Oxford Cambridge and RSA Examinations

OCR FREE STANDING MATHEMATICS QUALIFICATION (ADVANCED): ADDITIONAL MATHEMATICS 6993

Key Features

- replaces Additional Mathematics and Additional Mathematics (MEI);
- developed jointly by OCR and MEI;
- designed for students who will comfortably achieve Grade A at GCSE;
- provides an excellent preparation for AS study for Year 11 students;
- qualification at Level 3 attracting points on the UCAS tariff;
- content consists of four strands of pure mathematics, each with an associated application providing tasters for A level Applied Mathematics;
- single two hour examination and no coursework;
- textbook in preparation, to be published by Hodder & Stoughton.

Support and In-Service Training for Teachers

To support teachers using this specification, OCR will make the following material and services available:

- direct access to a mathematics subject team;
- specimen question paper and mark scheme, available from the Publications Department (telephone 0870870 6622; fax: 0870 870 6621; e-mail: publications@ocr.org.uk);
- a report on the examination, compiled by the senior examining personnel after each examination session;
- OCR website(www.ocr.org.uk).

This unit has been developed with the support of MEI. The Professional Officers of MEI are always ready and prepared to offer support, extra resource material and INSET training within Centres on request.

For further information about MEI, see Section 10.

CONTENTS

SECTION A: SPECIFICATION SUMMARY

COURSE OUTLINE

This course is designed to meet the needs of students who wish to continue the study of Mathematics beyond GCSE but for whom AS units may not be immediately appropriate.

The content consists of **four** areas of *Pure Mathematics*:

- Algebra;
- Co-ordinate Geometry;
- Trigonometry;
- Calculus.

Each of these is used to support a topic from a recognised branch of *Applied Mathematics*.

AIMS

- To introduce students to the power and elegance of advanced mathematics.
- To allow students to experience the directions in which the subject is developed post-GCSE.
- To develop confidence in using mathematical skills in other areas of study.

ASSESSMENT OBJECTIVES

A course based on this specification requires candidates to demonstrate their knowledge, understanding and skills in the following objectives:

Assessment Objective	Weighting
1. recall and use manipulative techniques	25-35
2. interpret and use mathematical data, symbols and terminology	25-35
3. recognise the appropriate mathematical procedure for a given situation	10-20
4. formulate problems into mathematical terms and select and apply appropriate techniques of solution	10-20
5. pursue a mathematical argument rigorously and with a high level of algebraic skill	10-20

ASSESSMENT

The assessment is by examination and will be set in summer of each year. There will be **one** paper of two hours. The examination result will be reported as a grade A, B, C, D, E or U.

There is no coursework requirement.

Candidates will be expected to have covered successfully the work of the Higher Tier of the National Curriculum.

SECTION B: GENERAL INFORMATION

1 Introduction

1.1 RATIONALE

The target students for this course are those who have taken Higher GCSE either at the end of Year 10 or in January of Year 11, or who will take GCSE at the same time as *Additional Mathematics*.

Many of the students will go on to study AS and A level modules in Year 12, and for these the course provides an introduction to the subject at that level, with the possibility of subsequent accelerated progress into *Further Mathematics*.

There are others who will not continue with Mathematics beyond Year 11, and for these students this unit provides a worthwhile and enriching course in its own right.

It is also expected that other students will follow this course and will benefit from it according to their circumstances.

1.2 CERTIFICATION TITLE

Free Standing Mathematics Qualification (Advanced): Additional Mathematics

1.3 LEVEL OF QUALIFICATION

This unit is approved by the regulatory bodies as part of the National Qualifications Framework as a Level 3 qualification.

1.4 GUIDED LEARNING HOURS

It is anticipated that about 60 guided learning hours are needed to achieve this qualification which could be co-taught along with GCSE. However, this is only a guide, Centres with particularly able candidates could deliver this course considerably faster.

1.5 RECOMMENDED PRIOR LEARNING

Candidates are expected to have a thorough knowledge of the content of the Higher Tier of the National Curriculum for Mathematics. They should either have achieved, or be expected to achieve, grade A*, A or B at GCSE.

1.6 PROGRESSION

The content of this course is contained in the AS units of OCR and other Examining Bodies. Consequently a student who has taken this unit is, by design, well-prepared to continue to Mathematics at AS and A level.

1.7 OVERLAP WITH OTHER QUALIFICATIONS

The content of this unit includes some of the content of the Higher Tier GCSE Mathematics: the remainder is a subset of the GCE Mathematics AS units.

1.8 RESTRICTION ON CANDIDATES' ENTRIES

Candidates may not obtain certification for this qualification in the same series as any Advanced GCE Mathematics qualification.

Candidates may, however, take this qualification in the same series as any GCE Mathematics unit.

1.9 CODE OF PRACTICE REQUIREMENTS

These specifications will comply in every respect with the revised Code of Practice requirements for GCE courses starting in September 2002.

1.10 STATUS IN WALES AND NORTHERN IRELAND

Although OCR will provide specifications, assessments and supporting documentation only in English, it is expected that Centres in Wales and Northern Ireland will be able to follow this course.

2 Specification Aims

- To introduce students to the power and elegance of advanced mathematics.
- To allow students to experience the directions in which the subject is developed post-GCSE.
- To develop confidence in using mathematical skills in other areas of study.

3 Assessment Objectives

The assessment will test the ability of candidates to:

- recall and use manipulative techniques (AO1; weighting 25-35);
- interpret and use mathematical data, symbols and terminology(AO2; weighting 25-35);
- recognise the appropriate mathematical procedure for a given situation(AO3; weighting 10-20);
- formulate problems into mathematical terms and select and apply appropriate techniques of solution(AO4; weighting 10-20);
- pursue a mathematical argument rigorously and with a high level of algebraic skill(AO5; weighting 10-20).

4 Scheme of Assessment

4.1 STRUCTURE AND AVAILABILITY

The assessment is by a single examination of length 2 hours. It will be offered in summer of each year.

4.2 THE QUESTION PAPER

There will be **two** sections to the paper.

Section A About **ten** compulsory short questions. These questions will not necessarily be equally weighted. Each will carry a maximum of 7 marks. **[Total: 52 marks]**

Section B **Four** equally weighted compulsory questions. Each question will carry 12 marks. **[Total: 48 marks]**

Within each main specification section there are several *Pure Mathematics* topics followed by a specific application to *Applied Mathematics*. There are, of course, other applications which will be examined, which may be thought of as *Pure Mathematics*, such as max/min problems in calculus. No topic is restricted to a particular section of the question paper.

4.3 CALCULATING AIDS

Candidates are permitted to use a scientific or graphical calculator in the examination for this unit. Computers and calculators with computer algebraic facilities are not permitted.

4.4 GRADING

The examination result is reported as a grade A, B, C, D, E or U.

4.5 CERTIFICATION

Candidates will receive a certificate entitled:

OCR Free Standing Mathematics Qualification (Advanced): Additional Mathematics

4.6 ASSESSMENT OF ICT

Candidates are expected to use calculators effectively, know how to enter complex calculations and use an extended range of function keys, including trigonometrical and statistical functions relevant to the course and content.

4.7 DIFFERENTIATION

There will be some variation in the difficulty of the questions, or part-questions, set on any paper. Differentiation will be achieved by the outcome of the assessment.

4.8 GRADE DESCRIPTORS

Grade E candidates understand what the questions are asking and are usually able to select the correct methods to answer them. However, subsequent progress is often limited either by poor algebraic skill or by lack of success in following an extended line of reasoning.

The following competence statements might typically be associated with the work of a candidate at this level:

- Be able to simplify expressions including algebraic fractions, square roots and polynomials.
- Be able to find the remainder of a polynomial up to order three when divided by a linear factor.
- Be able to solve a linear equation in one unknown.
- Be able to solve quadratic equations by factorisation, the use of the formula and by completing the square.
- Be able to solve two linear simultaneous equations in two unknowns.
- Be able to manipulate inequalities.
- Know the definition of the gradient of a line.
- Know the relationship between the gradients of parallel and perpendicular lines.
- Be able to calculate the distance between two points.
- Be able to find the mid-point of a line segment.
- Be able to form the equation of a straight line.
- Be able to draw a straight line given its equation.
- Be able to solve simultaneous equations graphically.

- Know that the equation of a circle, centre (0,0), radius r is $x^2 + y^2 = r^2$.
- Know that $(x - a)^2 + (y - b)^2 = r^2$ is the equation of a circle with centre (a, b) and radius r.
- Be able to illustrate linear inequalities in two variables.
- Be able to use the definitions of $\sin\theta$, $\cos\theta$ and $\tan\theta$ for any angle (measured in degrees only).
- Be able to apply trigonometry to right angled triangles.
- Be able to differentiate kx^n where n is a positive integer or 0, and the sum of such functions.
- Know that the gradient function $\frac{dy}{dx}$ gives the gradient of the curve and measures the rate of change of y with x.
- Be able to use differentiation to find stationary points on a curve.
- Be able to sketch a curve with known stationary points.
- Be aware that integration is the reverse of differentiation.
- Be able to integrate kx^n where n is a positive integer or 0, and the sum of such functions.
- Know what is meant by an indefinite and a definite integral.
- Be able to evaluate definite integrals.
- Be able to find the area between a curve, two ordinates and the x-axis.

Grade C candidates show all the positive characteristics of **E** grade candidates and at times, but not always, those of **A** grade candidates. It is common for candidates at this level to obtain good marks on just a few questions.

Candidates' work will be associated with those competence statements listed for grade **E** and some, but not all, of those listed for grade **A**.

Grade A candidates almost always select correct methods and apply them appropriately, often with success. The work of **A** grade candidates is characterised by high levels of algebraic skill and by success in following extended lines of reasoning.

The following competence statements might typically be associated with the work of a candidate at this level:

- Be able to find linear factors of a polynomial up to order three.
- Be confident in the use of brackets.
- Be able to solve a cubic equation by factorisation.
- Be able to solve two simultaneous equations in two unknowns where one equation is linear and the other is quadratic.
- Be able to set up and solve problems leading to linear, quadratic and cubic equations in one unknown, and to simultaneous linear equations in two unknowns.
- Be able to solve linear and quadratic inequalities algebraically and graphically.
- Understand and be able to apply the binomial expansion of $(a + b)^n$ where n is a positive integer.
- Recognise probability situations which give rise to the binomial distribution.
- Be able to identify the binomial parameter, p, the probability of success.
- Be able to calculate probabilities using the binomial distribution.
- Be able to express real situations in terms of linear inequalities.

- Be able to use graphs of linear inequalities to solve 2-dimensional maximisation and minimisation problems, involving integer values.
- Know the sine and cosine rules and be able to apply them.
- Be able to apply trigonometry to triangles with any angles.
- Know and be able to use the identity $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$.
- Know and be able to use the identity $\sin^2\theta + \cos^2\theta = 1$.
- Be able to solve simple trigonometrical equations in given intervals.
- Be able to apply trigonometry to 2- and 3-dimensional problems.
- Know that the gradient of the function is the gradient of the tangent at that point.
- Be able to find the equation of a tangent and normal at any point on a curve.
- Be able to determine the nature of a stationary point.
- Be able to find a constant of integration.
- Be able to find the equation of a curve, given its gradient function and one point.
- Be able to find the area between two curves.
- Be able to use differentiation and integration with respect to time to solve simple problems involving variable acceleration.
- Be able to recognise the special case where the use of constant acceleration formulae is appropriate.
- Be able to solve problems using these formulae.

SECTION C: SPECIFICATION CONTENT

5 Specification Content

Topic	Competence Statement
Algebra	
Manipulation of algebraic expressions	Be able to simplify expressions including algebraic fractions, square roots and polynomials.
The remainder theorem	Be able to find the remainder of a polynomial up to order 3 when divided by a linear factor.
The factor theorem	Be able to find linear factors of a polynomial up to order 3.
Solution of equations	Be confident in the use of brackets. Be able to solve a linear equation in one unknown. Be able to solve quadratic equations by factorisation, the use of the formula and by completing the square. Be able to solve a cubic equation by factorisation. Be able to solve two linear simultaneous equations in 2 unknowns. Be able to solve two simultaneous equations in 2 unknowns where one equation is linear and the other is quadratic. Be able to set up and solve problems leading to linear, quadratic and cubic equations in one unknown, and to simultaneous linear equations in two unknowns.
Inequalities	Be able to manipulate inequalities. Be able to solve linear and quadratic inequalities algebraically and graphically.
The binomial expansion	Understand and be able to apply the binomial expansion of $(a + b)^n$ where n is a positive integer.
Application to probability	Recognise probability situations which give rise to the binomial distribution. Be able to identify the binomial parameter, p, the probability of success. Be able to calculate probabilities using the binomial distribution.

Topic	Competence Statement
Co-ordinate Geometry (2 dimensions only)	
The straight line	Know the definition of the gradient of a line. Know the relationship between the gradients of parallel and perpendicular lines. Be able to calculate the distance between two points. Be able to find the mid-point of a line segment. Be able to form the equation of a straight line. Be able to draw a straight line given its equation. Be able to solve simultaneous equations graphically.
The co-ordinate geometry of circles	Know that the equation of a circle, centre (0,0), radius r is $x^2 + y^2 = r^2$. Know that $(x - a)^2 + (y - b)^2 = r^2$ is the equation of a circle with centre (a, b) and radius r.
Inequalities	Be able to illustrate linear inequalities in two variables.
Applications to linear programming	Be able to express real situations in terms of linear inequalities. Be able to use graphs of linear inequalities to solve 2-dimensional maximisation and minimisation problems, know the definition of objective function and be able to find it in 2-dimensional cases.
Trigonometry	
Ratios of any angles and their graphs	Be able to use the definitions of $\sin\theta$, $\cos\theta$ and $\tan\theta$ for any angle (measured in degrees only). Be able to apply trigonometry to right angled triangles. Know the sine and cosine rules and be able to apply them. Be able to apply trigonometry to triangles with any angles. Know and be able to use the identity that $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$. Know and be able to use the identity $\sin^2\theta + \cos^2\theta = 1$. Be able to solve simple trigonometrical equations in given intervals. Be able to apply trigonometry to 2 and 3 dimensional problems.

Topic	Competence Statement
Calculus	
Differentiation	Be able to differentiate kx^n where n is a positive integer or 0, and the sum of such functions. Know that the gradient function $\frac{dy}{dx}$ gives the gradient of the curve and measures the rate of change of y with x. Know that the gradient of the function is the gradient of the tangent at that point. Be able to find the equation of a tangent and normal at any point on a curve. Be able to use differentiation to find stationary points on a curve. Be able to determine the nature of a stationary point. Be able to sketch a curve with known stationary points.
Integration	Be aware that integration is the reverse of differentiation. Be able to integrate kx^n where n is a positive integer or 0, and the sum of such functions. Be able to find a constant of integration. Be able to find the equation of a curve, given its gradient function and one point.
Definite integrals	Know what is meant by an indefinite and a definite integral. Be able to evaluate definite integrals. Be able to find the area between a curve, two ordinates and the x-axis. Be able to find the area between two curves.
Application to kinematics	Be able to use differentiation and integration with respect to time to solve simple problems involving variable acceleration. Be able to recognise the special case where the use of constant acceleration formulae is appropriate. Be able to solve problems using these formulae.

SECTION D: FURTHER INFORMATION

6 Opportunities for Teaching

6.1 PROBLEM SOLVING

In the real world mathematics is used by industry and commerce to solve problems. The mathematics involved is often quite straightforward so that many problems can be solved by confident use of the techniques in this specification. Therefore, the specification content has been developed as topics in *Pure Mathematics* with applications. While the questions in Section A will be straightforward, the questions in Section B will contain extended questions which will encourage candidates to develop problem-solving skills.

6.2 ICT

In order to play a full part in society, candidates need to be confident and effective users of ICT. Where appropriate, candidates should be given opportunities to use ICT in order to further their study of mathematics.

The assessment of this course requires candidates to be able to use calculators effectively, know how to enter complex calculations and use function keys efficiently.

6.3 SPIRITUAL, MORAL, ETHICAL AND CULTURAL ISSUES

Candidates are required to examine arguments critically and so to distinguish between truth and falsehood. They are also expected to interpret the results of modelling exercises and there are times, particularly in statistical work, when this inevitably raises moral and cultural issues. Such issues will not be assessed in examination questions.

Spiritual development may be addressed through explaining the underlying mathematical principles behind natural forms and patterns.

Moral development may be addressed by helping candidates recognise how logical reasoning can be used to consider the consequences of particular decisions and choices and helping them learn the value of mathematical truth.

Social development may be addressed through helping candidates work together on complex mathematical tasks and helping them see that the result is often better than any of them can achieve separately.

Cultural development may be addressed through helping candidates appreciate that mathematical thought contributes to the development of our culture and is becoming increasingly central to our highly technological future, and through recognising that mathematicians from many cultures have contributed to the development of modern day mathematics.

6.4 HEALTH, SAFETY AND ENVIRONMENTAL ISSUES

OCR has taken account of the 1988 Resolution of the Council of the European community and the report Environmental Responsibility: An Agenda for Further and Higher Education, 1993 in preparing this specification and associated specimen assessments.

Environmental issues may be addressed in questions set in context.

6.5 THE EUROPEAN DIMENSION

OCR has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen assessments. European examples should be used where appropriate in the delivery of the subject content.

7 Key Skills

Key Skills are central to successful employment and underpin further success in learning independently. This course covers the techniques needed by a student preparing for the Key Skill *Application of Number*. It provides opportunities to produce portfolio evidence for *Communication* and *Information Technology*. The wider Key Skills of *Working with Others*, *Problem Solving* and *Improving own Learning and Performance* may also be developed through the teaching programme associated with this specification.

8 Reading List

At the time of the publication of this specification, Hodder & Stoughton are preparing this (Advanced) Free Standing Mathematics Qualification: Additional Mathematics textbook to accompany this course, planned publication date Spring 2003. It will be endorsed by OCR for use with this specification subject to OCR's quality assurance procedure before final publication.

Val Hanrahan	Additional Mathematics for OCR	Hodder & Stoughton ISBN (034 869 608)

The books referred to below may also prove useful in delivering this (Advanced) Free Standing Mathematics Qualification: Additional Mathematics. The list is not intended to be exhaustive nor does inclusion on the list constitute a recommendation of the suitability of the resource for the specification. Teachers will need to use their professional judgement in assessing the suitability of the named material.

Since the content forms part of the AS units of Advanced Mathematics specifications, the books for these courses may be used. In particular, the MEI series contains books for the units *Pure*

Mathematics 1, *Statistics 1*, *Mechanics 1* and *Decision and Discrete Mathematics 1* which together cover all the content of this specification. Likewise, the CUP series, Cambridge Advanced Level Mathematics, offers similar coverage.

It is expected that MEI will develop a range of resource material to support this course.

9 Arrangements for Candidates with Special Needs

For candidates whose performance may be adversely affected through no fault of their own, teachers should consult the Inter-Board Regulations and Guidance for Special Arrangements and Special Consideration.

In such cases, advice should be sought from the OCR Special Requirements Team (telephone: 01223 552505) as soon as possible during the course.

10 Support and In-Service Training

To support teachers using this specification, OCR will make the following material and services available:

- direct access to a mathematics subject team;
- specimen question paper and mark scheme, available from the Publications Department (telephone 0870 870 6622; fax: 0870 870 6621; e-mail: publications@ocr.org.uk);
- a report on the examination, compiled by the senior examining personnel after each examination session;
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This unit has been developed with the support of MEI. The Professional Officers of MEI are always ready and prepared to offer support, extra resource material and INSET training within Centres on request.

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