Rewarding Learning

CCEA GCSE Specification in Further Mathematics

For first teaching from September 2013

For first assessment from Summer 2014
For first award in Summer 2014

Subject Code: 2335

further mathematics

Foreword

This booklet contains CCEA's General Certificate of Secondary Education (GCSE) Further Mathematics for first teaching from September 2013. We have updated this specification to meet the requirements of the following:

- GCSE Qualifications Criteria; and
- Common Criteria for all Qualifications.

We will make the first full award based on this specification in summer 2014.

We are now offering this specification as a unitised course. This development increases flexibility and choice for teachers and learners.

The first assessment will be available in 2014 for:

- Unit 1: Pure Mathematics; and
- Unit 2: Mechanics and Statistics.

We will notify centres in writing of any major changes to this specification. We will also publish changes on our website at www.ccea.org.uk

The version on our website is the most up-to-date version. Please note that the web version may be different from printed versions.

Subject Code	2335
QAN	600/9508/8

Contents

1 Introduction

This specification sets out the content and assessment details for our GCSE Further Mathematics course. First teaching begins from September 2013, and we will make the first awards for this specification in 2014. You can view and download the latest version of this specification on our website at www.ccea.org.uk

The specification builds on the broad objectives of the Northern Ireland Curriculum.

This GCSE Further Mathematics specification replaces our Additional Mathematics specification and retains much of the same content. It provides a sound basis for further study of mathematics at AS/A2 level and related subjects at a more advanced level.

As with all GCSEs, the guided learning hours for this specification are 120–140 hours.

1.1 Aims

This specification aims to encourage students to:

- develop further their mathematical knowledge, skills and understanding;
- select and apply mathematical techniques and methods in mathematical, everyday and real-world situations;
- reason mathematically, interpret and communicate mathematical information, make deductions and inferences, and draw conclusions;
- extend the base in mathematics from which they can progress to:
  - higher studies in mathematics; and/or
  - studies such as science, geography, technology or business which contain a significant requirement in mathematics beyond Higher Tier GCSE Mathematics; and
- design and develop mathematical models that allow them to use problem solving strategies and apply a broader range of mathematics to a variety of situations.

1.2 Key features

The key features of the specification appear below:

- This course offers opportunities to build on the skills and capabilities developed through the delivery of the Key Stage 3 curriculum in Northern Ireland.
- It caters for students who require knowledge of mathematics beyond GCSE Higher Tier Mathematics and who are capable of working beyond the limits of the GCSE Mathematics specification.
- It is designed to broaden the experience of students whose mathematical ability is above average and who:
  - will follow mathematical courses at AS/A Level;
  - will follow other courses at AS/A Level that require mathematics beyond GCSE Higher Tier; or
  - would like to extend their knowledge of mathematics.
- This is now a unitised specification. This means that students have the opportunity to sit one or both units in the first year of teaching.

1.3 Prior attainment

Students taking this GCSE Further Mathematics specification should ideally have covered **all** of the content in the CCEA GCSE Mathematics specification at Higher Tier, including all of the content of units T3, T4 and T6. See Appendix 2 for a full list of assumed knowledge.

1.4 Classification codes and subject combinations

Every specification is assigned a national classification code that indicates the subject area to which it belongs. The classification code for this qualification is 2330.

Progression to another school/college

Should a student take two qualifications with the same classification code, schools and colleges that they apply to may take the view that they have achieved only one of the two GCSEs. The same view may be taken if students take two GCSE qualifications that have different classification codes but have content that overlaps significantly. Students who have any doubts about their subject combinations should check with the schools and colleges that they wish to attend before embarking on their planned study.

2 Specification at a Glance

The table below summarises the structure of this GCSE Further Mathematics course:

Content	Assessment	Weighting	Availability
Unit 1: Pure Mathematics	Written examination in the form of a single question-and-answer booklet that includes a formula sheet 2 hours	50%	January and Summer (beginning in Summer 2014)
Unit 2: Mechanics and Statistics	Written examination in the form of a single question-and-answer booklet that includes a formula sheet 2 hours	50%	January and Summer (beginning in Summer 2014)

At least 40 percent of the assessment (based on unit weightings) must be taken at the end of the course as terminal assessment.

3 Subject Content

We have divided the course into two units. The content of each unit, as well as the respective learning outcomes, appears below.

3.1 Unit 1: Pure Mathematics

In this unit students investigate algebra, trigonometry, differentiation, integration, logarithms, matrices and vectors.

Content	Learning Outcomes	Elaboration
1.1 Algebra **Algebraic Fractions**	Students should be able to: 1.1.1 add, subtract, multiply and divide rational algebraic fractions with linear and quadratic numerators and/or denominators;	Example: simplify $\frac{x^2-3x}{3} \times \frac{9}{x^2-x-6}$
Completing the Square	1.1.2 write $x^2 + bx + c$ in the form $\left(x+\frac{b}{2}\right)^2 + \left(c - \left(\frac{b}{2}\right)^2\right)$	The coefficient of x^2 will always be 1 for completing the square. Example: If $f(x) = x^2+5x+1$, rewrite this in the form $(x+a)^2+b$ and use this to find the minimum value of $f(x)$ and the value of x for which it occurs.
Equations	1.1.3 form and solve equations, sometimes given in context, in: – one variable: linear: including fractional terms; and quadratic: using the methods of factorising, formula and completing the square; and – two or three variables, including: up to three linear equations in three unknowns; and one linear and one quadratic equation in two unknowns.	Example: solve $x^2 - 5x = 1$ by completing the square, giving the answer in the form $x = a \pm \sqrt{b}$ The coefficient of x^2 will always be 1 for completing the square. Equations may be given, or students may be asked to form the equations and interpret the results.

Content	Learning Outcomes	Elaboration
1.2 Trigonometry **Trigonometric Equations**	Students should be able to: 1.2.1 solve simple trigonometric equations in a given range (in degrees only) with a maximum of two solutions;	Example: solve $\sin 2x = 0.5$ in the range $0° \le x \le 180°$ Example: solve $\cos\left(\frac{1}{2}x - 30°\right) = -0.7$ in the range $-360° \le x < 360°$ A variety of ranges will be used.
Solution of Triangles	1.2.2 use trigonometry in practical examples to solve triangles including their areas by using the sine rule, cosine rule and Area $= \frac{1}{2}ab\sin C$	Excluding the ambiguous case of the sine rule
1.3 Differentiation **Differentiation of a Basic Function**	1.3.1 differentiate powers and sums of powers of x to find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$	Including negative indices but excluding fractional indices Excluding differentiation from first principles
Applications of Differentiation	1.3.2 apply the method of differentiation to: – gradients, tangents, normals, maximum and minimum turning points; – simple optimisation problems; and – elementary curve sketching of a quadratic or cubic function; and	Excluding points of inflexion Excluding 3D optimising problems A cubic function will have x as a common factor. Axes will be drawn but not on squared paper.
1.4 Integration **Integration of a Basic Function**	1.4.1 integrate powers and sums of powers of x, including definite integration.	Including negative indices but excluding $\int x^{-1}dx$ and excluding fractional indices

Content	Learning Outcomes	Elaboration
Application of Integration	Students should be able to: 1.4.2 apply the method of integration to find the area under a curve;	Area enclosed between a curve, x-axis and two given ordinates $x = a$ and $x = b$ Excluding combinations of positive and negative areas
1.5 Logarithms **Laws of Logarithms**	1.5.1 understand logarithms as a natural evolution from indices; 1.5.2 use the three basic laws of logarithms in simplifying and manipulating expressions involving logarithms: $\log ab = \log a + \log b$ $\log \frac{a}{b} = \log a - \log b$ $\log a^n = n \log a$	Example: understand that $8 = 2^3 \Leftrightarrow \log_2 8 = 3$ Excluding change of base
Solution of Index Equations	1.5.3 solve equations of the form $a^{f(x)} = b^{g(x)}$ for simple functions $f(x)$ and $g(x)$;	Example: $f(x) = 2x + 3$ $g(x) = x$ Excluding quadratic functions
1.6 Matrices **Matrix Calculations**	1.6.1 add and subtract matrices; 1.6.2 multiply matrices – only matrices of size 2×2, 2×1 or 1×2 will be used; and 1.6.3 find det **A** and $\mathbf{A}^{-1}$ for 2×2 matrices.	Including non-square matrices, for example: $[2\ 3\ 4] + [5\ -2\ -7]$ Example: $[2\ -3]\begin{bmatrix}-4\\1\end{bmatrix}$

Content	Learning Outcomes	Elaboration
Matrix Equations	Students should be able to: 1.6.4 solve for matrix **X**, equations of the form **A** ± **X** = **B** **AX** = **B**	Example: $\mathbf{A} = \begin{bmatrix} -2 & 4 \\ 1 & 3 \end{bmatrix}$ $\mathbf{B} = \begin{bmatrix} 1 & -2 \\ -4 & 7 \end{bmatrix}$ Solve for matrix **X**: (i) **A** + **X** = **B** (ii) **AX** = **B**
Simultaneous Equations	1.6.5 solve two linear simultaneous equations using matrices;	
1.7 Vectors **Concept of a Vector**	1.7.1 understand the concept of a vector and use the notations $\overrightarrow{AB}$, **a**, column vectors and representation by a directed line segment;	Excluding vectors in the form **xi** + **yj** in Unit 1
Vector Geometry	1.7.2 calculate and represent graphically the sum of two vectors and a scalar multiple of a vector; 1.7.3 understand and use the commutative and associative properties of vector addition; and 1.7.4 solve simple geometrical problems in 2D using vector methods.	Prove that two lines are parallel by showing that one vector is a scalar multiple of another.

3.2 Unit 2: Mechanics and Statistics

In this unit, students explore kinematics, vectors, forces, Newton's Laws of Motion, friction, moments, understanding and using statistical terminology, measures of central tendency and measures of dispersion, probability, and bivariate analysis.

Content	Learning Outcomes	Elaboration
2.1 **Kinematics** **Displacement and Velocity Time Graphs**	Students should be able to: 2.1.1 demonstrate a knowledge of displacement/time and velocity/time graphs and their applications;	Including graphs showing two journeys, for example one vehicle meeting/ overtaking another
Constant Acceleration Formulae	2.1.2 demonstrate a knowledge of and use constant acceleration formulae;	Including vertical and horizontal motion
2.2 **Vectors** **Vector Introduction**	2.2.1 understand the definition of a vector: – force, velocity and acceleration are vectors; and – mass and time are scalars;	
Introduction to i and j Vectors	2.2.2 know that a vector has magnitude and direction; 2.2.3 use **i** and **j** vectors in calculations;	Including angle between x**i** + y**j** and either **i** or **j**
2.3 **Forces** **Units of Force**	2.3.1 understand that force is a vector and know the units of force;	
Resolving Forces	2.3.2 resolve a force into components and find the resultant of a set of forces; and	Resolving problems involve a maximum of four separate forces.
Equilibrium	2.3.3 know and apply the concept of equilibrium of a particle.	Equilibrium problems involve a maximum of four separate forces.

Content	Learning Outcomes	Elaboration
2.4 **Newton's Laws of Motion**	Students should be able to: 2.4.1 apply Newton's Laws of Motion, including $F = ma$;	Straight line motion only Including motion of a body on an inclined plane
Connected Particles	2.4.2 solve problems involving motion of two connected bodies;	Both bodies move horizontally, both vertically, or one moves horizontally and the other vertically.
2.5 **Friction** **Friction and Normal Reaction**	2.5.1 demonstrate a knowledge of the concept of friction and the normal reaction R;	
Limiting Friction	2.5.2 demonstrate a knowledge of the concept of limiting friction = μR, where R is the normal reaction and μ is the coefficient of friction; and	Any externally applied forces acting on a body on an inclined plane (for example the tension in a string) will be parallel to the plane. Excluding the 'angle of friction' concept
2.6 **Moments**	2.6.1 understand the principle of moments and equilibrium of a rigid body.	Turning effects of coplanar forces; problems will involve uniform rods only, no hinge or ladder questions.

Content	Learning Outcomes	Elaboration
2.7 Understanding and Using Statistical Terminology **Statistical Language**	Students should be able to: 2.7.1 demonstrate knowledge and understanding of the terms: – population; – sample; – discrete variable; and – continuous variable;	
Limits and Boundaries	2.7.2 distinguish between class limits and class boundaries;	
Class Widths and Mid-Values	2.7.3 calculate the class width and mid-value of classes;	
Age Distribution	2.7.4 demonstrate a knowledge and understanding of age distribution;	Example: 5–9 years means $5 \leq \text{age} < 10$ years.
Histograms	2.7.5 draw and use histograms of various widths using frequency density;	
2.8 Measures of Central Tendency and Measures of Dispersion	2.8.1 demonstrate knowledge and use of standard deviation;	
Standard Deviation, Mean and Median	2.8.2 calculate an estimate for the mean, median and standard deviation from data, which may be given in the form of a grouped frequency distribution; and	Excluding calculation of interquartile range, but including finding the mean and standard deviation for combined sets of data Formula for the median is: $\text{Median} = L_1 + \dfrac{\left\{\frac{N}{2} - (\Sigma f)_1\right\}c}{f_{med}}$
Results for Transformed Data	2.8.3 transform sets of data.	Know that if a data set is transformed such that: $Y = aX + b$, then $\overline{Y} = a\overline{X} + b$ and $\sigma_{\mathrm{y}} = a\sigma_X$

Content	Learning Outcomes	Elaboration
2.9 **Probability** **Independent and Mutually Exclusive Events**	Students should be able to: 2.9.1 demonstrate a knowledge of independent and mutually exclusive events;	
Tree Diagrams	2.9.2 construct tree diagrams with up to three branches;	
Venn Diagrams	2.9.3 construct Venn diagrams;	Understand and use P(A∪B) or P(A∩B)
Conditional Probability	2.9.4 understand conditional probability;	The calculation of a conditional probability may be from tree diagrams or Venn diagrams.
2.10 **Bivariate Analysis** **Scatter Diagrams and Correlation**	2.10.1 demonstrate a knowledge of scatter diagrams and correlation;	
Line of Best Fit	2.10.2 draw a line of best fit by eye, passing through the point $(\bar{x}, \bar{y})$; 2.10.3 find the equation of a line of best fit in the form $y = a + bx$; and	The plotting of original data will be given.
Spearman's Rank Correlation Coefficient	2.10.4 calculate and interpret Spearman's Rank Correlation Coefficient.	$r = 1 - \frac{6\Sigma d^2}{n(n^2 - 1)}$ will be given. Know that $-1 \leq r \leq 1$ and that, for this specification, values $-0.4 \leq r \leq 0.4$ will be taken as weak or no correlation.

4 Scheme of Assessment

4.1 Assessment opportunities

You can see the availability of the examinations in Section 2 of this specification.

Candidates studying unitised GCSE qualifications must complete at least 40 percent of the overall assessment requirements as terminal assessment.

Candidates may resit each individual assessment unit once. If candidates resit a unit, they are free to count the better of the two marks they achieve **unless** the resit makes up part of their 40 percent terminal assessment. If the resit **does** make up part of the terminal assessment, the resit mark will count towards the final grade.

Results for individual assessments units remain available to count towards a GCSE qualification until we withdraw the specification.

4.2 Assessment objectives

Below are the assessment objectives for this specification. Candidates must:

- recall and select mathematical facts, concepts and techniques in a variety of contexts (AO1);
- use their knowledge of standard mathematical models and apply mathematical methods in a range of contexts (AO2); and
- interpret and analyse problems and generate strategies to solve them (AO3).

4.3 Assessment objective weightings

The table below sets out the assessment objectives for each assessment component:

Assessment Objective	**Component Weighting %**	
	Unit 1	**Unit 2**
AO1	25–35	25–35
AO2	40–50	40–50
AO3	20–30	20–30

4.4 Reporting and grading

We report the results of individual assessment units on a uniform mark scale that reflects the assessment weighting of each unit. We determine the grades awarded by aggregating the uniform marks that candidates obtain on individual assessment units.

We award GCSE qualifications on an eight-grade scale A*–G, with A* being the highest. If candidates fail to attain a grade G or higher, we report their results as unclassified (U).

The grades that we award match the grade descriptions in Section 5.

5 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 descriptions must be interpreted in relation to the content in the specification; they are not designed to define that content.

The grade awarded depends in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of candidates' performance in the assessment may be balanced by better performances in others.

Grade	Description
A	Candidates use a wide range of mathematical techniques, terminology, diagrams and symbols consistently, appropriately and accurately. Candidates are able to use different representations effectively and they recognise equivalent representations: for example numerical, graphical and algebraic representations. Candidates use complex graphs, sketches and diagrams, all with accuracy and skill. Candidates manipulate complex algebraic expressions concisely, and use algebra to solve problems with fluency and accuracy. They use trigonometry to solve complex problems. Candidates demonstrate a comprehensive understanding of logarithms, vector geometry, matrices, differentiation, integration, kinematics, forces and equilibrium, Newton's laws, friction, moments, statistical language, measures of central tendency and spread, probability and bivariate analysis. They evaluate the appropriateness, effectiveness and efficiency of different approaches to problem solving through their knowledge and understanding. Candidates tackle problems that bring together different aspects of mathematics that involve multiple variables, often in non-standard situations. They can identify variables and investigate them systematically, and use the outcomes to solve a problem. Candidates communicate their chosen strategy concisely. They can construct a rigorous argument and engage in multi-step reasoning, making inferences and drawing conclusions. They use mathematical language correctly and proceed logically through extended arguments or proofs.

Grade	Description
C	Candidates use a range of mathematical techniques, terminology, diagrams and symbols consistently and appropriately. Candidates are able to use different representations effectively and they recognise equivalent representations: for example numerical, graphical and algebraic representations. Candidates use graphs, sketches and diagrams, all with reasonable accuracy and skill. Candidates manipulate algebraic expressions concisely, and use algebra to solve problems with reasonable accuracy. They use trigonometry to solve problems. Candidates demonstrate an understanding of logarithms, vector geometry, matrices, differentiation, integration, kinematics, forces and equilibrium, Newton's laws, friction, moments, statistical language, measures of central tendency and spread, probability and bivariate analysis. Candidates identify relevant information, select appropriate representations and apply appropriate methods and knowledge. They are able to move from one representation to another in order to make sense of a situation. Candidates tackle problems that bring aspects of mathematics together and use some algebraic, trigonometric, mechanical and statistical properties to understand problems and begin to seek solutions. They identify strategies to solve problems involving a limited number of variables. Candidates communicate their chosen strategy. They can construct a mathematical argument, although there may be gaps in their reasoning.
F	Candidates use some mathematical techniques, terminology, diagrams and symbols appropriately. Candidates are able to use some representations effectively and they recognise some equivalent representations: for example numerical, graphical and algebraic representations. Candidates use graphs, sketches and diagrams, all with some accuracy. Candidates manipulate algebraic expressions, and use algebra to solve problems with some accuracy. They attempt to use trigonometry to solve problems. Candidates demonstrate a limited knowledge of logarithms, vector geometry, matrices, differentiation, integration, kinematics, forces and equilibrium, Newton's laws, friction, moments, statistical language, measures of central tendency and spread, probability and bivariate analysis. Candidates identify some relevant information, select appropriate representations and apply appropriate methods and knowledge. They attempt to move from one representation to another, in order to make sense of a situation. Candidates attempt to tackle problems that bring aspects of mathematics together and use some algebraic, trigonometric, mechanical and statistical properties to understand problems and begin to seek solutions. They attempt to identify strategies to solve problems involving a limited number of variables. Candidates attempt to communicate their chosen strategy.

6 Links

6.1 Support

We provide the following resources to support this specification:

- our website;
- a subject microsite within our website;
- specimen papers and mark schemes; and
- Topic Tracker.

Topic Tracker allows teachers to produce their own test papers using past paper examination questions and generates a mark scheme to match.

Some support material from the previous specification may also remain useful.

We intend to expand our range of support to include the following:

- past papers;
- mark schemes;
- Chief Examiner's reports;
- schemes of work;
- centre support visits;
- support days for teachers; and
- a resource list.

You can find our annual support programme of events and materials for GCSE Further Mathematics on our website at www.ccea.org.uk

6.2 Curriculum objectives

This specification addresses and builds upon the broad curriculum objectives for Northern Ireland. In particular, it enables students to:

- develop as individuals and contributors to the economy, society and environment by providing opportunities to:
  - create personal meaning through problem-solving, applying rules and developing numeracy skills;
  - express their own logic through working out problems;
  - build an appreciation of the diverse branches of mathematics; and
  - explore and experiment creatively in a variety of situations;
- develop the skills that are central to their understanding of and response to mathematical problems;
- increase awareness of how mathematics influences behaviour and the world around them;
- develop their own understanding of mathematics from situations and experiences that are different from their own;
- develop their understanding of the theoretical and practical nature of mathematics;
- improve their mathematical competence, financial capabilities and responsibilities;
- develop their awareness and understanding of the skills required to be successful in employment and business (and how these skills are transferable to the world of work);

- progress from the Key Stage 3 Northern Ireland Curriculum requirements through:
  – knowledge and understanding of number, algebra, shape, space and measures, and handling data;
  – knowledge and understanding of personal finance issues;
  – skills that enable competent and responsible financial decision-making;
  – the application of mathematical skills to real-life and work situations; and
  – the creative use of technology to enhance mathematical understanding;
- develop an understanding of spiritual, moral, ethical, social, legislative, economic and cultural issues by providing opportunities to:
  – explore and understand the underlying mathematical principles behind some of the natural forms and patterns in the world around us;
  – recognise how logical reasoning can be used to consider the consequences of particular decisions and choices;
  – work together on complex mathematical tasks and see that the collaborative result is often better than what they could achieve individually;
- appreciate that mathematical thought contributes to the development of our culture and is becoming increasingly central to our highly technological future;
- recognise the ways in which mathematicians from many cultures have contributed to modern day mathematics; and
- develop an understanding of sustainable development, health and safety considerations and European developments.

6.3 Skills development

This specification provides opportunities for students to develop the following key skills:

- application of number;
- communication;
- improving their own learning and performance;
- information and communication technology;
- problem-solving; and
- working with others.

You can find details of the current standards and guidance for each of these skills on the CCEA website at www.ccea.org.uk

6.4 Examination entries

Entry codes for this subject and details on how to make entries are available on our Qualifications Administration Handbook microsite, which you can access at www.ccea.org.uk

Alternatively, you can telephone our Examination Entries, Results and Certification team using the contact details provided in this section.

6.5 Equality and inclusion

We have considered the requirements of equality legislation in developing this specification.

GCSE qualifications often require the assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare students for a wide range of occupations and higher level courses.

During the development process, an external equality panel reviewed the specification to identify any potential barriers to equality and inclusion. Where appropriate, we have considered measures to support access and mitigate barriers.

Reasonable adjustments are made for students with disabilities. For this reason very few students, if any, should have difficulty accessing the assessment.

It is important to note that where access arrangements are permitted, they must not be used in any way that undermines the integrity of the assessment. You can find information on reasonable adjustments in the Joint Council for Qualifications' document *Access Arrangements, Reasonable Adjustments and Special Consideration: General and Vocational Qualifications*, available at www.jcq.org.uk

6.6 Contact details

The following list provides contact details for relevant staff members and departments:

- Specification Support Officer: Eimear Dolan
  (telephone: (028) 9026 1200, extension 2552, email: edolan@ccea.org.uk)

- Officer with Subject Responsibility: Eleanore Thomas
  (telephone: (028) 9026 1200, ext. 2209, email: ethomas@ccea.org.uk)

- Examination Entries, Results and Certification
  (telephone: (028) 9026 1262, email: entriesandresults@ccea.org.uk)

- Examiner Recruitment
  (telephone: (028) 9026 1243, email: appointments@ccea.org.uk)

- Distribution
  (telephone: (028) 9026 1242, email: distribution@ccea.org.uk)

- Support Events Administration
  (telephone: (028) 9026 1401, email: events@ccea.org.uk)

- Information Section (including Freedom of Information requests)
  (telephone: (028) 9026 1200, email: info@ccea.org.uk)

- Business Assurance (Complaints and Appeals Manager: Heather Clarke)
  (telephone: (028) 9026 1244, email: hclarke@ccea.org.uk).

Appendix 1

Formula Sheets

Unit 1: Pure Mathematics

This page will be on the inside cover of the question-and-answer booklet for Unit 1.

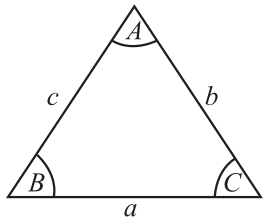
Quadratic equations: If $ax^2 + bx + c = 0 \qquad (a \neq 0)$

then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Trigonometry: $\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$

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

Area of triangle = ½ $ab \sin C$



Differentiation: If $y = ax^n$ then $\dfrac{dy}{dx} = nax^{n-1}$

Integration: $\int ax^n \, dx = \dfrac{ax^{n+1}}{n+1} + c \qquad (n \neq -1)$

Logarithms: If $a^x = n$ then $x = \log_a n$

$\log (a \times b) = \log a + \log b$

$\log (a \div b) = \log a - \log b$

$\log a^n = n \log a$

Matrices: If $\mathbf{A} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$

then $\det \mathbf{A} = ad - bc$

and $\mathbf{A}^{-1} = \dfrac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix} \qquad (ad - bc \neq 0)$

Unit 2: Mechanics and Statistics

This page will be on the inside cover of the question-and-answer booklet for Unit 2.

Vectors:

Magnitude of $x\mathbf{i} + y\mathbf{j}$ is given by $\sqrt{x^2 + y^2}$
Angle between $x\mathbf{i} + y\mathbf{j}$ and $\mathbf{i}$ is given by

$\tan^{-1}\left(\frac{y}{x}\right)$

Uniform Acceleration:

$v = u + at$
$v^2 = u^2 + 2as$
$s = \frac{1}{2}(u + v)t$
$s = ut + \frac{1}{2}at^2$

where
u is initial velocity
v is final velocity
a is acceleration
t is time
s is change in displacement

Newton's Second Law:

$F = ma$

where
F is resultant force
m is mass
a is acceleration

STATISTICS

Statistical measures:

$\text{Mean} = \frac{\sum fx}{\sum f}$

$$\text{Median} = L_1 + \frac{\left\{\frac{N}{2} - (\sum f)_1\right\}c}{f_{med}}$$

where
L_1 is lower class boundary
N is total frequency
$(\sum f)_1$ is the sum of the frequencies up to but not including the median class
f_{med} is the frequency of the median class
c is the width of the median class

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Probability:

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$$

Bivariate Analysis:

Spearman's coefficient of rank correlation is given by

$$r = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Appendix 2

Assumed Knowledge

Students should have thorough knowledge of:

- using calculators effectively and efficiently, including trigonometrical functions
- factorising quadratic expressions
- simplifying algebraic fractions
- the use of the quadratic formula
- setting up and solving simple equations, including simple simultaneous linear equations in two unknowns
- the rules of indices
- the gradient of a straight line, parallel and perpendicular lines
- the equation of a straight line
- graphs of:
  - sin, cos and tan functions
  - reciprocal function
  - exponential function $y = a^x$ where $a = 2, 3, 4$ and $x \in \mathbb{Z}$
  - quadratic and simple cubic functions
- Pythagoras' theorem
- trigonometry
- the use of sine rule, cosine rule and area of triangle rule
- three figure bearings
- understanding and using compound measures
- finding areas of a rectangle, triangle and trapezium
- mean, mode, median and range for ungrouped and grouped data
- drawing scatter graphs
- drawing lines of best fit by eye
- distinguishing between positive, negative and zero correlation
- probability
  - probability scale
  - independent events
  - mutually exclusive events
  - illustrating combined probability of several events using tabulation or a tree diagram
  - producing a tree diagram to illustrate the combined probability of several events which are not independent.

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