

Class 9

Section I
Pedagogical processes suggested by NCERT
The learners may be provided with opportunities individually /in groups and encouraged to
Work with real numbers and consolidate and the concepts of numbers learnt in earlier classes. Some such opportunities could be, <ul style="list-style-type: none">a) To observe and discuss real numbers.b) To recall and observe the processes involved in different mathematical concepts studied earlier and find situations in which they come across irrational numbers. For example, finding the length of the diagonal of a square with side, say, 2 units or area of a circle with a given radius etc.c) To observe properties of different types of numbers, such as the denseness of the numbers, by devising different methods based on the knowledge of numbers gained in earlier classes. One of them could be by representing them on the number line.d) To facilitate<ul style="list-style-type: none">i) In making mental estimations in different situations such as arranging numbers like $2, 2^1/2, 2^3/2, 2^5/2$, etc. In ascending (or descending) order in a given time frame or telling between which two numbers like, $\sqrt{17}, \sqrt{23}, \sqrt{59}, -\sqrt{2}$, etc. Lie.ii) Discussion about how the polynomials are different from algebraic expressions.
Discuss proofs of mathematical statements using axioms and postulates.
Encourage to play the following games related to geometry. <ul style="list-style-type: none">a) If one group says, if equals are added to equals, then the results are equal. The other group may be encouraged to provide example such as, if $a=b$, then $a+3=b+3$, another group may extend it further as $a+3+5= b+3+5$ and so on.b) By observing different objects in the surroundings one group may find the similarities and the other group finds differences with reference to different geometrical shapes - lines, rays, angles, parallel lines, perpendicular lines, congruent shapes, non-congruent shapes etc. And justify their findings logically.
Discuss in groups about the properties of triangles and construction of geometrical shapes such as triangles, line segment and its bisector, angle and its bisector under different conditions
Find and discuss ways to fix position of a point in a plane and different properties related to it.
Engage in a survey and discuss about different ways to represent data pictorially such as bar graphs, histograms (with varying base lengths) and frequency polygons.
Collect data from their surroundings and calculate central tendencies such as mean, mode or median
Explore the features of solid objects from daily life situations to identify them as cubes, cuboids, cylinders etc.
Play games involving throwing a dice, tossing a coin etc. And find their chance of happening.
Do a project of collecting situations for different numbers representing probabilities

Section II	
Learning Outcomes of NCERT	Measuring the LOs
Applies logical reasoning in classifying real numbers, proving their properties and using them in different situations.	Applies logical reasoning in classifying real numbers in order to prove their properties and use them in different situations
Identifies /classifies polynomials among algebraic expressions and factorises them by applying appropriate algebraic identities.	Identifies /classifies polynomials among algebraic expressions in order to apply appropriate algebraic identities to factorise them
Relates the algebraic and graphical representations of a linear equation in one /two variables and applies the concepts to daily life situations.	Relates the algebraic and graphical representations of a linear equation in one /two variables in order to apply the concepts to daily life situations
Identifies similarities and differences among different geometrical shapes.	Identifies similarities and differences in order to differentiate between various geometrical shapes
Derives proofs of mathematical statements particularly related to geometrical concepts, like parallel lines, triangles, quadrilaterals, circles etc. by applying axiomatic approach and solves problems using them.	Applies axiomatic approach and derives proofs of mathematical statements particularly related to geometrical concepts, like parallel lines, triangles, quadrilaterals, circles etc. in order to solve problems using them
Finds areas of all types of triangles by applying appropriate formulae.	Applies appropriate formulae in order to find areas of all types of triangles
Constructs different geometrical shapes like bisectors of line segments, angles, and triangles under given conditions and provides reasons for the processes of such constructions.	Constructs different geometrical shapes like bisectors of line segments, angles, and triangles under given conditions in order to analyse and provide reasons for the processes of such constructions
Develops strategies to locate points in a cartesian plane.	Develops strategies from understanding of coordinate geometry in order to locate points in a cartesian plane
Identifies and classifies the daily life situations in which mean, median and mode can be used.	Identifies daily life situations in order to classify them as situations where mean, median and mode can be used
Analyses data by representing it in different forms like, tabular form (grouped or ungrouped), bar graph, histogram (with	Represents given data in different forms like, tabular form (grouped or ungrouped), bar graph, histogram (with equal and varying

equal and varying width and length), and frequency polygon.	width and length), and frequency polygon in order to analyse given data
Calculates empirical probability through experiments.	Conducts experiments and analyses data in order to calculate empirical probability
Derives formulas for surface areas and volumes of different solid objects like, cubes, cuboids, right circular cylinders / cones, spheres and hemispheres and applies them to objects found in the surroundings.	Derives formulas for surface areas and volumes of different solid objects like, cubes, cuboids, right circular cylinders / cones, spheres and hemispheres in order to apply them to objects found in the surroundings
	Solves problems that are not in familiar context of the child using above learning. These problems should include the situations about which child is not exposed earlier.

MAPPING OF GRADE 9 MATHEMATICS TOPICS WITH NCERT LEARNING OUTCOMES

Important Note: It must be ensured by the teachers that learners are able to use mathematical learning in day to day life and unfamiliar contexts/ situations about which they are not exposed earlier. Learning Objectives should also focus on enhancing the ability of the learner to convert a real life problem into a mathematical problem and the ability to interpret and evaluate mathematical results in the real life contexts.

Chapter 1	Content Area/Concept	Learning Objectives	Learning Outcome
1.Number Systems	Introduction to number system	Recall natural numbers, whole numbers, integers and Rational numbers and classify a given number as either of them	Applies logical reasoning in classifying real numbers, and proving their properties in order to use them in different situations
	Irrational Numbers	Represent a given number in the form p/q in order to show whether the given number is rational or not	
		Calculate and find rational numbers between any two rational numbers in order to prove that there are infinite rational numbers between any two given rational numbers	
		Modify a given non-terminating decimal number in the form of p/q and comment whether this number is irrational	
	Real Numbers and their Decimal Expansions	Use Pythagoras' theorem and create a Pythagorean triplet and construct the length equivalent to root of a given number	
		Deduce the value of a given fraction in its decimal form and infer if the decimal number is terminating or non-terminating	
	Representing Real Numbers on the Number Line	Use successive magnification and represent a given decimal number on a number line	
Operations on Real Numbers	Use the commutative, associative and distributive laws for addition and multiplication for irrational numbers and determine whether the sum, difference, quotients and products of irrational numbers are irrational or not		

		Rationalize the denominator of a given expression with a square root term in the denominator and convert it to an equivalent expression whose denominator is a rational number	
	Laws of Exponents for Real Numbers	Extend the laws of exponents and simplify a given expression	
2. Polynomials	Introduction to Polynomials	Recognize variables and their degree in a given algebraic expression and differentiate whether given expression is a polynomial in one variable or not.	Identifies /Classifies polynomials among algebraic expressions in order to apply appropriate algebraic identities to factories them
		Express real life situations into a polynomial.	
		Identify the degree of a given polynomial and classify an expression as zero, linear, quadratic and cubic polynomials	
	Polynomials in one variable	Substitute the value of 'a' in a given expression $p(x)$ and find the value of polynomial at 'a' i.e. $p(a)$	
	Zeroes of a Polynomial	Use given values for the variable 'x' in a polynomial $p(x)$ and identify if the given value is a zero of the polynomials	
	Remainder Theorem	Using Remainder Theorem, calculate division of $p(x)$ by a linear polynomial 'x - a' and find that the remainder is $p(a)$ and verify using long division method.	
	Factorization of Polynomials	Apply factor theorem and determine if a linear polynomial 'x-a' is a factor of the given polynomial $P(x)$	
		Apply factor theorem and determine the value of an unknown constant 'k' in Polynomial $P(x)$ when a linear polynomial 'x-a' is a known factor of $P(x)$	
Apply factor theorem and factories a given polynomial			
Factories a given polynomial using splitting middle-term method and factor theorem and compare the results of the two			

	Algebraic Identities	Point out to an algebraic identity that can be used and factorize a given expression Select appropriate algebraic identities and evaluate the values of given expressions	
3. Co-ordinate Geometry	Introduction to Coordinate Geometry	Determine the x & y co-ordinate of a point from a graph and write the co-ordinates of the point as an ordered pair	Develops strategies from understanding of coordinate geometry in order to locate points in a Cartesian plane
	Cartesian System	Plot a point on the Cartesian plane and determine QUADRANT of the point	
	Plotting a Point in the Plane if its Coordinates are given	Observe a given ordered pair and comment on its location	
	Application of Coordinate Geometry	Apply concepts of coordinate geometry and simplify given real life problems	
4. Linear Equations in two variables	Construction of Linear equations	Recall concepts of coefficients and variables and construct a linear equation from a given statement	Relates the algebraic and graphical representations of a linear equation in one /two variables in order to apply the concepts to daily life situations
	Linear Equations	Compare a given linear equation to the standard form $ax + by + c + 0$ and deduce the values of a, b and c	
	Solutions of Linear Equations	Use substitution method and deduce whether the ordered pair is solution to a given linear equation	
	Graph of Linear Equations	Plot the points on a graph and represent a linear equation in two variables	
		Solve an equation and represent it on a number line and a Cartesian plane	
Applications of Linear Equations	Using principles of linear equations, formulate and solve variety of problems in real life situations		
5. Introduction to Euclid's Geometry	Theorems, Postulates and Axioms	Give examples of theorems, postulates and axioms and differentiate between them with examples	Applies axiomatic approach and derives proofs of mathematical statements

	Euclid's Definitions, Axioms and Postulates	Reproduce Euclid's axioms in your own words and give examples for each	particularly related to geometrical concepts, like parallel lines, triangles, quadrilaterals, circles etc. in order to solve problems using them
		List Euclid's five postulates and visualize and illustrate them through a diagram	
		Analyze given statements /postulates and determine if they are extensions of Euclid's postulates	
		Apply Euclid's postulates and prove basic geometrical concepts about lines, points, planes, shapes, etc.	
Equivalent Versions of Euclid's Fifth Postulate	Illustrate the equivalent of Euclid's fifth postulate through a diagram and list conditions for two lines to be parallel		
6. Lines and Angles	Basic Terms and Definitions	Define segment, ray, collinear points, non-collinear points, acute angle, right angle, obtuse angle, straight angle, reflex angle, complementary angles, Supplementary angles and identify them in a given figure	Applies axiomatic approach and derives proofs of mathematical statements particularly related to geometrical concepts, like parallel lines, triangles, quadrilaterals, circles etc. in order to solve problems using them
	Pairs of Angles	Label angles created by two intersecting lines and identify vertically opposite pairs, adjacent angles, linear pairs, complementary /supplementary pairs of angles	
		Apply the concepts of linear pairs of angles and vertically opposite angles and establish relationships between the angles in a given figure and solve for missing values	
	Parallel Lines and a Transversal	Label angles created by a transversal intersecting two parallel lines and identify corresponding angles, alternate angles, interior angles and define relationship between these angles	
	Lines Parallel to the same Line	Find out the unknown angles created by a transversal in a given figure and infer if the lines are parallel or not	
Angle Sum Property of a Triangle	Define relationship between angles formed when a triangle is placed between two parallel lines and prove that exterior angle of a triangle is the sum of the two opposite interior angles		

7. Triangles		Observe the angles and sides of the given figures and find out whether they are congruent or not congruent	Applies axiomatic approach and derives proofs of mathematical statements particularly related to geometrical concepts, like parallel lines, triangles, quadrilaterals, circles etc. in order to solve problems using them
	Congruence of Triangles	Apply concepts of linear pairs of angles, vertically opposite angles, corresponding angles, alternate angles, transversal angles & exterior angles of a triangle and prove congruence between two triangles in a given figure	
	Criteria for Congruence of Triangles	Illustrate the criteria of congruencies of triangles through diagrams (ASA, SAS, SSS, RHS) and prove relationships between given angles, sides and triangles of a given figure	
	Some Properties of a Triangle	Apply criteria for congruence in a triangle with two congruent sides and prove that the angle opposite to the sides are equal and apply it in a given figure to solve for the measure of an angle	
	Some More Criteria for Congruence of Triangles	Examine given triangles that satisfy AAA or SSA criteria and comment whether they are congruent	
	Inequalities in a Triangle	Using properties of inequalities in triangles prove the relationship between any given sides or angles in a given figure	
8. Quadrilaterals	Angle sum property of a Quadrilateral	Apply angle sum property of quadrilateral and find the value of the unknown angle	Applies axiomatic approach and derives proofs of mathematical statements particularly related to geometrical concepts, like parallel lines, triangles, quadrilaterals, circles etc. in order to solve problems using them
	Types of Quadrilaterals	List the properties of quadrilaterals and classify real life objects into different types of Quadrilaterals	
	Properties of Parallelogram	List the properties of parallelogram and identify if a given quadrilateral is a parallelogram	
	Another Condition for a Quadrilateral to be a Parallelogram	Apply properties of parallelogram and find a) an unknown angle b) an unknown side	

	The Mid-point Theorem	Prove the midpoint theorem of triangles using concepts of congruency and transversal angles and extend the application to quadrilaterals	
9. Areas of Parallelograms and triangles	Figures on the same Base and Between the same Parallels	Identify the planar region and area associated and show that area of non-overlapping planar region formed is the sum of their areas	Applies appropriate formulae in order to find areas of all types of triangles
		Identify if given figures lie on the same base and between the same parallels and write the common base and the two parallels	
	Parallelograms on the same Base and between the same Parallels	Extend the understanding of congruency of triangle and prove that: Parallelograms on the same base and between the same parallels are equal in area	
	Triangle & Parallelogram on the same Base and between the same parallels	Extend prior knowledge from this chapter and prove that when a triangle and a parallelogram are on the same base and between the same parallels, the area of the triangle is equal to half the area of the parallelogram	
	Triangles on the same Base and between the same parallels	Extend prior knowledge and prove that Two triangles on the same base (or equal bases) and between the same parallels are equal in area	
Extend prior knowledge to prove that Two triangles having the same base (or equal bases) and equal areas lie between the same parallels.			
10. Circles	Circles and its Related Terms: A Review	Construct a circle of a given radius and verify that the length of multiple segments drawn from the center of the circle to the circumference is equal	Applies axiomatic approach and derives proofs of mathematical statements particularly related to geometrical concepts, like parallel lines, triangles, quadrilaterals, circles etc. in
		Define radius, chord, diameter, segment (major and minor), arc (major and minor), interior or exterior of a circle and illustrate and label them on a given circle	
	Angle Subtended by a Chord at a Point	Apply theorems regarding angle subtended by a chord in a circle and find the measure of an angle in the given figure	

	Perpendicular from the Centre to a Chord	Apply the property of perpendicular from the center to the chord and solve for the missing values (lengths and angles) in a given figure	order to solve problems using them
	Circle through Three Points	Construct circle passing through 1, 2 & 3 non-collinear points and comment on how many circles can be constructed passing through them	
	Equal Chords and their Distances from the Centre	Use the value of radius and perpendicular to the chord and compute the length of a chord	
	Angle subtended by arc of the circle	Interpret and apply theorems on the angles subtended by arcs of a circle and solve for unknown values in given examples	
	Cyclic Quadrilaterals	Apply the relation between angles of a cyclic quadrilateral and solve for the value of a given angle	
11. Constructions	Basic Constructions	List and execute steps of construction and bisect a given angle.	Constructs different geometrical shapes like bisectors of line segments, angles, and triangles under given conditions in order to provide reasons for the processes of such constructions
		List and execute steps of construction and draw the perpendicular bisector of a given line segment.	
		List and execute steps of construction and construct an angle of any given measurement	
	Some Constructions of Triangles	List and execute steps of construction and construct a triangle given its base, a base angle and the sum of the other two sides.	
		List and execute steps of construction and construct a triangle given its base, a base angle and the difference of the other two sides	
		List and execute steps of construction and construct a triangle given its perimeter and its two base angles	
12. Heron's formula	Standard formula of a triangle	Calculate area of a given triangle to state the limitation of the Standard formula (Area of Triangle = $\frac{1}{2} b.h$)	Applies appropriate formulae in order to find areas of all types of triangles
	Area of a Triangle by Heron's formula	Apply Heron's formula and calculate the area of a Triangle	

	Application of Heron's Formula in finding Areas of Quadrilateral	Breakdown a given polygon into triangles and find the area of a given polygon as a sum of areas of those triangles	
13. Surface areas and volumes	Surface Area of a Cuboid and a Cube	Visualize a cube and cuboid in its 2-D form and calculate the surface area	Derives formulas for surface areas and volumes of different solid objects like, cubes, cuboids, right circular cylinders / cones, spheres and hemispheres in order to apply them to objects found in the surroundings
		Calculate the surface area (lateral and total) of the cube or cuboid and determine the cost of painting /covering the given surface	
	Surface Area of a Right Circular Cylinder	Visualize a cylinder in its 2-D form and calculate the curved surface area and total surface area	
		Calculate the surface area (curved and total) of a cylinder to determine the cost of painting /covering the given surface	
	Surface Area of a Right Circular Cone	Visualize a right circular cone in 2-D and calculate the surface area (curved and total)	
		Calculate the surface area (curved and total) of a cone to determine the cost of painting /covering the given surface	
	Surface Area of a Sphere	Calculate the surface area of a sphere /hemisphere to determine the cost of painting /covering the given surface of a sphere /hemisphere	
	Volume of a Cube	Calculate the volume of a given cube and infer the quantity of any substance it can hold	
	Volume of a Cuboid	Calculate the volume of a given cuboid and infer the quantity of any substance it can hold	
	Volume of a Cylinder	Calculate the volume of a given cylinder and infer the quantity of any substance it can hold	
Volume of a Cone	Calculate the volume of a given cone and infer the quantity of any substance it can hold		
Volume of a sphere	Calculate the volume of a given sphere and infer the quantity of any substance it can hold		

	Volume of a hemisphere	Calculate the volume of a given hemisphere and infer the quantity of any substance it can hold	
14. Statistics	Frequency Table	Record and label a given data set and create a frequency table	Represents given data in different forms like, tabular form (grouped or ungrouped), bar graph, histogram (with equal and varying width and length), and frequency polygon in order to analyses given data
	Bar Graph	Identify an appropriate scale and labels and represent given data through a bar graph	
		Read a given bar graph and infer a variety of information from it	
		Compare the values and correlate two data points from the graph	
	Histogram	Read the given data and create a histogram for continuous and discontinuous data sets	
		Read a given histogram and infer a variety of information from it	
	Frequency Polygon	Read the given data and create a frequency polygon for given data sets	
		Read a given frequency polygon and infer a variety of information from it	
Mean, Median and Mode	Differentiate between mean, median and mode with examples and understand most effective measure of central tendency in various cases	Identifies daily life situations in order to classify them as situations where mean, median and mode can be used	
	Apply appropriate formula and calculate the mean and median of even and odd number of data points		
	Recall and use the formula for mean in order find the value of a missing observation		
15. Probability	Calculation of Empirical Probability in various experiments	With the formula for Empirical probability, calculate the probability for a simple event	Conducts experiments and analyses data in order to calculate empirical probability
		Create a flow chart of all the terms related to random experiments (coins, dice, cards) and calculate the total number of trials of a given experiment and calculate the Empirical Probability	

		Compute the total number of trials and trials for a given event E represent in various forms (table, histogram, pie-charts, etc.) to solve for the value of Empirical Probability $P(E)$	
		Calculate empirical probability of a situation and predict the likelihood of an event	
		Arrange events from least likely to most likely and predict outcomes in a given experiment	
		Calculate the sum of probabilities of all events and prove that the sum of the probability of all events in a single experiment is 1	