∪ (B-A)	.....
2.	If A and B are any two sets, then A∩(A ∪ B)	.....
3.	Sets A and B have 3 and 6 elements respectively. What can be the minimum number of elements in (A ∪ B)?	.....






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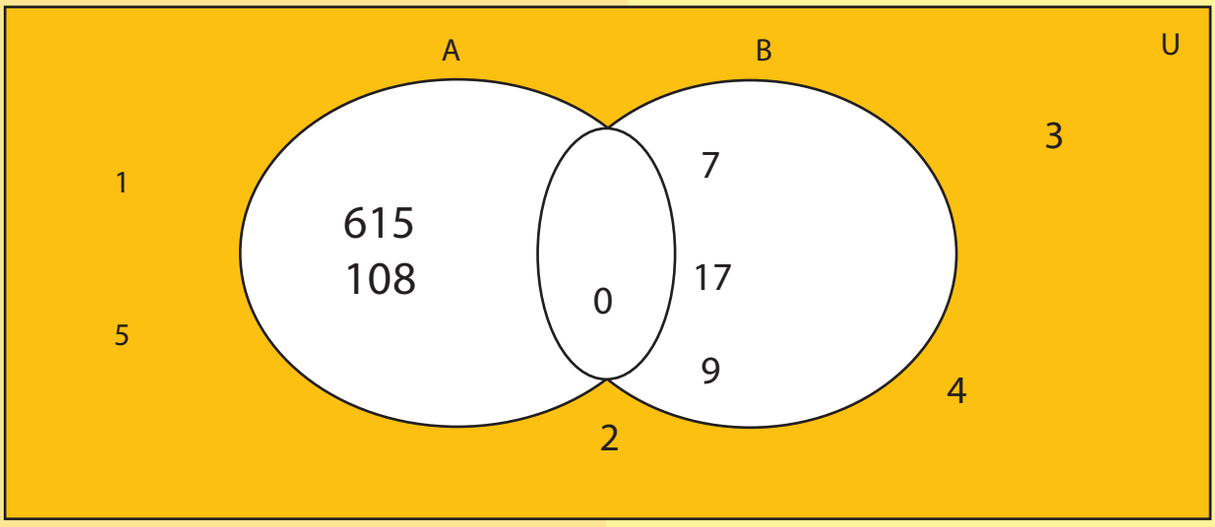
Activity 5

Create Set Builder Form

Using the given Venn diagram, represent the following sets in set builder form.



1. $(A \cup B)'$ 2. $(A \Delta B)'$

2.1.6 Suggestive Plan for Teacher and Student Activity

S.No.	Teacher's role as a facilitator (explaining /solving problems)	Problems to be solved by the students
1.	➢ Define sets with various illustrations ➢ Describe a set ➢ Explain notations of a set, belongs to, does not belong to ➢ Implement activities 1, 2, and 3	Exercise 1.1, problems 1, 3, 4, 5 and 6
2.	➢ Explain Example 1.2	Exercise 1.1, problem 2
3.	➢ Explain Empty set, Singleton set, Finite set, Infinite set, Equivalent sets, Equal sets, Subsets, Proper subset, and Power set with own examples as well as with examples given in the textbook	Exercise 1.2, problems 2, 3, 4, 5, 6, 7 and 8
4.	➢ Explain cardinal number	Exercise 1.2, problems 1 and 9
5.	➢ Explain: Set operations, Universal set, Complement of a set, Union and Intersection of two sets, Difference of two sets, Symmetric difference of sets, Disjoint sets ➢ Work out examples in above topics	Exercise 1.3, problems 1, 2, 5, 6
6.	➢ Solve problem 3 in Exercise 1.3	Exercise 1.3, problem 4
7.	➢ Solve Examples 1.18 and 1.19	Exercise 1.3, problems 7 and 8

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S.No.	Teacher's role as a facilitator (explaining /solving problems)	Problems to be solved by the students
8.	➢ Explain cardinality and practical problems on set operations ➢ Explain: If A and B are any two finite sets, then ➢ $n(A \cup B) = n(A) + n(B) - n(A \cap B)$ ➢ $n(A - B) = n(A) - n(A \cap B)$ ➢ $n(B - A) = n(B) - n(A \cap B)$ ➢ $n(A') = n(U) - n(A)$	Exercise 1.4, problems 1, 2, and 3
9.	➢ Solve Examples 1.20, 1.21, 1.22	
10.	➢ Solve Examples 1.23, 1.24, problems 8 and 9 under Exercise 1.4	Exercise 1.4, problems 4, 5, 6, 7 and 10

2.1.7 Additional Information Pertaining to the Corresponding Topics for Teacher's Professional Development

1. $(A')' = A$, $\emptyset' = U$, $U' = \emptyset$
2. $(A \cup A') = U$ *and* $A \cap A' = \emptyset$
3. $A - B = A \cap B'$ *and* $B - A = B \cap A'$
4. $A - B = \emptyset$ *and* $A - B \subseteq A$
5. $A - B \neq B - A$
6. $(A \cup B) \cap (A \cup B') = A$
7. $A - B = (A \cup B) - B$
8. $A - B = A$ *if and only if* $A \cap B = \emptyset$
9. $n(A \cup B) = n(A) + n(B)$ *if* $A \cap B = \emptyset$
10. $n(A - B) = n(A) - n(A \cap B)$ *and* $n(B - A) = n(B) - n(A \cap B)$
11. $n(A \Delta B) = n(A) + n(B) - 2n(A \cap B)$
12. $n(A') = n(U) - n(A)$
13. $n(A' \cup B') = n(U) - n(A \cap B)$ *and* $n(A' \cap B') = n(U) - n(A \cup B)$

2.1.8 Additional Problems for Competitive Examinations

1. If X and Y are two sets, then $X \cap (X \cup Y)'$ *is* ..... .
2. If $aN = \{ax : x \in N\}$, then the set $3N \cap 7N$ is ..... .
3. Let A and B be two sets such that n(A)=20, $n(A \cup B)$=42 and $n(A \cap B)$=4, then the value of $n(B) + n(A-B) + n(B-A)$ is ..... .
4. Set A has three elements and set B has six elements. Then the number of elements in the set $A \cup B$ is ..... .
5. If A and B are any two sets, then $(A - B) \cap B$ = ...
6. Suppose that $A_1, A_2, A_3, \ldots A_{50}$ are 50 sets each with six elements and $B_1, B_2, B_3, \ldots B_m$ are m sets with five elements. Let, $\bigcup_{i=1}^{50} A_i = \bigcup_{j=1}^{m} B_j = A$. If each element of A belongs to exactly 15 A_i's and to exactly 10 B_j's then m is ..... .
7. In a group of 50 persons, 14 drink tea but not coffee and 30 drink tea. find the number of persons who drink both tea and coffee.






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8. If $n(A)=n$, *then* $n\{(x,y,z); x,y,z \in A, x \neq y, y \neq z, z \neq x\}$ is ..... .

9. The power set of A contains 256 elements, then the number of elements in set A is ..... .

10. If $X=\{8^n - 7n - 1 ; n \in N\}$ *and* $Y = \{49(n - 1); n \in N\}$, then the relation between X and Y is ..... .

Key

1.	$\varnothing$	2.	$\{21x : x \in N\}$
3.	64	4.	6
5.	$\varnothing$	6.	40
7.	16	8.	$n^3 - 3n^2 + 2n$
9.	8	10.	$X \in Y$

2.1.9 Self-Evaluation

Revise topics and ask questions to ensure students' understanding on the concepts.

2.1.10 Consolidation

Students are able to

- find and how it was used
- define a set and its descriptions
- differentiate descriptive form, set builder form, and roster form
- identify different types of sets
- perform set operations
- represent sets through Venn diagrams

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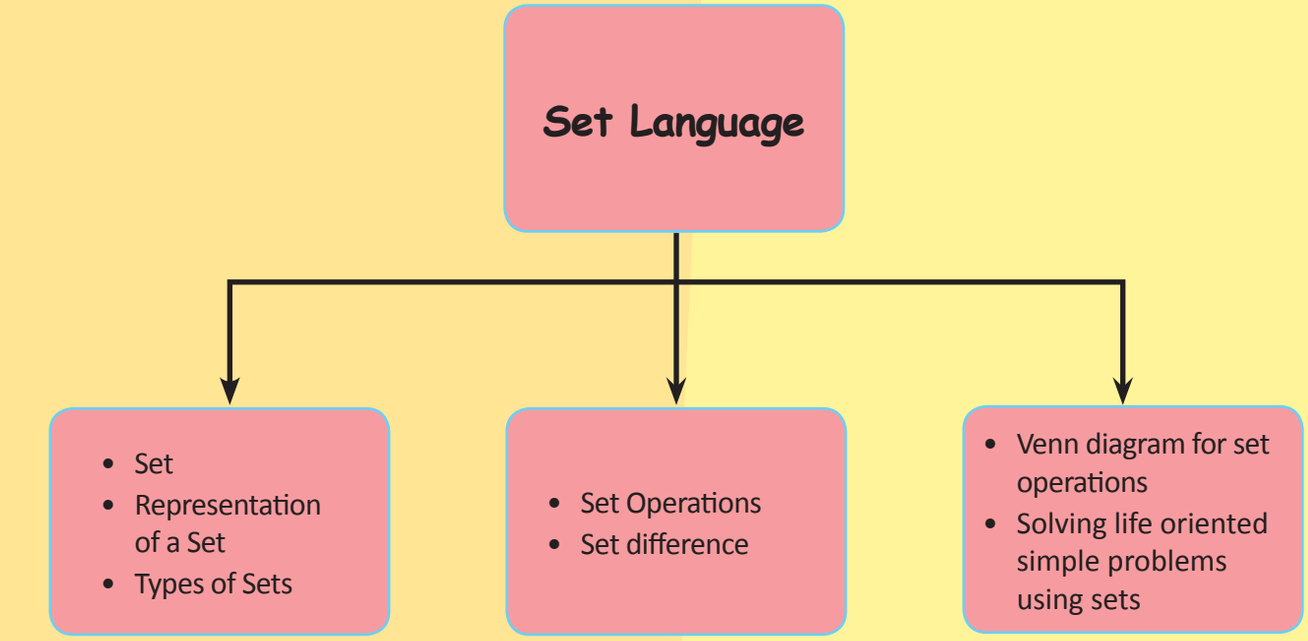
2.1.10 Mind Mapping



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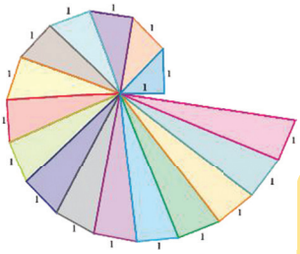
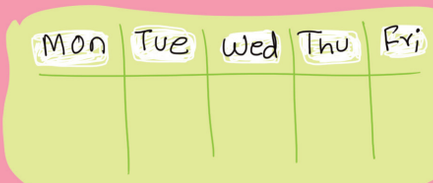


2.2 Real Numbers

Teaching / Learning tools

textbook, blackboard



Spotlight

- Understanding the concept of real numbers.
- Learning the concept of rational and irrational numbers.
- Learning how to denote rational and irrational numbers on the number line.
- Learning to represent rational numbers as terminating decimals.
- Learning to represent irrational numbers as decimals.
- In real life, real numbers are used in many calculations.
  Examples:
  - Speed, in general, is a numerical value obtained by measuring distance and time.
  - weather, air, temperature, wind speed and direction, nature
  - graph of stock prices on NYMEX web page.

Learning Objectives

At the end of the lesson, students will be able to

- find rational numbers between the given numbers
- appreciate the fact that infinitely many rational numbers can be inserted between two given rational numbers
- represent irrational numbers such as $\sqrt{2}, \sqrt{3}, \sqrt{5}, \ldots$ on the number line
- find the decimal expansion of real numbers and determine a rational and an irrational number on this basis
- insert irrational numbers between two rational numbers

Learning Outcomes

Through the course of the lesson, students will be able to

- recall the concept of rational numbers
- realize the existence of infinitely many rational numbers between two given rational numbers
- denote rational numbers on the number line
- represent rational numbers as terminating decimals
- express an irrational number in decimal form
- locate irrational numbers on the number line
- visualize real numbers on the number line

2.2.1 Introduction

Transactional Strategy

Teaching-Learning method

00:15

Warm up

- Recall the terms natural numbers, whole numbers, and integers.

Classroom Situation

- Draw number lines on the board and represent natural numbers, whole numbers, and integers on them.

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Teaching-Learning method

- Divide the class into four groups and assign the following topics to each group. Ask the groups to do a role play to explain their topic.
  - Group 1 Natural numbers (N)
  - Group 2 Whole numbers (W)
  - Group 3 Integers (Z)
  - Group 4 Rational numbers (Q)

Note: The aim of warm up activity is to get students to talk about the topic that is going to be taken up.

Classroom Situation

- Play the given weblinks to show videos on natural numbers, whole numbers, and integers.

https://www.youtube.com/watch?v=3YwrcJxEbZw (video: natural numbers, whole numbers, and integers)
https://www.ck12.org/algebra/The-Real-Numbers/

Assessment

Divide the class into groups of three and make each group solve problems on natural numbers, whole numbers, and integers on the blackboard.

2.2.2 Rational Numbers

Transactional Strategy

Teaching-Learning method

- At the start of the lesson, present the students with a one rupee coin. (You may use play money or real money including fifty paise and twenty five paise for this presentation.) Ask the following questions to elicit answers.
  - What would happen if the one rupee is split into two parts? (You would have one half of a rupee—50 paise, that is, 0.50)
  - What if it is split into four parts? (You would have one fourth of a rupee—25 paise, that is, 0.25)
  - What if it is split into three parts? (You would have one third of a rupee, that is, 0.3333....)

Classroom Situation

- Write numbers on the blackboard and ask students to identify the type of number—if it is natural, whole, integer, or rational.
- Play the given weblink to show a video on rational numbers.

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Teaching-Learning method

Classroom Situation

- Discuss with students how they calculated the decimal for one third.
  - They should recall that in order to change a fraction into a decimal they must divide the numerator by the denominator.
  - Point out that these are called *rational numbers*.
  - Ask students to identify which way of writing a rational number is most consistent. *(fraction)*
  - How can we define fraction? *(a ratio of two integers)*
  - Are there any restrictions on these integers? *(denominator cannot be zero)*

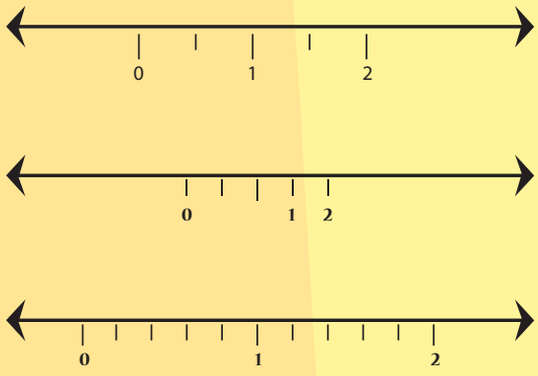
https://www.youtube.com/watch?v=9yvtLN_24G0 (video: rational numbers)

Assessment

Ask students to mark rational numbers between 0 and 2 on the number line.

- first mark $\frac{1}{2}$, $1\frac{1}{2}$
- then mark one-thirds
- then the quarters
- then mark one-fifths

As we proceed with the activity, the gaps between the points get smaller and smaller and as we mark more and more rational numbers, the largest gap between successive dots tends to be zero.



This activity will help students realise that all the infinite number of rational numbers on the number line seem to have no gap at all and the rational numbers are infinitely present along the number line.

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2.2.3 Irrational Numbers

Transactional Strategy

Teaching-Learning method

- Recall the concept of rational numbers.
- Play the given weblink to show a video introducing the concept of irrational numbers.

Classroom Situation

- Write the numbers $\sqrt{2}$ and $\sqrt{5}$ and ask students to locate them on the number line and find the decimal form of these numbers.
- Ask students to convert decimals into fractions. Explain that these are irrational numbers.

https://www.youtube.com/watch?v=CtRtXoT_2Ps (video: irrational numbers)

Assessment

Follow the questions given in the text book.

2.2.4 Real Numbers

Transactional Strategy

Teaching-Learning method

- Explain that all rational and irrational numbers together form the set of real numbers.

Classroom Situation

- The class can be divided into groups of four. Give flash cards of different numbers to each group and ask

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Teaching-Learning method

- Play the given weblink to show a video on real numbers.

Classroom Situation

them to identify whether the number is rational or irrational.

- Explain decimal working of rational and irrational numbers.
- Make students solve problems based on terminating, non-terminating, recurring, and non-recurring real numbers to help them familiarize with the concepts. If students make mistakes, correct them and give reasons to help them understand better.

https://www.youtube.com/watch?v=d9pO2z2qvXU (video: real numbers)

Assessment

Activity 1

Draw an integer line representing ..., -2, -1, 0, 1, 2,.....

Divide each unit into four equal parts. Mark a. -1/4 and 1/4 b. $-1\frac{1}{2}$ and $1\frac{1}{2}$ on the number line. Ask students if it is possible to mark 9/4 and -9/4 on the number line.

Activity 2

Discuss in class if the following statement is true or false.

If a number is not a perfect square, then the square root of the number is irrational.

2.2.5 Suggestive Plan for Teacher and Student Activity

S.No.	Teacher's role as a facilitator (explaining /solving problems)	Problems to be solved by the students
1.	• Define rational numbers with different examples. • Explain denseness property of rational numbers. • Explain Example 2.1	Exercise 2.1, problems 1, 2, 3
2.	Explain the definition of irrational numbers, irrational numbers on the number line, and decimal representation of rational number	Exercise 2.2, problem 1
3.	Explain the period of decimal concept and Example 2.3	Exercise 2.2, problem 2 only
4.	Explain conversion of terminating decimal into rational numbers with Example 2.4	Exercise 2.2, problem 4
5.	Explain conversion of non-terminating and recurring decimal into rational numbers with Examples 2.5 and 2.6	Exercise 2.2, problem 5

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Teaching-Learning method — Classroom Situation

S.No.	Teacher's role as a facilitator (explaining /solving problems)	Problems to be solved by the students
6.	Explain Example 2.7 and Exercise 2.2, problem 3	----------
7.	Explain the relation 1 = 0.999.... 7 = 6.99999..... 3.6 = 3.5999....	----------
8.	Explain the decimal representation to identify irrational numbers with Example 2.8 and explain $\sqrt{2}$, $\sqrt{5}$, $\sqrt{7}$,...	Exercise 2.3, problem 1
9.	Explain the concept of irrational number between two irrational number and rational number	Exercise 2.3, problems 2 and 3
10.	Explain the definition of real numbers; Real numbers can be visualized in representing numbers on the number line. Explain Examples 2.16, 2.17	Exercise 2.4, problem 1

2.2.6 Additional Information Pertaining to the Corresponding Topics for Teacher's Professional Development

S.No.	Types of numbers	Illustration
1.	Natural numbers (N)	{1 , 2, 3, ...}
2.	Whole numbers (W)	{0}∪N
3.	Integers (Z)	Z = { ...., -3, -2, -1, 0 , 1, 2, 3, ...}
4.	Rational numbers (Q)	$\frac{p}{q}$, where q ≠ 0,p,q ∈ Z
5.	Irrational numbers	Numbers cannot be put in the form $\frac{p}{q}$, where q ≠ 0,p,q ∈ Z
6.	Real numbers (R)	{RATIONALS} U {IRRATIONALS}
7.	Even numbers	Exactly divisible by 2
8.	Odd numbers	Not divisible by 2
9.	Prime numbers	Divisible by 1 and itself. Example: 2, 3, 5, 7, ... 2 is the least prime and also the only even prime number.
10.	Composite numbers	Numbers other than 1 which are not prime numbers are called *composite numbers*. Example: 4, 6, 8, ...
11.	Perfect numbers	If the sum of all the factors of a number is twice itself, such a number is called a *perfect number*. Example: 6, 28, 496, and so on, are perfect numbers Example: Let us take 28. Its factors are 1, 2, 4, 7, 14, 28. Their sum is 1+2+4+7+14+28 = 56 = 2 x 28. Therefore, 28 is a perfect number.

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S.No.	Types of numbers	Illustration
12.	Twin primes	Primes that differ by 2 are called *twin primes*. Example: 3 and 5, 5 and 7, 11 and 13, 29 and 31, and so on.
13.	Co-primes	If any two numbers have no common factor other than 1, they are called *co-primes* or relatively prime numbers. Example: 2 and 3, 7 and 8, 8 and 9 and so on. Note: For two numbers to be relatively prime, it is not necessary that either both of them or one of them should be prime.
14.	Armstrong numbers	A number for which the sum of the cubes of the digits is equal to the original number is called an *Armstrong number*. Example: $1^3+5^3+3^3=153$.
15.	Palindrome	If a number and its reverse are same, then those numbers are called *palindrome numbers*. Example: 1234321, 343, ...
16.	Fibonacci numbers	Fibonacci numbers are those terms beginning with the third term formed by adding the preceding two numbers. Example: 1, 1, 2, 3, 5, ...
17.	Powerful numbers	A number for which the sum of its digits with power as the digit itself is equal to the original numbers is called a *powerful number*. Example: $3435=3^3+4^4+3^3+5^5$. Here, the base is equal to power.
18.	Triangular numbers	The numbers which are in the form $\frac{n(n+1)}{2}$ are called triangular numbers. Example: 1, 3, 6, 10, 15, ...
19.	Amicable numbers	If the sum of factors of one number excluding the number is equal to the other number, then the numbers are said to be *amicable numbers*. Example: (220, 284), (1184, 1210), (2620, 2924), (5020, 5564),...

2.2.7 Additional Problems for Competitive Examinations

Additional Problems for Competitive Examinations

1. The least value of p so that the number 6p545 divisible by 3 is ..... .
2. The least value of x such that the number 43x4567 divisible by 11 is ..... .

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Teaching-Learning method

Classroom Situation

3. $\sqrt{63}-\sqrt{175}+\sqrt{28}=$ ..... .

4. $\sqrt{4+\sqrt{5}+\sqrt{17-4\sqrt{15}}}=$ ..... .

5. If $\sqrt{x}-\sqrt{12}+\sqrt{4-\sqrt{x}}$, *then* $x=$ ..... .

6. $\sqrt{2+\sqrt{2+\sqrt{2+\cdots\infty}}}=$ ..... .

(Hint : $\sqrt{x+\sqrt{x+\sqrt{x+\cdots\infty}}}=\frac{1+\sqrt{1+4x}}{2}$)

7. If $\frac{4}{2+\sqrt{3}-\sqrt{7}}=\sqrt{a}+\sqrt{b}+\sqrt{c}$ *then the value of* $a+b+c$ *is* ..... .

8. $\sqrt{-\sqrt{3}+\sqrt{3+8\sqrt{7+4\sqrt{3}}}}=$ ..... .

9. $\sqrt{\frac{x}{x+1}}+\sqrt{\frac{x+1}{x}}=\frac{17}{4}$, *then the value of x is* ..... .

10. *If x,y,z are rational numbers and* $x+(3x+y)2+(x-3y+z)3O=2$, *then* $(x,y,z)=$ ..... .

Key

1. 1 2. 8 3. 0 4. $\sqrt{3}+1$ 5. $4+2\sqrt{3}$ 6. 2 7. $\frac{14}{3}$

8. 2 9. $\frac{1}{15}, \frac{-16}{15}$ 10. (2, -6, -20)

2.2.8 Self-Evaluation

- I can identify types of numbers.
- I can express rational numbers in the ratio form and decimal form.
- I can express irrational numbers in the decimal form.

2.2.9 Consolidation

Students are able to

- find rational numbers and irrational numbers
- write rational numbers in the form of ratio and decimals
- identify the irrational numbers and express them in decimals






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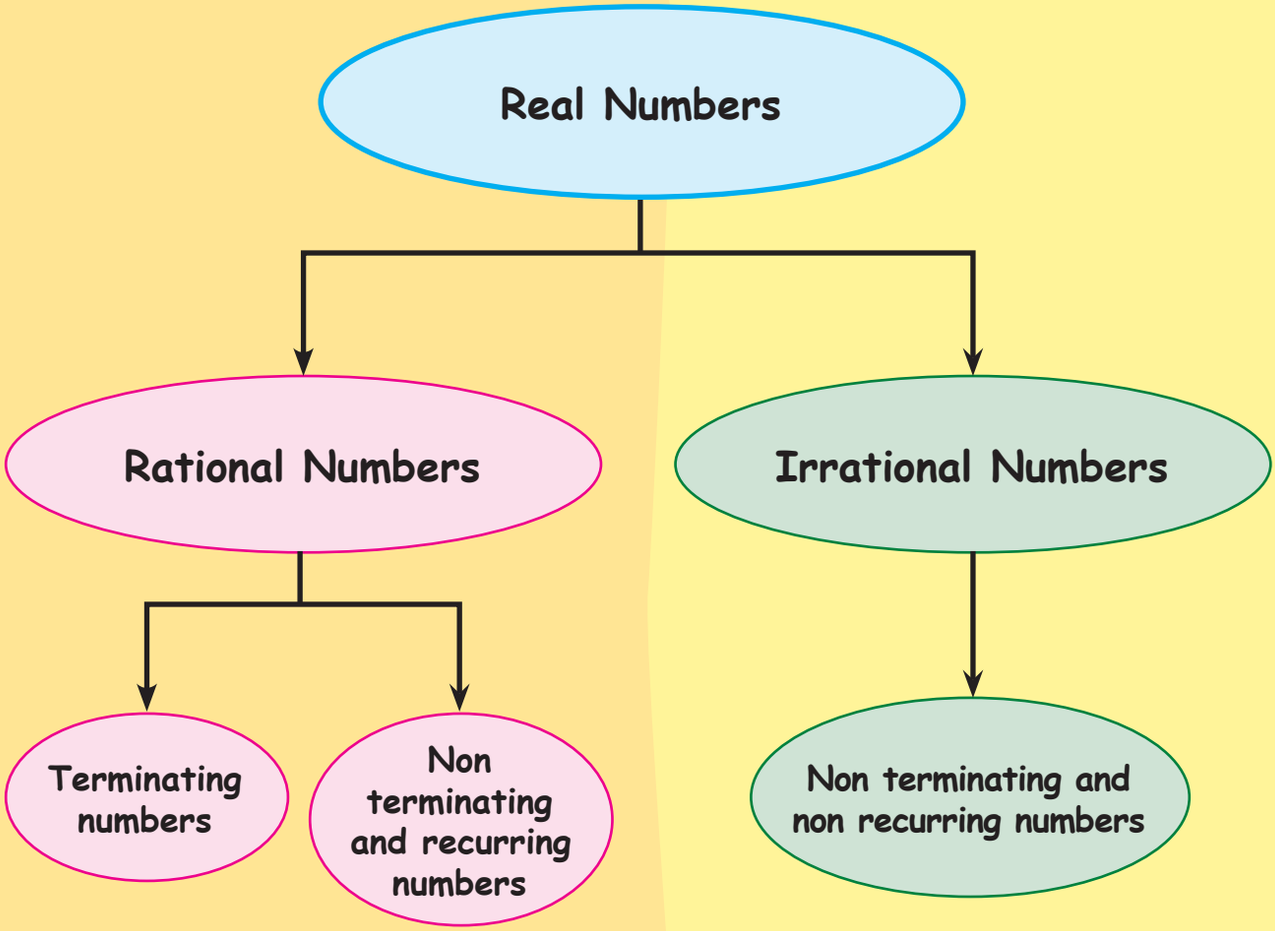
2.2.10 Mind Mapping





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2.3 Algebra

Teaching / Learning tools

textbook, blackboard, and dice

Mon	Tue	Wed	Thu	Fri

Spotlight

- Understanding the concept of polynomials.
- Learning the classification of polynomials.
- Learning the value and zeros of a polynomial.
- Performing arithmetic operations on polynomials.
- Understanding remainder theorem.
- Understanding application of algebra in real life.

  Examples:
  - Ratios: relationships between quantities
  - working with proportion
  - Metre and litres: converting to the metric system of measurements
  - used in banking field

Learning Objectives

At the end of the lesson, students will be able to

- recall the meanings of algebraic terms—variable, constant, term, monomial, binomial, trinomial
- understand polynomials using patterns
- evaluate polynomials in one variable
- identify the types of polynomials
- add, subtract, multiply, and divide polynomials
- find the value and zeros of a polynomial
- find the roots of polynomials
- understand remainder theorem
- use algebraic concepts in daily life

Learning Outcomes

Through the course of the lesson, students will be able to

- recall algebraic expressions, constants, variables, and coefficients
- understand a polynomial in one variable
- understand the classification of polynomials based on degree and number of terms
- identify the types of polynomials
- understand addition, subtraction, multiplication, and division of polynomials
- evaluate a polynomial for the given value
- understand the zeros of a polynomial
- apply the remainder theorem

2.3.1 Introduction

Transactional Strategy

Teaching-Learning method

Warm up

- Recall the terms: constant, variable, exponent, and coefficient.

00:45

Classroom Situation

Ask students to imagine that they are at a fruit shop buying 5 mangoes and 2 apples. Now, ask them to calculate the total amount to be paid.

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Teaching-Learning method

- Play the given weblinks to show videos to introduce the concepts of constant, variable, exponent, and coefficient.

Classroom Situation

Students will ask for the prices of fruits to calculate the total amount. Use this opportunity to introduce an algebraic expression as given below.

5 mangoes + 2 apples, that is, 5m+2a

Explain that this is an algebraic expression with three terms (5m, 2a), two variables (m and a), two coefficients (5 and 2), and three constants (5, 2).

Point out to students that this is a polynomial (Poly—many; nomial—term).

https://www.youtube.com/watch?v=xnBibS2WJCk (video: constant, variable, exponent, and coefficient)
https://www.mathplanet.com

Assessment

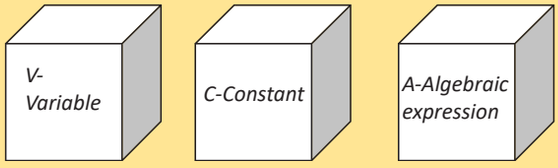
- Pick and identify

  Prepare cards with examples of constants, variables, and algebraic expressions written on them as given below.

x+4	–32	4π	m
–5+a	8.7	–1/2	10
$\sqrt{5}$	4y+7	1	lb
2πr	7/5	$-\sqrt{7}$	$3\pi r^2$

Set three empty boxes with the names V-variable, C-constant, A-algebraic expression written on each box.

Ask any student to pick a card and drop it into the correct box.



- You can follow the questions given in the textbook.

2.3.2 Polynomials

Transactional Strategy

Teaching-Learning method

- Recall the term 'polynomials'.
- Choose some ideas that many students often misunderstand. Write them down as statements on

Classroom Situation

- Explain polynomials in one variable, standard form of polynomials, types of polynomials.

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Teaching-Learning method

pieces of paper. Give one statement to be discussed to each group of students.

Example:

Tick (✓) if statements below are always true/ sometimes true/never true. You can explain your answer or give examples.

S. No.	Statement	Always True	Sometimes True	Never True
1.	$2x+3x+5$ is an algebraic expression containing two terms	TRUE. But it can be $5x+5$ $\because 2x+3x=5x$ is one term and 5 is another term	_____	_____
2.	$-8xy+7/2$ is having variables x, y	_____	_____	✓
3.	The coefficient of $p+\sqrt{5}$ is one	✓	_____	_____

Classroom Situation

- Encourage students to practise identifying constants, variables, and exponents in the polynomials as well as identifying the number of terms in each polynomial and its degree.
- Ask questions to elicit answers.
  - How many terms can a polynomial have?
  - When is an algebraic expression not a polynomial?
- Play the weblinks to show a video on polynomials.

https://www.youtube.com/watch?v=uHiE-o_Q83s (video: polynomials)
https://www.quora.com

Assessment

- Set students in pairs and give each pair two dice. For each round, students in a pair will take turns rolling two dice to create a polynomial. One dice will determine how many terms should be in the polynomial, while the other dice will determine the degree of the polynomial.

  Example:

  If a student rolled a 3 and 2, he/she could write polynomials such as $x^3 + 34$ (2 terms, 3rd degree polynomial) or $x^2 - 23x - 5$ (3 terms, 2nd degree polynomial). Partners should check each other's work to make sure it meets the criteria for a polynomial.
- You can follow the questions given in the textbook.

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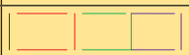
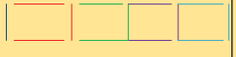
2.3.3 Arithmetic Operations on Polynomials

Transactional Strategy

Teaching-Learning method

- Recall the term 'polynomials' and its types.
- Prepare a chart as given below and ask students to complete the chart.

S. No.	Pattern	No. of squares	No. of sticks	Total sticks
1.	 A colour for one side and some other colour for other sides.	1	3 + 1	4
2.		2	3 + 3 + 1	7
3.		3	3 + 3 + 3 + 1	10
4.		4	3 + 3 + 3 + 3 + 1	13
5.	_____	_____	_____	_____

- Ask students to study the above pattern and write the algebraic expression.
  - How many sticks are in the next diagram?
  - How many sticks are in the 10^{th} diagram?
  - Write an algebraic sentence to describe this system.

M = 3s +1

- Students can refer the patterns given on pages 71 and 72 in the textbook.

https://www.youtube.com/watch?v=7SnmUoVhYqw
https://www.khanacademy.org (video: arithmetic operations on polynomials)

Classroom Situation

- Explain addition, subtraction, and multiplication of polynomials.
- Solve problems and encourage students to work out the arithmetic operations.
- Play the weblinks to show a video on arithmetic operation on polynomials.

Assessment

- Students can work in pairs to do this activity. Write statements on chits of paper. Ask each pair to come forward and one of them should pick a chit of paper. The student will read out the statement and his/her friend must say if the statement is true or false and give reasons.
- Examples:
  - One student says, '12ab and 10ab are binomial'. His/her pair explains if the statement is true or false.
  - One student says, '$y - 7$ and $5y^2+3y^2$ has two terms'. His/her pair explains if the statement is true or false.
- You can follow the questions given in the textbook.

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2.3.4 Value and Zeros of a Polynomial

Transactional Strategy

Teaching-Learning method

Recall the term 'polynomial' in one variable.

https://www.youtube.com/watch?v=EVYR-Lcy9lg (video: value and zeros of a polynomial)
https://www.commensense.org

Classroom Situation

- Write a polynomial expression with one variable on the blackboard. Give different values for the variable. Ask students to apply the value to the variable in the expression and find the answer. Explain the value of a polynomial and zeros of a polynomial.
- Play the weblinks to show a video on values and zeros of polynomials.

Assessment

- Students can work in pairs to do this activity. Write statements on chits of paper and distribute them to each pair of students. They can discuss and decide if they agree or disagree with the statement and give reasons. Ask each pair to come forward and give their answers.

  Example

S.No.	Statement	Agree	Disagree	Reason
1.	$5x^{-3}+3x^3$ is a polynomial	____	✓	one of the powers is negative
2.	$\sqrt{5}\, m^3+4m^2-8m+3$ is a polynomial	✓	____	non-negative integral power
3.	$6p^3-9p^2+4p+8$ is in standard form	✓	____	decreasing order of the power p
4.	$4m^2n^3+3m^2\, n^2+2$. The degree of the polynomial is 2.	____	✓	highest power of the variable is 5

  At the end of the activity, students will be able to identify the polynomial, degree, and standard form.
- You can follow the questions given in the textbook.






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2.3.5 Division of Polynomials

Transactional Strategy

Teaching-Learning method

- Recall the term 'polynomials'.
- Play the given weblinks to show a video on division of polynomials.

Classroom Situation

- Explain division of polynomials.
- Encourage students to solve the problems to familiarise with division of polynomials.

https://www.youtube.com/watch?v=8Wxw9bpKEGQ (video: division of polynomials)
https://www.khanacademy.org

Assessment

You can follow the questions given in the textbook.

2.3.6 Remainder Theorem

Transactional Strategy

Teaching-Learning method

- Recall division of polynomials.
- Play the given weblinks to show a video on remainder theorem.

Classroom Situation

- Write two problems related to division of polynomials on the blackboard. Ask two students to come forward and solve the problems on the blackboard. After they complete, ask the students if they can find a pattern by observing the solutions.

Ask questions to encourage students to think and answer.

- Looking at the results of the quotient, what pattern do we see? (*The remainder is the value of the function.*)
- What do we infer from the connection between the remainder from dividing a polynomial P(x) by x-a and the value of P(a)? (*The remainder found after dividing P(x) by x-a will be the same value as P(a).*)
- Write the general form of polynomial P(x) by including dividend, divisor, quotient, and remainder.

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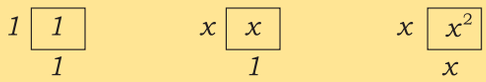
https://www.youtube.com/watch?v=JUDuoOHv7_g
https://www.commensense.org (video: remainder theorem)

Assessment

✧ **Activity 1**

Use the algebraic tiles given below for the multiplication of the polynomial.



The algebraic tiles for g(x) are arranged horizontally and the tiles for f(x) are arranged vertically as shown below.

f(x)=2x+3 and g(x)= x+4

f(x)=2x+3 \ g(x)=x+4					
1	x	1	1	1	1
1	x	1	1	1	1
1	x	1	1	1	1
x	x^2				
x	x^2	x	x	x	x
0		1	1	1	1

The area formed after keeping algebraic tiles were measured by counting the tiles as below.

$x^2+x^2 = 2x^2$, x+x+ ... 11 terms = 11x , 1+1+1+ ... 12 terms = 12

By adding the result, we get $2x^2+11x+12$. Also, the area of the rectangle formed is equal to the result obtained. Hence, $f(x) \times g(x) = 2x^2+11x+12$.

✧ **Activity 2**

For any two polynomials, find the multiplication and division of polynomials. Also, verify the remainder theorem.

✧ You can follow the questions given in the textbook.

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2.3.7 Suggestive Plan for Teacher and Student Activity

S.No.	Teacher's role as a facilitator (explaining/solving problems)	Problems to be solved by the students
1.	Define polynomial in one variable Standard form Degree, Zero polynomial Types of polynomial Fundamental operations on polynomials	Exercise 3.1, problems 7, 8, 10, 11, and 12
2.	Explain value of a polynomial, zeros of a polynomial, and roots of polynomial	Exercise 3.2, problems 2, 5, and 6
3.	Explain division algorithm for polynomials	Exercise 3.3, problems 2, 3, and 4
4.	Define the remainder theorem	Exercise 3.4, problems 3 to 7

2.3.8 Additional Information Pertaining to the Corresponding Topics for Teacher's Professional Development

S.No.	Properties of Integers	Properties of Polynomials
1.	The sum of two integers is an integer.	The sum of two polynomials is a polynomial.
2.	Addition of integers is commutative, that is, a + b = b + a for all integers a,b.	Addition of polynomials is commutative, that is, p(x)+ q(x)= q(x)+ p(x) for all polynomials p(x),q(x).
3.	Addition of integers is associative, that is, (a + b)+c = a+ (b + c) for all integers a,b,c.	Addition of polynomials is associative, that is, p(x)+[q(x)+r(x)]=[p(x)+q(x)]+r(x) for all polynomials p(x),q(x),r(x).
4.	The integer zero (0) is such that a + 0 = a = 0 + a for any integer a.	The zero polynomial (0) is such that, p(x)+ 0 = p(x)= 0 + p(x) for any polynomial p(x).
5.	For any integer a, there corresponds an integer - a such that, a + (-a) = 0 = (-a) + a.	For any polynomial p(x) , there corresponds a polynomial -p(x) such that, p(x)+ (-p(x))= 0=(-p(x)) + p(x).
6.	The product of any two integers is an integer.	The product of any two polynomials is a polynomial.
7.	Multiplication of integers is commutative, that is, a.b =b. a for any two integers a,b.	Multiplication of any two polynomials is commutative, that is p(x).q(x)= q(x).p(x) for any two polynomials p(x),q(x).
8.	Multiplication of integers is associative, that is, (a.b).c = a.(b.c) for all integers a,b,c.	Multiplication of polynomials is associative, that is, [p(x).q(x)].r(x) p(x).[q(x).r(x)] for all polynomials p(x),q(x),r(x).
9.	Multiplication of integers is distributive over addition, that is, a .(b + c) = a.b + a.c (b + c).a = b.a + c.a for all integers a,b,c.	Multiplication of polynomials is distributive over addition, that is, p(x) .[q(x) + r(x)] = p(x).q(x) + p(x).r(x) [q(x)+ r(x)].p(x)= p(x) q(x)+ r(x).p(x) for all polynomials p(x),q(x),r(x).

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S.No.	Properties of Integers	Properties of Polynomials
10.	The integer 1 is such that, a.1 = 1.a =a, for any integer a.	The constant polynomial 1 is such that p(x).1 = 1.p(x)=p(x) for any polynomial p(x).

2.3.9 Additional Problems for Competitive Examinations

1. The value of k, if x^8+kx^3-2x+1 is divisible by (x+1) is ..... .
2. If the polynomial $x^{19}+x^{17}+x^{13}+x^{11}+x^7+x^5+x^3$ is divided by (x^2+1), then the remainder is ..... .
3. If (x-2) is a divisor of x^3-4x^2+ax+b and x^3-ax^2+bx+8, then the values of a and b respectively are ..... .
4. If the polynomial $2x^3-9x^2+15x+p$ when divided by (x-2) leaves p as remainder, then p = ...
5. If $a^2=by+cz$, $b^2=cz+ax$, $c^2=ax+by$, then the value of $\frac{x}{a+x}+\frac{y}{b+y}+\frac{z}{c+z}$ will be ..... .
6. Degree of the polynomial $(y^3-2)(y^3+11)$ is ..... .
7. If the degree of the expression $\left(x^4-\frac{3}{8}\right)\left(x^n+\frac{16}{17}\right)$ is 12, then n = ...
8. If $\sqrt{5}\,x^m \div 5x^3 = \frac{x}{\sqrt{5}}$, then m = ...
9. When x^2+6x+8 is divided by x + 4, then the quotient is ..... .
10. If (a+2)(3a-1)+9 is of the form divisor x quotient + remainder, then the dividend is ..... .

Key

1. 4 2. -x 3. 4,0 4. -5 5. 1 6. 6 7. 8 8. 4
9. x+2 10. $3a^2+5a+7$

2.3.10 Self-Evaluation

- I can explain the term polynomial and its types.
- I can write a polynomial expression.
- I can evaluate polynomials for given values.
- I can apply arithmetic operations and remainder theorem on polynomials.

2.3.11 Consolidation

Students are able to

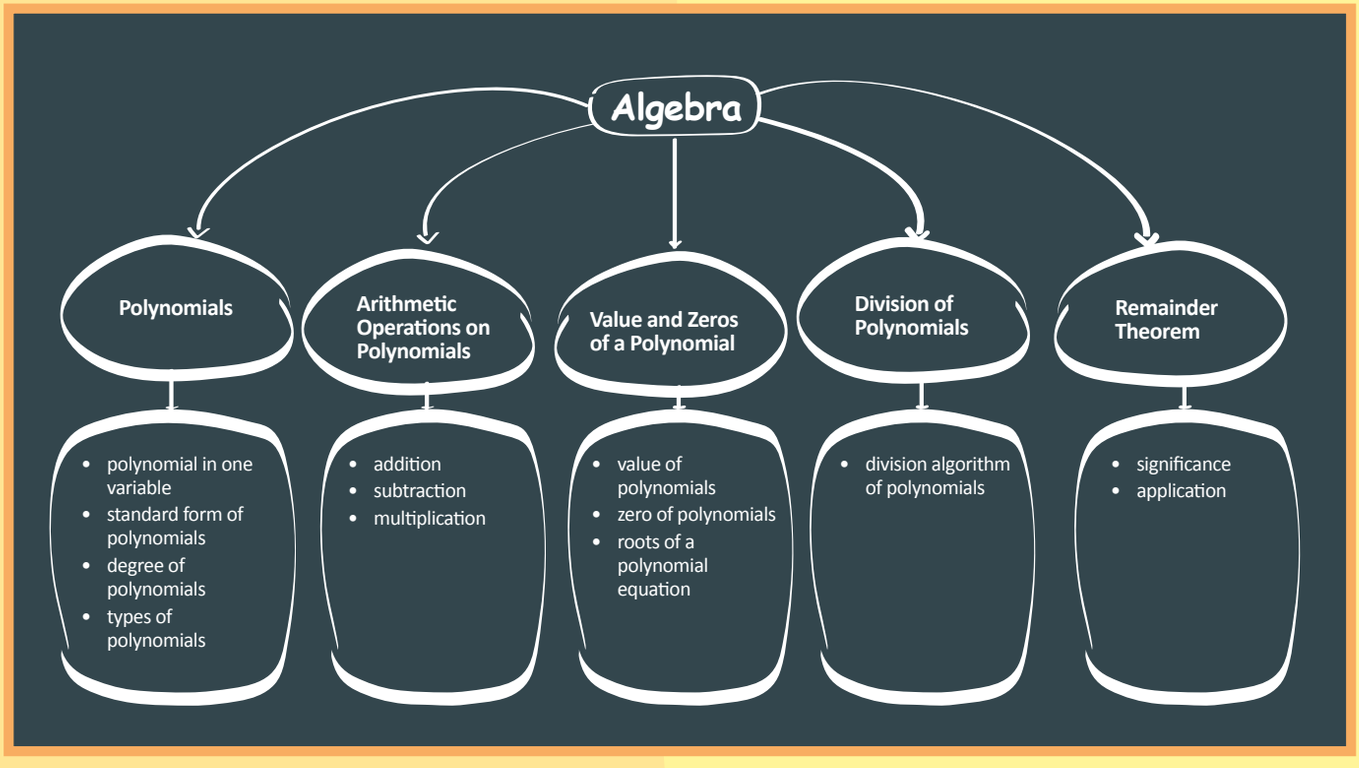
- identify polynomials and write polynomials
- perform arithmetic operations on polynomials
- evaluate polynomials
- apply remainder theorem on polynomials








2.3.12 Mind Mapping



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2.4 Geometry

Teaching / Learning tools

textbook, blackboard, scale, pencil, chart, colour papers, various triangle cutouts, tangrams, graph sheet, various cutouts of quadrilaterals

Mon	Tue	Wed	Thu	Fri

Spotlight

- Understanding theorems on linear pairs.
- Classifying quadrilaterals.
- Understanding the properties of quadrilaterals.
- Constructing the circumcentre of a triangle.
- Constructing the orthocentre of a triangle.
- Understanding real life applications such as patterns found in painting designs, window placements, and carpeting.
- Realising the role of geometry in the construction of houses and buildings.
- Understanding which angles provide stronger and safer buildings.

Learning Objectives

At the end of the lesson, students will be able to

- develop spatial awareness, geometric intuition, and ability to visualize
- perceive geometrical figures in two and three dimensions
- develop knowledge and understanding of geometrical properties and theorems
- encourage the development and use of conjecture, deductive reasoning, and proof
- develop skills that will help apply geometry to real life situations
- develop a penchant for geometry

Learning Outcomes

Through the course of the lesson, students will be able to

- understand theorems on linear pair
- know the concept of vertically opposite angles
- understand the different types of angles formed when a pair of parallel lines are intersected by a transversal
- understand angle sum property and congruence of triangles
- classify quadrilaterals
- understand the properties of quadrilaterals and use them while solving problems
- construct the circumcentre of a triangle
- construct the orthocentre of a triangle

2.4.1 Introduction

Transactional Strategy

Teaching-Learning method

00:45

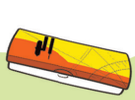
Warm up: Visual and oral activity

- Discuss and recall the concept of shapes.

Classroom Situation

Divide the class into pairs. Give a shape or a figure to one student in each pair.



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Teaching-Learning method

- Ask students to bring to class regular and irregular objects such as eraser, scale, leaf, thread, pen, and so on. They must superimpose their collected objects.

  Ask students to identify line and curved line from the above activity.
- Play the given weblinks to show a video on properties of shapes and a general introduction to geometry.

Note: The aim of warm up activities is to get students to talk about the topic that is going to be taken up.

Classroom Situation

The student with the object must describe the object to his/her friend. The other student must draw the object on a sheet of paper without looking at the object, relying only on the descriptions given by his/her friend.

Point out the properties of the shape or figure mentioned by the student to describe the object to his/her friend.

https://youtu.be/PBD3_TRCLFA (video: introduction to geometry)
https://www.mathopenref.com/

Assessment

You can follow the questions given in the textbook.

2.4.2 Geometry Basics—Recall

Transactional Strategy

Teaching-Learning method

- Discuss and recall lines and their properties—parallel lines, intersecting lines, perpendicular lines, concurrent lines, and so on.
- Connect lines with acute angle/right angle/obtuse angle/straight angle/reflex angle.

Classroom Situation

- Play the given weblinks to show a video on types of angles.
- Ask students to give examples for the following:
  - complementary angles
  - supplementary angles
  - adjacent angles
  - linear pair
  - transversals
  - congruency of triangles (SSS, SAS, ASA, AAS, RHS)
- Teach alternate angles, vertically opposite angles, corresponding angles, and consecutive angles in a transversal.

https://youtu.be/zeqx23LtuB8 (video: types of angles)
https://www.vedanthu.com

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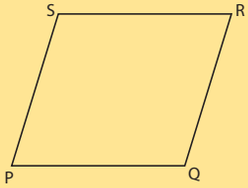
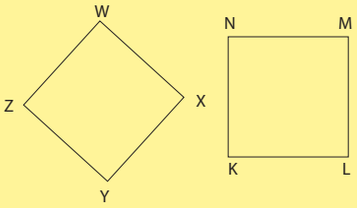
Assessment

- Measure the length of sides, angles, and diagonals.





- You can follow the questions given in the textbook.

2.4.3 Quadrilaterals

Transactional Strategy

Teaching-Learning method

- Ask students to observe objects in their surroundings and identify their shapes.
- Play the given weblinks to show a video to introduce quadrilaterals.

Classroom Situation

- Draw a few closed shapes made of straight lines on the blackboard. Explain that these shapes are called as *polygons*.

  Explain the following.
  - A polygon with three straight lines is a triangle.
  - A polygon with four straight lines can be a square/rectangle.
- Draw a few polygons with four straight lines but not a square or a rectangle and explain that these are called quadrilaterals. (Quadri–four)

https://youtu.be/FYXFef19ZwM (video: introduction to quadrilaterals)
https://www.khanacademy.org

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Teaching-Learning method

Classroom Situation

- Explain the following types with the help of diagrams to the class.
  - parallelogram
  - rhombus
  - trapezium
  - rectangle
  - square
  - kite

Assessment

- Set up two chairs facing opposite directions in front of the class. Ask two students to volunteer for the activity and ask them to sit on the chairs. Give a picture of any quadrilateral to one student. Give a blank paper to the other student. The student with the picture must give proper instructions to the other student and help him/her draw the quadrilateral in the picture.
- After introducing quadrilaterals, ask the following questions to elicit answers.
  - In a parallelogram, ... sides are equal.
  - In a square, the diagonals are ..... in length.
  - In a ....., only one pair of opposite sides are parallel.
- You can follow the questions given in the textbook.

2.4.4 Constructions

Transactional Strategy

Teaching-Learning method

- Recall the properties of points, lines, and other figures to construct geometrical figures.
- Play the given weblinks to show a video on constructions of points, lines, and other figures.

Classroom Situation

- Recall the concept of midpoint of a line segment by paper-folding method.
- Construct a perpendicular bisector of a line segment.
- Construct a perpendicular to a line segment from an external point by paper-folding.
- Explain the concept of circumcentre of a triangle.

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Teaching-Learning method

Classroom Situation

- Explain the concept of circumcircle and circumradius.
- Explain the concept of orthocentre of a triangle.

https://youtu.be/9r25owCq3oY (video: constructions of points,
https://youtu.be/Sjj_7ASP4Wc lines and other figures)
https://www.studyrankers.com

Assessment

- **Activity 1** Draw a rectangle PQRS. Join PR and QS. Colour/shade the pairs of congruent triangles. Also, find the number of pairs of congruent triangles.
- **Activity 2** List out the household objects that can be described as four-sided shapes.
- **Activity 3** Draw a transversal using two parallel lines l_1 and l_2 which meet the lines l_1 and l_2 at A and B. Draw bisectors of interior angles of a transversal and mark the point of intersection of line of bisectors as C and D. Name the quadrilateral ACBD or ADBC.
- You can follow the questions given in the textbook.

2.4.5 Suggestive Plan for Teacher and Student Activity

S.No.	**Teacher's role as a facilitator (explaining /solving problems)**	**Problems to be solved by the students**
1.	Define an angle and types of angles	Exercise 4.1, problems 1, 2, and 3
2.	Explain the concept of complementary, supplementary, adjacent, linear pair, and vertically opposite angles.	----------
3.	Explain the concept of transversal	Exercise 4.1, problems 4 and 5
4.	Explain the concept of angle sum property, exterior angle property, and congruency of triangles	Exercise 4.1, problems 6, 7, 8, and 9
5.	Explain the concept of quadrilaterals, special names, and their properties	Exercise 4.2, problems 1, 2, and 3
6.	Explain properties, theorems, and proof on parallelogram, Examples 4.1 to 4.4	Exercise 4.2, problems 4, 5, 6, 7, 8, and 9
7.	Explain problems 10 to 15 under Exercise 4.2	----------
8.	Explain the theorem on page 124 in the textbook with suitable examples	Self-evaluation can be done







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2.4.6 Additional Information Pertaining to the Corresponding Topics for Teacher's Professional Development: Quadrilaterals

- A closed figure bounded by four line segments is called a *quadrilateral*.
- A quadrilateral in which the measure of each angle is less than 180° is known as a *convex quadrilateral*.
- A quadrilateral in which one of the angles measures more than 180° is known as a *concave quadrilateral*.
- To construct a quadrilateral, we need five measurements.
- Types of quadrilaterals
  - parallelogram
  - rectangle
  - square
  - rhombus
  - kite
  - trapezium

2.4.7 Additional activities

S.No.	Property	Parallelogram	Rhombus	Rectangle	Square	Trapezium	Kite
1.	diagonals bisect each other	Yes	Yes	Yes	Yes	No	No
2.	each diagonal bisects each pair of opposite angles	No	No	No	Yes	No	No
3.	the diagonals form four congruent triangles	No	No	No	Yes	No	No
4.	the diagonals are perpendicular to each other	No	Yes	No	Yes	No	Yes
5.	the diagonals are equal	No	No	Yes	Yes	No	No
6.	diagonals are equal and right bisectors of each other	No	No	No	Yes	No	No

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2.4.8 Additional Problems for Competitive Examinations

1. The angles of a quadrilateral are in the ratio 3 : 5 : 9 : 13. Find all the angles of the quadrilateral.
2. Show that in a parallelogram, angle bisectors of two adjacent angles intersect at right angles.
3. ABCD is a quadrilateral. If AC and BD bisect each other, then ABCD must be ..... .
4. If angles P, Q, R, and S of the quadrilateral PQRS taken in order are in the ratio 3 : 7 : 6 : 4, then PQRS is a ..... .
5. The perimeter of a parallelogram is 180 cm. One side exceeds another by 10 cm. The sides of the parallelogram are ..... .
6. In a parallelogram ABCD, if AB = 2x +5, CD = y + 1, AD = y +5 and BC = 3x – 4, then ratio of AB : BC is ..... .
7. If one of the angles measures more than 180° in a quadrilateral, then it is known as ..... .
8. The number of measurements required to construct a parallelogram is ..... .
9. In a quadrilateral PQRS, if $\angle P = \angle R = 100°$ and $\angle S = 75°$, then $\angle Q$ = ...
10. If the lengths of two diagonals of a rhombus are 12 cm and 16 cm, then the length of each side of the rhombus is ..... .

Key

1. 36°, 60°, 108°, 156° 2. Prove it 3. Parallelogram 4. Trapezium
5. 40 cm, 50 cm 6. 31:35 7. a concave quadrilateral 8. 3 9. 85° 10. 10 cm

2.4.9 Self-Evaluation

- I can explain a quadrilateral and its types.
- I can construct circumcentre of a triangle.
- I can construct orthocentre of a triangle.

2.4.10 Consolidation

Students are able to

- explain a quadrilateral and its types
- construct circumcentre of a triangle
- construct orthocentre of a triangle






2.2.11 Mind Mapping

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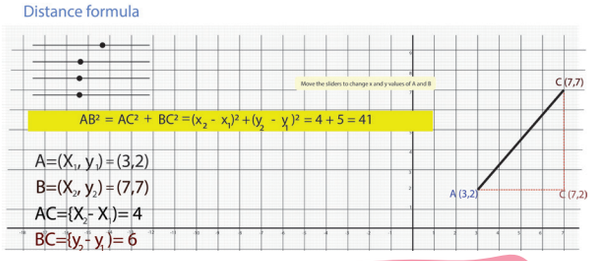
2.5 Coordinate Geometry



Teaching / Learning tools

textbook, blackboard, graph, peg board, line diagrams

Mon	Tue	Wed	Thu	Fri

Spotlight

- Understanding the concept of Cartesian coordinate system.
- Understanding the properties of distances.
- Understanding the distance between any two points in a real life situation.
- Describing the position of any object in the real world using a simple coordinate system.
- Understanding that to give the correct location using latitude, longitude and shape of features, a coordinate framework for defining real world locations is required.

Learning Objectives

At the end of the lesson, students will be able to

- understand the Cartesian coordinate system—abscissa, ordinate, and coordinates of any given point
- plot points in Cartesian coordinate plane
- understand the distance between any two points in a real life situation
- find the distance between two points on a plane
- learn properties of distances

Learning Outcomes

Through the course of the lesson, students will be able to

- understand the Cartesian coordinate system
- identify the abscissa, ordinate, and coordinates of any given point
- find the distance between any two points in the Cartesian plane using formula
- apply coordinate system in day-to-day life

2.5.1 Introduction

Transactional Strategy

Teaching-Learning method

00:30

Warm up: Visual and oral activity

- Recall directions, real line, and plane.

Classroom Situation

Draw a grid on the blackboard. Mark the columns of the grid as A, B, C, and so on and the rows as 1, 2, 3, and so on from the top. Mark a dot anywhere on the grid. For example, mark a dot in the column D corresponding to the row 3. Explain that the dot is in box D3. Point to students that D and 3 are called the coordinates of the box. It has two parts—the row and the column. There are many boxes in each row and each column. But by having both, we can find one single box, where the row and column intersect.

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Teaching-Learning method

- Play the given weblink to introduce coordinate geometry.

Note: The aim of warm up activities is to get students to talk about the topic that is going to be taken up.

https://www.mathopenref.com/coordintro.html (video: introduction to coordinate geometry)

Classroom Situation

Assessment

You can follow the questions given in the textbook.

2.5.2 Devising a Coordinate System

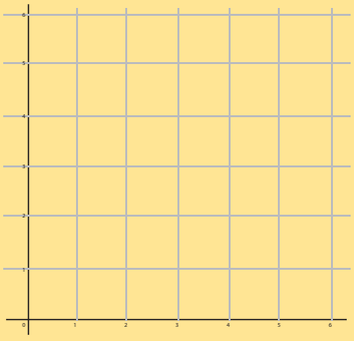
Transactional Strategy

Teaching-Learning method

- Recall integers, number line, graph, and plotting points using various activities.

  Example:

  Required materials: checked sheet, a pair of dice, and six different colour buttons



Divide the class into pairs. Give a pair of dice to each pair of students. One student can roll the pair of dice, and other student in the pair can note down the numbers. Ask the students to form a coordinate pair with the numbers obtained. Ask them to place a button in the checked sheet accordingly. This activity will help students understand Cartesian coordinates.

Classroom Situation

Perform the following steps in class to help students understand coordinates.

- Take an A4 sheet. Fold it into an equal half both vertically and horizontally.
- The sheet is divided into quadrants, that is, four parts.
- Draw lines along the folding impressions.
- Number the lines with negative and positive integers.
- Place a small object anywhere on the sheet.
- Express the exact position of the object in numbers.
- Note that the horizontal line is x-axis and the vertical line is y-axis.

Now, explain to the students that the coordinates of the object varies as per the position of the object. In general, the coordinates can be expressed as (x, y).

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Teaching-Learning method

Classroom Situation

✧ Play the weblink to show a video on coordinate system.

https://www.youtube.com/watch?v=mgx0kT5UbKk (video: coordinate system)

Assessment

Divide the class into groups. Each group is provided with a graph sheet and the points A(3, -6), B(5, 3), C(-7, -2), D(-6, 6), E(-3, 2), G(2,2), O(-6, -5), S(-2, -3), T(0, -6), U(2, 6), N(6, 5), I(3, -2), R(6, -3) and H(0, 4).
Students in the group are instructed to plot the points on the graph sheet.

2.5.3 Distance between any Two Points

Transactional Strategy

Teaching-Learning method

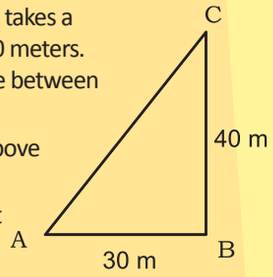
✧ Explain how to find real time distance between two points with the help of examples.

Example:

A boy walks 30 metres towards north and takes a turn towards east and further walks for 40 meters. How do we calculate the shortest distance between the starting point and final destination ?

✧ Give the pictorial representation of the above situation on the blackboard.

The starting point is A and the final point is C. The distance between the points A and B is 30 m and between points B and C is 40 m.



✧ Now, ask students to find the shortest distance between points A and C (AC), using Pythagoras theorem.

Using Pythagoras theorem,

$AC^2 = AB^2 + BC^2$,

we find

$AC = \sqrt{30^2 + 40^2} = 50$ m

Explain that distance between two points in a coordinate plane can be calculated using the above method.

Classroom Situation

✧ Find the distance between two points using Pythagoras theorem. Give more problems for students to solve and get familiar with the concept.

✧ Play the weblinks to show a video on how to find the distance between two points.

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https://www.youtube.com/watch?v=LdmfnpcU6EM
https://www.khanacademy.org/geometry (videos: find the distance between two points)

Assessment

✧ **Activity 1**

Plot the points A(2, 0), B(2, 8), and C(5, 4). Join them and name the diagram obtained.

✧ **Activity 2**

On a political map of India, mark the following cricket stadiums and connect using ruler and pencil.

- Wankhede Cricket stadium, Mumbai
- Eden Garden Cricket Stadium, Kolkata
- Feroz Shah Kotla Cricket Stadium, New Delhi
- M.A. Chidambaram Cricket Stadium, Chennai

Write the obtained shape, and then write the condition to make the shape as rectangle.

✧ **Activity 3**

Plot and join the following points on a graph sheet and write the shape obtained.

- A(0, 3), B(3, 0), C(-3, 0), and D(0, -3)
- D(3, -1), E(3, 3), F(-3, 3), and G(-3, -1)

✧ **Activity 4**

Plot the points A (3, 0), B(6, 0), and C(3, 3). Complete a square ABCD and find the coordinates of D. Calculate the length of the side.

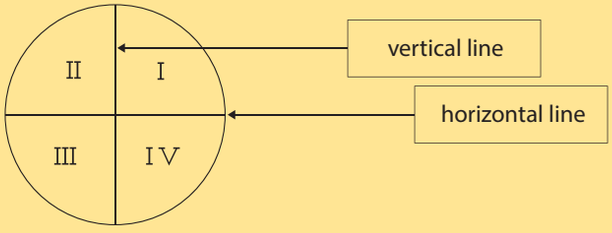
✧ **Activity 5**

Plot the points A(2, 2), B(-2, -1), and C(2, a) such that $\angle ACB = 90°$. Find the value of A by completing the triangle.

✧ **Activity 6 (Group)**

Divide the classroom into two groups as A and B.

- Ask students of group A to say *abscissa* and *ordinate* alternatively.
- The students who said *abscissa* should form a horizontal line and the students who said *ordinate* should form a vertical line.
- Ask students of group B to say 1, 2, 3, 4 one after the other.
  Students of group B must cover group A students to form a circle as shown in the figure given below.



- Now, students of group B should sing *Merry-Go-Around* and move around in a circle. When you say 'STOP', students of group B should stand in their respective quadrants.

✧ You can follow the questions given in the textbook.

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Assessment

2.5.4 Suggestive Plan for Teacher and Student Activity

S.No	Teacher's role as a facilitator (explaining /solving problems)	Problems to be solved by the students
1.	✧ Mapping a plane and devising a coordinate system (abscissa and ordinate) ✧ Explaining the meaning of quadrant and plotting the points in the Cartesian plane ✧ Solving Examples 5.1 to 5.7	Exercise 5.1, problems 1 to 4
2.	Explaining the distance between any two points	Exercise 5.2, problem 1
3.	✧ Explaining the properties of distance in a Cartesian plane ✧ Solving Examples 5.9 to 5.17	Exercise 5.2, problems 2 to 14

2.5.5 Additional Information Pertaining to the Corresponding Topics for Teacher's Professional Development

Let P and Q be two points (x1, y1) and (x2, y2) respectively. Then the distance between P and Q is given by $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$.

PQ is found by extracting a square root, so that either sign might be given to it. Except in the case of lines parallel to either axis, there is no convention about the direction to be considered either positive or negative. So, the distance between two points can be measured as a positive number. However, when we have more than two points, say A, B, C, D in a straight line, it is necessary to adhere to the rules.

AB = -BA, AB + BC + CD = AD.

2.5.6 Additional Problems for Competitive Examinations

1. Find the distance between the points (6, 8) and (3, 4).
2. Find the distance between the points $(at_1^2, 2at1)$ and $(at_2^2, 2at2)$.
3. Find the distance between the points $\left(ct_1, \frac{c}{t_1}\right)$ and $\left(ct_2, \frac{c}{t_2}\right)$.
4. Show that the triangle whose vertices are (-3, -4), (2, 6) and (-6, 10) is right angled.
5. Prove that the points (-7, -3), (5, 10), (15, 8) and (3, -5) are at the corners of a parallelogram.
6. Show that the three points (4, 2), (7, 5) and (9, 7) lie on a straight line.
7. Prove that the points (0, -1), (2, 1), (0, 3) and (-2, 1) taken in order are the vertices of a square.
8. The points (2, 1), (5, 4) and (1, 4) are three of the corners of a parallelogram. Find the coordinates of the remaining corner which is opposite to (2, 1).







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9. Prove that (2, 2), (-2, -2) and $(-2\sqrt{3}, 2\sqrt{3})$ are the vertices of an equilateral triangle.
10. Show that the points (1, -2), (-3, 0) and (5, 6) form the vertices of a right-angled triangle. Find the coordinate of the fourth vertex of the rectangle having three of its vertices at these points.

Key

1. 5 2. $\sqrt{(a^2(t_1 - t_2)^2\{(t_2 + t_1)^2 + 4\}}$ 3. $\frac{\sqrt{c^2(t_1 - t_2)^2(1 + t_1^2 t_2^2)}}{t\ t}$

8 (4,7) 10. (1,8) 4 to 7, 9 *Student's work*

2.5.7 Self-Evaluation

- I can understand Cartesian coordinate system.
- I can identify abscissa, ordinate, and coordinates of any given point.
- I can find the distance between any two points in the Cartesian plane.

2.5.8 Consolidation

Students are able to

- understand Cartesian coordinate system
- identify abscissa, ordinate, and coordinates of any given point
- find distance between any two points in the Cartesian plane

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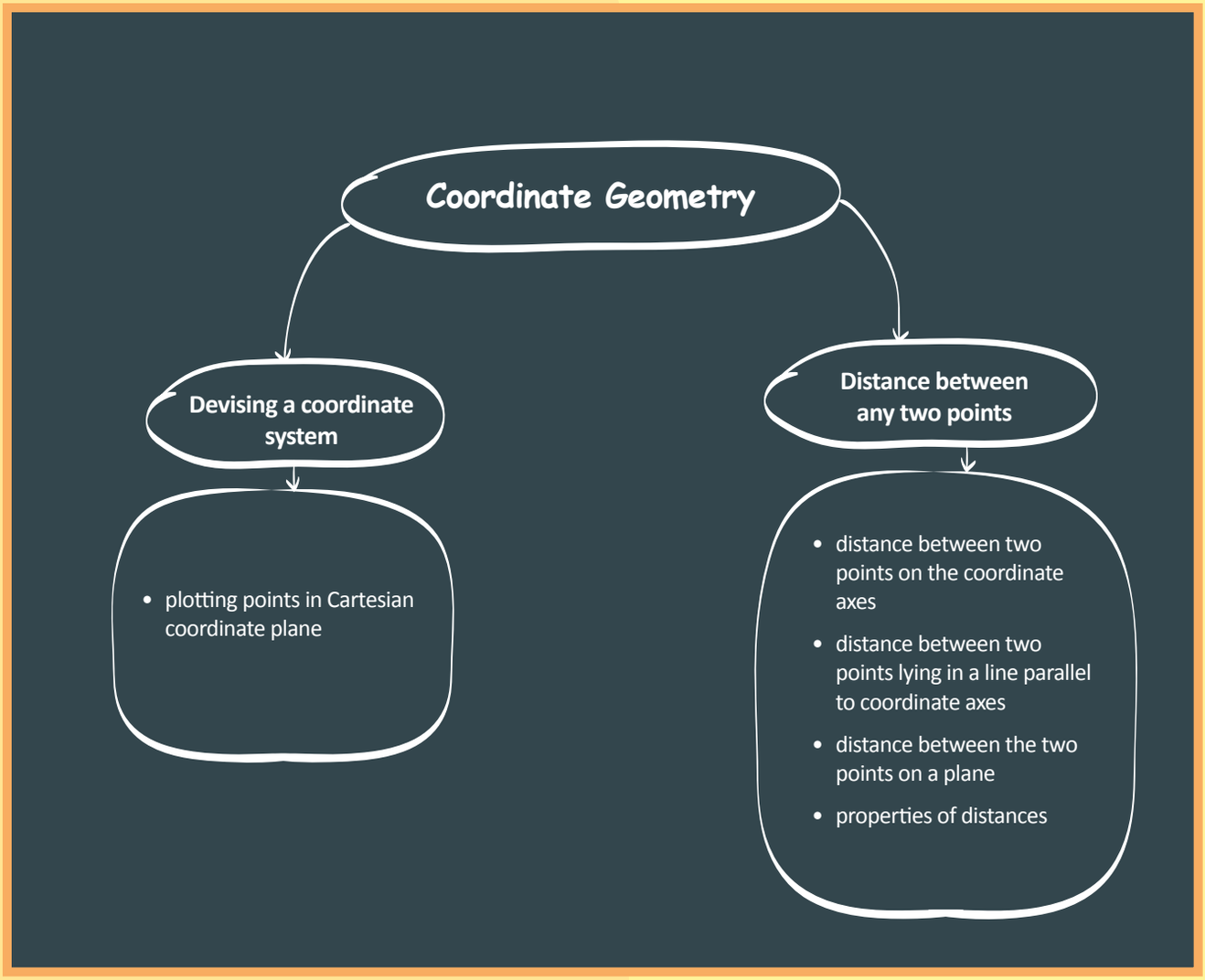
2.5.9 Mind Mapping



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