Maths
A-level

General Introduction

Welcome to your A-level Mathematics course. This General Introduction should provide you with all the information you need to make a successful start to your studies.

The Specification (or Specification)

This course has been designed to give you a full and thorough preparation for the AS level or A-level Mathematics specifications, set by the Assessment and Qualifications Alliance (AQA).

The **Subject Code** for entry to the AS only award is **7356.**

The **Subject Code** for entry to the Advanced level (A-level) award is **7357**. Full details are given below.

The first year of examination for both the AQA AS specification and for the A-level is 2018. Please check the AQA site for the latest information.

Private Candidates

The AQA specification is open to private candidates. Private candidates should contact AQA for a copy of *'Information for Private Candidates'*.

Oxford Open Learning

Arrangement of Modules

OOL's A-level Maths course is divided into eight separate modules. Each module corresponds to a component of the A-level specification, four components for each year. The first two "core" modules cover all the topics in Sections A-H of the AQA AS (7356) specification. These topics are compulsory for all students of AQA AS level Maths.

Textbooks

It is essential that you acquire the following textbook to support your AS-level studies:

David Bowles and 9 others: *AQA A Level Maths: Year 1 / AS Student Book* Paperback (OUP: ISBN-13: 978-0198412953)

If you go on to Year 2 and the full A-level, you will also need

David Bowles and 9 others: *AQA A Level Maths: Year 2 Book* Paperback (OUP; ISBN-13: 978-0198412960)

Alternatively, you can buy the two books combined, ISBN-13: 978-0198412946.

The Arrangement of Lessons

Module One: Core Maths 1

Lesson	Subject	Reading
1	Modelling and Proof	Bowles, *Year 1*, Ch. 1, Section 1.1
2	Algebra Review	Ch. 1.5, 1.7
3	Surds	Ch. 1.3
4	Straight Lines	Ch. 1.6
5	Quadratic Equations and Functions **TMA A**	Ch. 1.4, 2.4
6	Polynomials	Ch. 2.1, 2.2, 2.4
7	Further Algebra	Ch. 1.7
8	The Coordinate Geometry of the Circle **TMA B**	Ch. 1.6
9	Differentiation (1)	Ch. 4.1 – 4.4
10	Differentiation (2)	Ch. 4.5
11	Integration (1) **TMA C**	

Module Two: Core Maths 2

Lesson	Subject	Reading
12	Indices; Further Differentiation and Integration	Bowles, Ch. 1.2, 4.2, 4.6
13	Trigonometry (1) **TMA D**	Ch. 3.1, 3.2
14	Graphs and Transformations	Ch. 2.4, 4.6
15	Trigonometry (2)	Ch. 3.1
16	Binomial Expansions **TMA E**	Ch. 2.2
17	Exponential Functions and Logarithms	Ch. 5.1 – 5.4
18	Vectors **TMA F**	Ch. 6.1, 6.2

Module Three: Mechanics 1

Lesson	Subject	Reading
19	Kinematics	Bowles, Ch. 7.1 – 7.4
20	Forces **TMA G**	Ch. 8.1 – 8.4

Module Four: Statistics 1

Lesson	Subject	Reading
21	Statistical Data	Bowles, Ch. 9.1 – 9.4
22	Probability	Ch. 10.1
23	The Binomial Distribution **TMA H**	Ch. 10.2, 11.1 – 11.2
	TMA I (Practice AS Exam Paper 1) – optional **TMA J** (Practice AS Exam Paper 2) – optional	

Year 2 (provisional)

Module Five: Core Maths 3

Lesson	Subject	Reading
24. 25. 26.	Functions Composite Transformations and the Modulus Function Inverse and Reciprocal Trigonometric Functions **TMA K**	Bowles, *Year 2*, details to be confirmed
27. 28. 29.	The Exponential and Natural Logarithm Functions Further Differentiation Numerical Methods for Solving Equations **TMA L**	
30. 31.	Further Integration Volumes of Revolution and Numerical Integration **TMA M**	

Module Six: Core Maths 4

Lesson	Subject	Reading
32. 33.	The General Binomial Expansion Algebraic Fractions **TMA N**	Bowles, *Year 2*, details to be confirmed
34. 35.	Further Differentiation Parametric Equations	
36.	Further Trigonometry **TMA O**	
37. 38.	Growth and Decay and Differential Equations Vector Geometry **TMA P**	

Module Seven: Mechanics 2

Lesson	Subject	Reading
39	Moments and Forces in Equilibrium	Bowles, *Year 2*, details to be confirmed
40	Centres of Gravity	
41	Plane Laminas Suspended from a Point **TMA Q**	
42	Motion in a Line	
43	Motion of a Particle in 2D & 3D	
44	Work & Power	
45	Hooke's Law & Energy **TMA R**	
46	Uniform Circular Motion	pp. 293-297
47	The Conical Pendulum and Vertical Circular Motion **TMA S**	pp. 297-337

Module Eight: Statistics 2

Lesson	Subject	Reading
48	Discrete Probability Distributions	Bowles, *Year 2*, details to be confirmed
49	Poisson Distributions	
50	Continuous Probability Distributions and the Rectangular Distribution **TMA T**	
51	Confidence Limits	
52	Hypothesis Testing	
53	χ^2 -test and Contingency Tables **TMA U**	
	TMA V (Practice A-level Exam Paper 1) **TMA W** (Practice A-level Exam Paper 2) **TMA X** (Practice A-level Exam Paper 3)	

Prior Experience required

In order to study this course, you are expected to have a knowledge of mathematics up to a good 'O' level or GCSE standard. Just a mere pass is not usually a sufficient basis on which to progress to A-level. In particular you are expected to have a good grasp of algebra — equations, factors, fractions, and, especially, the manipulation of formulae. These are topics which are frequently encountered in all aspects of this course, and it will be assumed

that you have a sound knowledge of them. You should know, in geometry, the triangle and circle properties, together with the tests for similar and congruent triangles. The trigonometrical definitions of sine, cosine and tangent, together with Pythagoras' theorem, should be known.

If your Maths skills were acquired a number of years ago, it might be an idea to purchase a GCSE Maths revision book to help refresh your memory.

Electronic Calculators

All examining boards now recommend, or actually require, that a calculator is used in the examinations. The specification dictates the type of calculator allowed. Full details are given below. You would be at a disadvantage if you only have a calculator of a "scientific" type, with functions which include sin, cos, tan and their inverses, in both degrees and radians, $\sqrt{}$, x^y, e^x, $\log_a x$, $\ln x$, etc.

In this course you should use a calculator for all questions requiring a numerical answer, unless you are specifically told to leave answers in surd (root) form. Having said that, the usual preference of examiners is for answers to be left in fractional, rather than decimal form (i.e. *not* using a calculator); especially if this avoids rounding. Final answers should normally be given to three significant figures in an exam, but, during your working, keep intermediate values to as great a degree of accuracy as your calculator will allow. Some answers in this course are given to a larger number of significant figures, where it seems appropriate. You should show in your working any necessary explicit formula you use to calculate your answer. Marks may be deducted for lack of essential working. All steps in working should be shown.

Using the Course Materials

No textbook can take the place completely of an actual lesson, so, when studying this course, the lesson notes will add to, or expand, the text of the book, and you should study both together. The lesson notes will indicate at which points you should work from the book, and the exercises you should attempt.

At the start of each book there is a section on the use of the book which includes a list of notations, and instructions for answering multiple–choice exercises. You should study the list of notations carefully, and also refer to the notations which are listed in the specification of the examination board. Occasionally there will be slight variations in notation, so it is important to realise this, and, if two alternative notations are given, be able to recognise and use either.

As you follow the lesson notes, you will be told when to refer to the book, which sections to study, and which exercises to attempt. The textbooks contain very many worked examples. In order to save space, and so include all these, often lines of working have been omitted from the solutions. You should perform these lines yourself, as you follow through the examples. In general, always keep a pen and paper, and your calculator, beside you, as you work through the course.

Activities and Practice Exercises

The books also contain many exercises to be worked. The numerical solutions to these are given at the end of the books. Graphical solutions are not included, but they will be given to a selection of examples at the end of any appropriate lesson. When you have worked through the questions in an exercise, check your answers with those given. If you have made any mistakes, look through the question again, trying to see where you went wrong. If you still cannot see how to get the correct answer, ask your tutor for help, and he or she will show you your mistake.

There is no need to tackle every question of every exercise, but try to pick out a variety of different types. If, however, you find a topic more difficult, then try more of the questions set on it, to give you practice in overcoming the problems.

Where necessary, the lessons also include Activities to provide additional practice or help with difficult points. These Activities include space underneath for you to attempt your answer. Having done so, the correct answer will be found at the end of that particular lesson.

Practising with Markit!!

As well as the activities and SATs within the lessons, you are recommended to practise your skills using the internet-based *Markit!!* resources. Over 2,000 students and 40 schools and colleges are using this resource – we recommend you do too.

MarkIt!! worksheets are designed to recap the entire topic and sharpen exam technique. Research shows that doing some exam-focused practice soon after finishing the topic will consolidate your studies and lead to better retention for the exam.

You can access worksheets on all the core topics and you should find that Year 2 topics are also covered. The worksheets self-mark and instantly explain mistakes within each step. You can view your scores and see where you went wrong at the end! Markit's specially designed interface is like having a tutor next to you explaining

everything. The questions have been written with the support of the Maths department at University College London.

How to use *Markit!!* as a student

1. Go to the main website: www.markit.education
2. Signup as a Learner that has a Class Code
3. Enter class code: *****
4. Create your account using e-mail or a google account

And that's it!

Please note that these resources have *not* been produced by OOL. OOL and its tutors cannot answer any queries in relation to these resources. Don't worry if some of the practice questions entail skills that you have not yet acquired – the marks don't count for anything! But with a little perseverance, you should find it a resource that will improve your exam skills greatly.

Tutor-Marked Assignments

After a group of lessons you will find a tutor-marked assignment, and you will be told at which stage to work this. It should be attempted only when you are satisfied that you have completely studied and mastered the lessons to which it relates. It is best to attempt assignments under examination conditions, however it is not obligatory. Your answers to these assignments should be sent to your tutor for marking, and, when they are returned to you, suggested answers will be sent with them.

At this level of mathematics, there is rarely just one "right" method for solving a problem, however. The suggested answers will give one way, usually, but not always, the shortest. The method you have used may well be completely different. Your tutor will indicate whether it is as good on your test-paper when it is returned.

Experience shows that students who do submit assignments are much more successful than those who don't. It is your primary means of gaining individualised help, of sorting out problems and maintaining motivation.

To conclude, this is no easy, armchair, subject. Much depends on your ability to work hard, and puzzle out any problems. When you encounter difficulties, try the problem again, working the problem out in various ways, until you suddenly see the correct method. Always work the assignments without assistance, and send in an

attempt at every question, however badly you think you might have done. Only then can your tutor see what your difficulties are, and help you to overcome them.

The 'AS' level and 'A' level System

The Advanced Subsidiary (AS) Level

Until recently, in the old "modular" system, the AS examination counted as half of the full A-level and marks achieved in AS examinations could be carried forward to the point at which the 2 nd Year (A2) exams would be taken or the AS papers could be tackled again in the hope of gaining better marks.

That is no longer the case. The AS is a separate qualification. Marks cannot be carried forward to the A-level examinations. Whether or not you sit the AS papers, you must take all three A-level papers to gain a "full" A-level. Alternatively, you may stop with an AS qualification. If you are going on to the full A-level, there is no requirement to take the AS exams but, for many students, they *may* represent good practice and preparation for the exams at the end of the 2nd Year.

Grading

For the full A-level qualification, there is a 6-grade scale: A* (A-starred), A, B, C, D and E. Candidates who fail to reach the minimum standard for Grade E will be recorded as U (unclassified). For the AS-only qualification, there's a 5-grade scale, with A (not A*) as the top grade.

Private candidates

These specifications are available to private candidates. A private candidate is someone who enters for exams through an AQA approved school or college but is not enrolled as a student there.

A private candidate may be self-taught, home schooled or have private tuition, either with a tutor or through a distance learning organisation. They must be based in the UK.

If you have any queries as a private candidate, you can:

- speak to the exams officer at the school or college where you intend to take your exams
- visit aqa.org.uk/privatecandidates
- email privatecandidates@aqa.org.uk

Use of calculators

A calculator is required for use in all assessments in this specification. Details of the requirements for calculators can be found in the Joint Council for General Qualifications document Instructions for conducting examinations.

For AS and A-level Mathematics exams, calculators should have the following as a required minimum:

- an iterative function
- the ability to compute summary statistics and access probabilities from standard statistical distributions.

For the purposes of this specification, a 'calculator' is any electronic or mechanical device which may be used for the performance of mathematical computations. However, only those permissible in the guidance in the Instructions for conducting examinations are allowed in the AS and A-level Mathematics exams.

The AQA AS level 7356 specification

AS Paper 1

Content from the following sections:

- A: Proof
- B: Algebra and functions
- C: Coordinate geometry
- D: Sequences and series
- E: Trigonometry
- F: Exponentials and logarithms
- G: Differentiation
- H: Integration
- J: Vectors
- P: Quantities and units in mechanics
- Q: Kinematics
- R: Forces and Newton's laws

How it's assessed:

• Written exam: 1 hour 30 minutes, 80 marks, 50% of AS

A mix of question styles, from short, single-mark questions to multi-step problems.

AS Paper 2

Content from the following sections:

- A: Proof
- B: Algebra and functions
- C: Coordinate geometry
- D: Sequences and series
- E: Trigonometry
- F: Exponentials and logarithms
- G: Differentiation
- H: Integration
- K: Statistical sampling
- L: Data presentation and interpretation
- M: Probability
- N: Statistical distributions
- O: Statistical hypothesis testing

How it's assessed:

• Written exam: 1 hour 30 minutes, 80 marks, 50% of AS

A mix of question styles, from short, single-mark questions to multi-step problems.

The AQA A-level 7357 Specification

Paper 1

Any content from:

- A: Proof
- B: Algebra and functions
- C: Coordinate geometry
- D: Sequences and series
- E: Trigonometry
- F: Exponentials and logarithms
- G: Differentiation
- H: Integration
- I: Numerical methods

How it's assessed:

• Written exam: 2 hours, 100 marks, 33⅓ % of A-level

A mix of question styles, from short, single-mark questions to multi-step problems.

Paper 2

Any content from Paper 1 and content from:

- J: Vectors
- P: Quantities and units in mechanics
- Q: Kinematics
- R: Forces and Newton's laws
- S: Moments

How it's assessed:

• Written exam: 2 hours, 100 marks, 33⅓ % of A-level

A mix of question styles, from short, single-mark questions to multi-step problems.

Paper 3

Any content from Paper 1 and content from:

- K: Statistical sampling
- L: Data presentation and Interpretation
- M: Probability
- N: Statistical distributions
- O: Statistical hypothesis testing

How it's assessed:

• Written exam: 2 hour, 100 marks, 33⅓ % of A-level

A mix of question styles, from short, single-mark questions to multi-step problems.

Aims of the AQA A-level specification

Following the AQA specification, this course aims to encourage students to:

- understand mathematics and mathematical processes in a way that promotes confidence, fosters enjoyment and provides a strong foundation for progress to further study
- extend their range of mathematical skills and techniques
- understand coherence and progression in mathematics and how different areas of mathematics are connected
- apply mathematics in other fields of study and be aware of the relevance of mathematics to the world of work and to situations in society in general
- use their mathematical knowledge to make logical and reasoned decisions in solving problems both within pure mathematics and in a variety of contexts, and communicate the mathematical rationale for these decisions clearly

- reason logically and recognise incorrect reasoning
- generalise mathematically
- construct mathematical proofs
- use their mathematical skills and techniques to solve challenging problems which require them to decide on the solution strategy
- recognise when mathematics can be used to analyse and solve a problem in context
- represent situations mathematically and understand the relationship between problems in context and mathematical models that may be applied to solve them
- draw diagrams and sketch graphs to help explore mathematical situations and interpret solutions
- make deductions and inferences and draw conclusions by using mathematical reasoning
- interpret solutions and communicate their interpretation effectively in the context of the problem
- read and comprehend mathematical arguments, including justifications of methods and formulae, and communicate their understanding

Assessment Objectives

Assessment objectives (AOs) are set by Ofqual and are the same across all A-level Mathematics specifications and all exam boards.

The exams will measure how students have achieved the following assessment objectives.

AO1: Use and apply standard techniques. Learners should be able to:

- select and correctly carry out routine procedures;
- accurately recall facts, terminology and definitions.

AO2: Reason, interpret and communicate mathematically. Learners should be able to:

- construct rigorous mathematical arguments (including proofs);
- make deductions and inferences;
- assess the validity of mathematical arguments;
- explain their reasoning;
- use mathematical language and notation correctly.

Where questions/tasks targeting this assessment objective will also credit students for the ability to 'use and apply standard techniques' (AO1) and/or to 'solve problems within mathematics and in other contexts' (AO3) an appropriate proportion of the marks for the

question/task must be attributed to the corresponding assessment objective(s).

AO3: Solve problems within mathematics and in other contexts. Learners should be able to:

- translate problems in mathematical and non-mathematical contexts into mathematical processes;
- interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations;
- translate situations in context into mathematical models;
- use mathematical models;
- evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them.

Where questions/tasks targeting this assessment objective will also credit students for the ability to 'use and apply standard techniques' (AO1) and/or to 'reason, interpret and communicate mathematically' (AO2) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).

Assessment objective weightings in each A-level paper

	Paper 1	**Paper 2**	**Paper 3**	**Total**
AO1	50	50	50	50
AO2	25	25	25	25
AO3	25	25	25	25
Overall weighting of components	33⅓	33⅓	33⅓	100

Formulae for AS and A-level Maths Specifications

This is a list of the formulae which relate to the Core modules, and which candidates are expected to remember. Do not worry if you do not understand them at the outset of your course.

Quadratic Equations

$ax^2 + bx + c = 0$ has roots $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Laws of Logarithms

$\log_a x + \log_a y \equiv \log_a(xy)$

$\log_a x - \log_a y \equiv \log_a\left(\frac{x}{y}\right)$

$k\log_a x \equiv \log_a(x^k)$

Trigonometry

In the triangle ABC:

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

area = $\frac{1}{2}ab\sin C$
$\cos^2 A + \sin^2 A \equiv 1$
$\sec^2 A \equiv 1 + \tan^2 A$
$\operatorname{cosec}^2 A \equiv 1 + \cot^2 A$
$\sin 2A \equiv 2\sin A\cos A$
$\cos 2A \equiv \cos^2 A - \sin^2 A$
$\tan 2A \equiv \frac{2\tan A}{1-\tan^2 A}$

Differentiation

Function	**Derivative**
x^n	nx^{n-1}
$\sin kx$	$k\cos kx$
$\cos kx$	$-k\sin kx$
e^{kx}	ke^{kx}
$\ln x$	$\frac{1}{x}$
$f(x) + g(x)$	$f'(x) + g'(x)$
$f(x)g(x)$	$f'(x)g(x) + f(x)g'(x)$
$f(g(x))$	$f'(g(x))g'(x)$

Integration

Function	**Integral**
x^n	$\frac{1}{n+1}x^{n+1} + c, n \neq -1$
$\cos kx$	$\frac{1}{k}\sin kx + c$
$\sin kx$	$-\frac{1}{k}\cos kx + c$
e^{kx}	$\frac{1}{k}e^{kx} + c$
$\frac{1}{x}$	$\ln\lvert x\rvert + c, x \neq 0$
$f'(x) + g'(x)$	$f(x) + g(x) + c$
$f'(g(x))g'(x)$	$f(g(x)) + c$

Area

area under a curve = $\int_a^b y\,dx, y \geq 0$

Vectors

$$\begin{matrix} x \\ [y] \\ z \end{matrix} \times \begin{matrix} a \\ [b] \\ c \end{matrix} = xa + yb + zc$$

There is also an Appendix of mathematical notation given in the AQA specification and you should be familiar with all the standard symbols by the end of the course.

Studying the Specification

You should be sure to acquire your own copy of the specification, either via the AQA Publications Dept or from the website www.aqa.org.uk. The specification can be purchased from

AQA Publications
Unit 2, Wheel Forge Way,
Trafford Park
Manchester
M17 1EH (tel: 0870-410-1036)

or downloaded from www.ool.co.uk/0011ma.

We advise that you obtain a copy of the specification so that you can assess which topics you have covered in the most detail and which ones you will feel happiest about in the exam. AQA can also provide advice booklets on your course, including 'Supplementary Guidance for Private Candidates'. As you approach the examination, it will also be helpful to purchase and tackle past papers from AQA.

It will also help greatly with all your studies if you can print off a copy of AQA's *Formulae and Statistical Table*s which can currently be found at www.ool.co.uk/0012ma.

You will also need the AQA AS and A-level Mathematics Large Data Set – Family Food 2014 which needs to be downloaded from www.ool.co.uk/0014ma.

Using the Internet

All students would benefit from access to the Internet. You will find a wealth of information on all the topics in your course. As well as the AQA website (www.aqa.org.uk), you should get into the habit of checking the Oxford Open Learning site (www.ool.co.uk) where you may find news, additional resources and interactive features as time goes by. Put it on your Favourites list now!

Good luck with your studies!

NICK GEERE and others