The Learning Objectives of the Compulsory Part

Notes:

1. *Learning units are grouped under three strands ("Number and Algebra", "Measures, Shape and Space" and "Data Handling") and a Further Learning Unit.*
2. *Related learning objectives are grouped under the same learning unit.*
3. *The learning objectives underlined are the Non-foundation Topics.*
4. *The notes in the "Remarks" column of the table may be considered as supplementary information about the learning objectives.*
5. *To aid teachers in judging how far to take a given topic, a suggested lesson time in hours is given against each learning unit. However, the lesson time assigned is for their reference only. Teachers may adjust the lesson time to meet their individual needs.*
6. *Schools may allocate up to 313 hours (i.e. 12.5% of the total lesson time) to those students who need more time for learning.*

Learning Unit	Learning Objective	Time	Remarks
Number and Algebra Strand			
1. Quadratic equations in one unknown	1.1 solve quadratic equations by the factor method 1.2 form quadratic equations from given roots 1.3 solve the equation $ax^2 + bx + c = 0$ by plotting the graph of the parabola $y = ax^2 + bx + c$ and reading the x-intercepts	19	The given roots are confined to real numbers.

Learning Unit	Learning Objective	Time	Remarks
	1.4 solve quadratic equations by the quadratic formula		The following are **not** required for students taking only the Foundation Topics: • expressing nonreal roots in the form $a \pm bi$ • simplifying expressions involving surds such as $2 \pm \sqrt{48}$
	1.5 understand the relations between the discriminant of a quadratic equation and the nature of its roots		When $\Delta < 0$, students have to point out that "the equation has **no real roots**" or "the equation has **two nonreal roots**" as they are expected to recognise the existence of complex numbers in Learning Objective 1.8.

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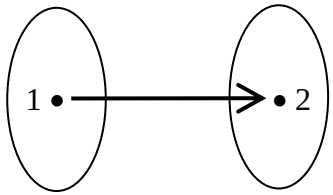
	1.6 solve problems involving quadratic equations		Teachers should select the problems related to students' experiences. Problems involving complicated equations such as $\frac{6}{x}+\frac{6}{x-1}=5$ are required only in the Non-foundation Topics and tackled in Learning Objective 5.4.
	1.7 understand the relations between the roots and coefficients and form quadratic equations using these relations		The relations between the roots and coefficients include: • $\alpha+\beta=-\frac{b}{a}$ and $\alpha\beta=\frac{c}{a}$, where α and β are the roots of the equation $ax^2+bx+c=0$ and $a\neq 0$.
	1.8 appreciate the development of the number systems including the system of complex numbers		The topics such as the hierarchy of the number systems and the conversion between recurring decimals and fractions may be discussed.

Learning Unit	Learning Objective	Time	Remarks
	1.9 perform addition, subtraction, multiplication and division of complex numbers		Complex numbers are confined to the form $a \pm bi$. Note: The coefficients of quadratic equations are confined to real numbers.
2. Functions and graphs	2.1 recognise the intuitive concepts of functions, domains and co-domains, independent and dependent variables 2.2 recognise the notation of functions and use tabular, algebraic and graphical methods to represent functions 2.3 understand the features of the graphs of quadratic functions	10	Finding the domain of a function is required but need **not** be stressed. Representations like  are also accepted. The features of the graphs of quadratic functions include: • the vertex • the axis of symmetry • the direction of opening • relations with the axes Students are expected to find the maximum

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	2.4 find the maximum and minimum values of quadratic functions by the algebraic method		and minimum values of quadratic functions by the graphical method. Students are expected to solve problems relating to maximum and minimum values of quadratic functions.
3. Exponential and logarithmic functions	3.1 understand the definitions of rational indices	16	The definitions include $\sqrt[n]{a}$, $a^{\frac{1}{n}}$ and $a^{\frac{m}{n}}$. Students are also expected to evaluate expressions such as $\sqrt[3]{-8}$.
	3.2 understand the laws of rational indices		The laws of rational indices include: • $a^p a^q = a^{p+q}$ • $\frac{a^p}{a^q} = a^{p-q}$ • $(a^p)^q = a^{pq}$ • $a^p b^p = (ab)^p$ • $\frac{a^p}{b^p} = \left(\frac{a}{b}\right)^p$

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	3.3 understand the definition and properties of logarithms (including the change of base)		The properties of logarithms include: • $\log_a 1 = 0$ • $\log_a a = 1$ • $\log_a MN = \log_a M + \log_a N$ • $\log_a \frac{M}{N} = \log_a M - \log_a N$ • $\log_a M^k = k \log_a M$ • $\log_b N = \frac{\log_a N}{\log_a b}$
	3.4 understand the properties of exponential functions and logarithmic functions and recognise the features of their graphs		The following properties and features are included: • the domains of the functions • the function $f(x) = a^x$ increases (decreases) as x increases for $a > 1$ $(0 < a < 1)$ • $y = a^x$ is symmetric to $y = \log_a x$ about $y = x$ • the intercepts with the axes • the rate of increasing/the rate of decreasing (by direct inspection)

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	3.5 solve exponential equations and logarithmic equations		Equations which can be transformed into quadratic equations such as $4^x - 3 \cdot 2^x - 4 = 0$ or $\log(x - 22) + \log(x + 26) = 2$ are tackled in Learning Objective 5.3.
	3.6 appreciate the applications of logarithms in real-life situations		The applications such as measuring earthquake intensity in the Richter Scale and sound intensity level in decibels may be discussed.
	3.7 appreciate the development of the concepts of logarithms		The topics such as the historical development of the concepts of logarithms and its applications to the design of some past calculation tools such as slide rules and the logarithmic table may be discussed.
4. More about polynomials	4.1 perform division of polynomials	14	Methods other than long division are also accepted.
	4.2 understand the remainder theorem		
	4.3 understand the factor theorem		

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	4.4 understand the concepts of the greatest common divisor and the least common multiple of polynomials		The terms "H.C.F." , "gcd", etc. can be used.
	4.5 perform addition, subtraction, multiplication and division of rational functions		Computation of rational functions with more than two variables is **not** required.
5. More about equations	5.1 use the graphical method to solve simultaneous equations in two unknowns, one linear and one quadratic in the form $y = ax^2 + bx + c$	10	
	5.2 use the algebraic method to solve simultaneous equations in two unknowns, one linear and one quadratic		
	5.3 solve equations (including fractional equations, exponential equations, logarithmic equations and trigonometric equations) which can be transformed into quadratic equations		Solutions for trigonometric equations are confined to the interval from 0° to 360° .
	5.4 solve problems involving equations which can be transformed into quadratic equations		Teachers should select the problems related to students' experience.
6. Variations	6.1 understand direct variations (direct proportions) and inverse variations (inverse proportions), and their applications to solving real-life problems	9	

Learning Unit	Learning Objective	Time	Remarks
	6.2 understand the graphs of direct and inverse variations 6.3 understand joint and partial variations, and their applications to solving real-life problems		
7. Arithmetic and geometric sequences and their summations	7.1 understand the concept and the properties of arithmetic sequences 7.2 understand the general term of an arithmetic sequence 7.3 understand the concept and the properties of geometric sequences 7.4 understand the general term of a geometric sequence	17	The properties of arithmetic sequences include: • $T_n = \frac{1}{2}(T_{n-1} + T_{n+1})$ • if $T_1, T_2, T_3, \ldots$ is an arithmetic sequence, then $kT_1 + a$, $kT_2 + a$, $kT_3 + a, \ldots$ is also an arithmetic sequence The properties of geometric sequences include: • $T_n^2 = T_{n-1} \times T_{n+1}$ • if $T_1, T_2, T_3, \ldots$ is a geometric sequence, then kT_1, kT_2, $kT_3, \ldots$ is also a geometric sequence

Learning Unit	Learning Objective	Time	Remarks
	7.5 understand the general formulae of the sum to a finite number of terms of an arithmetic sequence and a geometric sequence and use the formulae to solve related problems 7.6 explore the general formulae of the sum to infinity for certain geometric sequences and use the formulae to solve related problems 7.7 solve related real-life problems		Example: geometrical problems relating to the sum of arithmetic or geometric sequences. Example: geometrical problems relating to infinite sum of the geometric sequences. Examples: problems about interest, growth or depreciation.
8. Inequalities and linear programming	8.1 solve compound linear inequalities in one unknown 8.2 solve quadratic inequalities in one unknown by the graphical method 8.3 solve quadratic inequalities in one unknown by the algebraic method 8.4 represent the graphs of linear inequalities in two unknowns on a plane	16	Compound inequalities involving logical connectives “and” or “or” are required.

Learning Unit	Learning Objective	Time	Remarks
	8.5 solve systems of linear inequalities in two unknowns 8.6 solve linear programming problems		
9. More about graphs of functions	9.1 sketch and compare graphs of various types of functions including constant, linear, quadratic, trigonometric, exponential and logarithmic functions 9.2 solve the equation $f(x) = k$ using the graph of $y = f(x)$ 9.3 solve the inequalities $f(x) > k$, $f(x) < k$, $f(x) \geq k$ and $f(x) \leq k$ using the graph of $y = f(x)$ 9.4 understand the transformations of the function $f(x)$ including $f(x) + k$, $f(x + k)$, $kf(x)$ and $f(kx)$ from tabular, symbolic and graphical perspectives	11	Comparison includes domains, existence of maximum or minimum values, symmetry and periodicity.
Measures, Shape and Space Strand			
10. Basic properties of circles	10.1 understand the properties of chords and arcs of a circle	23	The properties of chords and arcs of a circle include: • the chords of equal arcs are equal • equal chords cut off equal arcs

Learning Unit	Learning Objective	Time	Remarks
			• the perpendicular from the centre to a chord bisects the chord • the straight line joining the centre and the mid-point of a chord which is not a diameter is perpendicular to the chord • the perpendicular bisector of a chord passes through the centre • equal chords are equidistant from the centre • chords equidistant from the centre are equal Students are expected to understand why there is one and only one circle passing through given three non-collinear points. Note: the property that the arcs are proportional to their corresponding angles at the centre should be discussed at Key Stage 3 when the formula for calculating arc lengths is being explicated.

Learning Unit	Learning Objective	Time	Remarks
	10.2 understand the angle properties of a circle		Angle properties of a circle include: • the angle subtended by an arc of a circle at the centre is double the angle subtended by the arc at any point on the remaining part of the circumference • angles in the same segment are equal • the arcs are proportional to their corresponding angles at the circumference • the angle in a semi-circle is a right angle • if the angle at the circumference is a right angle, then the chord that subtends the angle is a diameter
	10.3 understand the properties of a cyclic quadrilateral		The properties of a cyclic quadrilateral include: • the opposite angles of a cyclic quadrilateral are supplementary • an exterior angle of a cyclic quadrilateral equals its interior opposite angle

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	10.4 understand the tests for concyclic points and cyclic quadrilaterals		The tests for concyclic points and cyclic quadrilaterals include: • if A and D are two points on the same side of the line BC and $\angle BAC = \angle BDC$, then A, B, C and D are concyclic • if a pair of opposite angles of a quadrilateral are supplementary, then the quadrilateral is cyclic • if the exterior angle of a quadrilateral equals its interior opposite angle, then the quadrilateral is cyclic

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	10.5 understand the properties of tangents to a circle and angles in the alternate segments		The properties include: • a tangent to a circle is perpendicular to the radius through the point of contact • the straight line perpendicular to a radius of a circle at its external extremity is a tangent to the circle • the perpendicular to a tangent at its point of contact passes through the centre of the circle • if two tangents are drawn to a circle from an external point, then: - the distances from the external point to the points of contact are equal - the tangents subtend equal angles at the centre - the straight line joining the centre to the external point bisects the angle between the tangents

Learning Unit	Learning Objective	Time	Remarks
	10.6 use the basic properties of circles to perform simple geometric proofs		• if a straight line is tangent to a circle, then the tangent-chord angle is equal to the angle in the alternate segment • if a straight line passes through an end point of a chord of a circle so that the angle it makes with the chord is equal to the angle in the alternate segment, then the straight line touches the circle

Learning Unit	Learning Objective	Time	Remarks
11. Locus	11.1 understand the concept of loci	7	
	11.2 describe and sketch the locus of points satisfying given conditions		The conditions include: • maintaining a fixed distance from a fixed point • maintaining an equal distance from two given points • maintaining a fixed distance from a line • maintaining a fixed distance from a line segment • maintaining an equal distance from two parallel lines • maintaining an equal distance from two intersecting lines
	11.3 describe the locus of points with algebraic equations		Students are expected to find the equations of simple loci, which include equations of straight lines, circles and parabolas (in the form of $y = ax^2 + bx + c$).

Learning Unit	Learning Objective	Time	Remarks
12. Equations of straight lines and circles	12.1 understand the equation of a straight line	14	Students are expected to find the equation of a straight line from given conditions such as: • the coordinates of any two points on the straight line • the slope of the straight line and the coordinates of a point on it • the slope and the *y*-intercept of the straight line Students are expected to describe the features of a straight line from its equation. The features include: • the slope • the intercepts with the axes • whether it passes through a given point The normal form is **not** required.

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	12.2 understand the possible intersection of two straight lines		Students are expected to determine the number of intersection points of two straight lines from their equations. Note: Solving simultaneous linear equations in two unknowns is a learning objective at Key Stage 3.
	12.3 understand the equation of a circle		Students are expected to find the equation of a circle from given conditions such as: • the coordinates of the centre and the radius of the circle • the coordinates of any three points on the circle Students are expected to describe the features of a circle from its equation. The features include: • the centre • the radius • whether a given point lies inside, outside or on the circle

Learning Unit	Learning Objective	Time	Remarks
	12.4 find the coordinates of the intersections of a straight line and a circle and understand the possible intersection of a straight line and a circle		Finding the equations of tangents to a circle is required.
13. More about trigonometry	13.1 understand the functions sine, cosine and tangent, and their graphs and properties, including maximum and minimum values and periodicity 13.2 solve the trigonometric equations $a \sin \theta = b$, $a \cos \theta = b$, $a \tan \theta = b$ (solutions in the interval from 0° to 360°) and other trigonometric equations (solutions in the interval from 0° to 360°) 13.3 understand the formula $\frac{1}{2} ab \sin C$ for areas of triangles 13.4 understand the sine and cosine formulae 13.5 understand Heron's formula	21	Simplification of expressions involving sine, cosine and tangent of $-\theta$, $90° \pm \theta$, $180° \pm \theta$, … , etc. is required. Equations that can be transformed into quadratic equations are required only in the Non-foundation Topics and tackled in Learning Objective 5.3.

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	13.6 use the above formulae to solve 2-dimensional and 3-dimensional problems		The "above formulae" refer to those mentioned in Learning Objectives 13.3 – 13.5. 3-dimensional problems include finding the angle between two lines, the angle between a line and a plane, the angle between two planes, the distance between a point and a line, and the distance between a point and a plane. Note: Exploring the properties of simple 3-D figures is a learning objective at Key Stage 3.
Data Handling Strand			
14. Permutation and combination	14.1 understand the addition rule and multiplication rule in the counting principle	11	
	14.2 understand the concept and notation of permutation		Notations such as "P_r^n", "${}_nP_r$", "${}^nP_r$", etc. can be used.

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	14.3 solve problems on the permutation of distinct objects without repetition		Problems such as "permutation of objects in which three particular objects are put next to each other" are required. Circular permutation is **not** required.
	14.4 understand the concept and notation of combination		Notations such as "C_r^n", "${}_nC_r$", "${}^nC_r$", "$\binom{n}{r}$", etc. can be used.
	14.5 solve problems on the combination of distinct objects without repetition		
15. More about probability	15.1 recognise the notation of set language including union, intersection and complement	10	The concept of Venn Diagram is required.
	15.2 understand the addition law of probability and the concepts of mutually exclusive events and complementary events		The addition law of probability refers to "$P(A \cup B) = P(A) + P(B) - P(A \cap B)$".
	15.3 understand the multiplication law of probability and the concept of independent events		The multiplication law of probability refers to "$P(A \cap B) = P(A) \times P(B)$, where A and B are independent events".

Learning Unit	Learning Objective	Time	Remarks
	15.4 recognise the concept and notation of conditional probability 15.5 use permutation and combination to solve problems relating to probability		The rule "$P(A \cap B) = P(A) \times P(B \mid A)$" is required. Bayes' Theorem is **not** required.
16. Measures of dispersion	16.1 understand the concept of dispersion 16.2 understand the concepts of range and inter-quartile range 16.3 construct and interpret the box-and-whisker diagram and use it to compare the distributions of different sets of data 16.4 understand the concept of standard deviation for both grouped and ungrouped data sets 16.5 compare the dispersions of different sets of data using appropriate measures	14	A box-and-whisker diagram can also be called a "boxplot". The term "variance" should be introduced. Students are required to understand the following formula for standard deviation: $\sigma = \sqrt{\frac{(x_1 - \mu)^2 + \ldots + (x_N - \mu)^2}{N}}$.

Learning Unit	Learning Objective	Time	Remarks
	16.6 understand the applications of standard deviation to real-life problems involving standard scores and the normal distribution 16.7 explore the effect of the following operations on the dispersion of the data: (i) adding an item to the set of data (ii) removing an item from the set of data (iii) adding a common constant to each item of the set of data (iv) multiplying each item of the set of data by a common constant		
17. Uses and abuses of statistics	17.1 recognise different techniques in survey sampling and the basic principles of questionnaire design 17.2 discuss and recognise the uses and abuses of statistical methods in various daily-life activities or investigations	4	The concepts of "populations" and "samples" should be introduced. Probability sampling and non-probability sampling should be introduced. Students should recognise that, in constructing questionnaires, factors such as the types, wording and ordering of questions and response options influence their validity and reliability.

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	17.3 assess statistical investigations presented in different sources such as news media, research reports, etc.		
Further Learning Unit			
18. Further applications	Solve more sophisticated real-life and mathematical problems that may require students to search the information for clues, to explore different strategies, or to integrate various parts of mathematics which they have learned in different areas The main focuses are: (a) to explore and solve more sophisticated real-life problems (b) to appreciate the connections between different areas of mathematics	14	Examples: • solve simple financial problems in areas such as taxation and instalment payment • analyse and interpret data collected in surveys • explore and interpret graphs relating to real-life situations • explore Ptolemy's Theorem and its applications • model the relation between two sets of data which show a strong linear correlation and explore how to reduce simple non-linear relations such as $y = m\sqrt{x} + c$ and $y = k\,a^x$ to linear relations • explore the relation between the Fibonacci sequence and the Golden

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			Ratio • appreciate the applications of cryptography • explore the Ceva's Theorem and its applications • investigate the causes and effects of the three crises in mathematics • analyse mathematical games (e.g. explore the general solution of the water puzzle)
19. Inquiry and investigation	Through various learning activities, discover and construct knowledge, further improve the ability to inquire, communicate, reason and conceptualise mathematical concepts	10	This is **not** an independent and isolated learning unit. The time is allocated for students to engage in learning activities from different learning units.

Grand total: 250 hours