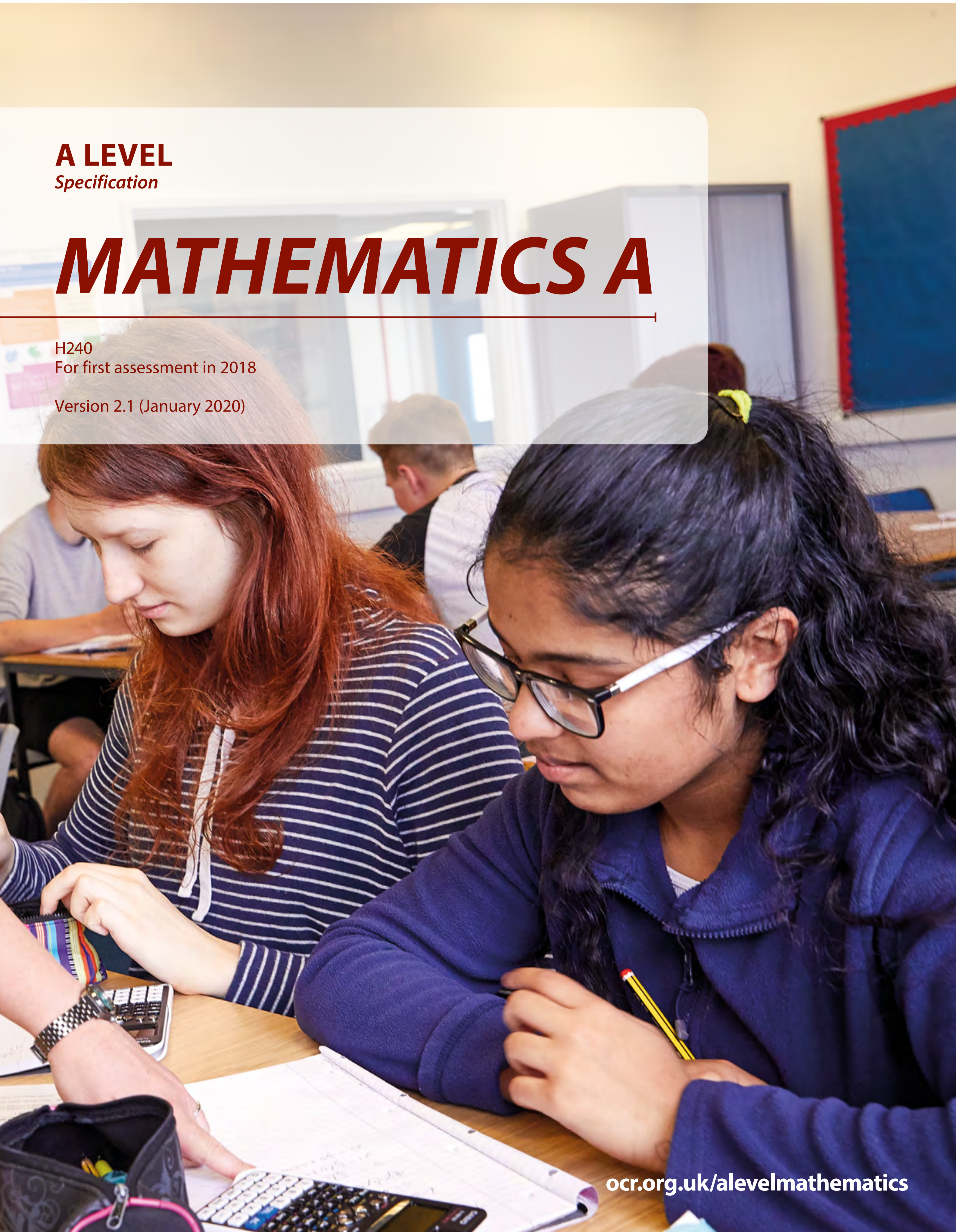
A LEVEL
Mathematics A

Qualification Accredited

OCR
Oxford Cambridge and RSA



A LEVEL
Specification

MATHEMATICS A

H240
For first assessment in 2018

Version 2.1 (January 2020)

ocr.org.uk/alevelmathematics

Registered office:
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

Disclaimer

Specifications are updated over time. Whilst every effort is made to check all documents, there may be contradictions between published resources and the specification, therefore please use the information on the latest specification at all times. Where changes are made to specifications these will be indicated within the document, there will be a new version number indicated, and a summary of the changes. If you do notice a discrepancy between the specification and a resource please contact us at: **resources.feedback@ocr.org.uk**

We will inform centres about changes to specifications. We will also publish changes on our website. The latest version of our specifications will always be those on our website (**ocr.org.uk**) and these may differ from printed versions.

Cover Image: A Level students and teachers from Exeter College

Contents

1 OCR's A Level in Mathematics A

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The subject content is divided into three areas: Pure Mathematics, Statistics and Mechanics. The Overarching Themes (Section 2d) must be applied, along with associated mathematical thinking and understanding, across the whole of the subject content.

Content Overview	Assessment Overview	
Component 01 assesses content from Pure Mathematics in a single section of 100 marks.	Paper 1: Pure Mathematics (01) 100 marks 2 hour written paper	**33⅓%** of total A Level
Component 02 assesses content from Pure Mathematics and Statistics in two separate sections of approximately 50 marks each. Some of the assessment items in the Statistics section will be set in the context of the pre-release large data set.	Paper 2: Pure Mathematics and Statistics (02) 100 marks 2 hour written paper	**33⅓%** of total A Level
Component 03 assesses content from Pure Mathematics and Mechanics in two separate sections of approximately 50 marks each.	Paper 3: Pure Mathematics and Mechanics (03) 100 marks 2 hour written paper	**33⅓%** of total A Level

Learners must take all components to be awarded OCR's A Level in Mathematics A.

Learners will be given formulae in each assessment on pages 2 and 3 of the question paper. See Section 5d for a list of these formulae.

Each section has a gradient of difficulty and consists of a mix of long and short questions.
All three components contain some synoptic assessment, some extended response questions and some stretch and challenge questions.

Learners are permitted to use a scientific or graphical calculator for all papers. Calculators are subject to the rules in the document Instructions for Conducting Examinations, published annually by JCQ (www.jcq.org.uk).

It is expected that calculators available in the assessment will include the following features:

- an iterative function such as an ANS key,
- the ability to compute summary statistics and access probabilities from the binomial and normal distributions.

Allowable calculators can be used for any function they can perform. In each question paper, learners are expected to support their answers with appropriate working.

All A Level qualifications offered by OCR are accredited by Ofqual, the Regulator for qualifications offered in England. The accreditation number for OCR's A Level in Mathematics A is 603/1038/8.

1a. Why choose an OCR A Level in Mathematics A?

Choose OCR and you've got the reassurance that you're working with one of the UK's leading exam boards. Our A Level in Mathematics A course has been developed in consultation with teachers, employers and Higher Education to provide learners with a qualification that's relevant to them and meets their needs.

We provide:

Specifications that are clear, easy to use, and flexible. Our specification is fully co-teachable, with AS and A Level Maths content presented together, and the way we've structured our assessments means that you can teach the mathematical content in the way which suits you and your students. You can teach this specification with our Further Maths qualification however you prefer - either fully integrated, in parallel, or as a separate course after completing the Maths A Level.

Assessments designed to give your students the best experience in the exam. We've reviewed our layout to make it clearer, while keeping the approach of providing a separate question paper and answer booklet to make it easier for students to plan their time in the exam and see the whole of multi-part questions.

Exam Practice materials that make sure you know how your students are performing and can track their progress. Secure Practice Papers can be used as mocks to prepare your students for the exam, we give you free access to Exam Builder, which you can use to create your own mock exams and classroom tests with marking guidance, and a range of quick Check In tests to use at the end of topics.

Support materials and advice to help you at every stage of your planning and teaching. Our brand new, expanded Examiner's Report will help you understand your students' performance in the exam and prepare future cohorts for their assessments. Use it alongside Active Results our free analysis service, to get the data on student performance that you need. We offer CPD training and network events both face to face and online. You can meet our Maths team at one of our events, or they are available online or over the phone to give you the specialist advice you need. You'll find our full range of planning, teaching and learning and assessment resources on our website, as well as information about endorsed textbooks.

1b. What are the key features of this specification?

<table>
<tr><td colspan="2">Exemplar content.
Clear command words and guidance on calculator use.
Separate Question Papers and Answer Booklets so that students can always see the whole of a question at one time and to allow for diagrams and tables for them to work on.
Easy to follow mark schemes with complete solutions and clear guidance.
Stretch and challenge questions designed to allow the most able learners the opportunity to demonstrate the full extent of their knowledge and skills, and to support the awarding of A* grade at A Level.
Applied content (statistics and mechanics) assessed on separate papers so that the content domains assessed on any given paper don’t cover both at once.</td></tr>
<tr><td>Mathematics A H240</td><td>Mathematics B (MEI) H640</td></tr>
<tr><td>Single pre-release data set designed to last the life of the qualification.
Components 02 and 03 are in two sections:
section A on the Pure Mathematics content;
section B on either Statistics or Mechanics.</td><td>Three data sets available at all times, so that you can use all three for teaching, but for each cohort of students just one will be the context for some of the questions in the exam. Each data set will be clearly labelled as to when it is used.
Components 01 and 02 are in two sections:
section A consists of shorter questions with minimal reading and interpretation;
section B includes longer questions and problem solving.
Includes mathematical comprehension in the assessment to help to prepare learners to use mathematics in a variety of contexts in higher education and future employment.</td></tr>
</table>

1c. Aims and learning outcomes

OCR's A Level in Mathematics A will encourage learners 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
- read and comprehend articles concerning applications of mathematics and communicate their understanding
- use technology such as calculators and computers effectively and recognise when such use may be inappropriate
- take increasing responsibility for their own learning and the evaluation of their own mathematical development.

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1d. How do I find out more information?

If you are already using OCR specifications you can contact us at: www.ocr.org.uk

If you are not already a registered OCR centre then you can find out more information on the benefits of becoming one at: www.ocr.org.uk

Get in touch with one of OCR's Subject Advisors:

Email: maths@ocr.org.uk

Twitter: @OCR_Maths

Customer Contact Centre: 01223 553998

Teacher resources, blogs and support: available from: www.ocr.org.uk

Sign up for our monthly Maths newsletter, Total Maths

Access CPD, training, events and support through OCR's CPD Hub

Access our online past papers service that enables you to build your own test papers from past OCR exam questions through OCR's ExamBuilder

Access our free results analysis service to help you review the performance of individual learners or whole schools through Active Results

2 The specification overview

2a. Content of A Level in Mathematics A (H240)

This A Level qualification builds on the skills, knowledge and understanding set out in the whole GCSE (9–1) subject content for mathematics for first teaching from 2015. All of this content is assumed, but will only be explicitly assessed where it appears in this specification.

The content is arranged by topic area and exemplifies the level of demand across two stages. The content is shown in Section 2f in two columns, demonstrating the progression across each topic. When this course is being co-taught with AS Level Mathematics A (H230) the 'Stage 1' column indicates the common content between the two specifications and the 'Stage 2' column indicates content which is particular to this specification.

Statements have a unique reference code. For ease of comparison, planning and co-teaching the 'Stage 1' content statements in this specification have reference codes corresponding to the same statements in OCR's AS Level in Mathematics A (H230). The content in these statements is identical, but the exemplification may differ as appropriate to the qualification.

The content is separated into three areas: Pure Mathematics, Statistics and Mechanics. However, links should be made between pure mathematics and each of statistics and mechanics and centres are free to teach the content in the order most appropriate to their learners' needs.

Sections 1, 2 and 3 cover the pure mathematics, statistics and mechanics content of A Level Mathematics. In our Further Mathematics specifications (H235 and H245) we have continued this numbering to sections 4, 5, 6, 7 and 8 for the pure core, statistics, mechanics, discrete mathematics and additional pure sections in order to facilitate the teaching of both qualifications.

The italic text in the content statements provides examples and further detail of the requirements of this specification. All exemplars contained in the specification under the heading "e.g." are for illustration only and do not constitute an exhaustive list. The heading "i.e." is used to denote a complete list. For the avoidance of doubt an italic statement in square brackets indicates content which will not be tested.

The expectation is that some assessment items will require learners to use two or more content statements without further guidance. Learners are expected to have explored the connections between different areas of the specification.

Learners are expected to be able to use their knowledge to reason mathematically and solve problems both within mathematics and in context. Content that is covered by any statement may be required in problem solving, modelling and reasoning tasks even if that is not explicitly stated in the statement.

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2b. The large data set

The large data set (LDS) is a pre-released set or sets of data that should be used as teaching material throughout the course. This data set will be made available on the OCR website, along with a document giving the source(s) and associate metadata, and will remain for the life of the specification, unless the review process identifies a necessary change. Any change to the data set will be made before the beginning of any given two year course and centres will be notified a year in advance.

The purpose of the LDS is that learners experience working with real data in the classroom and explore this data using appropriate technology. It is principally intended to enrich the teaching and learning of statistics, through which learners will become familiar with the context and main features of the data.

To support the teaching and learning of statistics with the large data set, we suggest that the following activities are carried out during the course:

1. Sampling: Learners should carry out sampling techniques, and investigate sampling in real world data sets including the LDS.
2. Creating diagrams: Learners should use spreadsheets or statistical software to create diagrams from data.
3. Calculations: Learners should use appropriate technology to perform statistical calculations.
4. Hypothesis testing: Learners should use the LDS as the population against which to test hypotheses based on their own sampling.
5. Repeated sampling: Learners should use the LDS as a model for the population to perform repeated sampling experiments to investigate variability and the effect of sample size.
6. Modelling: Learners should use the LDS to provide estimates of probabilities for modelling.
7. Exploratory data analysis: Learners should explore the LDS with both quantitative and visual techniques to develop insight into underlying patterns and structures, suggest hypotheses to test and to provide a motivation for further data collection.

Relation of the large data set(s) to the examination

In the assessment, it will be assumed that learners are familiar with the contexts covered by this data set, and any related metadata, and that they have used a spreadsheet or other statistical software when working with the data in the classroom.

Questions will be set in component 02 that give a material advantage to learners who have studied, and are familiar with, the large data set(s).

They might include questions/tasks which:

- assume familiarity with the terminology and contexts of the data, and do not explain them in a way which provides learners who have not studied the prescribed data set(s) the same opportunities to access marks as learners who have studied them;
- use summary statistics or selected data from, or statistical diagrams based on, the prescribed large data set(s) – these might be provided within the question/task, or as stimulus materials;
- are based on samples related to the contexts in the prescribed large data set(s), where learners' work with the prescribed large data sets will help them understand the background context; and/or
- require learners to interpret data in ways which would be too demanding in an unfamiliar context.

Knowledge of the actual data within the data set(s) will not be required in the examination, nor will there be a requirement to enter large amounts of data into a calculator during the examination.

Learners will NOT have a printout of the pre-release data set available to them in the examination but selected data or summary statistics from the data set may be provided within the examination paper.

2c. Use of technology

It is assumed that learners will have access to appropriate technology when studying this course such as mathematical and statistical graphing tools and spreadsheets. When embedded in the mathematics classroom, the use of technology can facilitate the visualisation of abstract concepts and deepen learners' overall understanding.
The primary use of technology at this level is to offload computation and visualisation, to enable learners to investigate and generalise from patterns. Learners are not expected to be familiar with any particular software, but they are expected to be able to use their calculator for any function it can perform, when appropriate.

To support the teaching and learning of mathematics using technology, we suggest that the following activities are carried out during the course:

1. Graphing: Learners should use graphing software to investigate families of curves.
2. Computer Algebra Software: Learners should use software to generate graphs and geometric diagrams, to evaluate derivatives and integrals, to solve equations, to perform symbolic manipulation and as an investigative problem solving tool.
3. Spreadsheets: Learners should use spreadsheet software to investigate numerical methods, sequences and series, for modelling in statistics and mechanics, and to generate tables of values for functions.
4. Statistics: Learners should use spreadsheets or statistical software to generate tables and diagrams, and to perform standard statistical calculations.
5. Mechanics: Learners should use spreadsheet software and computer algebra software for modelling, including kinematics and projectiles.

Use of calculators

Learners are permitted to use a scientific or graphical calculator for all papers. Calculators are subject to the rules in the document Instructions for Conducting Examinations, published annually by JCQ (www.jcq.org.uk).

It is expected that calculators available in the assessment will include the following features:

- an iterative function such as an ANS key,
- the ability to compute summary statistics and access probabilities from the binomial and normal distributions.

Allowable calculators can be used for any function they can perform.

When using calculators, candidates should bear in mind the following:

1. Candidates are advised to write down explicitly any expressions, including integrals, that they use the calculator to evaluate.
2. Candidates are advised to write down the values of any parameters and variables that they input into the calculator. Candidates are not expected to write down data transferred from question paper to calculator.
3. Correct mathematical notation (rather than "calculator notation") should be used; incorrect notation may result in loss of marks.

2d. Command words

It is expected that learners will simplify algebraic and numerical expressions when giving their final answers, even if the examination question does not explicitly ask them to do so.

Example 1:

$80\frac{\sqrt{3}}{2}$ should be written as $40\sqrt{3}$.

Example 2:

$\frac{1}{2}(1+2x)^{-\frac{1}{2}} \times 2$ should be written as either $(1+2x)^{-\frac{1}{2}}$ or $\frac{1}{\sqrt{1+2x}}$.

Example 3:

$\ln 2 + \ln 3 - \ln 1$ should be written as $\ln 6$.

Example 4:

The equation of a straight line should be given in the form $y = mx + c$ or $ax + by = c$ unless otherwise stated.

The meanings of **some** instructions and words used in this specification are detailed below.

Other command words, for example "explain" or "calculate", will have their ordinary English meaning.

Exact

An exact answer is one where numbers are not given in rounded form. The answer will often contain an irrational number such as $\sqrt{3}$, e or π and these numbers should be given in that form when an exact answer is required.

The use of the word 'exact' also tells learners that rigorous (exact) working is expected in the answer to the question.

Example 1:

Find the exact solution of $\ln x = 2$.

The correct answer is e^2 and not 7.389 056.

Example 2:

Find the exact solution of $3x = 2$

The correct answer is $x = \frac{2}{3}$ or $x = 0.\dot{6}$, not $x = 0.67$ or similar.

Prove

Learners are given a statement and must provide a formal mathematical argument which demonstrates its validity.

A formal proof requires a high level of mathematical detail, with candidates clearly defining variables, correct algebraic manipulation and a concise conclusion.

Example Question

Prove that the sum of the squares of any three consecutive positive integers cannot be divided by 3.

Example Response

Let the three consecutive positive integers be n, $n+1$ and $n+2$

$n^2 + (n+1)^2 + (n+2)^2$

$= 3n^2 + 6n + 5$

$= 3(n^2 + 2n + 1) + 2$

This always leaves a remainder of 2 and so cannot be divided by 3.

Show that

Learners are given a result and have to show that it is true. Because they are given the result, the explanation has to be sufficiently detailed to cover every step of their working.

Example Question

Show that the curve $y = x \ln x$ has a stationary point $\left(\frac{1}{\mathrm{e}},\ -\frac{1}{\mathrm{e}}\right)$.

Example Response

$\frac{\mathrm{d}y}{\mathrm{d}x} = 1.\ln x + x.\frac{1}{x} = \ln x + 1$

$\frac{\mathrm{d}y}{\mathrm{d}x} = 0$ for stationary point

When $x = \frac{1}{\mathrm{e}} \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = \ln\frac{1}{\mathrm{e}} + 1 = 0$ so stationary

When $x = \frac{1}{\mathrm{e}}, y = \frac{1}{\mathrm{e}}\ln\frac{1}{\mathrm{e}} \Rightarrow y = -\frac{1}{\mathrm{e}}$ so $\left(\frac{1}{\mathrm{e}},\ -\frac{1}{\mathrm{e}}\right)$ is a stationary point on the curve.

2

Verify

A clear substitution of the given value to justify the statement is required.

Example Question

Verify that the curve $y = x \ln x$ has a stationary point at $x = \frac{1}{e}$.

Example Response

$$\frac{dy}{dx} = \ln x + 1$$

At $x = \frac{1}{e}, \frac{dy}{dx} = \ln\frac{1}{e} + 1 = -1 + 1 = 0$ therefore it is a stationary point.

Find, Solve, Calculate

These command words indicate, while working may be necessary to answser the question, no justification is required. A solution could be obtained from the efficient use of a calculator, either graphically or using a numerical method.

Example Question

Find the coordinates of the stationary point of the curve $y = x \ln x$.

Example Response

$(0.368, -0.368)$

Determine

This command word indicates that justification should be given for any results found, including working where appropriate.

Example Question

Determine the coordinates of the stationary point of the curve $y = x \ln x$.

Example Response

$$\frac{dy}{dx} = 1.\ln x + x.\frac{1}{x} = \ln x + 1$$

$\ln x + 1 = 0 \Rightarrow x = 0.368...$

When $x = 0.368..., y = 0.368... \times \ln\frac{1}{0.368...} = -0.368...$

So $(0.368, -0.368)$

2

Give, State, Write down

These command words indicate that neither working nor justification is required.

In this question you must show detailed reasoning.

When a question includes this instruction learners must give a solution which leads to a conclusion showing a detailed and complete analytical method. Their solution should contain sufficient detail to allow the line of their argument to be followed. This is not a restriction on a learner's use of a calculator when tackling the question, e.g. for checking an answer or evaluating a function at a given point, but it is a restriction on what will be accepted as evidence of a complete method.

In these examples variations in the structure of the answers are possible, for example using a different base for the logarithms in example 1, and different intermediate steps may be given.

Example 1:

Use logarithms to solve the equation $3^{2x+1} = 4^{100}$, giving your answer correct to 3 significant figures.

The answer is $x = 62.6$, but the learner *must* include the steps $\log 3^{2x+1} = \log 4^{100}$, $(2x+1)\log 3 = \log 4^{100}$ and an intermediate evaluation step, for example $2x+1 = 126.18\ldots$. Using the solve function on a calculator to skip one of these steps would not result in a complete analytical method.

Example 2:

Evaluate $\int_0^1 x^3 + 4x^2 - 1\,\mathrm{d}x$.

The answer is $\frac{7}{12}$, but the learner *must* include at least $\left[\frac{1}{4}x^4 + \frac{4}{3}x^3 - x\right]_0^1$ and the substitution $\frac{1}{4} + \frac{4}{3} - 1$. Just writing down the answer using the definite integral function on a calculator would therefore not be awarded any marks.

Example 3:

Solve the equation $3\sin 2x = \cos x$ for $0° \le x \le 180°$.

The answer is $x = 9.59°$, $90°$ or $170°$ (to 3sf), but the learner *must* include … $6\sin x\cos x - \cos x = 0$, $\cos x(6\sin x - 1) = 0$, $\cos x = 0$ or $\sin x = \frac{1}{6}$.

A graphical method which investigated the intersections of the curves $y = 3\sin 2x$ and $y = \cos x$ would be acceptable to find the solution at 90° if carefully verified, but the other two solutions must be found analytically, not numerically.

Hence

When a question uses the word ‘hence’, it is an indication that the next step should be based on what has gone before. The intention is that learners should start from the indicated statement.

> You are given that $\mathrm{f}(x) = 2x^3 - x^2 - 7x + 6$. Show that $(x - 1)$ is a factor of $\mathrm{f}(x)$.
>
> Hence find the three factors of $\mathrm{f}(x)$.

Hence or otherwise

This is used when there are multiple ways of answering a given question. Learners starting from the indicated statement may well gain some information about the solution from doing so, and may already be some way towards the answer. The command phrase is used to direct learners towards using a particular piece of information to start from or to a particular method. It also indicates to learners that valid alternate methods exist which will be given full credit, but that they may be more time-consuming or complex.

Example:

> Show that $(\cos x + \sin x)^2 = 1 + \sin 2x$ for all x.
>
> Hence or otherwise, find the derivative of $(\cos x + \sin x)^2$.

You may use the result

When this phrase is used it indicates a given result that learners would not normally be expected to know, but which may be useful in answering the question.

The phrase should be taken as permissive; use of the given result is not required.

Plot

Learners should mark points accurately on the graph in their printed answer booklet. They will either have been given the points or have had to calculate them. They may also need to join them with a curve or a straight line, or draw a line of best fit through them.

Example:

> Plot this additional point on the scatter diagram.

2

Sketch

Learners should draw a diagram, not necessarily to scale, showing the main features of a curve. These are likely to include at least some of the following.

- Turning points
- Asymptotes
- Intersection with the y-axis
- Intersection with the x-axis
- Behaviour for large x (+ or –)

Any other important features should also be shown.

Example:

Sketch the curve with equation $y = \dfrac{1}{(x-1)}$

Draw

Learners should draw to an accuracy appropriate to the problem. They are being asked to make a sensible judgement about this.

Example 1:

Draw a diagram showing the forces acting on the particle.

Example 2:

Draw a line of best fit for the data.

2

2e. Overarching themes

These overarching themes should be applied, along with associated mathematical thinking and understanding, across the whole of the detailed content in this specification. These statements are intended to direct the teaching and learning of A Level Mathematics, and they will be reflected in assessment tasks.

OT1 Mathematical argument, language and proof

	Knowledge/Skill
OT1.1	Construct and present mathematical arguments through appropriate use of diagrams; sketching graphs; logical deduction; precise statements involving correct use of symbols and connecting language, including: constant, coefficient, expression, equation, function, identity, index, term, variable
OT1.2	Understand and use mathematical language and syntax as set out in the content
OT1.3	Understand and use language and symbols associated with set theory, as set out in the content Apply to solutions of inequalities and probability
OT1.4	Understand and use the definition of a function; domain and range of functions
OT1.5	Comprehend and critique mathematical arguments, proofs and justifications of methods and formulae, including those relating to applications of mathematics

OT2 Mathematical problem solving

	Knowledge/Skill
OT2.1	Recognise the underlying mathematical structure in a situation and simplify and abstract appropriately to enable problems to be solved
OT2.2	Construct extended arguments to solve problems presented in an unstructured form, including problems in context
OT2.3	Interpret and communicate solutions in the context of the original problem
OT2.4	Understand that many mathematical problems cannot be solved analytically, but numerical methods permit solution to a required level of accuracy
OT2.5	Evaluate, including by making reasoned estimates, the accuracy or limitations of solutions, including those obtained using numerical methods
OT2.6	Understand the concept of a mathematical problem solving cycle, including specifying the problem, collecting information, processing and representing information and interpreting results, which may identify the need to repeat the cycle
OT2.7	Understand, interpret and extract information from diagrams and construct mathematical diagrams to solve problems, including in mechanics

OT3 Mathematical modelling

	Knowledge/Skill
OT3.1	Translate a situation in context into a mathematical model, making simplifying assumptions
OT3.2	Use a mathematical model with suitable inputs to engage with and explore situations (for a given model or a model constructed or selected by the student)
OT3.3	Interpret the outputs of a mathematical model in the context of the original situation (for a given model or a model constructed or selected by the student)
OT3.4	Understand that a mathematical model can be refined by considering its outputs and simplifying assumptions; evaluate whether the model is appropriate
OT3.5	Understand and use modelling assumptions

2f. Detailed Content of A Level Mathematics A (H240)

1 – Pure Mathematics

When this course is being co-taught with AS Level Mathematics A (H230) the ‘Stage 1’ column indicates the common content between the two specifications and the ‘Stage 2’ column indicates content which is particular to this specification.

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.01 Proof				
1.01a 1.01d	Proof	a) Understand and be able to use the structure of mathematical proof, proceeding from given assumptions through a series of logical steps to a conclusion. *In particular, learners should use methods of proof including proof by deduction and proof by exhaustion.*	d) Understand and be able to use proof by contradiction. *In particular, learners should understand a proof of the irrationality of $\sqrt{2}$ and the infinity of primes.* *Questions requiring proof by contradiction will be set on content with which the learner is expected to be familiar e.g. through study of GCSE (9–1), AS or A Level Mathematics.*	MA1
1.01b		b) Understand and be able to use the logical connectives $\equiv$, $\Rightarrow$, $\Leftrightarrow$. *Learners should be familiar with the language associated with the logical connectives: “congruence”, “if..... then” and “if and only if” (or “iff”).*		
1.01c		c) Be able to show disproof by counter example. *Learners should understand that this means that, given a statement of the form “if $P(x)$ is true then $Q(x)$ is true”, finding a single x for which $P(x)$ is true but $Q(x)$ is false is to offer a disproof by counter example.* *Questions requiring proof will be set on content with which the learner is expected to be familiar e.g. through study of GCSE (9–1) or AS Level Mathematics.* *Learners are expected to understand and be able to use terms such as “integer”, “real”, “rational” and “irrational”.*		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.02 Algebra and Functions				
1.02a	Indices	a) Understand and be able to use the laws of indices for all rational exponents. *Includes negative and zero indices.* *Problems may involve the application of more than one of the following laws:* $x^a \times x^b = x^{a+b}, x^a \div x^b = x^{a-b}, (x^a)^b = x^{ab}$ $x^{-a} = \frac{1}{x^a}, \quad x^{\frac{m}{n}} = \sqrt[n]{x^m}, \quad x^0 = 1.$		MB1
1.02b	Surds	b) Be able to use and manipulate surds, including rationalising the denominator. *Learners should understand and use the equivalence of surd and index notation.*		MB2
1.02c	Simultaneous equations	c) Be able to solve simultaneous equations in two variables by elimination and by substitution, including one linear and one quadratic equation. *The equations may contain brackets and/or fractions.* *e.g.* $y = 4 - 3x$ *and* $y = x^2 + 2x - 2$ $2xy + y^2 = 4$ *and* $2x + 3y = 9$		MB4

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.02d 1.02e 1.02f	Quadratic functions	d) Be able to work with quadratic functions and their graphs, and the discriminant (*D* or Δ) of a quadratic function, including the conditions for real and repeated roots. *i.e. Use the conditions:* *1.* $b^2 - 4ac > 0 \Rightarrow$ *real distinct roots* *2.* $b^2 - 4ac = 0 \Rightarrow$ *repeated roots* *3.* $b^2 - 4ac < 0 \Rightarrow$ *roots are not real* *to determine the number and nature of the roots of a quadratic equation and relate the results to a graph of the quadratic function.* e) Be able to complete the square of the quadratic polynomial $ax^2 + bx + c$. *e.g. Writing* $y = ax^2 + bx + c$ *in the form* $y = a(x+p)^2 + q$ *in order to find the line of symmetry* $x = -p$*, the turning point* $(-p,\ q)$ *and to determine the nature of the roots of the equation* $ax^2 + bx + c = 0$ *for example* $2(x+3)^2 + 4 = 0$ *has no real roots because* $4 > 0$. f) Be able to solve quadratic equations including quadratic equations in a function of the unknown. *e.g.* $x^4 - 5x^2 + 6 = 0$*,* $x^{\frac{2}{3}} - 5x^{\frac{1}{3}} + 4 = 0$ *or* $\dfrac{5}{(2x-1)^2} - \dfrac{10}{2x-1} = 1$.		MB3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.02g	Inequalities	g) Be able to solve linear and quadratic inequalities in a single variable and interpret such inequalities graphically, including inequalities with brackets and fractions. *e.g.* $10 < 3x + 1 < 16$, $(2x+5)(x+3) > 0$. [*Quadratic equations with complex roots are excluded*.]		MB5
1.02h		h) Be able to express solutions through correct use of 'and' and 'or', or through set notation. *Familiarity is expected with the correct use of set notation for intervals, e.g.* $\{x : x > 3\}$, $\{x : -2 \le x \le 4\}$, $\{x : x > 3\} \cup \{x : -2 \le x \le 4\}$, $\{x : x > 3\} \cap \{x : -2 \le x \le 4\}$, $\varnothing$. *Familiarity is expected with interval notation, e.g.* $(2, 3)$, $[2, 3)$ *and* $[2, \infty)$.		
1.02i		i) Be able to represent linear and quadratic inequalities such as $y > x + 1$ and $y > ax^2 + bx + c$ graphically.		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.02j 1.02k	Polynomials	j) Be able to manipulate polynomials algebraically. *Includes expanding brackets, collecting like terms, factorising, simple algebraic division and use of the factor theorem.* *Learners should be familiar with the terms "quadratic", "cubic" and "parabola".* *Learners should be familiar with the factor theorem as:* *1.* $\mathrm{f}(a)=0 \Leftrightarrow (x-a)$ *is a factor of* $\mathrm{f}(x)$; *2.* $\mathrm{f}(\frac{b}{a})=0 \Leftrightarrow (ax-b)$ *is a factor of* $\mathrm{f}(x)$. *They should be able to use the factor theorem to find a linear factor of a polynomial normally of degree* ≤ 3*. They may also be required to find factors of a polynomial, using any valid method, e.g. by inspection.*	k) Be able to simplify rational expressions. *Includes factorising and cancelling, and algebraic division by linear expressions.* *e.g. Rational expressions may be of the form* $\dfrac{x^3-x-2}{2x+1}$ *or* $\dfrac{(x^2-x-6)(x^2+4x+3)}{(x^2-9)(x+3)}$. *Learners should be able to divide a polynomial of degree* ≥ 2 *by a linear polynomial of the form* $(ax-b)$*, identify the quotient and remainder and solve equations of degree* ≤ 4. *The use of the factor theorem and algebraic division may be required.*	MB6
1.02l	The modulus function		l) Understand and be able to use the modulus function, including the notation $\lvert x \rvert$, and use relations such as $\lvert a \rvert = \lvert b \rvert \Leftrightarrow a^2 = b^2$ and $\lvert x-a \rvert < b \Leftrightarrow a-b < x < a+b$ in the course of solving equations and inequalities. *e.g. Solve* $\lvert x+2 \rvert \leq \lvert 2x-1 \rvert$.	MB7

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.02m 1.02s 1.02n 1.02t 1.02o 1.02p 1.02q 1.02r	Curve sketching	m) Understand and be able to use graphs of functions. *The difference between plotting and sketching a curve should be known. See Section 2b.* n) Be able to sketch curves defined by simple equations including polynomials. *e.g. Familiarity is expected with sketching a polynomial of degree* ≤ 4 *in factorised form, including repeated roots.* *Sketches may require the determination of stationary points and, where applicable, distinguishing between them.* o) Be able to sketch curves defined by $y = \frac{a}{x}$ and $y = \frac{a}{x^2}$ (including their vertical and horizontal asymptotes). p) Be able to interpret the algebraic solution of equations graphically. q) Be able to use intersection points of graphs to solve equations. *Intersection points may be between two curves one or more of which may be a polynomial, a trigonometric, an exponential or a reciprocal graph.* r) Understand and be able to use proportional relationships and their graphs. *i.e. Understand and use different proportional relationships and relate them to linear, reciprocal or other graphs of variation.*	s) Be able to sketch the graph of the modulus of a linear function involving a single modulus sign. *i.e. Given the graph of* $y = ax + b$ *sketch the graph of* $y = \|ax + b\|$. [*Graphs of the modulus of other functions are excluded.*] t) Be able to solve graphically simple equations and inequalities involving the modulus function.	MB7

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.02u 1.02v	Functions	*Within Stage 1, learners should understand and be able to apply functions and function notation in an informal sense in the context of the factor theorem (1.02j), transformations of graphs (1.02w), differentiation (Section 1.07) and the Fundamental Theorem of Calculus (1.08a).*	u) Understand and be able to use the definition of a function. *The vocabulary and associated notation is expected i.e. the terms many-one, one-many, one-one, mapping, image, range, domain.* *Includes knowing that a function is a mapping from the domain to the range such that for each x in the domain, there is a unique y in the range with $\mathrm{f}(x) = y$. The range is the set of all possible values of $\mathrm{f}(x)$; learners are expected to use set notation where appropriate.* v) Understand and be able to use inverse functions and their graphs, and composite functions. Know the condition for the inverse function to exist and be able to find the inverse of a function either graphically, by reflection in the line $y = x$, or algebraically. *The vocabulary and associated notation is expected* *e.g.* $\mathrm{gf}(x) = \mathrm{g}(\mathrm{f}(x))$, $\mathrm{f}^2(x)$, $\mathrm{f}^{-1}(x)$.	MB8 OT1.1 OT1.4
1.02w 1.02x	Graph transformations	w) Understand the effect of simple transformations on the graph of $y = \mathrm{f}(x)$ including sketching associated graphs, describing transformations and finding relevant equations: $y = a\mathrm{f}(x)$, $y = \mathrm{f}(x) + a$, $y = \mathrm{f}(x + a)$ and $y = \mathrm{f}(ax)$, for any real a. *Only single transformations will be requested.* *Translations may be specified by a two-dimensional column vector.*	x) Understand the effect of combinations of transformations on the graph of $y = \mathrm{f}(x)$ including sketching associated graphs, describing transformations and finding relevant equations. *The transformations may be combinations of* $y = a\mathrm{f}(x)$, $y = \mathrm{f}(x) + a$, $y = \mathrm{f}(x + a)$ *and* $y = \mathrm{f}(ax)$, *for any real* a, *and* f *any function defined in the Stage 1 or Stage 2 content.*	MB9

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.02y	Partial fractions		y) Be able to decompose rational functions into partial fractions (denominators not more complicated than squared linear terms and with no more than 3 terms, numerators constant or linear). *i.e. The denominator is no more complicated than* $(ax+b)(cx+d)^2$ *or* $(ax+b)(cx+d)(ex+f)$ *and the numerator is either a constant or linear term.* *Learners should be able to use partial fractions with the binomial expansion to find the power series for an algebraic fraction or as part of solving an integration problem.*	MB10
1.02z	Models in context		z) Be able to use functions in modelling. *Includes consideration of modelling assumptions, limitations and refinements of models, and comparing models.*	MB11

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.03 Coordinate Geometry in the x–y Plane				
1.03a	Straight lines	a) Understand and be able to use the equation of a straight line, including the forms $y = mx + c, y - y_1 = m(x - x_1)$ and $ax + by + c = 0$. *Learners should be able to draw a straight line given its equation and to form the equation given a graph of the line, the gradient and one point on the line, or at least two points on the line.* *Learners should be able to use straight lines to find:* *1. the coordinates of the midpoint of a line segment joining two points,* *2. the distance between two points and* *3. the point of intersection of two lines.*		MC1
1.03b		b) Be able to use the gradient conditions for two straight lines to be parallel or perpendicular. *i.e. For parallel lines* $m_1 = m_2$ *and for perpendicular lines* $m_1 m_2 = -1$.		
1.03c		c) Be able to use straight line models in a variety of contexts. *These problems may be presented within realistic contexts including average rates of change.*		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.03d 1.03e 1.03f	Circles	d) Understand and be able to use the coordinate geometry of a circle including using the equation of a circle in the form $(x-a)^2+(y-b)^2=r^2$. *Learners should be able to draw a circle given its equation or to form the equation given its centre and radius.* e) Be able to complete the square to find the centre and radius of a circle. f) Be able to use the following circle properties in the context of problems in coordinate geometry: 1. the angle in a semicircle is a right angle, 2. the perpendicular from the centre of a circle to a chord bisects the chord, 3. the radius of a circle at a given point on its circumference is perpendicular to the tangent to the circle at that point. *Learners should also be able to investigate whether or not a line and a circle or two circles intersect.*		MC2
1.03g	Parametric equations of curves		g) Understand and be able to use the parametric equations of curves and be able to convert between cartesian and parametric forms. *Learners should understand the meaning of the terms parameter and parametric equation.* *Includes sketching simple parametric curves.* *See also Section 1.07s.*	MC3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.03h	Parametric equations in context		h) Be able to use parametric equations in modelling in a variety of contexts. *The contexts may be within pure mathematics or in realistic contexts, for example those involving related rates of change.*	MC4
1.04 Sequences and Series				
1.04a 1.04c 1.04b 1.04d	Binomial expansion	a) Understand and be able to use the binomial expansion of $(a+bx)^n$ for positive integer n and the notations $n!$ and ${}^nC_r$, ${}_nC_r$ or $\binom{n}{r}$, with ${}^nC_0 = {}^nC_n = 1$. *e.g. Find the coefficient of the x^3 term in the expansion of $(2-3x)^7$.* *Learners should be able to calculate binomial coefficients. They should also know the relationship of the binomial coefficients to Pascal's triangle and their use in a binomial expansion.* *They should also know that $0! = 1$.* b) Understand and know the link to binomial probabilities.	c) Be able to extend the binomial expansion of $(a+bx)^n$ to any rational n, including its use for approximation. *Learners may be asked to find a particular term, but the general term will not be required.* *Learners should be able to write $(a+bx)^n$ in the form $a^n\left(1+\frac{bx}{a}\right)^n$ prior to expansion.* d) Know that the expansion is valid for $\left\|\frac{bx}{a}\right\| < 1$. [*The proof is not required.*] *e.g. Find the coefficient of the x^3 term in the expansion of $(2-3x)^{\frac{1}{3}}$ and state the range of values for which the expansion is valid.*	MD1

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.04e	Sequences		e) Be able to work with sequences including those given by a formula for the nth term and those generated by a simple relation of the form $x_{n+1} = \mathrm{f}(x_n)$. *Learners may be asked to generate terms, find nth terms and comment on the mathematical behaviour of the sequence.*	MD2
1.04f			f) Understand the meaning of and work with increasing sequences, decreasing sequences and periodic sequences. *Learners should know the difference between and be able to recognise:* *1. a sequence and a series,* *2. finite and infinite sequences.*	
1.04g	Sigma notation		g) Understand and be able to use sigma notation for sums of series.	MD3
1.04h	Arithmetic sequences		h) Understand and be able to work with arithmetic sequences and series, including the formulae for the nth term and the sum to n terms. *The term arithmetic progression (AP) may also be used. The first term will usually be denoted by a, the last term by l and the common difference by d.* *The sum to n terms will usually be denoted by S_n.*	MD4

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.04i	Geometric sequences		i) Understand and be able to work with geometric sequences and series including the formulae for the nth term and the sum of a finite geometric series. *Learners should know the difference between convergent and divergent geometric sequences and series.*	MD5
1.04j			j) Understand and be able to work with the sum to infinity of a convergent geometric series, including the use of $\lvert r \rvert < 1$ and the use of modulus notation in the condition for convergence. *The term geometric progression (GP) may also be used. The first term will usually be denoted by a and the common ratio by r.* *The sum to n terms will usually be denoted by S_n and the sum to infinity by S_∞.*	
1.04k	Modelling		k) Be able to use sequences and series in modelling. *e.g. Contexts involving compound and simple interest on bank deposits, loans, mortgages, etc. and other contexts in which growth or decay can be modelled by an arithmetic or geometric sequence.* *Includes solving inequalities involving exponentials and logarithms.*	MD6

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.05 Trigonometry				
1.05a 1.05d 1.05b 1.05c	sin, cos and tan for all arguments Sine and cosine rules Radians	a) Understand and be able to use the definitions of sine, cosine and tangent for all arguments. b) Understand and be able to use the sine and cosine rules. *Questions may include the use of bearings and require the use of the ambiguous case of the sine rule.* c) Understand and be able to use the area of a triangle in the form $\frac{1}{2}ab\sin C$.	d) Be able to work with radian measure, including use for arc length and area of sector. *Learners should know the formulae* $s = r\theta$ *and* $A = \frac{1}{2}r^2\theta$. *Learners should be able to use the relationship between degrees and radians.*	ME1
1.05e	Small angle approximations		e) Understand and be able to use the standard small angle approximations of sine, cosine and tangent: 1. $\sin\theta \approx \theta$, 2. $\cos\theta \approx 1 - \frac{1}{2}\theta^2$, 3. $\tan\theta \approx \theta$, where θ is in radians. *e.g. Find an approximate expression for* $\frac{\sin 3\theta}{1+\cos\theta}$ *if* θ *is small enough to neglect terms in* θ^3 *or above.*	ME2
1.05f 1.05g	Graphs of the basic trigonometric functions Exact values of trigonometric functions	f) Understand and be able to use the sine, cosine and tangent functions, their graphs, symmetries and periodicities. *Includes knowing and being able to use exact values of* $\sin\theta$ *and* $\cos\theta$ *for* $\theta = 0°, 30°, 45°, 60°, 90°, 180°$ *and multiples thereof and exact values of* $\tan\theta$ *for* $\theta = 0°, 30°, 45°, 60°, 180°$ *and multiples thereof.*	g) Know and be able to use exact values of $\sin\theta$ and $\cos\theta$ for $\theta = 0, \frac{1}{6}\pi, \frac{1}{4}\pi, \frac{1}{3}\pi, \frac{1}{2}\pi, \pi$ and multiples thereof, and exact values of $\tan\theta$ for $\theta = 0, \frac{1}{6}\pi, \frac{1}{4}\pi, \frac{1}{3}\pi, \pi$ and multiples thereof.	ME3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.05h 1.05i	Inverse and reciprocal trigonometric ratios		h) Understand and be able to use the definitions of secant ($\sec\theta$), cosecant ($\operatorname{cosec}\theta$) and cotangent ($\cot\theta$) and of $\arcsin\theta$, $\arccos\theta$ and $\arctan\theta$ and their relationships to $\sin\theta$, $\cos\theta$ and $\tan\theta$ respectively. i) Understand the graphs of the functions given in 1.05h, their ranges and domains. *In particular, learners should know that the principal values of the inverse trigonometric relations may be denoted by* $\arcsin\theta$ *or* $\sin^{-1}\theta$, $\arccos\theta$ *or* $\cos^{-1}\theta$, $\arctan\theta$ *or* $\tan^{-1}\theta$ *and relate their graphs (for the appropriate domain) to the graphs of* $\sin\theta$, $\cos\theta$ *and* $\tan\theta$.	ME4
1.05j 1.05k	Trigonometric identities	j) Understand and be able to use $\tan\theta \equiv \frac{\sin\theta}{\cos\theta}$ and $\sin^2\theta + \cos^2\theta \equiv 1$. *In particular, these identities may be used in solving trigonometric equations and simple trigonometric proofs.*	k) Understand and be able to use $\sec^2\theta \equiv 1 + \tan^2\theta$ and $\operatorname{cosec}^2\theta \equiv 1 + \cot^2\theta$. *In particular, the identities in 1.05j and 1.05k may be used in solving trigonometric equations, proving trigonometric identities or in evaluating integrals.*	ME5

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.05l 1.05m 1.05n	Further trigonometric identities		l) Understand and be able to use double angle formulae and the formulae for $\sin(A \pm B)$, $\cos(A \pm B)$ and $\tan(A \pm B)$. *Learners may be required to use the formulae to prove trigonometric identities, simplify expressions, evaluate expressions exactly, solve trigonometric equations or find derivatives and integrals.* m) Understand the geometrical proofs of these formulae. n) Understand and be able to use expressions for $a\cos\theta + b\sin\theta$ in the equivalent forms of $R\cos(\theta \pm \alpha)$ or $R\sin(\theta \pm \alpha)$. *In particular, learners should be able to:* *1. sketch graphs of $a\cos\theta + b\sin\theta$,* *2. determine features of the graphs including minimum or maximum points and* *3. solve equations of the form $a\cos\theta + b\sin\theta = c$.*	ME6
1.05o	Trigonometric equations	o) Be able to solve simple trigonometric equations in a given interval, including quadratic equations in $\sin\theta$, $\cos\theta$ and $\tan\theta$ and equations involving multiples of the unknown angle. *e.g.* $\sin\theta = 0.5$ for $0 \le \theta < 360°$ $6\sin^2\theta + \cos\theta - 4 = 0$ for $0 \le \theta < 360°$ $\tan 3\theta = -1$ for $-180° < \theta < 180°$	*Extend their knowledge of trigonometric equations to include radians and the trigonometric identities in Stage 2.*	ME7

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.05p	Proof involving trigonometric functions		p) Be able to construct proofs involving trigonometric functions and identities. *e.g. Prove that* $\cos^2(\theta + 45°) - \frac{1}{2}(\cos 2\theta - \sin 2\theta) = \sin^2\theta$. *Includes constructing a mathematical argument as described in Section 1.01.*	ME8
1.05q	Trigonometric functions in context		q) Be able to use trigonometric functions to solve problems in context, including problems involving vectors, kinematics and forces. *Problems may include realistic contexts, e.g. movement of tides, sound waves, etc. as well as problems in vector form which involve resolving directions and quantities in mechanics.*	ME9
1.06 Exponentials and Logarithms				
1.06a	Properties of the exponential function	a) Know and use the function a^x and its graph, where a is positive. Know and use the function e^x and its graph. *Examples may include the comparison of two population models or models in a biological or financial context. The link with geometric sequences may also be made.*		MF1
1.06b	Gradient of e^{kx}	b) Know that the gradient of e^{kx} is equal to ke^{kx} and hence understand why the exponential model is suitable in many applications. *See 1.07j for explicit differentiation of* e^x.		MF2

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.06c 1.06d 1.06e	Properties of the logarithm	c) Know and use the definition of $\log_a x$ (for $x > 0$) as the inverse of a^x (for all x),where a is positive. *Learners should be able to convert from index to logarithmic form and vice versa as* $a = b^c \Leftrightarrow c = \log_b a$. *The values* $\log_a a = 1$ *and* $\log_a 1 = 0$ *should be known*. d) Know and use the function $\ln x$ and its graph. e) Know and use $\ln x$ as the inverse function of e^x. *e.g. In solving equations involving logarithms or exponentials*. *The values* $\ln e = 1$ *and* $\ln 1 = 0$ *should be known*.		MF3
1.06f	Laws of logarithms	f) Understand and be able to use the laws of logarithms: 1. $\log_a x + \log_a y = \log_a (xy)$ 2. $\log_a x - \log_a y = \log_a \left(\frac{x}{y}\right)$ 3. $k \log_a x = \log_a x^k$ (including, for example, $k = -1$ and $k = -\frac{1}{2}$). *Learners should be able to use these laws in solving equations and simplifying expressions involving logarithms*. [*Change of base is excluded*.]		MF4
1.06g	Equations involving exponentials	g) Be able to solve equations of the form $a^x = b$ for $a > 0$ *Includes solving equations which can be reduced to this form such as* $2^x = 3^{2x-1}$, *either by reduction to the form* $a^x = b$ *or by taking logarithms of both sides.*		MF5

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.06h	Reduction to linear form	h) Be able to use logarithmic graphs to estimate parameters in relationships of the form $y = ax^n$ and $y = kb^x$, given data for x and y. *Learners should be able to reduce equations of these forms to a linear form and hence estimate values of a and n, or k and b by drawing graphs using given experimental data and using appropriate calculator functions.*		MF6
1.06i	Modelling using exponential functions	i) Understand and be able to use exponential growth and decay and use the exponential function in modelling. *Examples may include the use of* e *in continuous compound interest, radioactive decay, drug concentration decay and exponential growth as a model for population growth. Includes consideration of limitations and refinements of exponential models.*		MF7

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.07 Differentiation				
1.07a	Gradients	a) Understand and be able to use the derivative of $\mathrm{f}(x)$ as the gradient of the tangent to the graph of $y = \mathrm{f}(x)$ at a general point (x, y).		MG1
1.07b		b) Understand and be able to use the gradient of the tangent at a point where $x = a$ as: 1. the limit of the gradient of a chord as x tends to a 2. a rate of change of y with respect to x. *Learners should be able to use the notation* $\frac{\mathrm{d}y}{\mathrm{d}x}$ *to denote the rate of change of* y *with respect to* x. *Learners should be able to use the notations* $\mathrm{f}'(x)$ *and* $\frac{\mathrm{d}y}{\mathrm{d}x}$ *and recognise their equivalence.*		
1.07c		c) Understand and be able to sketch the gradient function for a given curve.		
1.07d 1.07f		d) Understand and be able to find second derivatives. *Learners should be able to use the notations* $\mathrm{f}''(x)$ *and* $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ *and recognise their equivalence.*	f) Understand and be able to use the second derivative in connection to convex and concave sections of curves and points of inflection. *In particular, learners should know that:* *1. if* $\mathrm{f}''(x) > 0$ *on an interval, the function is convex in that interval;* *2. if* $\mathrm{f}''(x) < 0$ *on an interval the function is concave in that interval;* *3. if* $\mathrm{f}''(x) = 0$ *and the curve changes from concave to convex or vice versa there is a point of inflection.*	
1.07e		e) Understand and be able to use the second derivative as the rate of change of gradient. *e.g. For distinguishing between maximum and minimum points.* *For the application to points of inflection, see 1.07f.*		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.07g 1.07h	Differentiation from first principles	g) Be able to show differentiation from first principles for small positive integer powers of x. *In particular, learners should be able to use the definition* $\mathrm{f}'(x) = \lim\limits_{h \to 0} \frac{\mathrm{f}(x+h) - \mathrm{f}(x)}{h}$ *including the notation.* [*Integer powers greater than 4 are excluded.*]	h) Be able to show differentiation from first principles for $\sin x$ and $\cos x$.	MG1
1.07i 1.07j 1.07k 1.07l	Differentiation of standard functions	i) Be able to differentiate x^n, for rational values of n, and related constant multiples, sums and differences.	j) Be able to differentiate e^{kx} and a^{kx}, and related sums, differences and constant multiples. k) Be able to differentiate $\sin kx$, $\cos kx$, $\tan kx$ and related sums, differences and constant multiples. l) Understand and be able to use the derivative of $\ln x$.	MG2
1.07m 1.07p 1.07n 1.07o	Tangents, normals, stationary points, increasing and decreasing functions	m) Be able to apply differentiation to find the gradient at a point on a curve and the equations of tangents and normals to a curve. n) Be able to apply differentiation to find and classify stationary points on a curve as either maxima or minima. *Classification may involve use of the second derivative or first derivative or other methods.* o) Be able to identify where functions are increasing or decreasing. *i.e. To be able to use the sign of* $\frac{\mathrm{d}y}{\mathrm{d}x}$ *to determine whether the function is increasing or decreasing.*	p) Be able to apply differentiation to find points of inflection on a curve. *In particular, learners should know that if a curve has a point of inflection at* x *then* $\mathrm{f}''(x) = 0$ *and there is a sign change in the second derivative on either side of* x*; if also* $\mathrm{f}'(x) = 0$ *at that point, then the point of inflection is a stationary point, but if* $\mathrm{f}'(x) \neq 0$ *at that point, then the point of inflection is not a stationary point.*	MG3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.07q 1.07r	Techniques of differentiation		q) Be able to differentiate using the product rule and the quotient rule. r) Be able to differentiate using the chain rule, including problems involving connected rates of change and inverse functions. *In particular, learners should be able to use the following relations:* $\frac{\mathrm{d}y}{\mathrm{d}x} = 1 \div \frac{\mathrm{d}x}{\mathrm{d}y}$ *and* $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y}{\mathrm{d}u} \times \frac{\mathrm{d}u}{\mathrm{d}x}$.	MG4
1.07s	Parametric and implicit differentiation		s) Be able to differentiate simple functions and relations defined implicitly or parametrically for the first derivative only. *They should be able to find the gradient at a point on a curve and to use this to find the equations of tangents and normals, and to solve associated problems.* *Includes differentiation of functions defined in terms of a parameter using the chain rule.*	MG5
1.07t	Constructing differential equations		t) Be able to construct simple differential equations in pure mathematics and in context (contexts may include kinematics, population growth and modelling the relationship between price and demand).	MG6

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.08 Integration				
1.08a	Fundamental theorem of calculus	a) Know and be able to use the fundamental theorem of calculus. *i.e. Learners should know that integration may be defined as the reverse of differentiation and be able to apply the result that* $\int f(x)\,dx = F(x) + c \Leftrightarrow f(x) = \frac{d}{dx}(F(x))$, *for sufficiently well-behaved functions.* *Includes understanding and being able to use the terms indefinite and definite when applied to integrals.*		MH1
1.08b 1.08c	Indefinite integrals	b) Be able to integrate x^n where $n \neq -1$ and related sums, differences and constant multiples. *Learners should also be able to solve problems involving the evaluation of a constant of integration e.g. to find the equation of the curve through* $(-1, 2)$ *for which* $\frac{dy}{dx} = 2x + 1$.	c) Be able to integrate e^{kx}, $\frac{1}{x}$, $\sin kx$, $\cos kx$ and related sums, differences and constant multiples. [*Integrals of* arcsin, arccos *and* arctan *will be given if required.*] *This includes using trigonometric relations such as double-angle formulae to facilitate the integration of functions such as* $\cos^2 x$.	MH2
1.08d 1.08e 1.08f	Definite integrals and areas	d) Be able to evaluate definite integrals. e) Be able to use a definite integral to find the area between a curve and the *x*-axis. *This area is defined to be that enclosed by a curve, the x-axis and two ordinates. Areas may be included which are partly below and partly above the x-axis, or entirely below the x-axis.*	f) Be able to use a definite integral to find the area between two curves. *This may include using integration to find the area of a region bounded by a curve and lines parallel to the coordinate axes, or between two curves or between a line and a curve.* *This includes curves defined parametrically.*	MH3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.08g	Integration as the limit of a sum		g) Understand and be able to use integration as the limit of a sum. *In particular, they should know that the area under a graph can be found as the limit of a sum of areas of rectangles.* *See also 1.09f.*	MH4
1.08h	Integration by substitution		h) Be able to carry out simple cases of integration by substitution. *Learners should understand the relationship between this method and the chain rule.* *Learners will be expected to integrate examples in the form* $\mathrm{f}'(x)(\mathrm{f}(x))^n$*, such as* $(2x+3)^5$ *or* $x(x^2+3)^7$*, either by inspection or substitution.* *Learners will be expected to recognise an integrand of the form* $\frac{k\mathrm{f}'(x)}{\mathrm{f}(x)}$ *such as* $\frac{x^2+x}{2x^3+3x^2-7}$ *or* $\tan x$. *Integration by substitution is limited to cases where one substitution will lead to a function which can be integrated. Substitutions may or may not be given.* *Learners should be able to find a suitable substitution in integrands such as* $\frac{(4x-1)}{(2x+1)^5}$, $\sqrt{9-x^2}$ *or* $\frac{1}{1+\sqrt{x}}$.	MH5

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.08i	Integration by parts		i) Be able to carry out simple cases of integration by parts. *Learners should understand the relationship between this method and the product rule.* *Integration by parts may include more than one application of the method e.g.* $x^2 \sin x$. *Learners will be expected to be able to apply integration by parts to the integral of* $\ln x$ *and related functions.* [*Reduction formulae are excluded*.]	MH5
1.08j	Use of partial fractions in integration		j) Be able to integrate functions using partial fractions that have linear terms in the denominator. *i.e. Functions with denominators no more complicated than the forms* $(ax+b)(cx+d)^2$ *or* $(ax+b)(cx+d)(ex+f)$.	MH6
1.08k	Differential equations with separable variables		k) Be able to evaluate the analytical solution of simple first order differential equations with separable variables, including finding particular solutions. *Separation of variables may require factorisation involving a common factor.* *Includes: finding by integration the general solution of a differential equation involving separating variables or direct integration; using a given initial condition to find a particular solution.*	MH7

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.08l	Interpreting the solution of a differential equation		l) Be able to interpret the solution of a differential equation in the context of solving a problem, including identifying limitations of the solution. *Includes links to differential equations connected with kinematics.* *e.g. If the solution of a differential equation is $v = 20 - 20e^{-t}$, where v is the velocity of a parachutist, describe the motion of the parachutist.*	MH8
1.09 Numerical Methods				
1.09a	Sign change methods		a) Be able to locate roots of $f(x) = 0$ by considering changes of sign of $f(x)$ in an interval of x on which $f(x)$ is sufficiently well-behaved. *Includes verifying the level of accuracy of an approximation by considering upper and lower bounds.*	MI1
1.09b			b) Understand how change of sign methods can fail. *e.g. when the curve $y = f(x)$ touches the x-axis or has a vertical asymptote.*	

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.09c 1.09d 1.09e	Formal iterative methods		c) Be able to solve equations approximately using simple iterative methods, and be able to draw associated cobweb and staircase diagrams. d) Be able to solve equations using the Newton-Raphson method and other recurrence relations of the form $x_{n+1} = \mathrm{g}(x_n)$. e) Understand and be able to show how such methods can fail. *In particular, learners should know that:* *1. the iteration* $x_{n+1} = \mathrm{g}(x_n)$ *converges to a root at* $x = a$ *if* $\lvert \mathrm{g}'(a) \rvert < 1$, *and if* x_1 *is sufficiently close to* a*;* *2. the Newton-Raphson method will fail if the initial value coincides with a stationary point.*	MI2
1.09f	Numerical integration		f) Understand and be able to use numerical integration of functions, including the use of the trapezium rule, and estimating the approximate area under a curve and the limits that it must lie between. *Learners will be expected to use the trapezium rule to estimate the area under a curve and to determine whether the trapezium rule gives an under- or over-estimate of the area under a curve.* *Learners will also be expected to use rectangles to estimate the area under a curve and to establish upper and lower bounds for a given integral. See also 1.08g.* [*Simpson's rule is excluded*]	MI3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.09g	Use numerical methods in context		g) Be able to use numerical methods to solve problems in context. *i.e. for solving problems in context which lead to equations which learners cannot solve analytically.*	MI4
1.10 Vectors				
1.10a 1.10b	Vectors	a) Be able to use vectors in two dimensions. *i.e. Learners should be able to use vectors expressed as* $x\mathbf{i}+y\mathbf{j}$ *or as a column vector* $\begin{pmatrix} x \\ y \end{pmatrix}$*, to use vector notation appropriately either as* $\overrightarrow{AB}$ *or* $\mathbf{a}$*.* *Learners should know the difference between a scalar and a vector, and should distinguish between them carefully when writing by hand.*	b) Be able to use vectors in three dimensions. *i.e. Learners should be able to use vectors expressed as* $x\mathbf{i}+y\mathbf{j}+z\mathbf{k}$ *or as a column vector* $\begin{pmatrix} x \\ y \\ z \end{pmatrix}$*.* *Includes extending 1.10c to 1.10g to include vectors in three dimensions, excluding the direction of a vector in three dimensions.*	MJ1
1.10c	Magnitude and direction of vectors	c) Be able to calculate the magnitude and direction of a vector and convert between component form and magnitude/direction form. *Learners should know that the modulus of a vector is its magnitude and the direction of a vector is given by the angle the vector makes with a horizontal line parallel to the positive x-axis. The direction of a vector will be taken to be in the interval* $[0°, 360°)$*.* *Includes use of the notation* $\|\mathbf{a}\|$ *for the magnitude of* $\mathbf{a}$ *and* $\|\overrightarrow{OA}\|$ *for the magnitude of* $\overrightarrow{OA}$*.* *Learners should be able to calculate the magnitude of a vector* $\begin{pmatrix} x \\ y \end{pmatrix}$ *as* $\sqrt{x^2+y^2}$ *and its direction by using* $\tan^{-1}\begin{pmatrix} x \\ y \end{pmatrix}$*.*		MJ2

2

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
1.10d	Basic operations on vectors	d) Be able to add vectors diagrammatically and perform the algebraic operations of vector addition and multiplication by scalars, and understand their geometrical interpretations. *i.e. Either a scaling of a single vector or a displacement from one position to another by adding one or more vectors, often in the form of a triangle of vectors*.		MJ3
1.10e	Position vectors	e) Understand and be able to use position vectors. *Learners should understand the meaning of displacement vector, component vector, resultant vector, parallel vector, equal vector and unit vector.*		MJ4
1.10f	Distance between points	f) Be able to calculate the distance between two points represented by position vectors. *i.e. The distance between the points* $a\mathbf{i}+b\mathbf{j}$ *and* $c\mathbf{i}+d\mathbf{j}$ *is* $\sqrt{(c-a)^2+(d-b)^2}$.		
1.10g 1.10h	Problem solving using vectors	g) Be able to use vectors to solve problems in pure mathematics and in context, including forces.	h) Be able to use vectors to solve problems in kinematics. *e.g. The equations of uniform acceleration may be used in vector form to find an unknown. See section 3.02e.*	MJ5

2 – Statistics

When this course is being co-taught with AS Level Mathematics A (H230) the 'Stage 1' column indicates the common content between the two specifications and the 'Stage 2' column indicates content which is particular to this specification.

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.01 Statistical Sampling				
2.01a	Statistical sampling	a) Understand and be able to use the terms 'population' and 'sample'.		MK1
2.01b		b) Be able to use samples to make informal inferences about the population.		
2.01c		c) Understand and be able to use sampling techniques, including simple random sampling and opportunity sampling. *When considering random samples, learners may assume that the population is large enough to sample without replacement unless told otherwise.*		
2.01d		d) Be able to select or critique sampling techniques in the context of solving a statistical problem, including understanding that different samples can lead to different conclusions about the population. *Learners should be familiar with (and be able to critique in context) the following sampling methods, but will not be required to carry them out: systematic, stratified, cluster and quota sampling.*		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.02 Data Presentation and Interpretation				
2.02a	Single variable data	a) Be able to interpret tables and diagrams for single-variable data. *e.g. vertical line charts, dot plots, bar charts, stem-and-leaf diagrams, box-and-whisker plots, cumulative frequency diagrams and histograms (with either equal or unequal class intervals). Includes non-standard representations.*		ML1
2.02b		b) Understand that area in a histogram represents frequency. *Includes the link between histograms and probability distributions.* *Includes understanding, in context, the advantages and disadvantages of different statistical diagrams.*		
2.02c	Bivariate data	c) Be able to interpret scatter diagrams and regression lines for bivariate data, including recognition of scatter diagrams which include distinct sections of the population. *Learners may be asked to add to diagrams in order to interpret data, but not to draw complete scatter diagrams.* [*Calculation of equations of regression lines is excluded.*]		ML2
2.02d		d) Be able to understand informal interpretation of correlation.		
2.02e		e) Be able to understand that correlation does not imply causation.		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.02f	Measures of average and spread	f) Be able to calculate and interpret measures of central tendency and variation, including mean, median, mode, percentile, quartile, inter-quartile range, standard deviation and variance. *Includes understanding that standard deviation is the root mean square deviation from the mean.* *Includes using the mean and standard deviation to compare distributions.*		ML3
2.02g	Calculations of mean and standard deviation	g) Be able to calculate mean and standard deviation from a list of data, from summary statistics or from a frequency distribution, using calculator statistical functions. *Includes understanding that, in the case of a grouped frequency distribution, the calculated mean and standard deviation are estimates.* *Learners should understand and be able to use the following formulae for standard deviation:* $\sqrt{\frac{\Sigma(x-\bar{x})^2}{n}} = \sqrt{\frac{\Sigma x^2}{n} - \bar{x}^2}$, $\sqrt{\frac{\Sigma f(x-\bar{x})^2}{\Sigma f}} = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \bar{x}^2}$ [*Formal estimation of population variance from a sample is excluded. Learners should be aware that there are different naming and symbol conventions for these measures and what the symbols on their calculator represent.*]		ML3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.02h 2.02i 2.02j	Outliers and cleaning data	h) Recognise and be able to interpret possible outliers in data sets and statistical diagrams. i) Be able to select or critique data presentation techniques in the context of a statistical problem. j) Be able to clean data, including dealing with missing data, errors and outliers. *Learners should be familiar with definitions of outliers:* *1. more than 1.5 × (interquartile range) from the nearer quartile* *2. more than 2 × (standard deviation) away from the mean.*		ML4
2.03 Probability				
2.03a	Mutually exclusive and independent events	a) Understand and be able to use mutually exclusive and independent events when calculating probabilities. *Includes understanding and being able to use the notation:* $\mathrm{P}(A)$, $\mathrm{P}(A')$, $\mathrm{P}(X=2)$, $\mathrm{P}(X=x)$. *Includes linking their knowledge of probability to probability distributions.*		MM1

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.03b 2.03c	Probability	b) Be able to use appropriate diagrams to assist in the calculation of probabilities. *Includes tree diagrams, sample space diagrams, Venn diagrams.*	c) Understand and be able to use conditional probability, including the use of tree diagrams, Venn diagrams and two-way tables. *Includes understanding and being able to use the notations:* $A \cap B$, $A \cup B$, $A \mid B$. *Includes understanding and being able to use the formulae:* $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B \mid A)$, $\mathrm{P}(A \cup B) = \mathrm{P}(A) + \mathrm{P}(B) - \mathrm{P}(A \cap B)$.	MM1 MM2
2.03d			d) Understand the concept of conditional probability, and calculate it from first principles in given contexts. *Includes understanding and being able to use the conditional probability formula* $\mathrm{P}(A \mid B) = \dfrac{\mathrm{P}(A \cap B)}{\mathrm{P}(B)}$. [*Use of this formula to find* $\mathrm{P}(A \mid B)$ *from* $\mathrm{P}(B \mid A)$ *is excluded.*]	
2.03e	Modelling with probability		e) Be able to model with probability, including critiquing assumptions made and the likely effect of more realistic assumptions.	MM3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.04 Statistical Distributions				
2.04a	Discrete probability distributions	a) Understand and be able to use simple, finite, discrete probability distributions, defined in the form of a table or a formula such as: $\mathrm{P}(X=x)=0.05x(x+1)$ for $x=1,2,3$. [*Calculation of mean and variance of discrete random variables is excluded*.]		MN1 MN2 MN3
2.04b 2.04d		b) Understand and be able to use the binomial distribution as a model.	d) Know and be able to use the formulae $\mu=np$ and $\sigma^2=npq$ when choosing a particular normal model to use as an approximation to a binomial model.	
2.04c		c) Be able to calculate probabilities using the binomial distribution, using appropriate calculator functions. *Includes understanding and being able to use the formula* $\mathrm{P}(X=x)=\binom{n}{x}p^x(1-p)^{n-x}$ *and the notation* $X\sim\mathrm{B}(n,p)$. *Learners should understand the conditions for a random variable to have a binomial distribution, be able to identify which of the modelling conditions (assumptions) is/are relevant to a given scenario and be able to explain them in context. They should understand the distinction between conditions and assumptions.*		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.04e 2.04f 2.04g	The normal distribution		e) Understand and be able to use the normal distribution as a model. *Includes understanding and being able to use the notation $X \sim \mathrm{N}(\mu, \sigma^2)$.* f) Be able to find probabilities using the normal distribution, using appropriate calculator functions. *This includes finding x, for a given normal variable, when $\mathrm{P}(X < x)$ is known.* *Learners should understand the standard normal distribution, Z, and the transformation $Z = \frac{X-\mu}{\sigma}$.* g) Understand links to histograms, mean and standard deviation. *Learners should know and be able to use the facts that in a normal distribution,* *1. about two-thirds of values lie in the range $\mu \pm \sigma$,* *2. about 95% of values lie in the range $\mu \pm 2\sigma$,* *3. almost all values lie in the range $\mu \pm 3\sigma$ and* *4. the points of inflection in a normal curve occur at $x = \mu \pm \sigma$.* [*The equation of the normal curve is excluded.*]	MN2
2.04h	Selecting an appropriate distribution		h) Be able to select an appropriate probability distribution for a context, with appropriate reasoning, including recognising when the binomial or normal model may not be appropriate. *Includes understanding that a given binomial distribution with large n can be approximated by a normal distribution.* [*Questions explicitly requiring calculations using the normal approximation to the binomial distribution are excluded.*]	MN2 MN3

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.05 Statistical Hypothesis Testing				
2.05a	The language of hypothesis testing	a) Understand and be able to use the language of statistical hypothesis testing, developed through a binomial model: null hypothesis, alternative hypothesis, significance level, test statistic, 1-tail test, 2-tail test, critical value, critical region, acceptance region, *p*-value. *Hypotheses should be stated in terms of parameter values (where relevant) and the meanings of symbols should be stated. For example,* *"* $\mathrm{H}_0: p = 0.7$*,* $\mathrm{H}_1: p \neq 0.7$*, where* p *is the population proportion in favour of the resolution".* *Conclusions should be stated in such a way as to reflect the fact that they are not certain. For example,* *"There is evidence at the 5% level to reject* H_0*. It is likely that the mean mass is less than 500 g."* *"There is no evidence at the 2% level to reject* H_0*. There is no reason to suppose that the mean journey time has changed."* *Some examples of incorrect conclusion are as follows:* *"* H_0 *is rejected. Waiting times have increased."* *"Accept* H_0*. Plants in this area have the same height as plants in other areas."*		MO1

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.05b 2.05c	Hypothesis test for the proportion in a binomial distribution	b) Be able to conduct a statistical hypothesis test for the proportion in the binomial distribution and interpret the results in context. c) Understand that a sample is being used to make an inference about the population and appreciate that the significance level is the probability of incorrectly rejecting the null hypothesis. *Learners should be able to use a calculator to find critical values.* *Includes understanding that, where the significance level of a test is specified, the probability of the test statistic being in the rejection region will always be less than or equal to this level.* [*The use of normal approximation is excluded*.]		MO2

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.05d	Hypothesis test for the mean of a normal distribution		d) Recognise that a sample mean, $\overline{X}$, can be regarded as a random variable. *Learners should know and be able to use the result that if* $X \sim \mathrm{N}(\mu, \sigma^2)$ *then* $\overline{X} \sim \mathrm{N}\left(\mu, \frac{\sigma^2}{n}\right)$. [*The proof is excluded.*]	MO3
2.05e			e) Be able to conduct a statistical hypothesis test for the mean of a normal distribution with known, given or assumed variance and interpret the results in context. *Learners should be able to use a calculator to find critical values, but standard tables of the percentage points will be provided in the assessment.* [*Test for the mean of a non-normal distribution is excluded.*] [*Estimation of population parameters from a sample is excluded*]	

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
2.05f 2.05g	Hypothesis test using Pearson's correlation coefficient		f) Understand Pearson's product-moment correlation coefficient as a measure of how close data points lie to a straight line. g) Use and be able to interpret Pearson's product-moment correlation coefficient in hypothesis tests, using either a given critical value or a *p*-value and a table of critical values. *When using Pearson's coefficient in an hypothesis test, the data may be assumed to come from a bivariate normal distribution.* *A table of critical values of Pearson's coefficient will be provided.* [*Calculation of correlation coefficients is excluded.*]	MO1

3 – Mechanics

When this course is being co-taught with AS Level Mathematics A (H230) the 'Stage 1' column indicates the common content between the two specifications and the 'Stage 2' column indicates content which is particular to this specification.

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.01 Quantities and Units in Mechanics				
3.01a	SI units	a) Understand and be able to use the fundamental quantities and units in the S.I. system: length (in metres), time (in seconds), mass (in kilograms). *Learners should understand that these three base quantities are mutually independent.*		MP1
3.01b 3.01c		b) Understand and be able to use derived quantities and units: velocity (m/s or m s^{-1}), acceleration (m/s^2 or m s^{-2}), force (N), weight (N). *Learners should be able to add the appropriate unit to a given quantity.*	c) Understand and be able to use the unit for moment (N m).	
3.02 Kinematics				
3.02a	Language of kinematics	a) Understand and be able to use the language of kinematics: position, displacement, distance, distance travelled, velocity, speed, acceleration, equation of motion. *Learners should understand the vector nature of displacement, velocity and acceleration and the scalar nature of distance travelled and speed.*		MQ1

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.02b 3.02c	Graphical representation	b) Understand, use and interpret graphs in kinematics for motion in a straight line. c) Be able to interpret displacement-time and velocity-time graphs, and in particular understand and be able to use the facts that the gradient of a displacement-time graph represents the velocity, the gradient of a velocity-time graph represents the acceleration, and the area between the graph and the time axis for a velocity-time graph represents the displacement.		MQ2
3.02d 3.02e	Constant acceleration	d) Understand, use and derive the formulae for constant acceleration for motion in a straight line: $v = u + at$ $s = ut + \frac{1}{2}at^2$ $s = \frac{1}{2}(u + v)t$ $v^2 = u^2 + 2as$ $s = vt - \frac{1}{2}at^2$ *Learners may be required to derive the constant acceleration formulae using a variety of techniques:* *1. by integration, e.g.* $v = \int a\,\mathrm{d}t \Rightarrow v = u + at$, *2. by using and interpreting appropriate graphs, e.g. velocity against time,* *3. by substitution of one (given) formula into another (given) formula, e.g. substituting* $v = u + at$ *into* $s = \frac{1}{2}(u + v)t$ *to obtain* $s = ut + \frac{1}{2}at^2$.	e) Be able to extend the constant acceleration formulae to motion in two dimensions using vectors: $\mathbf{v} = \mathbf{u} + \mathbf{a}t$ $\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$ $\mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$ $\mathbf{s} = \mathbf{v}t - \frac{1}{2}\mathbf{a}t^2$ *Questions set involving vectors may involve either column vector notation, e.g.* $\mathbf{u} = \begin{pmatrix} u_1 \\ u_2 \end{pmatrix}$ *or* $\mathbf{i}$, $\mathbf{j}$ *notation, e.g.* $\mathbf{u} = u_1\mathbf{i} + u_2\mathbf{j}$. [*The formula* $\mathbf{v}\cdot\mathbf{v} = \mathbf{u}\cdot\mathbf{u} + 2\mathbf{a}\cdot\mathbf{s}$ *is excluded.*]	MQ3

2

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.02f 3.02g	Non uniform acceleration	f) Be able to use differentiation and integration with respect to time in one dimension to solve simple problems concerning the displacement, velocity and acceleration of a particle: $v = \frac{\mathrm{d}s}{\mathrm{d}t}$ $a = \frac{\mathrm{d}v}{\mathrm{d}t} = \frac{\mathrm{d}^2 s}{\mathrm{d}t^2}$ $s = \int v\,\mathrm{d}t$ and $v = \int a\,\mathrm{d}t$	g) Be able to extend the application of differentiation and integration to two dimensions using vectors: $\mathbf{x} = \mathrm{f}(t)\mathbf{i} + \mathrm{g}(t)\mathbf{j}$ $\mathbf{v} = \frac{\mathrm{d}\mathbf{x}}{\mathrm{d}t} = \dot{\mathbf{x}} = \mathrm{f}'(t)\mathbf{i} + \mathrm{g}'(t)\mathbf{j}$ $\mathbf{a} = \frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t} = \dot{\mathbf{v}} = \frac{\mathrm{d}^2\mathbf{x}}{\mathrm{d}t^2} = \mathrm{f}''(t)\mathbf{i} + \mathrm{g}''(t)\mathbf{j}$ $\mathbf{x} = \int \mathbf{v}\,\mathrm{d}t$ and $\mathbf{v} = \int \mathbf{a}\,\mathrm{d}t$ *Questions set may involve either column vector or* $\mathbf{i}$, $\mathbf{j}$ *notation*.	MQ4

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.02h 3.02i	Gravity		h) Be able to model motion under gravity in a vertical plane using vectors where $\mathbf{a} = \begin{pmatrix} 0 \\ -g \end{pmatrix}$ or $\mathbf{a} = -g\mathbf{j}$. i) Be able to model the motion of a projectile as a particle moving with constant acceleration and understand the limitation of this model. *Includes being able to:* *1. Use horizontal and vertical equations of motion to solve problems on the motion of projectiles.* *2. Find the magnitude and direction of the velocity at a given time or position.* *3. Find the range on a horizontal plane and the greatest height achieved.* *4. Derive and use the cartesian equation of the trajectory of a projectile.* [*Projectiles on an inclined plane and problems with resistive forces are excluded.*]	MQ5

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.03 Forces and Newton's Laws				
3.03a	Newton's first law	a) Understand the concept and vector nature of a force. *A force has both a magnitude and direction and can cause an object with a given mass to change its velocity.* *Includes using directed line segments to represent forces (acting in at most two dimensions).* *Learners should be able to identify the forces acting on a system and represent them in a force diagram.*		MR1
3.03b		b) Understand and be able to use Newton's first law. *A particle that is at rest (or moving with constant velocity) will remain at rest (or moving with constant velocity) until acted upon by an external force.* *Learners should be able to complete a diagram with the force(s) required for a given body to remain in equilibrium.*		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.03c 3.03e 3.03d	Newton's second law	c) Understand and be able to use Newton's second law ($F = ma$) for motion in a straight line for bodies of constant mass moving under the action of constant forces. *e.g. A car moving along a road, a passenger riding in a lift or a crane lifting a weight.* *For stage 1 learners, examples can be restricted to problems in which the forces acting on the body will be collinear, in two perpendicular directions or given as 2-D vectors.* d) Understand and be able to use Newton's second law ($F = ma$) in simple cases of forces given as two dimensional vectors. *e.g. Find in vector form the force acting on a body of mass 2 kg when it is accelerating at* $(4\mathbf{i} - 3\mathbf{j})$ *m s*$^{-2}$. *Questions set involving vectors may involve either column vector notation* $\mathbf{F} = \begin{pmatrix} F_1 \\ F_2 \end{pmatrix}$ *or* $\mathbf{i}$, $\mathbf{j}$ *notation* $\mathbf{F} = F_1\mathbf{i} + F_2\mathbf{j}$.	e) Be able to extend use of Newton's second law to situations where forces need to be resolved (restricted to two dimensions). *e.g. A force acting downwards on a body at a given angle to the horizontal or the motion of a body projected down a line of greatest slope of an inclined plane.*	MR2

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.03f	Weight	f) Understand and be able to use the weight ($W = mg$) of a body to model the motion in a straight line under gravity. *e.g. A ball falling through the air.*		MR3
3.03g		g) Understand the gravitational acceleration, *g*, and its value in S.I. units to varying degrees of accuracy. *The value of g may be assumed to take a constant value of 9.8 ms* $^{-2}$ *but learners should be aware that g is not a universal constant but depends on location in the universe.* [*The inverse square law for gravitation is not required.*]		

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.03h 3.03l	Newton's third law	h) Understand and be able to use Newton's third law. *Every action has an equal and opposite reaction.* *Learners should understand and be able to use the concept that a system in which none of its components have any relative motion may be modelled as a single particle.*	l) Be able to extend use of Newton's third law to situations where forces need to be resolved (restricted to two dimensions).	MR4
3.03i		i) Understand and be able to use the concept of a normal reaction force. *Learners should understand and use the result that when an object is resting on a horizontal surface the normal reaction force is equal and opposite to the weight of the object. This includes knowing that when $R = 0$ contact is lost.*		
3.03j		j) Be able to use the model of a 'smooth' contact and understand the limitations of the model.		
3.03k 3.03m		k) Be able to use the concept of equilibrium together with one dimensional motion in a straight line to solve problems that involve connected particles and smooth pulleys. *e.g. A train engine pulling a train carriage(s) along a straight horizontal track or the vertical motion of two particles, connected by a light inextensible string passing over a fixed smooth peg or light pulley.*	m) Be able to use the principle that a particle is in equilibrium if and only if the sum of the resolved parts in a given direction is zero. *Problems may involve the resolving of forces, including cases where it is sensible to:* *1. resolve horizontally and vertically,* *2. resolve parallel and perpendicular to an inclined plane,* *3. resolve in directions to be chosen by the learner, or* *4. use a polygon of forces.*	

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.03n 3.03o	Newton's third law (continued)	n) Be able to solve problems involving simple cases of equilibrium of forces on a particle in two dimensions using vectors, including connected particles and smooth pulleys. *e.g. Finding the required force* $\mathbf{F}$ *for a particle to remain in equilibrium when under the action of forces* $\mathbf{F}_1, \mathbf{F}_2, \ldots$ *For stage 1 learners, examples can be restricted to problems in which the forces acting on the body will be collinear, in two perpendicular directions or given as 2-D vectors.*	o) Be able to resolve forces for more advanced problems involving connected particles and smooth pulleys. *e.g. The motion of two particles, connected by a light inextensible string passing over a light pulley placed at the top of an inclined plane.*	MR4
3.03p	Applications of vectors in a plane		p) Understand the term 'resultant' as applied to two or more forces acting at a point and be able to use vector addition in solving problems involving resultants and components of forces. *Includes understanding that the velocity vector gives the direction of motion and the acceleration vector gives the direction of resultant force.* *Includes being able to find and use perpendicular components of a force, for example to find the resultant of a system of forces or to calculate the magnitude and direction of a force.* [*Solutions will involve calculation, not scale drawing.*]	MR5

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.03q			q) Be able to solve problems involving the dynamics of motion for a particle moving in a plane under the action of a force or forces. *e.g. At time t s the force acting on a particle* P *of mass* 4 *kg is* $(4\mathbf{i} + t\mathbf{j})$ N. P *is initially at rest at the point with position vector* $(3\mathbf{i} - 5\mathbf{j})$. *Find the position vector of* P *when* $t = 3\,s$.	

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.03r 3.03s	Frictional forces	r) Understand the concept of a frictional force and be able to apply it in contexts where the force is given in vector or component form, or the magnitude and direction of the force are given.	s) Be able to represent the contact force between two rough surfaces by two components (the ‘normal’ contact force and the ‘frictional’ contact force). *Questions set will explicitly use the terms normal (contact) force, frictional (contact) force and magnitude of the contact force*.	MR6
3.03t			t) Understand and be able to use the coefficient of friction and the $F \leq \mu R$ model of friction in one and two dimensions, including the concept of limiting friction. [*Knowledge of the angle of friction is excluded.*]	
3.03u			u) Understand and be able to solve problems regarding the static equilibrium of a body on a rough surface and solve problems regarding limiting equilibrium.	
3.03v			v) Understand and be able to solve problems regarding the motion of a body on a rough surface. *e.g. The motion of a body projected down a line of greatest slope on a rough inclined plane*. [*Problems set on inclined planes will only consider motion along the line of greatest slope and therefore a vector consideration of the motion will not be required.*]	

OCR Ref.	Subject Content	Stage 1 learners should ...	Stage 2 learners additionally should ...	DfE Ref.
3.04 Moments				
3.04a	Statics		a) Be able to calculate the moment of a force about an axis through a point in the plane of the body. *For coplanar forces, moments may be described as being about a point.* [*Understanding of the vector nature of moments is excluded.*]	MS1
3.04b			b) Understand that when a rigid body is in equilibrium the resultant moment is zero and the resultant force is zero.	
3.04c			c) Be able to use moments in simple static contexts. *e.g. To determine the forces acting on a horizontal beam or to determine the forces acting on a ladder resting on horizontal ground against a vertical wall.* *Questions will be set in which the context of the problem can be modelled using rectangular laminas, uniform and non-uniform rods only.* *Learners may assume that:* *1. for a uniform rod the weight acts at the midpoint of the rod,* *2. for a non-uniform rod the weight acts at either a specified given point or is to be determined by moments,* *3. for a rectangular lamina the weight acts at its point of symmetry.*	

2g. Prior knowledge, learning and progression

- It is assumed that learners are familiar with the content of GCSE (9–1) Mathematics for first teaching from 2015.
- A Level Mathematics provides the framework within which a large number of young people continue the subject beyond GCSE (9–1) Level. It supports their mathematical needs across a broad range of other subjects at this level and provides a basis for subsequent quantitative work in a very wide range of higher education courses and in employment. It also supports the study of AS and A Level Further Mathematics.
- A Level Mathematics builds from GCSE (9–1) Level Mathematics and introduces calculus and its applications. It emphasises how mathematical ideas are interconnected and how mathematics can be applied to help make sense of data, to understand the physical world and to solve problems in a variety of contexts, including social sciences and business.
- A Level Mathematics prepares learners for further study and employment in a wide range of disciplines involving the use of mathematics, including STEM disciplines.
- Some learners may wish to follow a mathematics course only up to AS, in order to broaden their curriculum, and to develop their interest and understanding of different areas of the subject
- Learners who wish to extend their knowledge and understanding of mathematics and its applications can take Further Mathematics AS or A Level, and can choose to specialise in the particular aspect of mathematics that supports progression in their chosen higher education or employment pathway.

There are a number of Mathematics specifications at OCR. Find out more at www.ocr.org.uk

3 Assessment of A Level in Mathematics A

3a. Forms of assessment

OCR's A Level in Mathematics A consists of three components that are externally assessed.

All three components (01–03) contain some synoptic assessment, some extended response questions and some stretch and challenge questions.

Stretch and challenge questions are designed to allow the most able learners the opportunity to demonstrate the full extent of their knowledge and skills.

Stretch and challenge questions will support the awarding of A* grade at A Level, addressing the need for greater differentiation between the most able learners.

The set of assessments in any series will include at least one unstructured problem solving question which addresses multiple areas of the problem solving cycle as set out in the Overarching Themes.

The set of assessments in any series will include at least one extended problem solving question which addresses the first two bullets of assessment objective 3 in combination and at least one extended modelling question which addresses the last three bullets of assessment objective 3 in combination.

All examinations have a duration of 2 hours.

Learners are permitted to use a scientific or graphical calculator for all papers. Calculators are subject to the rules in the document Instructions for Conducting Examinations, published annually by JCQ (www.jcq.org.uk).

It is expected that calculators available in the assessment will include the following features:

- an iterative function such as an ANS key,
- the ability to compute summary statistics and access probabilities from the binomial and normal distributions.

Allowable calculators can be used for any function they can perform.

In each question paper, learners are expected to support their answers with appropriate working.

See section 2b for use of calculators.

Paper 1: Pure Mathematics (Component 01)

This component is worth 33⅓% of the total A Level. All questions are compulsory and there are 100 marks in total.

The paper assesses content from the Pure Mathematics section of the specification, in the context of the Overarching Themes.

The assessment has a gradient of difficulty throughout the paper and consists of a mix of short and long questions.

Paper 2: Pure Mathematics and Statistics (Component 02)

This component is worth 33⅓% of the total A Level. All questions are compulsory and there are 100 marks in total.

The paper assesses content from the Pure Mathematics and Statistics sections of the specification, in the context of the Overarching Themes.

The assessment is structured in two sections of approximately 50 marks each: Pure Mathematics, and Statistics. Each section has a gradient of difficulty throughout the section and consists of a mix of short and long questions.

Some of the assessment items which target the statistics section of the content will be set in the context of the pre-release large data set and will assume familiarity with the key features of that data set.

3

Paper 3: Pure Mathematics and Mechanics (Component 03)

This component is worth 33⅓% of the total A Level. All questions are compulsory and there are 100 marks in total.

The paper assesses content from the Pure Mathematics and Mechanics sections of the specification, in the context of the Overarching Themes.

The assessment is structured in two sections of approximately 50 marks each: Pure Mathematics, and Mechanics. Each section has a gradient of difficulty throughout the section and consists of a mix of short and long questions.

3b. Assessment Objectives (AO)

There are three Assessment Objectives in OCR A Level in Mathematics A. These are detailed in the table below.

	Assessment Objectives	Weightings
		A Level
AO1	**Use and apply standard techniques** Learners should be able to: • select and correctly carry out routine procedures; and • accurately recall facts, terminology and definitions.	50% (±2%)
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; and • use mathematical language and notation correctly. *Where questions/tasks targeting this assessment objective will also credit Learners for the ability to 'use and apply standard techniques' (AO1) and/or to 'solve problems within mathematics and other contexts' (AO3) an appropriate proportion of the marks for the question/task must be attributed to the corresponding assessment objective(s).*	25% (±2%)
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; and • 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 Learners 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).*	25% (±2%)

3

AO weightings in A Level in Mathematics A

The relationship between the Assessment Objectives and the components are shown in the following table:

Component	% of overall A Level in Mathematics A (H240)		
	AO1	AO2	AO3
(H240/01) Pure Mathematics	47–53 marks	25–29 marks	18–28 marks
(H240/02) Pure Mathematics and Statistics	47–53 marks	23–27 marks	20–30 marks
(H240/03) Pure Mathematics and Mechanics	47–53 marks	21–25 marks	22–32 marks
Total	48–52%	23–27%	23–27%

More variation is allowed per paper than across the full set of assessments to allow for flexibility in individual assessment design while retaining consistent weightings over time.

3c. Assessment availability

There will be one examination series available each year in May/June to **all** learners.

All examined components must be taken in the same examination series at the end of the course.

This specification will be certificated from the June 2018 examination series onwards.

3d. Retaking the qualification

Learners can retake the qualification as many times as they wish. They must retake all components of the qualification.

3e. Assessment of extended response

The assessment materials for this qualification provide learners with the opportunity to demonstrate their ability to construct and develop a sustained and coherent line of reasoning and marks for extended responses are integrated into the marking criteria. Tasks which offer this opportunity will be found across all three components.

3f. Synoptic assessment

Mathematics is, by nature, a synoptic subject. The assessment in this specification allows learners to demonstrate the understanding they have acquired from the course as a whole and their ability to integrate and apply that understanding. This level of understanding is needed for successful use of the knowledge and skills from this course in future life, work and study.

In the examination papers, learners will be required to integrate and apply their understanding in order to address problems which require both breadth and depth of understanding in order to reach a satisfactory solution.

Learners will be expected to reflect on and interpret solutions, drawing on their understanding of different aspects of the course.

Tasks which offer this opportunity will be found across all three components.

3g. Calculating qualification results

A learner's overall qualification grade for A Level in Mathematics A will be calculated by adding together their marks from the three components taken to give their total mark. This mark will then be compared to the qualification level grade boundaries for the relevant exam series to determine the learner's overall qualification grade.

4 Admin: what you need to know

The information in this section is designed to give an overview of the processes involved in administering this qualification so that you can speak to your exams officer. All of the following processes require you to submit something to OCR by a specific deadline.

More information about the processes and deadlines involved at each stage of the assessment cycle can be found in the Administration area of the OCR website.

OCR's *Admin overview* is available on the OCR website at http://www.ocr.org.uk/administration

4a. Pre-assessment

Estimated entries

Estimated entries are your best projection of the number of learners who will be entered for a qualification in a particular series. Estimated entries should be submitted to OCR by the specified deadline. They are free and do not commit your centre in any way.

4

Final entries

Final entries provide OCR with detailed data for each learner, showing each assessment to be taken. It is essential that you use the correct entry code, considering the relevant entry rules.

Final entries must be submitted to OCR by the published deadlines or late entry fees will apply.

All learners taking an A Level in Mathematics A must be entered for H240.

Entry code	Title	Component code	Component title	Assessment type
H240	Mathematics A	01	Pure Mathematics	External Assessment
		02	Pure Mathematics and Statistics	External Assessment
		03	Pure Mathematics and Mechanics	External Assessment

4b. Special consideration

Special consideration is a post–assessment adjustment to marks or grades to reflect temporary injury, illness or other indisposition at the time the assessment was taken.

Detailed information about eligibility for special consideration can be found in the JCQ publication *A guide to the special consideration process.*

4c. External assessment arrangements

Regulations governing examination arrangements are contained in the JCQ *Instructions for conducting examinations*

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Head of centre annual declaration

The Head of Centre is required to provide a declaration to the JCQ as part of the annual NCN update, conducted in the autumn term, to confirm that the centre is meeting all of the requirements detailed in the specification. Any failure by a centre to provide the Head of Centre Annual Declaration will result in your centre status being suspended and could lead to the withdrawal of our approval for you to operate as a centre.

Private candidates

Private candidates may enter for OCR assessments.

A private candidate is someone who pursues a course of study independently but takes an examination or assessment at an approved examination centre. A private candidate may be a part-time student, someone taking a distance learning course, or someone being tutored privately. They must be based in the UK.

Private candidates need to contact OCR approved centres to establish whether they are prepared to host them as a private candidate. The centre may charge for this facility and OCR recommends that the arrangement is made early in the course.

Further guidance for private candidates may be found on the OCR website: http://www.ocr.org.uk

4d. Results and certificates

Grade Scale

A Level qualifications are graded on the scale: A*, A, B, C, D, E, where A* is the highest. Learners who fail to reach the minimum standard for E will be Unclassified (U). Only subjects in which grades A* to E are attained will be recorded on certificates.

4

Results

Results are released to centres and learners for information and to allow any queries to be resolved before certificates are issued.

Centres will have access to the following results information for each learner:

- the grade for the qualification
- the raw mark for each component
- the total mark for the qualification.

The following supporting information will be available:

- raw mark grade boundaries for each component
- mark grade boundaries for the qualification.

Until certificates are issued, results are deemed to be provisional and may be subject to amendment.

A learner's final results will be recorded on an OCR certificate. The qualification title will be shown on the certificate as 'OCR Level 3 Advanced GCE in Mathematics A'.

4e. Post-results services

A number of post-results services are available:

- **Review of marking** – If you are not happy with the outcome of a learner's results, centres may request a review of marking. Full details of the post-results services are provided on the OCR website.
- **Missing and incomplete results** – This service should be used if an individual subject result for a learner is missing, or the learner has been omitted entirely from the results supplied.
- **Access to scripts** – Centres can request access to marked scripts.

4f. Malpractice

Any breach of the regulations for the conduct of examinations and non-exam assessment work may constitute malpractice (which includes maladministration) and must be reported to OCR as soon as it is detected.

Detailed information on malpractice can be found in the JCQ publication *Suspected Malpractice in Examinations and Assessments: Policies and Procedures*.

5 Appendices

5a. Overlap with other qualifications

This qualification overlaps with OCR's AS Level Mathematics A and with other specifications in A Level Mathematics and AS Level Mathematics.

5b. Accessibility

Reasonable adjustments and access arrangements allow learners with special educational needs, disabilities or temporary injuries to access the assessment and show what they know and can do, without changing the demands of the assessment. Applications for these should be made before the examination series. Detailed information about eligibility for access arrangements can be found in the JCQ *Access Arrangements and Reasonable Adjustments.*

The A Level qualification and subject criteria have been reviewed in order to identify any feature which could disadvantage learners who share a protected Characteristic as defined by the Equality Act 2010. All reasonable steps have been taken to minimise any such disadvantage.

5c. Mathematical notation

The table below sets out the notation that may be used in A Level Mathematics A. Students will be expected to understand this notation without need for further explanation.

1	**Set Notation**	
1.1	$\in$	is an element of
1.2	$\notin$	is not an element of
1.3	$\subseteq$	is a subset of
1.4	$\subset$	is a proper subset of
1.5	$\{x_1,\ x_2,\ \ldots\}$	the set with elements $x_1,\ x_2,\ \ldots$
1.6	$\{x : \ldots\}$	the set of all x such that $\ldots$
1.7	$\mathrm{n}(A)$	the number of elements in set A
1.8	$\varnothing$	the empty set
1.9	ε	the universal set
1.10	A'	the complement of the set A
1.11	$\mathbb{N}$	the set of natural numbers, $\{1,\ 2,\ 3,\ \ldots\}$
1.12	$\mathbb{Z}$	the set of integers, $\{0,\ \pm1,\ \pm2,\ \pm3,\ \ldots\}$
1.13	$\mathbb{Z}^+$	the set of positive integers, $\{1,\ 2,\ 3,\ \ldots\}$
1.14	$\mathbb{Z}_0^+$	the set of non-negative integers, $\{0, 1, 2, 3, \ldots\}$
1.15	$\mathbb{R}$	the set of real numbers
1.16	$\mathbb{Q}$	the set of rational numbers, $\left\{\frac{p}{q} : p \in \mathbb{Z},\ q \in \mathbb{Z}^+\right\}$
1.17	$\cup$	union
1.18	$\cap$	intersection
1.19	$(x,\ y)$	the ordered pair x, y
1.20	$[a,\ b]$	the closed interval $\{x \in \mathbb{R} : a \le x \le b\}$
1.21	$[a,\ b)$	the interval $\{x \in \mathbb{R} : a \le x < b\}$
1.22	$(a,\ b]$	the interval $\{x \in \mathbb{R} : a < x \le b\}$
1.23	$(a,\ b)$	the open interval $\{x \in \mathbb{R} : a < x < b\}$
2	**Miscellaneous Symbols**	
2.1	$=$	is equal to
2.2	$\neq$	is not equal to

2.3	$\equiv$	is identical to or is congruent to
2.4	$\approx$	is approximately equal to
2.5	∞	infinity
2.6	$\propto$	is proportional to
2.7	$\therefore$	therefore
2.8	$\because$	because
2.9	$<$	is less than
2.10	$\leqslant, \leq$	is less than or equal to, is not greater than
2.11	$>$	is greater than
2.12	$\geqslant, \geq$	is greater than or equal to, is not less than
2.13	$p \Rightarrow q$	p implies q (if p then q)
2.14	$p \Leftarrow q$	p is implied by q (if q then p)
2.15	$p \Leftrightarrow q$	p implies and is implied by q (p is equivalent to q)
2.16	a	first term for an arithmetic or geometric sequence
2.17	l	last term for an arithmetic sequence
2.18	d	common difference for an arithmetic sequence
2.19	r	common ratio for a geometric sequence
2.20	S_n	sum to n terms of a sequence
2.21	S_∞	sum to infinity of a sequence
3	**Operations**	
3.1	$a + b$	a plus b
3.2	$a - b$	a minus b
3.3	$a \times b,\ ab,\ a.b$	a multiplied by b
3.4	$a \div b, \dfrac{a}{b}$	a divided by b
3.5	$\sum_{i=1}^{n} a_i$	$a_1 + a_2 + \ldots + a_n$
3.6	$\prod_{i=1}^{n} a_i$	$a_1 \times a_2 \times \ldots \times a_n$
3.7	$\sqrt{a}$	the non-negative square root of a
3.8	$\lvert a \rvert$	the modulus of a
3.9	$n!$	n factorial: $n! = n \times (n-1) \times \ldots \times 2 \times 1,\ n \in \mathbb{N};\ 0! = 1$

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3.10	$\binom{n}{r}$, ${}^nC_r$, ${}_nC_r$	the binomial coefficient $\frac{n!}{r!\,(n-r)!}$ for $n, r \in \mathbb{Z}_0^+, r \leqslant n$ or $\frac{n(n-1)\ldots(n-r+1)}{r!}$ for $n \in \mathbb{Q}, r \in \mathbb{Z}_0^+$
4	**Functions**	
4.1	$\mathrm{f}(x)$	the value of the function f at x
4.2	$\mathrm{f}: x \mapsto y$	the function f maps the element x to the element y
4.3	f^{-1}	the inverse function of the function f
4.4	gf	the composite function of f and g which is defined by $\mathrm{gf}(x) = \mathrm{g}(\mathrm{f}(x))$
4.5	$\lim_{x \to a} \mathrm{f}(x)$	the limit of $\mathrm{f}(x)$ as x tends to a
4.6	Δx, δx	an increment of x
4.7	$\frac{\mathrm{d}y}{\mathrm{d}x}$	the derivative of y with respect to x
4.8	$\frac{\mathrm{d}^n y}{\mathrm{d}x^n}$	the nth derivative of y with respect to x
4.9	$\mathrm{f}'(x),\ \mathrm{f}''(x),\ \ldots,\ \mathrm{f}^{(n)}(x)$	the first, second, ..., n^{th} derivatives of $\mathrm{f}(x)$ with respect to x
4.10	$\dot{x},\ \ddot{x},\ \ldots$	the first, second, ... derivatives of x with respect to t
4.11	$\int y\,\mathrm{d}x$	the indefinite integral of y with respect to x
4.12	$\int_a^b y\,\mathrm{d}x$	the definite integral of y with respect to x between the limits $x = a$ and $x = b$
5	**Exponential and Logarithmic Functions**	
5.1	e	base of natural logarithms
5.2	e^x, $\exp x$	exponential function of x
5.3	$\log_a x$	logarithm to the base a of x
5.4	$\ln x$, $\log_\mathrm{e} x$	natural logarithm of x
6	**Trigonometric Functions**	
6.1	$\left.\begin{matrix}\sin, \cos, \tan \\ \operatorname{cosec}, \sec, \cot\end{matrix}\right\}$	the trigonometric functions
6.2	$\left.\begin{matrix}\sin^{-1}, \cos^{-1}, \tan^{-1} \\ \arcsin,\ \arccos,\ \arctan\end{matrix}\right\}$	the inverse trigonometric functions
6.3	$^\circ$	degrees
6.4	rad	radians

9	Vectors	
9.1	$\mathbf{a}$, $\underline{a}$, $\underset{\sim}{a}$	the vector $\mathbf{a}$, $\underline{a}$, $\underset{\sim}{a}$; these alternatives apply throughout section 9
9.2	$\overrightarrow{\mathrm{AB}}$	the vector represented in magnitude and direction by the directed line segment AB
9.3	$\hat{\mathbf{a}}$	a unit vector in the direction of $\mathbf{a}$
9.4	$\mathbf{i}, \mathbf{j}, \mathbf{k}$	unit vectors in the directions of the cartesian coordinate axes
9.5	$\lvert \mathbf{a} \rvert,\ a$	the magnitude of $\mathbf{a}$
9.6	$\lvert \overrightarrow{\mathrm{AB}} \rvert$, AB	the magnitude of $\overrightarrow{\mathrm{AB}}$
9.7	$\begin{pmatrix} a \\ b \end{pmatrix},\ a\mathbf{i}+b\mathbf{j}$	column vector and corresponding unit vector notation
9.8	$\mathbf{r}$	position vector
9.9	$\mathbf{s}$	displacement vector
9.10	$\mathbf{v}$	velocity vector
9.11	$\mathbf{a}$	acceleration vector
11	**Probability and Statistics**	
11.1	$A,\ B,\ C,$ etc.	events
11.2	$A \cup B$	union of the events A and B
11.3	$A \cap B$	intersection of the events A and B
11.4	$\mathrm{P}(A)$	probability of the event A
11.5	A'	complement of the event A
11.6	$\mathrm{P}(A \mid B)$	probability of the event A conditional on the event B
11.7	$X,\ Y,\ R,$ etc.	random variables
11.8	$x,\ y,\ r,$ etc.	values of the random variables $X,\ Y,\ R$ etc.
11.9	$x_1,\ x_2,\ \ldots$	values of observations
11.10	$f_1,\ f_2,\ \ldots$	frequencies with which the observations $x_1,\ x_2,\ \ldots$ occur
11.11	$\mathrm{p}(x)$, $\mathrm{P}(X=x)$	probability function of the discrete random variable X
11.12	$p_1,\ p_2,\ \ldots$	probabilities of the values $x_1,\ x_2,\ \ldots$ of the discrete random variable X
11.13	$\mathrm{E}(X)$	expectation of the random variable X
11.14	$\mathrm{Var}(X)$	variance of the random variable X

11.15	$\sim$	has the distribution
11.16	$\mathrm{B}(n,\ p)$	binomial distribution with parameters n and p, where n is the number of trials and p is the probability of success in a trial
11.17	q	$q = 1 - p$ for binomial distribution
11.18	$\mathrm{N}(\mu,\ \sigma^2)$	Normal distribution with mean μ and variance σ^2
11.19	$Z \sim N(0, 1)$	standard Normal distribution
11.20	ϕ	probability density function of the standardised Normal variable with distribution $\mathrm{N}(0,\ 1)$
11.21	Φ	corresponding cumulative distribution function
11.22	μ	population mean
11.23	σ^2	population variance
11.24	σ	population standard deviation
11.25	$\overline{x}$	sample mean
11.26	s^2	sample variance
11.27	s	sample standard deviation
11.28	H_0	Null hypothesis
11.29	H_1	Alternative hypothesis
11.30	r	product moment correlation coefficient for a sample
11.31	ρ	product moment correlation coefficient for a population
12		**Mechanics**
12.1	kg	kilograms
12.2	m	metres
12.3	km	kilometres
12.4	$\mathrm{m/s},\ \mathrm{m\,s^{-1}}$	metres per second (velocity)
12.5	$\mathrm{m/s^2},\ \mathrm{m\,s^{-2}}$	metres per second per second (acceleration)
12.6	F	Force or resultant force
12.7	N	Newton
12.8	N m	Newton metre (moment of a force)
12.9	t	time
12.10	s	displacement
12.11	u	initial velocity
12.12	v	velocity or final velocity

12.13	a	acceleration
12.14	g	acceleration due to gravity
12.15	μ	coefficient of friction

5d. Mathematical formulae and identities

Learners must be able to use the following formulae and identities for A Level mathematics, without these formulae and identities being provided, either in these forms or in equivalent forms. These formulae and identities may only be provided where they are the starting point for a proof or as a result to be proved.

Pure Mathematics

Quadratic Equations

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

Laws of Indices

$a^x a^y \equiv a^{x+y}$

$a^x \div a^y \equiv a^{x-y}$

$(a^x)^y \equiv a^{xy}$

Laws of Logarithms

$x = a^n \Leftrightarrow n = \log_a x$ for $a > 0$ and $x > 0$

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

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

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

Coordinate Geometry

A straight line graph, gradient m passing through (x_1, y_1) has equation

$y - y_1 = m(x - x_1)$

Straight lines with gradients m_1 and m_2 are perpendicular when $m_1 m_2 = -1$

Sequences

General term of an arithmetic progression:

$u_n = a + (n-1)d$

General term of a geometric progression:

$u_n = ar^{n-1}$

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Trigonometry

In the triangle ABC

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

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

Area $= \frac{1}{2}ab\sin C$

$\cos^2 A + \sin^2 A \equiv 1$

$\sec^2 A \equiv 1 + \tan^2 A$

$\operatorname{cosec}^2 A \equiv 1 + \cot^2 A$

$\sin 2A \equiv 2\sin A\cos A$

$\cos 2A \equiv \cos^2 A - \sin^2 A$

$\tan 2A \equiv \dfrac{2\tan A}{1 - \tan^2 A}$

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Mensuration

Circumference and Area of circle, radius r and diameter d:

$C = 2\pi r = \pi d \qquad A = \pi r^2$

Pythagoras' Theorem: In any right-angled triangle where a, b and c are the lengths of the sides and c is the hypotenuse:

$c^2 = a^2 + b^2$

Area of a trapezium = $\frac{1}{2}(a+b)h$, where a and b are the lengths of the parallel sides and h is their perpendicular separation.

Volume of a prism = area of cross section × length

For a circle of radius r, where an angle at the centre of θ radians subtends an arc of length s and encloses an associated sector of area A:

$s = r\theta \qquad A = \frac{1}{2}r^2\theta$

Calculus and Differential Equations

<u>Differentiation</u>

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

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}	$\frac{1}{k}\mathrm{e}^{kx}+c$
$\frac{1}{x}$	$\ln\lvert x\rvert+c,\ x\neq 0$
$\mathrm{f}'(x)+\mathrm{g}'(x)$	$\mathrm{f}(x)+\mathrm{g}(x)+c$
$\mathrm{f}'(\mathrm{g}(x))\mathrm{g}'(x)$	$\mathrm{f}(\mathrm{g}(x))+c$

Area under a curve $=\int_a^b y\,\mathrm{d}x\ (y\geq 0)$

Vectors

$\lvert x\mathbf{i}+y\mathbf{j}\rvert=\sqrt{x^2+y^2}$

$\lvert x\mathbf{i}+y\mathbf{j}+z\mathbf{k}\rvert=\sqrt{x^2+y^2+z^2}$

Mechanics

Forces and Equilibrium

Weight = $\text{mass}\times g$

Friction: $F\leq \mu R$

Newton's second law in the form: $F=ma$

Kinematics

For motion in a straight line with variable acceleration:

$v=\frac{\mathrm{d}r}{\mathrm{d}t}$ $\quad a=\frac{\mathrm{d}v}{\mathrm{d}t}=\frac{\mathrm{d}^2r}{\mathrm{d}t^2}$

$r=\int v\,\mathrm{d}t$ $\quad v=\int a\,\mathrm{d}t$

$v=\frac{\mathrm{d}s}{\mathrm{d}t}$ $\quad a=\frac{\mathrm{d}v}{\mathrm{d}t}=\frac{\mathrm{d}^2s}{\mathrm{d}t^2}$

$r=\int v\,\mathrm{d}t$ $\quad v=\int a\,\mathrm{d}t$

Statistics

The mean of a set of data: $\bar{x}=\frac{\sum x}{n}=\frac{\sum fx}{\sum f}$

The standard Normal variable: $Z=\frac{X-\mu}{\sigma}$ where $X\sim N(\mu,\sigma^2)$

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Learners will be given the following formulae sheet in each question paper.

Formulae
A Level Mathematics A (H240)

Arithmetic series

$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n\{2a+(n-1)d\}$

Geometric series

$$S_n = \frac{a(1-r^n)}{1-r}$$

$$S_\infty = \frac{a}{1-r} \quad \text{for } |r| < 1$$

Binomial series

$$(a+b)^n = a^n + {}^nC_1\, a^{n-1}b + {}^nC_2\, a^{n-2}b^2 + \ldots + {}^nC_r\, a^{n-r}b^r + \ldots + b^n \qquad (n \in \mathbb{N}),$$

where ${}^{\mathrm{n}}\mathrm{C}_{\mathrm{r}} = {}_{\mathrm{n}}\mathrm{C}_{\mathrm{r}} = \binom{n}{r} = \dfrac{n!}{r!\,(n-r)!}$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \ldots + \frac{n(n-1)\ldots(n-r+1)}{r!}x^r + \ldots \qquad (|x| < 1,\ \ n \in \mathbb{R})$$

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Differentiation

$f(x)$	$f'(x)$
$\tan kx$	$k\sec^2 kx$
$\sec x$	$\sec x \tan x$
$\cot x$	$-\operatorname{cosec}^2 x$
$\operatorname{cosec} x$	$-\operatorname{cosec} x \cot x$

Quotient Rule $y = \dfrac{u}{v}$, $\dfrac{dy}{dx} = \dfrac{v\dfrac{du}{dx} - u\dfrac{dv}{dx}}{v^2}$

Differentiation from first principles

$$f'(x) = \lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

Integration

$$\int \frac{f'(x)}{f(x)}\,dx = \ln|f(x)| + c$$

$$\int f'(x)(f(x))^n\,dx = \frac{1}{n+1}(f(x))^{n+1} + c$$

Integration by parts $\int u\frac{\mathrm{d}v}{\mathrm{d}x}\mathrm{d}x = uv - \int v\frac{\mathrm{d}u}{\mathrm{d}x}\mathrm{d}x$

Small angle approximations

$\sin\theta \approx \theta$, $\cos\theta \approx 1 - \frac{1}{2}\theta^2$, $\tan\theta \approx \theta$ where θ is measured in radians

Trigonometric identities

$\sin(A \pm B) = \sin A\cos B \pm \cos A\sin B$

$\cos(A \pm B) = \cos A\cos B \mp \sin A\sin B$

$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B} \qquad (A \pm B \neq (k + \frac{1}{2})\pi)$

Numerical methods

Trapezium rule: $\int_a^b y\,\mathrm{d}x \approx \frac{1}{2}h\{(y_0 + y_n) + 2(y_1 + y_2 + \ldots + y_{n-1})\}$, where $h = \frac{b-a}{n}$

The Newton-Raphson iteration for solving $\mathrm{f}(x) = 0 : x_{n+1} = x_n - \frac{\mathrm{f}(x_n)}{\mathrm{f}'(x_n)}$

Probability

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

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

Standard deviation

$\sqrt{\frac{\Sigma(x-\overline{x})^2}{n}} = \sqrt{\frac{\Sigma x^2}{n} - \overline{x}^2}$ **or** $\sqrt{\frac{\Sigma f(x-\overline{x})^2}{\Sigma f}} = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \overline{x}^2}$

The binomial distribution

If $X \sim \mathrm{B}(n, p)$ then $P(X = x) = \binom{n}{x}p^x(1-p)^{n-x}$, Mean of X is np, Variance of X is $np(1-p)$

Hypothesis test for the mean of a normal distribution

If $X \sim N(\mu, \sigma^2)$ then $\overline{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$ and $\frac{\overline{X} - \mu}{\sigma/\sqrt{n}} \sim \mathrm{N}(0,1)$

Percentage points of the normal distribution

If Z has a normal distribution with mean 0 and variance 1 then, for each value of p, the table gives the value of z such that $P(Z \leq z) = p$.

p	0.75	0.90	0.95	0.975	0.99	0.995	0.9975	0.999	0.9995
z	0.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Kinematics

Motion in a straight line	Motion in two dimensions
$v = u + at$	$\mathbf{v} = \mathbf{u} + \mathbf{a}t$
$s = ut + \frac{1}{2}at^2$	$\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$
$s = \frac{1}{2}(u + v)t$	$\mathbf{s} = \frac{1}{2}(\mathbf{u} + \mathbf{v})t$
$v^2 = u^2 + 2as$	
$s = vt - \frac{1}{2}at^2$	$\mathbf{s} = \mathbf{v}t - \frac{1}{2}\mathbf{a}t^2$

Summary of updates

Date	Version	Section	Title of section	Change
June 2018	1.1	Front cover	Disclaimer	Addition of Disclaimer
October 2018	2.0	Multiple		Revised sections 1 and 2 with new subsections focusing on key features and command words. Correction of minor typographical errors. No changes have been made to any assessment requirements.
January 2020	2.1	Back cover	NA	Delete reference to Social Community and replace with Online Support Centre

YOUR CHECKLIST

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