Mathematics Syllabus, Grades 9

Introduction

The curriculum guide for grade 9 is a continuation of the syllabi of mathematics of the preceding grades and is based on the knowledge acquired and competencies developed by students in their mathematics study of the earlier grades. Mathematics learning in grade 9 has to be performed in such a way that students' interest in the subject is stimulated. This can be done by connecting the lesson in the classroom with real life and theory with practice by using students' experience gained from their environment and other subjects. Interesting problems concerning the broad application of mathematics in agriculture, industrial arts, trade, production, investment, the other sciences, etc. should be used.

While planning, the teacher the teacher should always look for hands-on, minds-on and interesting activities that can motivate students to study the subject. Learning has to be facilitated by the teacher in such a way that new subject matter is linked with deepening of the already acquired knowledge and developed abilities and skills.

Objectives

After completing grade 9 mathematics, students should be able to

- deal with and perform the four operations using the set of real numbers.
- solve linear and quadratic equations.
- use basic knowledge about sets to solve related problems.
- develop basic knowledge about relations, functions and their respective graphs.
- know important properties of regular polygons and use the properties to solve related problems.
- use postulates and theorems on congruent and similar figures and solve related real life problems.
- solve real-life problems on height, distance and angle using their knowledge and skills in trigonometry.
- use symmetrical and angle properties of circles to solve related problems.
- calculate are lengths perimeters and areas of segments and sectors
- calculate areas of triangular and parallelogram regions.
- calculate surface areas and volumes of cylinders and prisons.
- collect, tabulate, draw histograms and calculate measures of location and measures of dispersion for ungrouped statistical data.
- calculate probability of an event.
- identify vector and scalar quantities.
- represent vectors pictorially.
- determine the sum of vectors and multiply a given vector by a scalar.
- express any given vector as a position vector.

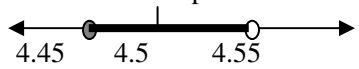
Unit 1: The Number System *(33 periods)*

Unit outcomes: Students will be able to:

- Know basic concepts and important facts about real numbers
- Justify methods and procedures in computation with real numbers
- Solve mathematical problems involving real numbers.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
Students will be able to: • identify natural numbers and integers • define prime numbers and composite numbers • determine common factors and common multiples of pairs of numbers.	***1. The Number System*** **1.1 Revision on the set of rational Numbers** *(3 periods)* **1.1.1 Natural numbers, integers, prime numbers and composite numbers** **1.1.2 Common factors and common multiples**	• You can start the lesson by revising the Natural numbers, integers, prime and composite numbers. • Let students revise prime factorization of composite numbers. • Let students revise on finding common factors and common multiples of given numbers. • Discuss with students about the definition of rational numbers together with their important properties	• Turn by turn ask students to tell to the class, what they know about natural numbers, integers, prime numbers, and composite numbers • Asking oral questions • Giving group work exercises' • Giving class activities • Homework and check their work
• show that repeating decimals are also rational numbers	**1.2 The real number system** *(30 periods)*	• After a brief discussion of terminating decimals, then with active participation of students discuss on the method of converting repeating decimals to fraction	• Assignment • quiz I
• identify irrational numbers	**1.2.1 Representation of rational numbers by decimals.**	• You can start the learning by discussing the necessity of irrational numbers as an extension of the number system. For example you may ask students to solve equations of the form $x^2 = 3$	• Ask students to define rational number and to give their own examples of rational numbers.
• locate some irrational numbers on a number line.	**1.2.2 Irrational numbers**	• After considering several examples of irrational numbers (expressed in either decimal form or in radical form), encourage students to describe the nature of irrational numbers and then state the definition of irrational number.	• Ask students to give their own examples of irrational number and let them justify their answers.
• define real numbers. • describe the correspondence between real numbers and points on a numbers line.	**1.2.3 Real numbers**	• Assist students to come to the definition of real numbers in their own words • i.e. real number is the union of rational and irrational numbers and introduce the notation $\Re$ of the set of all real numbers.	• Ask students to give their own examples of real numbers • Give exercises problems on locating a given real

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		• Assist students to locate real number say $\sqrt{2}$ or $\sqrt{2}+3$ on the number line and describe the correspondence between real numbers and points on the number line.	number, say $\sqrt{3}$ or $\sqrt{3}+2$ on the number line.
• Realize the relationship between a power with fractional exponent and a radical form.	**1.2.4 Exponents and radicals**	• Discuss the relationship between power with fractional exponent form i.e. in which the exponent is $1/_n$ when n is a natural number and radical form.	• Ask students to describe what is meant by $a^{1/n} = \sqrt[n]{a}$ for different values of n and a
• Convert powers with fractional exponent to radical form and vice-versa		• Assist students to convert from one form to the other form and encourage them to come to the rule which is stated as $a^{1/n} = \sqrt[n]{a}$ where $a > 0$ and $n \in \mathbf{N}$	e.g. $9^{1/2}=\sqrt{9}$, $8^{1/3}=\sqrt[3]{8}$, $4\sqrt{725}$,..
• perform any one of the four operation on the set of real numbers	**1.2.5 The four operations on real numbers.**	• You may start the lesson by asking students to perform the four operation on rational numbers; • Assist students to perform the same operations on real numbers. i.e. which involves radicals.	• Give exercise problems on computing with real numbers (i.e., to find the sum, difference, product and quotient of real numbers.
• use the laws of exponents to simplify expression.		• Let students generalize the commutative and associative properties of addition and multiplication on the set of real numbers • Discuss with students the distributive properties of multiplication over addition and discuss also the existence of the additive and multiplicative identities and inverses for every real number (except 0 which has no multiplicative inverse) • Let students state the laws of exponents after considering several examples i.e. (1) $a^n \times a^m = a^{n+m}$ (2) $\frac{a^n}{a^m} = a^{n-m}$,(n > m) (3) $(a^n)^m = a^{n\times m} = (a^m)^n$ (4) $(a \times b)^n = a^n \times b^n$	• Ask students to identify important properties of addition and multiplication of real numbers, i.e. for $a, b, c \in \mathcal{R}$ • $a+b=b+a$ and $a\times b= b\times a$ • $(a+b)+c=a+(b+c)$ and $(a\times b) \times c = a \times (b\times c)$ • $a\times(b+c) = (a\times b) + (a\times c)$ • Ask students questions like the following and let them justify their answer by giving their own examples.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
			(1) if a is rational number and b is an irrational numbers, then - What type of number is a + b ? - What type of number is a × b? (2) if both a and b are irrational numbers, then - What type of number is a + b - What type of number is a × b • Give exercise problems on simplification powers by using the laws of exponents.
• give appropriate upper and lower bounds for a given data to a specified accuracy (e.g. rounding off)	**1.2.6 Limits of accuracy**	• You may start the lesson by revising some important points on the rational number expressed in decimal numerals (i.e. terminating and repeating decimals). • With active participation of students discuss on the idea of "rounding off" and the notion of "significant figures" in a number, in doing so verify the concept using several examples. • For example: 4.5, 4.50 and 4.500 although appearing to represent the same number, but do not. This is because they are written in different degree of accuracy, for instance **4.5** is rounded to one decimal place and therefore any numbers from 4.45 up to but not including 4.55 would be rounded to 4.5. On a number line this would be represented as  Using in equality this can be expressed as $4.45 \leq 4.5 < 4.55$ the number **4.45** is called the **lower bound** while **4.55** is known as the **upper bound.**	• Give several exercise problems on rounding off and finding the lower and upper boundaries of number (or measurements). • Ask students to find the sum and difference of numbers to a given number of significant figures.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		• By considering examples like: "A carpenter measures the width (w) of a window rounded off to 2.4m to the nearest one decimal place (or 2 significant figures). What are the minimum and maximum values of the width (w) when rounding off?" • Since $2.35 \leq w < 2.45$, the number 2.35 is the lower bound while 2.45is the upper bound. • You may consider the effect of operations (addition, subtraction and multiplication) on accuracy. **E.g.** The effect of addition on accuracy The two sides of a triangle are 7.6cm and 5.4cm long. Find their sum. **Ans.** If $\ell_1 = 7.6$cm and $\ell_2 = 5.4$, then $7.55 \leq \ell_1 \leq 7.65$ and $5.35 \leq \ell_2 \leq 5.45$ or 7.6 ± 0.05cm and 5.4 ± 0.5. Therefore their sum is $(7.6 \pm 0.05)+(5.4 \pm 0.05)=13.0 \pm 0.1$cm and sum lies between 12.9cm and 13.1cm. (***Note**: Care should be taken in the calculations and in the numbers taken, the significant figures not to be more than three (or two decimal places))*	
• express any positive rational number in its standard form.	**1.2.7 Standard form (scientific notation).**	• Assist students to practice writing standard notations of positive rational numbers • Assist students to recognize that this notation is useful in writing very small and very large positive numbers.	• Ask students to write large numbers like the population of Ethiopia in standard form. • Give exercises on expressing large or small numbers by using their standard notation.
• explain the notion of rationalization. • identify a rationalizing factor for a given expression.	**1.2.8 Rationalization**	• With active participating of the students discuss the rules of rationalization with the help of examples, in doing so give emphasis on how to determine the rationalizing factors and also emphasize on rationalizing the denominator as it is commonly used.	• Give exercise problems on rationalizing a given expression.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
• use the Euclid's division algorithm to express given quotients of the form $\frac{p}{q}$ where p > q.	**1.2.9 Euclid's division algorithms.**	• Assist students to express, state and generalize the Euclid's division algorithm. i.e. given two numbers **p** and **d** where **p > d** the **p = q.d + r**. Where **q** is the quotient and **r** is the remainder and $r \geq 0$, in doing so give emphasis on the nature of the numbers, i.e. all **p, q, d** and **r** are non-negative integers and $0 \leq r < d$	• Give exercise problems on the application of the algorithm e.g. $7 = (2 \times 3) + 1$.

Unit 2: Solution of Equation *(22periods)*

Unit outcomes: Students will be able to:

- Solve problems on equations involving exponents and radicals
- Solve systems of simultaneous equations in two variables.
- Solve simple equations involving absolute values
- Solve quadratic equations.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
Students will be able to: • Solve equations involving exponents and radicals	***2. Solution of Equation*** **2.1 Equations involving exponents and radicals** *(3 periods)*	• You may start the lesson by the rules for exponents and introduce the fact that for $a > 0$, $a^x = a^y$ if and only if $x = y$ • Assist students to use the above statement and solve some simple equations involving exponents and radicals.	• Class activities • Group discussions • Giving Assignment • Give exercise problems on equations involving exponents and radicals like find x • $2^x = 8$ • $x^2 = 16$ • $\sqrt{x} = 9$
• Solve simultaneous equation • identify the three cases of solutions of simultaneous equations (a unique solution, no solution, infinitely many solutions)	**2.2 Systems of linear equation two variables.** *(8 periods)*	• With active participation of the students revise how to find solution for a linear equation, i.e., equation like $2x + 3 = 7$ and following this discuss with students how the solution of an equation of the form $2x + 3y = 5$ is determined. • Introducing the general form of a system of two linear equations with the help of examples. • Discuss the different methods of finding the solutions of the systems of two linear equations' • Help students them solve the system of simultaneous equations using elimination on substitutions or graphical methods.	• **Homework** • **Quiz IX** • Give exercise problems on the application of each of the methods for solving system of linear equation.
• Solve equations involving absolute value	**2.3 Equations involving absolute value.** *(3 periods)*	• You may start the lesson by asking students to state the definition of absolute values. • Assist students to solve equations involving absolute value such as $\|3x - 2\| = 1$ by using the definition of absolute value.	• Give exercise problems on solving equations involving absolute value of linear expression

Competencies	***Contents***	***Teaching / Learning Activities and Resources***	***Assessment***
• Solve quadratic equations by using any one of the three methods. • Apply Viete's theorem to solve related problems	**2.4 Quadratic equation** *(8 periods)* • Solution of quadration equation using factorization • solution of quadratic equation using completing the square. • Solutions of quadratic equations using the formula. • The relationship between coefficients of quadratic equations and its roots (Viete's theorem)	• Introduce the general form of a quadratic equation. • Discuss on the different methods of determining the solutions of quadratic equation. • Help students to find the solutions of a quadratic equation by factorization and by completing the square methods. • Help students find the solutions of a quadratic equation using the general quadratic formula. • Let students practice on the application of Viete's theorem through different exercises.	• Give exercise problems on solving quadratic equations (ask the application each method) • Ask students questions about the roots of a given quadratic equations.

Unit 3: Further on Sets *(15 periods)*

Unit outcomes: Students will be able to:

- Understand additional facts and principles about sets
- Apply rules of operation on sets and find the result
- Demonstrate correct usage of Venn-diagram in set operations
- Apply rules and principles of set theory to practical situations.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
Students will be able to: • describe sets in different ways	***3. Further on Sets*** **3.1 Ways to describe sets** *(2 periods)*	• Revise important points from previous grade which discussed about sets and emphasise on how the sets are described • Guide the students to write a set whose elements are related by mathematical formula • After revising what the students know about set description , introduce the new way set builder methods of describing sets, by using several examples.	• Ask students to describe a given set in as many ways as possible.
• identify the elements of a given set • explain the notion "empty set" and "universal set"	**3.2 The notion of sets** *(4 periods)*	• Assist students to name some elements of a given set and encourage them to explain whether a given object/number belongs to the set or not and to use the appropriate symbol accordingly. • After describing different sets (using either word description, or set builder method) let the student identify which of these set(s) is/are empty set/s	• Ask students to give examples of empty sets particularly from practical situations (like: the set of dogs that can fly) • Ask the students to explain the difference among each sets: { }, {x} and {0}
• determine the numbers of subsets of a given finite set and list them. • give the power set of a given set		• You may start the lesson by introducing what is meant by "universal set" and explain when and how to use it using Venn-diagram in illustration of relations among sets.	• Group discussions on what they had learnt about sets in earlier grades.
• determine the number of proper subsets of a given finite set and list them. • distinguishes between equal sets and equivalent sets		• Assist students to list and count the number of subsets and proper subsets of some given finite sets (i.e. sets with 1, 2, 3, 4 or 5 elements) and encourage the students to derive general formulas to find the numbers of these subsets and proper subsets. • After explaining the meaning of "equal sets" and "equivalent sets" by using several examples, assist the students to determine equal sets and equivalent sets to a given set.	• Ask students to list all the subsets, power sets and proper subsets of a given finite set. • Give exercise problems on finding equal and equivalent sets to a given set.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
• find equal sets and equivalent sets to a given set			
• determine number of elements in the union of two finite set. • describe the properties of "union" and "intersection" of sets.	**3.3 Operations on sets** *(9 periods)* • "union" and "intersection"	• Let the students be familiar with the notation used for number of elements in a given finite set. • By using some practical examples lead the students to see the relation between the numbers of elements in two finite sets, in their intersection and union. • Let the students apply this relation to find the number of elements in the union of two sets using real life examples/ exercises. • Use several examples and lead your students to conclude that the commutative and associative properties of "union" and "intersection" of sets hold true.	• Ask the students to describe the number of elements using mathematical language • Ask students to find the union and intersection of sets • Ask students to find the number of elements in the union of two sets using both Venn diagrams and formula.
• determine the absolute complement of a given set.	• Complements of a set - De- Morgan's Law	• You can start the lesson by defining the notion "absolute complement" of a given set in terms of the universal set and by using Venn diagram let the students become familiar with the concept and its notation. • Assist students to determine the absolute complement of a given set. • You may use Venn-diagram in your discussion of showing the validity of the De-Morgan's Law and other properties of complements.	• Ask students to demonstrate De-Morgan's Law using Venn diagram by means of group work approach • Class activities
• determine the relative complement of two sets	• Relative complement (difference) of two sets	• Define the notion "Relative complement" or "Difference of two sets" using Venn-diagram. • Let students determine the relative complement of two set and state some of its properties • Lead the students to differentiate between the notions of absolute complement and relative complement.	• Ask the students to explain the difference between relative complement and absolute complements • Ask students to find the relative complement of two given sets.
• determine the symmetric difference of two sets.	• Symmetric difference of two sets	• Start the lesson by defining what is meant by "symmetric difference" of two sets.	• Ask students to describe the symmetric difference of two sets in different ways i.e.

Competencies	***Contents***	***Teaching / Learning Activities and Resources***	***Assessment***
		• Discuss and guide the student to state and explain its properties by using several examples.	• $A \Delta B = (A \setminus B) \cup \Delta (B \setminus A)$ • $A \Delta B = ((A \cup B) \setminus A \cap B)$ • Ask students to show the commutative and associative properties of "Δ" by giving specific examples.
• determine the Cartesian product of two sets.	• Cartesian product of two sets.	• Define the notion "Product of two sets" and let the students find out its peculiar nature, i.e., the elements of this set are ordered pairs unlike the sets considered so far. • Let the students explain which properties are true for the product of two sets and which are not true. • Assist the students to see the importance of the Cartesian product of two sets in setting up the coordinate system.	• Ask the students to determine whether an ordered pair/s belong to the product of two given sets or not.

Unit 4: Relations and Functions *(22periods)*

Unit outcomes: Students will be able to:

- know specific facts about relation and function
- understand basic concepts and principles about combination of functions.
- sketch graphs of relations and functions (i.e. of linear and quadratic functions)

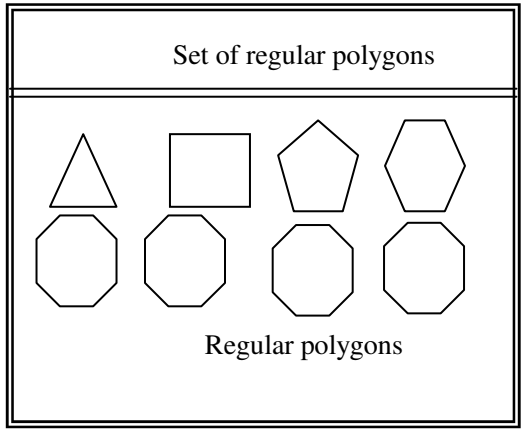
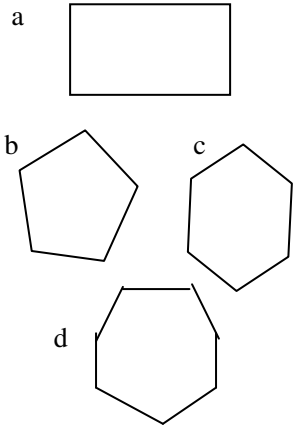
Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
Students will be able to: • define the notions "relation", "domain" and "range"	***4. Relations and Functions*** **4.1 Relations (** *7 periods)* • Cartesian product of sets • The Notion "Relation"	• You can start the lesson by revising the Cartesian product of two sets. • Assist students to explain the meaning of relation from their daily life. Let them state the formal defining of relation and give examples of relations themselves based on the definition. • You can give some examples of relations and ask students to determine the domain and range	• Ask students to give their own examples of relation taken from their daily life in mathematical language. • Give exercise problems on algebraic relations, and on their domains and ranges. • Give exercises on determining the domain and range of a relation from its graph.
• draw graphs of relations • use graphs of relation to determine domain and range	• Graphs of relations	• You can start the lesson by discussing with student on how to sketch graphs of relations, like $R = \{(x, y): \quad y < x \}$ $R = \{(x, y) : y > x + 1\}$ etc. and on determining the domain and range from their graphs. • Assist students to draw graphs of relations of the type. $R = \{(x, y) : \quad y \leq x + 1$ and $y \geq 1 - x\}$. and determine the domain and range. • Allow students to practice writing the rule or formula of a relation from its graph.	• Give exercises on graphing simple linear inequalities
• define function • determine the domain and range of a given function.	**4.2 Functions** *(6 periods)*	• You may start the lesson by considering different types of relations. For example $R_1 = \{(a, 1) , (b, 2), (c, 3) \}$ $R_2 = \{(a, 0), (b, 0), c, 0)\}$ $R_3 = \{(a, 1), (a, 2) , (a, 3) \}$ and	• Ask students to write down functions written in the form of ordered pairs

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
• determine the sum difference, produced and quotient of functions. • Evaluate combination of functions for a given values from their respective domain.	• Combinations of function	• Assist students to observe that types of relations like R_1 and R_2 are function while R_3 is not a function. After considering several examples and discussing them with students state the formal definition of function. • Let students give examples of relations which are functions by themselves. • Assist students to determine the domains and ranges of functions defined by the set of ordered pairs. • You may proceed the lesson by considering functions defined by formulas like. f (x) = x + 2 and g(x) = 3 - 3x and guide students to find their sum, difference, product and quotients. Encourage students to determine the relationship between the domains of the component functions and the resulting function. • Assist students to evaluate the sum, difference, product and quotient of functions at a given value of x from the domain.	• Give exercise problems that the students should identify as relations or functions or both and let them give their reason for their answers and let them give the domains and ranges as well.. • Ask students to evaluate the value of a given function at given value from its domain. • Ask students to find combination of simple linear functions, to determine the domain of the resulting function and to find the value of this function at a given value from its domain.
• sketch graphs of linear functions • describe the properties of the graphs of linear functions. • sketch the graphs of a given quadratic function. • describe the properties of the graphs of given quadratic functions • determine the maximum and minimum values of a given quadratic function	**4.3 Graphs of functions** *(9 periods)* • graphs of linear as functions • graphs of quadratic functions	• Define "linear function $y= mx+b$ and quadratic function $y= ax^2 +bx+c \ (a\neq 0)$ " and discuss some basic important properties of each function by using appropriate examples. • You may start the lesson by setting an activity that allows students to construct table of values for given linear and quadratic functions. • Let students sketch the graphs of the given linear and quadratic function whose tables of values are prepared above. • Assist students to describe some of the properties of the graphs of linear and quadratic functions ,the intercepts, the nature of the graphs in relation with the leading coefficients and the coordinates of the vertex of a parabola • Assist students to determine the maximum and minimum values of quadratic function.	• Give exercise problems on sketching the graph of linear and quadratic functions. • Ask students to describe the properties of the graphs of linear and quadratic functions.

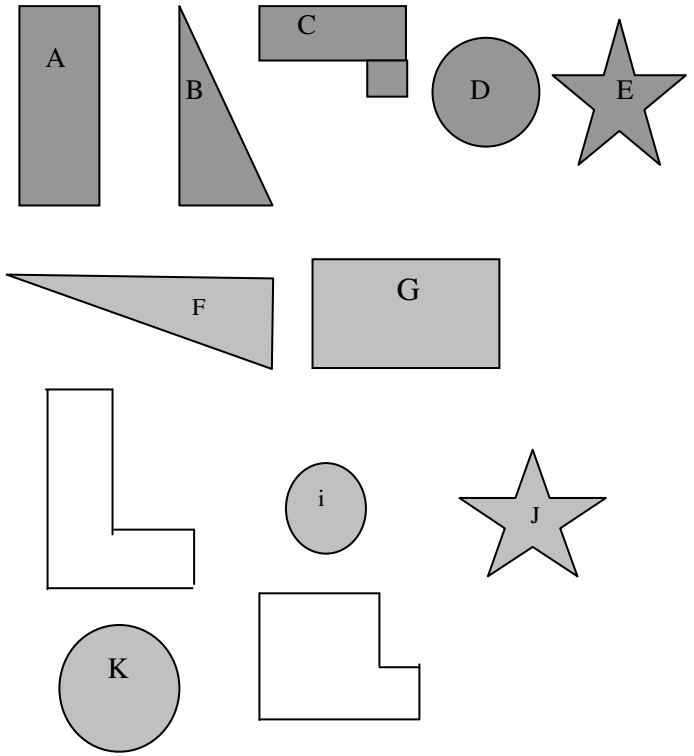
Unit 5: Geometry and Measurement (*36 periods)*

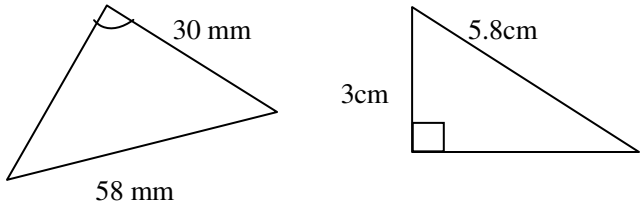
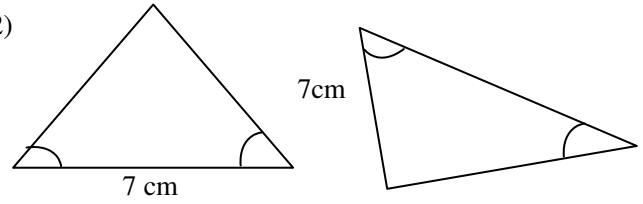
Unit outcomes: Students will be able to:

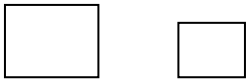
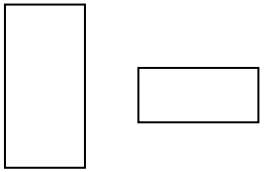
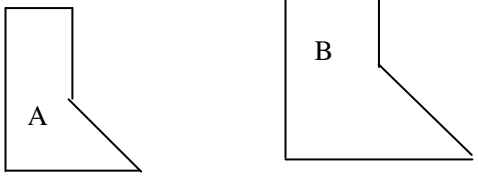
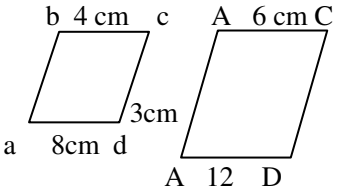
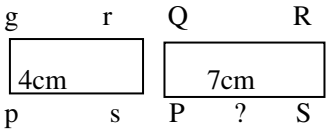
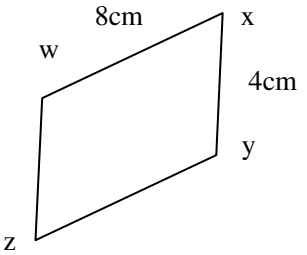
- know basic concepts about regular polygons
- apply postulates and theorems in order to prove congruence and similarity of triangles
- construct similar figures
- apply the concept of trigonometric ratio to solve problems on practical situations
- know specific facts on circles
- solve problems on areas of triangles and parallelograms.

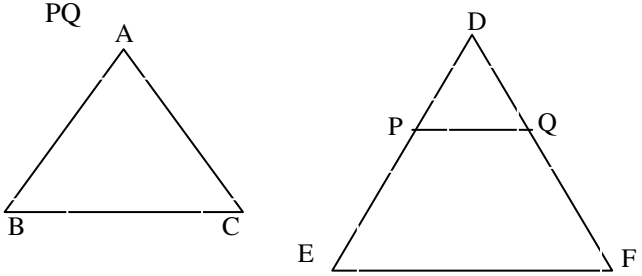
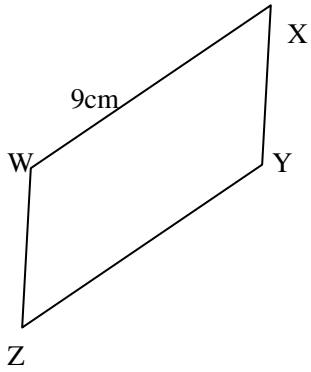
Competencies	***Contents***	***Teaching / Learning Activities and Resources***	***Assessment***
Students will be able to: • show that the sum of the measures of the interior angles of a triangle is 180^0 • define a regular polygon and related terms • find the measure of each interior or exterior angle of a regular polygon	***5. Geometry and Measurement*** **5.1 Regular Polygons** *(5 periods)* **5.1.1 Measures of angles of a regular polygon.**	• It is suggested that the teacher begins this lesson by providing activities to students so that they revise what they have already studied about polygon, then define regular polygon as "a polygon which is equiangular (all angles are congruent) and equilateral (all sides have the same length)"  • **Interior angles:** The interior angles of a polygon are those angles at each vertex on the inside of the polygon. There is one per vertex. For a polygon with n sides, there are n interior angles. • Let students discover the theorem "the sum of the measures of the angles of a triangle is 180^0" by cutting the corners of triangle formed from manila paper and fitting the cutouts to form straight angle.	• "Consider each of the following polygons, and show into how many triangles can it be divided by the diagonals from one vertex to the other vertices?"  • Give exercise problems on calculation of interior angles and exterior angles of a regular polygon such as:

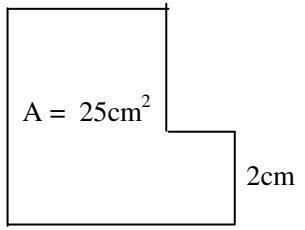
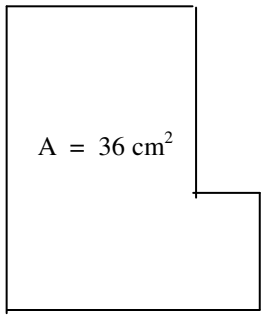
Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		• Assist students to arrive at the fact that each interior angle of a regular polygon is given by $\frac{180^0(n-2)}{n}$ by using the angle sum theorem for triangle. • Define exterior angle as "the angle formed on the outside of a polygon between a side and the extended adjacent side. • The students should be aware that the exterior angle and interior angle are measured from the same line, so that they add up to 180^0, so the external angle is just 180^0 - (Measure of interior angle).	a) An equilateral triangle b) regular pentagon c) regular hexagon
• state properties and related terms of regular polygons. • determine the lines of symmetry of regular polygons ▪ Determine the perimeter of a given regular polygon. ▪ Determine the area of a given regular polygon	**5.1.2 Properties of regular polygon** • Pentagon, hexagon, octagon and decagon	• Under "properties of regular polygon" in radius/apothem, circum radius, in circle, circum circle, diagonals, perimeter, area and symmetry of regular polygons, particularly of pentagon, hexagon, octagon and decagon will be dealt with. • Students should be encouraged to find the rules for finding measures of interior and exterior angles, opothem, perimeter and area of a given regular polygon. • Assist students to find general formulae for finding perimeters and areas of regular polygons, given the length of sides, radius and/or apothem.	• Students can be asked to construct (draw) regular pentagon, hexagon, octagon and decagon and to state the properties of these regular polygons and to show the lines of symmetry of these polygons. • Students calculate perimeters and areas of the polygons (supported by measurement). • Students can be asked to make wall charts on which regular pentagons, hexagons, octagons and decagons and their corresponding lines of symmetries are drawn.

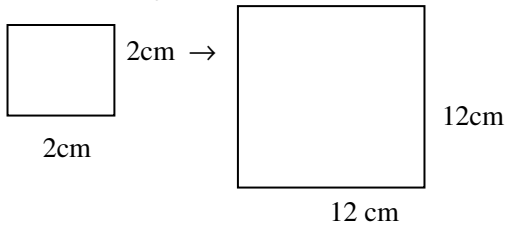
Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
• use the postulates and theorem on congruent triangle in solving related problems.	**5.2 Further on congruency and similarity** (*13 periods)* **5.2.1 Congruency of triangles**	• The lesson can be started by giving revision activity questions like: Which of the following shapes are congruent?  • Students are encouraged and motivated to revise conditions for triangles to be congruent:- SSS, SAS, AAS and RHS for right - angled triangles.	• Various exercise problems can be given on using the conditions given for triangles to be congruent.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		Exercises such as For each of the following pairs of triangles, state whether they are congruent or not. If they are congruent, give reason. 1)  2)  	
• Define similar plane figures and similar solid figures.	**5.2.2 Definition of similar figures**	• The teacher can start this lesson by defining similar figures as: similar figures are identical in shape, but not necessarily in size." • Students can be given different activity problems, and make groups to discuss and come up with answers and reason out. **Activity:** Which of the following pairs are always similar?	• Oral questions can be asked demanding students to give examples of similar figures. • Ask students to draw different plane figures and sketch their similar ones. • Exercise problems such as:-

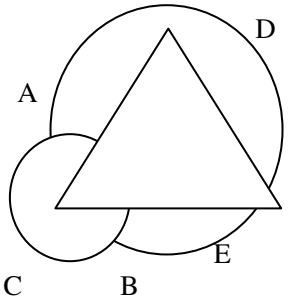
Competencies	***Contents***	***Teaching / Learning Activities and Resources***	***Assessment***
		1.  Any two circles 2.  Any two squares 3.  Any two rectangles 4.  B is an enlargement of figure A • Students should be encouraged and assisted to come to the conclusion. " For any pair of similar figures, corresponding sides are in the same ratio and corresponding angles are equal"	1.  Figures abcd and ABCD are similar, find the lengths of CD and AB.  The rectangles pqrs and PQRS are similar, What is the length of PS? 

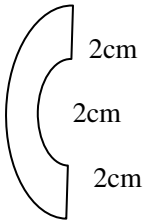
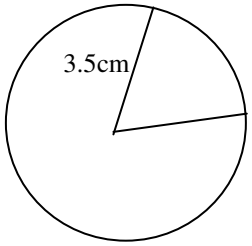
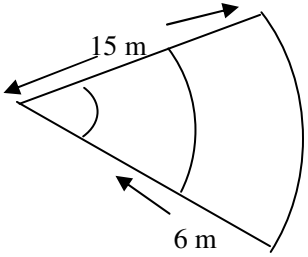
Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
• apply the SSS, SAS and AA similarity theorems to prove similarity of triangles	**5.2.3 Theorems on similarity of triangles**.	• The teacher can state these theorems and activities to students so that students verify these theorems E.g. Theorem: If two angles of a triangle are respectively equal to two angles of another triangle then the two triangles are similar. **Activity** Consider 'two triangles ABC and DEF such that <A ≡ <D" and <B ≡ <E show that Δ ABC is similar to Δ'DEF. • Encourage students to cut DP = AB and DQ = AC and join PQ 	 wxyz and WXYZ are similar figures. a) What is the length of XY? b) What is the size of angle WXY? • Various exercise problems on the application of the similarity theorems can be given and corrected to get feedback.

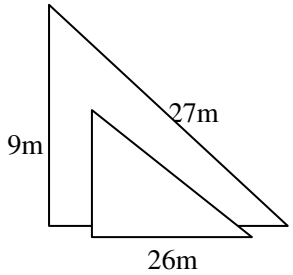
Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		and show that" $\frac{DP}{DE} = \frac{DQ}{DF}$ so that $\frac{AB}{DE} = \frac{AC}{DF}$ similarly to show that $\frac{AB}{DE} = \frac{BC}{EF}$	
• Discover the relationship between the perimeters of similar plane figures and use this relationship to solve related problems. • discover the relationship between the areas of similar plane figures and use this' relationship to solve related problems. ..	**5.2.4 Theorems on similar plane figures** • Ratio of perimeters of similar plane figures. • Ratio of areas of similar plane figures. … .	Similar activity problems can be given to prove the other theorems as well; for instance assist and encourage the to prove that if a perpendicular is drawn from the vertex of the right angle of a right angled triangle to the hypotenuse, then the triangles on each side of the perpendicular are similar to the given triangle and to each other. • Before students generalize the ratio of perimeters, ratio of areas of similar polygons and .. let them be given various activity problems on finding these ratios from given similar polygons...	• Giving different exercise problems such as: 1. The following two shapes are similar. What is the length of X?  

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
			2. Two similar pyramids have volumes 64 cm^3 and 343 cm^3. What is the ratio of their surface areas?
• enlarge and reduce plane figures by a given scale factor.	**5.2.5 Construction of similar figures**	• Students can exercise drawing plane figures similar to give ones by multiplying each side by a given scale factor. E.g. Draw a square which has a length six times the given one.  	• Let enough exercise problems be given on construction of similar plane figures. • Let enough exercise problems be given on construction of similar plane figures.
• solve real life problems using the concepts of similarity and congruency.	**5.2.6 Real life problems using congruency and similarity.**		• Different real life exercise problems and activities on the use of similarity and congruence concepts can be given.
• describe radian measure of an angle. • convert radian measure to degree measure and vice versa.	**5.3 Further on Trigonometry** *(7 periods)* **5.3.1 Radian measure of angle** • Conversion between radian and degree measures.	• The teacher can start this lesson by defining the radian measure like: Radian is a central angle subtended in a circle by an arc whose length is equal to the radius of the circle 1 rad. $\therefore$ 1 rad = 57.296^0 1 rad $\approx 57^0$ Thus the **radian measure** of an angle is the ratio of the length of the arc subtending it to the radius of the in which it is the central angle" The circumference of the circle is given by $C = 2\pi r$	• Different exercise problems on the radian measure and on conversion between radian and degree measures can be given Ex 1) Express each of the following in radian a) 45^0 b) 60^0 c) 270^0

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		Substituting r = 1 gives C = 2π (1) C = 2π	2) Express each of the angles in degrees a) $\frac{\pi}{6}$ rad b) $\frac{5\pi}{6}$ rad c) $\frac{4\pi}{3}$ rad
• use the trigonometrical ratios to solve right angled triangles.	**5.3.2 Trigonometrical ratios to solve right angled triangle.**	• Assist students to arrive at conversion formula:- a) from degree measure to radian measure b) from radian measure to degree measure. • Let students exercise solving right - angled triangles using the trigonometrical ratios. (Trigonometrical values for 30^0, 45^0, 60^0 should be studied by heart). • Let students summarize trigonometric ratios of 0^0, 30^0, 45^0 60^0 and 90^0 using table.	• Exercise problems similar to the following can be given. • Find the perimeter of ΔABC, expressing your answer in the form a + b $\sqrt{2}$ + c $\sqrt{3}$, where a, b and c are integers
• find the trigonemetrical values of angles from trigonometrical table. • find the angle whose trigonometrical value is given (using trigonometrical table.) • determine the trigonometrical values for obtuse angles using trigonometrical table.	**5.3.3 Trigonometrical values of angles from table (Sin θ, cos θ, and tan θ for $0^0 \leq \theta \leq 180^0$)**	• Let students revise the definitions of the trigonometrical ratios sine, cosine and tangent for acute angles using right - angled triangle. • Let students study the values of the ratios for 30^0, 45^0, 60^0 and 90^0. • Assist students how to read trigonometrical table to find the values of the ratios and vice versa. • Encourage the students to use the Cartesian coordinate plane the unit circle and trigonometrical table to find the values for the ratios of obtuse angles.	• Let students exercise finding trigonometrical values of different angles, including obtuse angles using the trigonometrical tables.
• discover the symmetrical properties of circles • use the symmetrical properties of circles to solve related problems	**5.4 Circles** *(5 periods)* **5.4.1 Symmetrical properties of circles**	• Assist students to construct circles and find out that: 1) A circle is symmetrical about every diameter, hence any chord AB perpendicular to a diameter is bisected by the diameter.	• Let students do exercise problems on stating the symmetrical properties of circles and solve related exercise problems using these properties.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		2) In Equal circles or in the same circle equal chords are equidistant from the center. Chords which are equidistant from the center are equal 3) Tangents from an external point are equal in length.	
• state angle properties of circles in their own words. • apply angle properties of circles to solve related problems	**5.4.2 Angle properties of circles**.	• Let students be familiar with the angle properties of circles and re-state the properties in their own words. 1) An angle at the centre of a circle is twice any angle at the circumference subtended by the same arc 2) Every angle at the circumference subtended by the diameter of a circle is a right angle. 3) Angles in the same segment of a circle are equal.	• Different exercise problem such as the following are given and students' works are checked to get feedback.  • In the figure, CAD and CBE are straight lines. If CA is the diameter of the circle ABC, Explain why < ADE is a right angle.
• Find arc length, perimeters and areas of segments and sectors	**5.4.3 Arc length, perimeters and areas of segment and sectors**.	• Let the teacher define arc, segment and sector of a circle and students try to explain the concepts in their own words. • Assist students to calculate lengths of arcs, perimeters and areas of segments and sectors.	

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
		E.g. 1) Find the perimeter of each of the following. a) 4 cm  b)  2) Find the area of the shaded region of the circle. 	• Various exercise problems on calculations of arc length, sector, segment areas and perimeters can be given. Like:- Find the area of a plot of land in the shape of a segment no shown 
• At the end of this lesson the students should be able to: • calculate areas of triangles using Heron's formula, whenever the lengths of the three sides only are given.	**5.5 Measurement** *(6 periods)* **5.5.1 Areas of triangles and parallelograms** • Heron's formula for the area of triangles. • Area of parallelograms.	Let students be familiarized with Heron's formula to calculate areas of triangles whenever only the lengths of the three sides of a triangle are given. If a, b, c are the lengths of the sides of a triangle, and $s = \frac{a + b + c}{2}$, then	

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
• calculate areas of parallelograms.		the area A of ΔABC is given by $A = \sqrt{s(s-a)\,(s-b)\,(s-c)}$ The following type of questions can be given. E.g. Find the area of a triangle whose sides are of lengths 20cm, 12cm and 16cm, using Heron's formula. Also find its perimeter. $s = \frac{20 + 12 + 16}{2} = 24$ cm $A = \sqrt{24(24-20)(24-12)(24-16)}$ $= \sqrt{24 \times 4 \times 12 \times 8}$ cm^2 $= (24 \times 4)$ $= 96$ cm^2 P = (20 + 12 + 16) cm = 48 cm	• Different exercise problems on calculations of areas of triangles and parallelograms can be given. Like: • A triangular field has dimensions 24m, 7m and 25m. • It has a road running around it which is 1m wide. Find the area of the road. 
• Calculate the surface areas of cylinders and prisms. • Calculate volumes of cylinders and prisms.	**5.5.2 Further on surface areas and volumes of cylinders and prisms**.	• Let students revise on the definitions of cylinders and prisms. • Let students make models of these solids. • Assist students to formulate and use area formula for these solids. • The formula for the volumes of the solids are given as V = Area of base × height $V_{cylinder} = (\pi r^2) \times h$ $V_{Prism} = (\ell \times w) \times h$ Let students exercise on calculations of surface areas and volumes of cylinders and prisms	• Different activities on calculation of surface areas and volumes of cylinders and prisms can be given.

Unit 6: Statistics and Probability *(22 periods)*

Unit outcomes: Students will be able to:

- know methods and procedures in collecting and presenting simple statistical data.
- know basic concepts about statistical measures.
- understand facts and basic principles about probability
- solve simple mathematical problems on statistics and probability

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
Students will be able to: • differentiate primary and secondary data • collect data from their environment • classify and tabulate primary data according to the required criteria.	***6. Statistics and Probability*** **6.1 Statistical Data** *(14periods)* **6.1.1 Collection and tabulation of statistical data**	• You may begin the lesson by discussing the importance and purposes of statistics by raising issues like HIV/AIDS, population growth, Health and Transport, etc. • After introducing the notions "Population" and "Population function" discuss the concept of "Descriptive statistics" and by using several examples let the student differentiate between "primary data" and "secondary data". • Arrange students in groups and let them collect data from their environment (for instance, in their school compound about students achievement in the National Exams, etc.) • After setting a certain criteria let the student either classify or tabulate the data that they collected from their environment (for instance for the data they collected from their school let them present a table for the medium achievers according to their age	• Ask students about some important concepts that they had learnt in the previous grades. • After forming groups among the students let them collect data and present it in tabular form then let them explain and defend their findings (or conclusion) in the class.
• Construct a frequency distribution table for ungrouped data • construct a histogram for a given data • interpret a given histogram	**6.1.2 Distribution and Histogram**	• Assist students to construct frequency distribution table for various ungrouped data, for instance you may take students' test score as an example. • After explaining how to draw a histogram, let the students draw a histogram for a certain given frequency distribution. • Guide students to interpret a given histogram i.e., let them explain what they understand from the given histogram.	• Give exercise problems on drawing histograms for a given data. • Ask students to tell, as much as they can, about the data by observing its histogram.
• determine the Mean, Median and Mode of a given data • describe the purposes and uses of Mean, Median and Mode	**6.1.3 Measures of Location (Mean, median and Mode(s)**	• You may start the lesson by revising the definitions of Mean, Median and Mode that the students had learnt in grade 7 • Assist students to determine the mean, median and mode for a given data, (the data can be given as a frequency distribution table)	• Give exercise problems on computations of the Mean, Median and Mode of a given data.

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
• identify the properties of the Mean of a given data (population function)		• Discuss with your students about the purpose and uses of the Mean, Median and Mode (or why we calculate them). • By using several examples assist students to generalize the properties of "Mean" of a given data (population function) that are. 1) The sum of the deviations from the mean, taken with their proper signs is zero. 2) The mean of the sum or difference of two population functions (of equal numbers of observations) is equal to the sum or difference of the means of the two population functions. 3) The mean of a constant times a population function is equal to the constant times the mean of the population function.	• Ask students to explain with their own words about the use of these measures of location in interpreting the data (they can also give examples)
• compute the measures of dispersion for ungrouped data (manually and using scientific calculator) • describe the purpose and use of measures of dispersion for ungrouped data.	**6.1.4 Measures of dispersion for ungrouped data**	• You may start the lesson by introducing the notion "Measures of dispersion" and then discuss what is meant by "range" "variance" and "standard Deviation" of a population function (data) • By using several examples, guide students in computation of range, variance and standard deviation. • Discuss with your students about the purposes and uses of the range, variance and standard deviation.	• Give exercise problems on computation of the range, variance and standard deviation for a given data. • Ask students to describe, with their own words, the purpose of the measures of dispersion in understanding /interpreting a given data.
• determine the probability of an event from a repeated experiment.	**6.2 Probability** *(8 periods)* • **..Probability of an event** Experimental approach	• You can start the lesson by revising important point from grade 8 such as experiments, events, impossible out comes, certain out-come; uncertainty, possibility set, probability (expressed as fraction, decimal or percentage). • You may begin the topic "experimental approach" as follows: form several groups among the students and let each group perform simple activities which lead to the concept of probability, for instance, let them take a coin and toss it 5 times 10 times or 15 times,... and record their observations in the following table.	• Either by letting the students to perform experiments or from a record of events obtained from similar activities let the students obtain probability of the events in the performed experiments.

<table>
<tr><th>Competencies</th><th>Contents</th><th>Teaching / Learning Activities and Resources</th><th>Assessment</th></tr>
<tr>
<td>• determine the probability of an event.</td>
<td>• Theoretical approach</td>
<td>
<table>
<tr><th rowspan="2">Number of times the coin is tossed</th><th colspan="2">Number of times the</th></tr>
<tr><th>Head turns up</th><th>Tail turns up</th></tr>
<tr><td>5</td><td>....</td><td>....</td></tr>
<tr><td>10</td><td>....</td><td>....</td></tr>
<tr><td>15</td><td>....</td><td>....</td></tr>
</table>
• After completing the above activity guide them to calculate the values of the following two fractions F_1 and F_2 for each trials
$F_1 =$ Number of times a head turns up / Total number of times the coin is tossed
$F_2 =$ Number of times the tail turns up / Total number of times the coin is tossed
• From the results they obtained (for F_1 and F_2) guide the students to observe the situation that, as the number of tosses increase the values of F_1 and F_2 gets closer and closer to ½
• At the end encourage them to state "experimental probability, denoted by P(E), of an event E, in n trials is:
$P(E) =$ Number of trials in which the event (E) has occurred / Total number of trials
and let them internalize the formula by performing such kind of several experiments (like throwing a die) or from a record of events obtained from similar activities so that they can calculate the experimental probability of an event.
• You may start the lesson by revising the main idea of experimental probability of an event and then explain that, in order to compute probability of an event using the experimental approach, it is necessary that the experiment should be done for a large number of times and this makes it difficult.
• Through discussion, let the students see the need for an efficient method and hence, introduce the "Theoretical approach of probability" as a second and effective method
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Competencies	***Contents***	***Teaching / Learning Activities and Resources***	***Assessment***
		which is formulated after performing several experiment to compute probability of an event. In the discussion define related terms like "equally likely outcomes" or "possible outcomes" etc. • Assist students in writing all the possible out comes of a given experiment and in identifying out comes that are favorable to an event in the given experiment for computing probability of the event. You may consider examples like: e.g. If a fair die is thrown the numbers 1, 2, 3, 4, 5 and 6 are "equally likely" to appear (i.e. 1, 2, 3, 4, 5 and 6 are the possible outcomes) thus we say the probability of showing up any one of the six number is 1/6. • From similar activities encourage the students to suggest the following definition of theoretical probability of an event. "Theoretical probability of an event E, written as P(E), is defined as follows. $P(E) = \frac{\text{Number of outcomes favorable to the event E}}{\text{Total number of possible outcomes}}$ • By giving various types of several exercises let the students familiarize themselves with the calculation and concepts of probability.	

Unit 7: Vectors In Two Dimensions *(12 periods)*

Unit outcomes: Students will be able to:

- know basic concept specific facts about vectors.
- perform operations on vectors

Competencies	*Contents*	*Teaching / Learning Activities and Resources*	*Assessment*
Students will be able to: • differentiate Vectors from scalars quantities. • represent vectors pictorially • explain what is meant by magnitude and direction of a vector.	***7. Vectors in Two Dimensions*** **7.1 Introduction to vectors and scalars.** *(2 periods)* **7.2 Representation of a vector.** *(2 periods)* **7.1.3 The magnitude and direction of a vector**;	• You may start the lesson with an activity which deals with the concepts "vector quantity" and "scalar quantity" and then state the formal definitions of "vector quantities" and "scalar quantities" • Discuss the representation of vectors by arrows through different examples • Guide students to realize that the magnitude of a vector is proportion and represented by the length of the arrow while its direction is given by the angle that is formed by the arrow with horizontal line or vertical (incase of compass direction) lines, in doing so, use several examples. • Assist students to realize and define opposite vector of a given vector.	• From a given list of different quantities. • Ask students to list vectors and scalars quantities separately and check their work. • Ask students questions like a) Can a vector and its opposite vector have the same initial point? b) Can a vector and its opposite vector lie on the same straight line?
• determine the sum of given vectors • determine the difference of two vectors • multiply a given vector by a given scales.	**7.3 Addition and Subtraction of vectors and multiplication of a vector by a scalar.** *(6 periods)*	• Discuss the laws of addition of vectors. (triangular law and the parallelogram law) • Introduce the concept of scalar multiplication of vectors. $\vec{\mathbf{a}} = k\,\vec{\mathbf{y}}, \quad k \in \mathbf{R}$	• Ask students to determine the sum of some pair of vector. • Ask students to enlarge or shorten the pictorial representation of a given vector quantity and let them explain the physical interpretation of enlarging or shortening a vector.
• express any given vector as position vector.	**7.4 Position vector of a point.** *(2 periods)*	• Help students practice how to find position vectors of given vectors. Provided the coordinates of its terminal and initial points are given.	• Ask students to determine the coordinate representation of vectors.