



REPUBLIC OF BOTSWANA

BOTSWANA SENIOR SECONDARY ASSESSMENT SYLLABUS

MATHEMATICS



EXAMINATIONS RESEARCH AND TESTING DIVISION

MINISTRY OF EDUCATION

**BOTSWANA SENIOR SECONDARY ASSESSMENT
SYLLABUS FOR MATHEMATICS
BECOMES
EFFECTIVE FOR EXAMINATION IN 1999**

MATHEMATICS
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FOREWORD

The ministry of Education is pleased to Authorise the publication of this assessment Syllabus for the senior secondary programme. It marks a watershed in the development of the public education system in Botswana and signals another milestone of progress in fulfillment of the goals set by the Revised National Policy on Education, Government Paper No. 2 of 1994.

The purpose of this syllabus is to guide schools, teachers and other educational institutions on what will be assessed in the subject area and how the assessment will be carried out for certification of students completing the course. The syllabus, therefore, should be used as a source of information on the examination.

Critical to the success of our secondary education programme, is the recognition of individual talents, needs and learning styles of students. Hence, the role of teachers in the classrooms has to adapt to the changed environment. They must be able managers and facilitators and proficient in planning and directing a variety of learning activities. They should be conscious of the need for the students to be accountable and responsible for their own learning to some extent. They must also take into account the widening different levels of achievement which they aspire to. This implies active participation by both students and teachers, the creation of rich and diverse learning environments and the use of relevant assessment procedures to monitor the development of each learner.

In pursuit of the above principles, the examination emphasises the assessment of students across a broad ability range and different levels of achievement. It also calls for the demonstration of what each candidate knows, understands and can do.

It is important then that we value the student's own experiences, build upon what they know and reward them for positive achievement. At the same time, we must be prepared to offer them guidance and counseling at all levels; assist them to make the best decisions in keeping with their own interests, career prospects and ability. In that way we shall prevail in nurturing at the roots of our system, the national ideals of democracy, development, self-reliance, unity and social harmony.

This syllabus document is the outcome of a great deal of professional consultation and collaboration. On behalf of the Ministry, I wish to record my appreciation for the input received from the University of Cambridge Local Examinations Syndicate and thank sincerely all those who contributed to and were involved in the production of this syllabus.



*Permanent Secretary
Ministry of Education*

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P A Chakalisa	UB - Mathematics and Science Education (chairman)
B Radipotsane	Department of Secondary Education
O Setlhare	Examinations Research and Testing (secretary)
D K Morake	Examinations Research and Testing (secretary)
B S Barungwi	Teacher Training and Development
S Mooketsi	Francistown Senior Secondary School
J Setlhong	St Joseph's College
B Raboijane	Lobatse Senior Secondary School
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1. INTRODUCTION

As part of the Senior Secondary Education, this Mathematics Assessment Syllabus is designed to assess candidates who have completed a two-year course based on the Senior secondary Mathematics Teaching Syllabus.

This syllabus aims to assess positive achievement at all levels and candidates will be assessed in ways that encourage them to show what they know, understand and can do.

Candidates will be assessed on either the **core** syllabus or the **extended** syllabus. The **core** syllabus is examined by two written papers. The **extended** syllabus is examined by three written papers. The papers are described in the Scheme of Assessment.

The assessment syllabus assumes knowledge, understanding and skills developed by the candidates during their study of Mathematics for the Junior Certificate Examination.

This syllabus leads to the single-subject award: **Mathematics**.

This syllabus should be read in conjunction with:

- (a) the Senior Secondary Mathematics Teaching Syllabus;
- (b) the specimen question papers and marking schemes.

Syllabus-specific requirements and any further information are given in the Appendices.

2. AIMS

Candidates following this syllabus should acquire and develop:

- (a) a positive attitude to mathematics, including confidence, enjoyment and perseverance;
- (b) abilities to understand and use mathematics as a means of communication, with emphasis on the use of clear expression and representation of ideas and facts;
- (c) abilities to solve problems, model and describe varieties of practical life situations, present the solution clearly, check and interpret the results;
- (d) abilities to produce and appreciate imaginative and creative work arising from mathematical ideas;
- (e) willingness and abilities to work independently and co-operatively;
- (f) abilities to apply mathematical concepts and skills in other disciplines of the curriculum;
- (g) abilities to apply skills and knowledge in situations met in life;
- (h) an understanding of the role mathematics plays in society;
- (i) a feel for number, measure, shape, movement, position and carry out calculations and understand the significance of the results obtained;
- (j) an appreciation of the role of mathematics in technology and the whole society;
- (k) an appreciation in patterns and relationships in mathematics;
- (l) an appreciation of the interdependence of different branches of mathematics;
- (m) an appreciation of the role of modern technology in mathematics;
- (n) appropriate mathematical knowledge, skills and attitudes to meet the challenges in the world of work and to function as well-informed citizens;
- (o) basic mathematical knowledge and skills for further study at tertiary level, pertinent to any discipline.

As far as possible, the Aims will be reflected in the Assessment Objectives; however, some Aims cannot readily be assessed.

3. ASSESSMENT OBJECTIVES

There is a single Assessment Objective: **Technique with Application**, which will be tested in all papers.

The Assessment Objective is broken down into smaller units, 1.1 – 1.10. Overall, candidates should be able to:

- 1.1 perform calculations with and/or without a calculating aid;
- 1.2 estimate, approximate and use appropriate degrees of accuracy;
- 1.3 use common systems of units;
- 1.4 recognize, understand and apply appropriate mathematical procedures in a given situation;
- 1.5 recognize, understand and apply properties of shapes, positions, movements and transformations in two and/or three dimensions;
- 1.6 understand and apply relationships and their representations;
- 1.7 collect, process, present (in tabular, graphical and diagrammatic forms) and interpret data;
- 1.8 use geometrical instruments;
- 1.9 recognize and justify generalizations of patterns and structures in a variety of situations and forms;
- 1.10 formulate problems in mathematical terms, select, apply and communicate appropriate techniques of solution and interpret the solutions in terms of the problem (e.g., investigations).

4. SCHEME OF ASSESSMENT

Candidates may be assessed on the **core** syllabus or the **extended** syllabus.

Core Syllabus

Candidates will sit two written papers (Papers 1 and 2). They will be graded on a scale C – G.

Extended Syllabus

This is intended for candidates who are expected to achieve grade C or better on the core syllabus.

Candidates will sit the core papers (Papers 1 and 2), and an extra written paper (Paper 3) which will contain questions on both the core and the extended syllabus. They will be graded on a scale A – G.

The knowledge, understanding and skills required for both the core and the extended syllabuses are clearly identified in the syllabus Content, given in Section 5 below.

The Papers

Paper 1

Written **1 hour 30 minutes** **50 marks**

This paper will be taken by both **core and extended** syllabus candidates.

Short answer questions, covering the core syllabus. Calculators will not be permitted.

Candidates will be required to attempt all questions: there will be no choice of question.

Paper 2

Written

2 hours

75 marks

This paper will be taken by both **core and extended** syllabus candidates.

Structured questions, based on the core syllabus. Calculators will be permitted.

Candidates will be required to attempt all questions: there will be no choice of question.

Paper 3

Written

2 hours 30 minutes

125 marks

This paper will be taken by **extended** syllabus candidates only.

Structured questions. The questions will be based on the core and extended syllabuses and will be aimed at candidates who might be expected to achieve at least a C standard.

Candidates will be required to attempt all questions: there will be no choice of question.

Weightings of the Papers

Paper	Weight (%)	
	Core	Extended
1	40	20
2	60	30
3		50

5. CONTENT

The syllabus content is arranged in three columns:

- (a) **Topics**
- (b) **General Learning Objectives**
- (c) **Specific Learning Objectives**

The **Topics**, in the first column, are those strands of the subject which candidates should have studied.

Each topic is then defined in the second and third columns in terms of **General and Specific Learning Objectives** - items of knowledge, understanding and skills on which candidates may be assessed.

Core Syllabus

Those items in normal print apply to those candidates following the **core** syllabus.

Extended Syllabus

All items apply to those candidates following the **extended** syllabus; that is, items which are in normal print **and** those which are in ***bold italic*** print.

Thus, once a topic has been identified in the first column, the second and third columns show, in increasing detail, what aspects of that topic are likely to be assessed.

Division of Content by Area

The content is divided into five sections, each of which corresponds to a well-defined area of mathematics. These are:

1. **Number**
2. **Measure**
3. **Algebra**
4. **Geometry**
5. **Statistics and Probability.**

The grid below shows the approximate weighting (in percentage terms) of these areas in the papers.

	Number	Measure	Algebra	Geometry	Stats & Prob.
Papers 1 and 2	25	20	20	25	10
Paper 3	15	15	30	25	15

1. NUMBER

Topics	General Objectives	Specific Objectives
	Candidates should be able to:-	candidates should be able to:-
1.1 Numbers and operations		
Types of Numbers	1.1.1 understand concepts of number	1.1.1.1 identify, represent and use numbers [whole numbers, natural (including zero), integer, rational, irrational, real] 1.1.1.2 demonstrate an understanding of classes of numbers (e.g. odd, even, rectangle, triangle, square, square roots, cube, cube roots, prime, factors, multiples, reciprocal etc.) in a variety of situations
The four operations	1.1.2 use the four basic operations	1.1.2.1 use the four basic operations for calculations with whole numbers, decimal fractions and vulgar (and mixed) fractions, including correct ordering of operations and use of brackets
Calculator	1.1.3 acquire further knowledge and skills on the use of a calculator	1.1.3.1 use efficiently the facilities of a scientific calculator
Patterns and Sequences	1.1.4 explore sequences	1.1.4.1 complete/continue a sequence 1.1.4.2 describe in words the pattern of a linear sequence 1.1.4.3 state in algebraic form a pattern of a linear sequence 1.1.4.4 generate a sequence of numbers 1.1.4.5 use patterns of sequences to represent a given situation and solve problems 1.1.4.6 state in algebraic form a pattern of a simple non-linear sequence
Approximation and Estimation	1.1.5 understand and use the concept of estimation and approximation	1.1.5.1 approximate to a specified number of decimal places, number of significant figures or place value in a given context 1.1.5.2 approximate to reasonable degree of accuracy 1.1.5.3 estimate quantities 1.1.5.4 approximate quantities 1.1.5.5 check reasonableness of results

Directed Numbers	1.1.6 use and apply directed numbers	1.1.6.1 solve problems involving directed numbers in practical situations
Fractions	1.1.7 use and apply fractions	<p>1.1.7.1 use the language and notation of simple vulgar and decimal fractions and percentages in appropriate contexts</p> <p>1.1.7.2 recognise equivalence and convert between vulgar and decimal fractions and percentages</p> <p>1.1.7.3 solve problems involving fractions, percentages (including simple and compound interest) and ratio/proportions(direct and inverse) in practical situations</p> <p>1.1.7.4 solve problems involving reversed percentages</p>
Indices	1.1.8 acquire knowledge on indices and apply them	<p>1.1.8.1 interpret integral (including negative) indices) and simple fractional indices</p> <p>1.1.8.2 solve problems involving integral (including negative) indices and simple positive fractional indices of the form $\frac{1}{k}$</p> <p>1.1.8.3 simplify expressions involving fractional indices</p> <p>1.1.8.4 interpret and solve problems involving fractional indices</p>
	1.1.9 express and use numbers in standard form	<p>1.1.9.1 express numbers in standard form to a specified number of decimal places or significant figures</p> <p>1.1.9.2 order numbers in standard form</p> <p>1.1.9.3 solve problems involving numbers in standard form</p>
Applications	1.1.10 work with money	1.1.10.1 calculate using money and convert from one currency to another
	1.1.11 solve problems involving personal and household finances	1.1.11.1 use given data to solve problems on personal and household finances involving earnings, discount, profit and loss; extract data from tables and charts

2.MEASURES

Topics	General Objectives	Specific Objectives
	candidates should be able to:-	candidates should be able to:-
2.1 Mensuration		
Perimeter, Area, Volume, Mass, Density and Time	2.1.1 develop further knowledge on measures and apply it	2.1.1.1 use units of time and metric units of length, area, mass, and capacity. 2.1.1.2 read timetables and calculate times in terms of the 12 and 24-hour clocks. 2.1.1.3 solve practical problems involving perimeters and areas of compound shapes(i.e. shapes bounded by line segments and/or circular arcs). 2.1.1.4 apply the formula $\text{Area} = \frac{1}{2} ab \sin C$ 2.1.1.5 calculate surface area and volume of cylinders, prisms, pyramid, cones and spheres (for cone, pyramid and sphere the formula are to be given) 2.1.1.6 solve practical problems involving density, volume and mass. 2.1.1.7 <i>solve practical problems involving compound shapes and solids</i>
2.2 Estimates		
Limits of Accuracy	2.2.1 understand and use limits of accuracy	2.2.1.1 give appropriate upper and lower bounds for data given to a specified accuracy (e.g. measured lengths) 2.2.1.2 <i>obtain appropriate upper and lower bounds to solutions of simple problems (e.g. calculations of the perimeter or the area of rectangle) given data to a specified accuracy.</i>

2.3 Graphs		
Travel Graphs	2.3.1 acquire knowledge on travel graphs	2.3.1.1 draw and interpret distance-time and speed-time graphs 2.3.1.2 calculate speed using distance-time graphs 2.3.1.3 calculate acceleration and/or deceleration using velocity-time graphs 2.3.1.4 calculate distance travelled as area under a linear speed-time graph

3. ALGEBRA

Topics	General Objectives	Specific Objectives
	Candidates should be able to:-	candidates should be able to:-
3.1 Formulae		
Substitution Subject of the Formula	3.1.1 understand and use formulae	3.1.1.1 substitute for variables and evaluate a specified variable in a given formula 3.1.1.2 change the subject of simple formula to a specified variable 3.1.1.3 <i>change the subject of the formula to a specified variable</i>
3.2 Expressions		
Expressions	3.2.1 manipulate expressions	3.2.1.1 simplify algebraic expressions including binomial products 3.2.1.2 form simple algebraic expressions 3.2.1.3 manipulate simple algebraic fractions 3.2.1.4 factorise expressions of the form $ax \pm ay$, $ax + bx + kay + kby$, $a^2x^2 - b^2y^2$, $x^2 + bx + c$ and $x^2 + 2xy + y^2$, where a, b, c and k are constants 3.2.1.5 <i>manipulate algebraic fractions</i> 3.2.1.6 <i>factorise expressions of the form $ax^2 + bxy + cy^2$ and $ax^2 + bx + c$ where a, b and c are constants</i>

3.3 Equations and Inequalities		
Equations	3.3.1 form and solve equations	<p>3.3.1.1 form and/or solve linear equations in practical situations</p> <p>3.3.1.2 solve fractional equations with numerical or one term linear algebraic denominator and at most two-term linear algebraic numerators in one variable leading to a linear equation.</p> <p>3.3.1.3 solve simultaneous linear equations in two variables, using graphical, substitution and elimination methods</p> <p>3.3.1.4 solve quadratic equations by graphical method.</p> <p><i>3.3.1.5 solve fractional equations with numerical or linear algebraic denominators/numerators leading to a linear or quadratic equation</i></p> <p><i>3.3.1.6 solve quadratic equations by factorisation or formula.</i></p> <p><i>3.3.1.7 form and solve quadratic equations in practical situations</i></p> <p><i>3.3.1.8 form and solve linear simultaneous equations in practical situations</i></p>
Inequalities	3.3.2 form and solve inequalities	<p>3.3.2.1 solve simple linear inequalities</p> <p>3.3.2.2 indicate the region containing the points whose co-ordinates satisfy at least one inequality of the form $ax + by < c$, $ax + by \leq c$, $ax + by > c$, $ax + by \geq c$ where a, b and c are integers</p> <p><i>3.3.2.3 form and solve simple linear inequalities in practical situations</i></p>

3.4 Functions		
Graphs	3.4.1 acquire knowledge on graphs	<p>3.4.1.1 find the equations of line graphs given two points, gradient and a point, gradient and intercept or given the graph</p> <p>3.4.1.2 interpret equations of line graphs of the form $y = mx + c$</p> <p>3.4.1.3 construct tables of values and graph functions of the form $y = ax^3 + bx^2 + cx + d$ where at least one of the constants a, b, c, and d is zero</p> <p>3.4.1.4 recognise and interpret graphs of the form $y = ax^3 + bx^2 + cx + d$ where at least one of the constants a, b, c, and d is zero</p> <p>3.4.1.5 construct tables of values and draw and interpret graphs for the functions of the form ax^n where a is a rational constant and $n = -2, -1, 0, 1, 2, 3$ and simple sums of not more than three of these and for functions of the form ka^x where a is a positive integer and k a rational constant</p> <p>3.4.1.6 estimate and/or interpret the gradient at a point by drawing a tangent</p> <p>3.4.1.7 interpret and apply translations in the context of a graphical representation</p>
3.5 Graphs in Practical Situations		
Graphs	3.5.1 acquire knowledge on graphs	<p>3.5.1.1 draw graphs from practical situations</p> <p>3.5.1.2 interpret graphs representing practical situations</p>

4. GEOMETRY

Topics	General Objectives	Specific Objectives
	Candidates should be able to:-	candidates should be able to:-
4.1 Geometrical Terms and Relationships		
Geometrical terms and relationships	4.1.1 acquire further knowledge on geometrical terms and relationships	4.1.1.1 use and interpret geometrical terms associated with: points, lines, parallels, angles, perpendiculars, similarity, congruence, triangles, quadrilaterals, circles, polygons, and simple solid figures including nets 4.1.1.2 use properties of angles to calculate specified angles and/or length of line segments including angle properties of special triangles and quadrilaterals 4.1.1.3 use properties of polygons to calculate specified angles and/or sides
4.2 – Circles		
Angle properties of circle	4.2.1 acquire knowledge on properties of a circle	4.2.1.1 calculate specified angles or line segments using the properties:- angle in a semi-circle is 90° , angle between tangent and radius at a point of contact is 90° 4.2.1.2 <i>calculate specified angles or line segments using the properties:- angle at the centre of a circle is twice the angle at the circumference subtended by the same arc, angles at the circumference subtended by the same arc are equal, opposite angles in a cyclic quadrilateral are supplementary</i>
Symmetry properties of circle		4.2.1.3 calculate specified angles or line segments using the properties:- chords equidistant from the centre are equal in length, a perpendicular bisector of a chord passes through the centre, tangents from an external point to the circle are equal in length

4.3 Symmetry		
Reflectional symmetry	4.3.1 Understand and use properties of symmetry	4.3.1.1 recognise and describe line symmetry
Rotational symmetry		4.3.1.2 recognise and describe rotational system
Symmetry properties of polygons		4.3.1.3 recognise and use symmetry properties of plane shapes 4.3.1.4 recognise and use symmetry properties of prisms (including cylinder) and pyramids (including cone)

4.4 Trigonometry		
Bearings	4.4.1 understand and use bearings	4.4.1.1 interpret and use three-figure bearings to describe journeys
Trigonometric ratios and Pythagorean theorem	4.4.2 understand and apply trigonometric ratios and Pythagorean theorem	4.4.2.1 apply Pythagorean theorem and the sine, cosine and tangent ratios for acute angles to calculate a side or an angle of a right-angled triangle including problems involving angles of elevation or depression and bearings 4.4.2.2 <i>solve problems using sine and cosine ratios for angles between 90° and 360°</i>
Sine and Cosine Rule	4.4.3 understand and use sine and cosine rules	4.4.3.1 solve problems using the sine rule in acute angled triangles (formula to be provided) 4.4.3.2 <i>solve problems using the sine and cosine rule in any triangle (formula to be provided)</i> 4.4.3.3 <i>solve simple trigonometric problems in 3-D including angle between a line and a plane</i>
4.5 - Co-ordinate Geometry		
Distances	4.5.1 understand and use co-ordinates in Cartesian plane	4.5.1.1 calculate the distance between two points
Co-ordinates of midpoint of the line segment		4.5.1.2 calculate the co-ordinates of the midpoint of a line segment given the co-ordinates of its endpoints 4.5.1.3 calculate the co-ordinates of the end point of a line segment given the co-ordinates of its midpoint and one endpoint

4.6 – Constructions and Loci in 2-D		
Geometrical Constructions	4.6.1 acquire skills in constructions	4.6.1.1 measure lines and angles 4.6.1.2 construct triangles and other simple geometric figures using ruler, compasses and protractors as necessary 4.6.1.3 construct perpendicular lines (including perpendicular bisectors) using straight edges and compasses only 4.6.1.4 construct parallel lines using compasses, ruler and set square as necessary 4.6.1.5 construct angle bisectors using ruler and compasses only
Loci in 2-D	4.6.2 understand and use loci in 2-D	4.6.2.1 draw and/or state the locus of points at a given distance from a given point 4.6.2.2 draw and/or states the locus of points at a given distance from a given line 4.6.2.3 draw and/or state the locus of points equidistant from two given points 4.6.2.4 draw and/or state the locus of points equidistant from two given intersecting lines 4.6.2.5 <i>use the above loci, and the method of intersecting loci and constructions to locate specific points and sets of points</i>
4.7 – Transformations		
Reflection	4.7.1 understand and use transformations	4.7.1.1 reflect simple plane figures on a grid 4.7.1.2 recognise and describe fully a reflection given a shape and its image on a grid
Rotation		4.7.1.3 rotate simple plane shapes about any point through multiples of right-angles on a grid 4.7.1.4 recognise and describe fully a rotation given a shape and its image on a grid (restrict angle of rotation to multiples of right-angles)

Translation		<p>4.7.1.5 translate plane figures on a grid</p> <p>4.7.1.6 recognise and describe a translation given a shape and its image on a grid using a vector</p>
Enlargement		<p>4.7.1.7 draw an enlargement of a simple shape on a grid</p> <p>4.7.1.8 recognise and describe fully an enlargement</p> <p>4.7.1.9 make, use and interpret scale drawing e.g. maps</p> <p><i>4.7.1.10 use the relationship between lengths of line segments, surface areas and volumes of similar solids to solve problems</i></p> <p><i>4.7.1.11 describe a single transformation , which is equivalent to a combination of two transformations</i></p>
4.8 – Vectors		
Vectors	4.8.1 understand and use vectors	<p>4.8.1.1 represent vectors by, $\begin{pmatrix} x \\ y \end{pmatrix}$, \mathbf{a}, \underline{a}, or AB</p> <p>4.8.1.2 represent vectors by directed line segments</p> <p>4.8.1.3 add and subtract vectors</p> <p>4.8.1.4 multiply vectors by scalar</p> <p>4.8.1.5 calculate the magnitude of a vector</p> <p><i>4.8.1.6 use the sum and the difference of two vectors to express given vectors in terms of two coplanar vectors</i></p>

5. STATISTICS AND PROBABILITY

Topics	General Objectives	Specific Objectives
	Candidates should be able to:-	candidates should be able to:-
5.1 Data Handling		
Data Processing	5.1.1 collect and manipulate statistical data	5.1.1.1 represent data in a frequency table 5.1.1.2 construct and interpret a histogram (equal intervals), pie chart, frequency polygon, cumulative frequency table and curve 5.1.1.3 understand the reasons for organising, presenting data in a tabular or diagrammatic form and point out advantages and/or disadvantages that particular representations may have 5.1.1.4 <i>construct and interpret histograms with unequal intervals</i>
Measures of Central Tendency	5.1.2 acquire further knowledge on measures of central tendency	5.1.2.1 find mean, median, mode and modal class 5.1.2.2 estimate median from cumulative frequency curve 5.1.2.3 <i>estimate median by linear interpolation from a cumulative frequency table</i> 5.1.2.4 <i>interpret measures of central tendency (median, mean, mode)</i>
Measures of Dispersion	5.1.3 acquire knowledge on measures of dispersion	5.1.3.1 calculate range and interquartile range 5.1.3.2 estimate quartiles and percentiles from a cumulative frequency curve 5.1.3.3 <i>estimate quartiles and percentiles by linear interpolation from a cumulative frequency table</i> 5.1.3.4 <i>calculate variance and standard deviation (formula to be provided).</i> NOTE: Readings taken from a statistical scientific calculator with no working shown will not be accepted.

	5.1.4 understand and use scatter diagrams	<p>5.1.4.1 plot scatter graphs</p> <p>5.1.4.2 draw conclusions from scatter graphs using terms such as positive correlation, negative correlation, no correlation</p> <p>5.1.4.3 draw the line of best fit by inspection</p> <p>5.1.4.4 <i>find the equation of the line of best fit (line drawn by inspection)</i></p>
5.2 – Probability		
Simple Probability	5.2.1 understand and use probability	<p>5.2.1.1 understand and use the vocabulary of probability in practical situations</p> <p>5.2.1.2 understand and use the probability scale</p> <p>5.2.1.3 calculate the probability of a single event</p> <p>5.2.1.4 distinguish between theoretical and experimental probability</p> <p>5.2.1.5 <i>calculate the probability of simple combined events, using possibility diagrams and tree diagrams where appropriate</i></p>
Mutually Exclusive and Independent Events		<p>5.2.1.6 <i>have an informal understanding of the meaning of mutually exclusive and independent events when applied to simple problems</i></p> <p>5.2.1.7 <i>use addition and multiplication of probabilities, as appropriate, in simple cases.</i></p>

6. ASSESSMENT OF PRACTICAL SKILLS

To assess those skills which are best assessed by methods other than by timed, written papers, it is intended to introduce centre-based assessment (Coursework) as soon as suitable materials and training are available.

7. GRADE DESCRIPTIONS

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of candidates' performance in the examination may be balanced by better performances in others.

GRADE F

Candidate should be able to:

- F1 Apply the four operations on positive integers and decimal fractions to two decimal places in context using a calculator where appropriate.
- F2 Convert vulgar fractions to decimals.
- F3 Solve simple practical problems involving percentages and ratios.
- F4 Order integers.
- F5 Use metric units of length, area, mass and capacity.
- F6 Understand the relationship between metric units.
- F7 Use common units of time; read timetables.
- F8 Solve practical problems involving perimeters and areas of simple compound rectilinear shapes.
- F9 Find areas and circumferences of circles.
- F10 Substitute numbers in simple formulae and evaluate the remaining variable. Form and solve simple linear equations in one variable related to practical situation.
- F11 Manipulate simple algebraic expressions.
- F12 Recognise and name plane shapes and common solids.
- F13 Use ruler, compass and protractor to construct triangles and simple geometrical figures as accurately as possible.
- F14 Reflect simple plane shapes on a co-ordinate grid in lines parallel to the axes.
- F15 Recognise and describe reflections given on a coordinate grid.
- F16 Draw an enlargement of plane shapes given a positive integer scale factor on plane grid.
- F17 Translate plane shapes on a plane grid.
- F18 Identify and use reflectional symmetry in 2-dimensional shapes
- F19 Calculate distance between two points in 2- dimensions.
- F20 Use the Pythagorean theorem to calculate the third side in a right-angled triangle.
- F21 Use properties of angles and of polygons to calculate specified angles and/or lengths of sides.
- F22 Represent, add and subtract vectors. Multiply vectors by a scalar.
- F23 Tabulate and represent discrete data.
- F24 Find mean, mode, median and range from a discrete data distribution.
- F25 Read and interpret tables, graphs, (including travel graphs) and diagrams.

GRADE C

Candidate should be able to:

- C1 Apply in practical situations integers, vulgar and decimal fractions (including percentages), ratios and proportions using the four basic operations (the calculations involving several operations) and using a calculator efficiently when appropriate.
- C2 Understand and use the equivalence between vulgar fractions, decimals and percentages. Give a reasonable approximation to calculations involving the four operation rules. Interpret and use integer indices, including problems involving numbers in standard notation.
- C3 Solve problems involving perimeters and areas of compound shapes bounded by line segments and/or circular arcs, including the use of the area formula for a triangle $A = \frac{1}{2}ab \sin C$.
- C4 Calculate surface area and volume of cylinders, prisms, pyramids, cones and spheres.
- C5 Solve practical problems involving mass, volume and density.
- C6 Give appropriate upper and lower bounds for data given to a specified accuracy.
- C7 Draw distance – time and speed – time graphs.
- C8 Make quantitative and qualitative conclusion from distance – time graphs and speed – time graphs.
- C9 Change the subject of a simple formula to a specified variable.
- C10 Simplify algebraic expressions including binomial products.
- C11 Manipulate algebraic fractions with denominators containing a single term (numerical or algebraic).
- C12 Form simple algebraic expressions.
- C13 Substitute for variable in more difficult formulae and find the value of the remaining variable.
- C14 Factorise expressions.
- C15 Form and solve linear equations in practical situations.
- C16 Manipulate and solve fractional equations, simultaneous linear equations in two variables and quadratic equations.
- C17 Form and solve simple linear inequalities.
- C18 Represent regions in the plane determined by linear inequalities.
- C19 Plot, recognise and interpret graphs of quadratic functions and of the function $f(x) = ax^3 + bx^2 + cx + d$.
- C20 Plot and interpret graphs representing practical situations.
- C21 Find and interpret equations of lines.
- C22 Identify and describe rotational symmetry in 2-D.
- C23 Use angle properties and symmetry properties of a circle to calculate specified angles and/or length of line segments.
- C24 Use sine, cosine and tangent ratios in right angled triangles when solving problems in two dimensions (including bearings, angles of elevation and depression).
- C25 Use sine rule.
- C26 Draw and/or state loci of points in two dimensions.
- C27 Draw, recognise and describe transformations of shapes on a grid (translations, rotations and enlargements).

- C28 Calculate the co-ordinates of the mid point of a line segment given the co-ordinates of its end points.
- C29 Calculate the co-ordinates of the end point of a line segment given the co-ordinates of its mid point and of one end point.
- C30 Make, use and interpret scale drawings.
- C31 Find the magnitude of given vectors.
- C32 Represent and interpret continuous data.
- C33 Find modal class.
- C34 Estimate the median, quartiles and percentiles from a cumulative frequency curve.
- C35 Represent continuous data in a table, histogram, cumulative frequency polygon/curve.
- C36 Plot and interpret scatter diagrams.
- C37 Understand and use the probability scale.
- C38 Make and justify estimates of probability.
- C39 Calculate the probability of single events.
- C40 Understand that different probabilities may result from repeating an experiment.
- C41 Recognise, describe and generalise in algebraic format patterns of linear sequences.
- C42 Check reasonableness of their results.
- C43 Analyse a given situation, generate data, generalise the data obtained and describe the situation using mathematical symbols, words or diagrams.

GRADE A

Candidate should be able to:

- A1 Interpret and use fractional indices.
- A2 Solve practical problems involving compound shapes and solids.
- A3 Obtain appropriate upper and lower bounds for data and to solutions to simple problems given data to a specified accuracy.
- A4 Solve fractional equations.
- A5 Form and solve quadratic equations.
- A6 Form and solve linear inequalities.
- A7 Solve quadratic inequalities algebraically and graphically.
- A8 Plot, recognise and/or interpret graphs of the functions $f(x) = ax^n$, and $g(x) = ka^x$.
- A9 Draw the tangent, estimate and interpret gradients of a curve at a point.
- A10 Interpret and apply translation to graphs of functions.
- A11 Recognise and use symmetry properties of prisms (including cylinder) and pyramids (including cone).
- A12 Solve problems involving sine and cosine ratios of angles in the range 90° to 360° , cosine rule and simple 3-dimension situations.
- A13 Use and apply loci.
- A14 Recognise and describe fully rotations and enlargements.
- A15 Describe a single transformation which is equivalent to the combination of two transformations.
- A16 Use the relationships between lengths of line segments, areas, surface area, volume of similar shapes or solids to solve problems.

- A27 Use vectors in two dimensions.
- A18 Construct and interpret histograms with unequal intervals.
- A19 Interpret measures of central tendency.
- A20 Calculate variance and standard deviation.
- A21 Draw, and hence find the equation of the line of best fit.
- A22 Calculate the probability of simple combined events, using addition or multiplication of probabilities as appropriate.
- A23 Understand mutually exclusive and independent events.
- A24 Estimate the median, percentiles and quartiles by linear interpolation from a frequency table.
- A25 Recognise, describe and generalise in algebraic format patterns of non-linear sequences.
- A26 Make clear, concise and accurate mathematical statements, showing the use of symbolic forms and accuracy in algebraic and arithmetic manipulations.
- A27 Give clear mathematical justifications for the conjectures made in problem solving.

8. APPENDICES**A. Mathematical formulae for papers 1 and 2****Surface area and volume of solids**

Name of solid	Total Surface area	volume
cone	$\pi r^2 + \pi r l$	$\frac{1}{3} \pi r^2 h$
pyramid		$\frac{1}{3}$ base area x height
sphere	$4 \pi r^2$	$\frac{4}{3} \pi r^3$

Trigonometry

Sin rule $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Area of a triangle $= \frac{1}{2} a b \sin C$

B. Mathematical formulae for paper 3

Surface area and volume of solids

Name of solid	Total Surface area	volume
cone	$\pi r^2 + \pi r l$	$\frac{1}{3} \pi r^2 h$
pyramid		$\frac{1}{3}$ base area x height
sphere	$4 \pi r^2$	$\frac{4}{3} \pi r^3$

Trigonometry

Sin rule $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Area of a triangle $= \frac{1}{2} a b \sin C$

Cos rule $a^2 = b^2 + c^2 - 2bc \cos A$

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

Statistics

$$\text{Variance} = \frac{\sum (x - \bar{x})^2}{n}$$

$$\text{Standard deviation (SD)} = \sqrt{\text{Variance}} = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

$$\text{Or } \sqrt{\frac{\sum x^2}{n} - (\bar{x})^2}$$