A-level Mathematics/Further Mathematics Introduction to the New Specification

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- General approach
- Structure
- Assessment
- Content (further maths only)
- Resources and support

APPROACH

Background

- Maths and Further Maths has not changed since 2004
- The move to linear qualifications, announced in June 2012, meant that the subjects would need to be redeveloped
- Students were entering Higher Education having taken many different routes and lacking skills in the use of technology
- Number of different routes difficult to compare
- A-Level Content Advisory Board (ALCAB) formed to decide content, common to all exam boards
- Defined content for AS and A-level Maths and 50% for AS and A-level Further Maths

Key changes

- A-levels no longer modular
- AS will be a stand-alone qualification
- Redevelopment needed to better prepare students for higher education
- Input from higher education throughout the process
- Large data set in AS/A-level Maths
- Prescribed content from the DfE for Maths and partly for Further Maths, confirmed in December 2014
- The UCAS tariff has changed so that an AS is now worth approximately 40% of an A-level

Key features of the new Maths A-level generally

Key features

- The content has been defined for us by the DfE – this is common across all exam boards.
- The content for both AS and A-level splits approximately into two-thirds Pure content, one-sixth Mechanics content and one-sixth Statistics.
- There is no Decision featured in this defined content.
- The AS no longer contributes to the A-level, it is a separate qualification.
- First exam for AS **and** A-level Maths will be summer 2018.

AQA's philosophy

- Top priority: Assessment that will encourage good teaching of mathematics
- Applications with Pure Maths embedded
- Holistic, non-modular approach to mathematics
- Problem solving and modelling central

Targets

- Clarity for teachers/ease of delivery in classrooms
- Confidence building for students
- Further Maths optionality - to suit needs of Higher Education, teacher preferences and sizes of centres - without loss of holistic approach

Key features of our development

- We have chosen an assessment time of 3 hours for AS and 6 hours for A-level.
- Exams of no more than 2 hours
- We have split the applications by sections in papers.
- Question papers/sections ramp up in difficulty throughout
- We have allowed calculators in all papers.
- We have chosen multiple choice questions to ease the student in.
- We have decreased the number of words used in our questions
- Our papers look a little different – answer space now directly beneath the question

STRUCTURE

Our A-level Maths structure (Content 100% prescribed)

3 papers, 6 hours assessment time

Paper 1: Pure	+	Paper 2: Pure and Mechanics	+	Paper 3: Pure and Statistics
2 hours 100 marks		2 hours 100 marks (two sections of 50 marks)		2 hours 100 marks (two sections of 50 marks)
Assesses the following content **only**		**May** assess the following: Any content from Paper 1		**May** assess the following: Any content from Paper 1
(A) Proof (B) Algebra and functions (C) Coordinate Geometry (D) Sequences and series (E) Trigonometry (F) Exponentials and logarithms (G) Differentiation (H) Integration (I) Numerical Methods		**Will** assess the following: (J) Vectors (P) Quantities and units in mechanics (Q) Kinematics (R) Forces and Newton's laws (S) Moments		**Will** assess the following: (K) Statistical sampling (L) Data presentation and interpretation (M) Probability (N) Statistical distributions (O) Statistical hypothesis testing

Our AS Maths structure

2 papers, 3 hours assessment time

Paper 1: Pure and Mechanics 1 hour 30 minutes 80 marks (two unequal sections, Pure larger section)	+	Paper 2: Pure and Statistics 1 hour 30 minutes 80 marks (two unequal sections, Pure larger section)

Assesses the following content **only**

(A) Proof
(B) Algebra and functions
(C) Coordinate Geometry
(D) Sequences and series
(E) Trigonometry
(F) Exponentials and logarithms
(G) Differentiation
(H) Integration

(J) Vectors
(P) Quantities and units in mechanics
(Q) Kinematics
(R) Forces and Newton's laws

Assesses the following content **only**

(A) Proof
(B) Algebra and functions
(C) Coordinate Geometry
(D) Sequences and series
(E) Trigonometry
(F) Exponentials and logarithms
(G) Differentiation
(H) Integration

(K) Statistical sampling
(L) Data presentation and interpretation
(M) Probability
(N) Statistical distributions
(O) Statistical hypothesis testing

Our A-level Further Maths structure

3 papers, 6 hours assessment time

Paper 1: Compulsory content

2 hours

100 marks

+

Paper 2: Compulsory content

2 hours

100 marks

+

Paper 3: Discrete and Statistics

2 hours
100 marks
(two sections of 50 marks)

or

Paper 3: Statistics and Mechanics

2 hours
100 marks
(two sections of 50 marks)

or

Paper 3: Mechanics and Discrete

2 hours
100 marks
(two sections of 50 marks)

Our AS Further Maths structure

2 papers, 3 hours assessment time

Paper 1: Compulsory content

1 hour 30 minutes
80 marks

+

Paper 2: Discrete and Statistics

1 hour 30 minutes
80 marks
(two sections of 40 marks)

or

Paper 2: Statistics and Mechanics

1 hour 30 minutes
80 marks
(two sections of 40 marks)

or

Paper 2: Mechanics and Discrete

1 hour 30 minutes
80 marks
(two sections of 40 marks)

ASSESSMENT

Overarching themes from the DfE

1. Mathematical argument, language and proof

2. Mathematical problem solving

3. Mathematical modelling

The whole assessment is set within the context of the overarching themes.

Assessment Objectives

Assessment Objective	Weighting			
	AS Maths	A-level Maths	AS Further Maths	A-level Further Maths
AO1 Use and apply standard techniques	60%	50%	60%	50%
AO2 Reason, interpret and communicate mathematically	20%	25%	At least 10%	At least 15%
AO3 Solve problems within mathematics and in other contexts	20%	25%	At least 10%	At least 15%

Assessment Objective 3

AO3: Solve problems within mathematics and in other contexts **Learners should be able to:** ▪ **translate problems in mathematical and non-mathematical contexts into mathematical processes** ▪ **interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations** ▪ **translate situations in context into mathematical models** ▪ **use mathematical models** ▪ **evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them**			*25% (A level)* *20% (AS)*
Strands	**Elements**	**Coverage**	**Interpretation and definitions**
2 – interpret solutions to problems in their original context, and, where appropriate evaluate their accuracy and limitations	2a – interpret solutions to problems in their original context 2b – where appropriate, evaluate [the] accuracy and limitations [of solutions to problems]	reasonably practicable (but not necessarily in every set of assessments). ▪ Taken together, strands 1 and 2 should comprise at least 40% of the marks for this	▪ Within strand 3, the context may be either mathematical or non-mathematical. ▪ A problem-solving question/task would typically exhibit[2] one or more of the following attributes – ▫ Little or no scaffolding – the Learner receives little guidance beyond a start point and a finish point, and the mathematical processes required for the solution are not explicitly stated ▫ Provision for multiple representations (such as the use of a sketch or diagram as well as calculations)

Problem solving – some examples

6 A parallelogram has sides of length 6 cm and 4.5 cm.

The larger interior angles of the parallelogram have size α

Given that the area of the parallelogram is 24 cm^2, find the exact value of $\tan \alpha$

[4 marks]

Q	Marking Instructions	AO	Marks	Typical Solution
6	Translates given information into an equation by using the formula for the area of triangle or parallelogram to form a correct equation	AO3.1a	M1	$AB \times AD \times \sin\alpha = 24$ hence $6 \times 4.5 \times \sin\alpha = 24$
	Rearranges 'their' equation to obtain a correct value of $\sin\alpha$	AO1.1b	A1F	$\sin\alpha = \frac{24}{27} = \frac{8}{9}$
	Uses 'their' $\sin\alpha$ value to identify an appropriate right-angled triangle **or** uses identities **and** deduces exact ratio of $\tan\alpha$ – positive or negative Condone only positive ratio seen	AO2.2a	M1	Sides of right angled triangle are 8, 9 and $\sqrt{17}$ Hence $\tan\alpha = \pm\frac{8}{\sqrt{17}}$
	Relates back to mathematical context of problem and hence chooses negative ratio – accept any equivalent exact form FT 'their' tan values for obtuse α	AO3.2a	A1F	α is one of the largest angles and must be obtuse hence tangent is negative $\tan\alpha = -\frac{8}{\sqrt{17}} = -\frac{8\sqrt{17}}{17}$
	Total		**4**	

14 An open-topped fish tank is to be made for an aquarium.

It will have a square horizontal base, rectangular vertical sides and a volume of 60 m^3

The materials cost:

- £15 per m^2 for the base
- £8 per m^2 for the sides.

14 (a) Modelling the sides and base of the fish tank as laminae, use calculus to find the height of the tank for which the overall cost of the materials has its minimum value.

Fully justify your answer.

[8 marks]

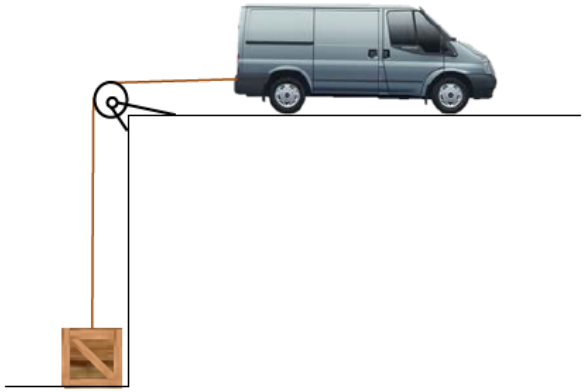
Q	Marking Instructions	AO	Marks	Typical Solution
14(a)	Identifies and clearly defines variables.	AO3.1b	B1	Let C = total cost x = length of base edges h = length of height
	Models the cost with an expression of the form $ax^2 + bxh$	AO3.3	M1	$C = 15x^2 + 32xh$
	Eliminates either variable, using volume equation, to form a model for the cost in one variable.	AO3.3	M1	$x^2h = 60$ $h = \frac{60}{x^2}$
	Obtains a correct equation to model cost in one variable	AO3.1b	A1	$C = 15x^2 + \frac{1920}{x}$ (*)
	Uses their model to find minimum. (at least one term correctly differentiated **and** equated to zero)	AO3.4	M1	Differentiating $30x - \frac{1920}{x^2} = 0$ $x^3 = 64$ $x = 4$
	Obtains correct equation	AO1.1b	A1	$h = \frac{60}{4^2} = 3.75$ Height of tank is 3.75 m
	Obtains correct value for h with correct units in context Award FT from correct substitution into incorrect equation for h but only if all three M1 marks have been awarded, must have correct units.	AO3.2a	A1F	$\frac{d^2C}{dx^2} = 30 + \frac{3840}{x^3}$ $x = 4 \Rightarrow \frac{d^2C}{dx^2} > 0$ therefore minimum **ALT from (*) onwards** $C = 900h^{-1} + 32\sqrt{60}h^{\frac{1}{2}}$ $0 = -900h^{-2} + 16\sqrt{60}h^{-\frac{1}{2}}$ Height of tank is 3.75 m $\frac{d^2C}{dh^2} = 1800h^{-3} - 8\sqrt{60}h^{-\frac{3}{2}}$ $h = 3.75 \Rightarrow \frac{d^2C}{dh^2} = 25.6 > 0$ $\therefore$ minimum
	Performs a correct test of 'their' solution: uses the second derivative of 'their' expression for C in terms of x or h to justify that a minimum value for h has been found OE (Second derivative > 0 or test gradient/values either side)	AO2.4	R1	

17 **In this question use $g = 9.8$ m s^{-2}, giving your final answers to an appropriate degree of accuracy.**

A van of mass 1300 kg and a crate of mass 300 kg are connected by a light inextensible rope.

The rope passes over a light smooth pulley, as shown in the diagram.

The rope between the pulley and the van is horizontal.



Initially, the van is at rest and the crate rests on the lower level. The rope is taut.

The van moves away from the pulley to lift the crate from the lower level.

The van's engine produces a constant driving force of 5000 N.

A constant resistance force of magnitude 780 N acts on the van.

Assume there is no resistance force acting on the crate.

17 (a) (i) Draw a diagram to show the forces acting on the crate while it is being lifted.

[1 mark]

17 (a) (ii) Draw a diagram to show the forces acting on the van while the crate is being lifted.

[1 mark]

17 (b) Show that the acceleration of the van is 0.80 m s^{-2}

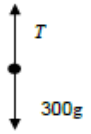
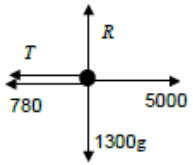
[4 marks]

17 (c) Find the tension in the rope.

[2 marks]

17 (d) Suggest how the assumption of a constant resistance force could be refined to produce a better model.

[1 mark]

Q	Marking Instructions	AO	Marks	Typical Solution
17(a)(i)	Draws correct force diagram for crate from information given to use as a model in this context Must introduce a variable to represent the tension in the string	AO3.3	B1	
(a)(ii)	Draws correct force diagram for van from information given to use as a model in this context Must introduce a variable to represent the tension in the string	AO3.3	B1	
(b)	Applies Newton's 2nd Law ($F = ma$) to the crate	AO3.4	M1	For crate $T - 300g = 300a$
	Applies Newton's 2nd Law ($F = ma$) to the van ($F = ma$ 'round the corner' scores 0)	AO3.4	M1	For van $5000 - T - 780 = 1300a$ $(4220 - T = 1300a)$
	Solve their simultaneous equations	AO1.1a	M1	$4220 - 300g = 1600a$
	Finds the value of a correctly AG	AO1.1b	A1	$a = 1280 \div 1600 = 0.80$ m s^{-2} (AG)
(c)	Uses $a = 0.80$ in either of their two equations in (b)	AO3.4	M1	$T = 300 \times 0.80 + 300g$
	Finds the correct value for T (condone omission of units) Possibly done in (b)	AO1.1b	A1	$= 3180$ $= 3200$ (N) (2 sf)
(d)	Explains that the model could be refined by including air resistance	AO3.5c	E1	Resistance will increase with speed
	Total		**9**	
	TOTAL		**80**	

Use of large data in statistics

The use of one or more real ‘large data’ set

Chosen by each exam board

Used as a classroom tool including use of technology

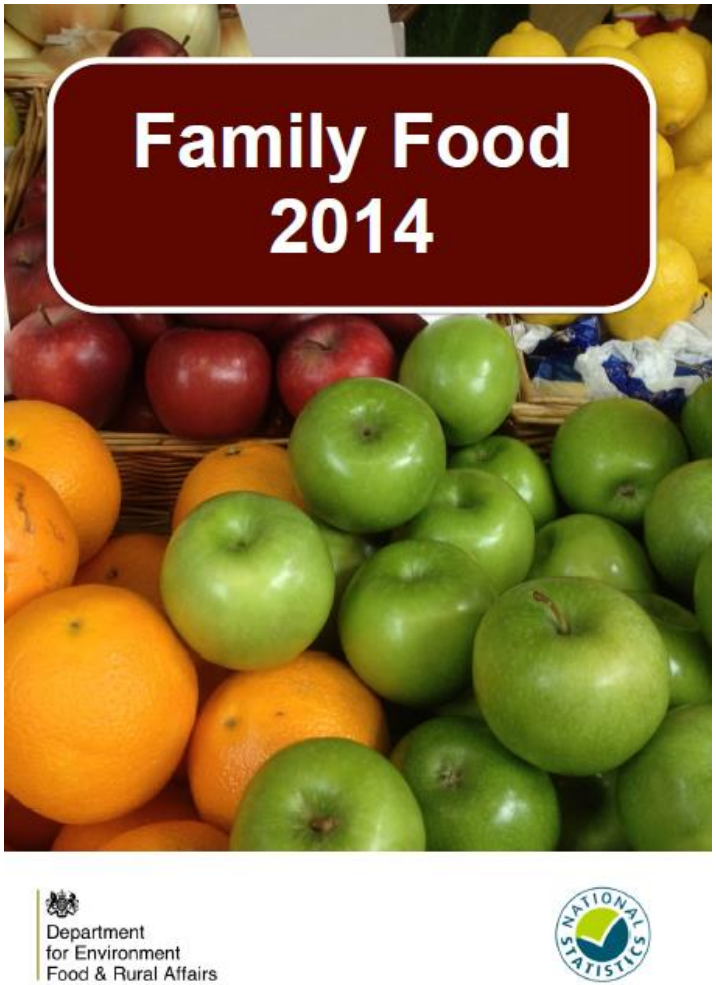
Gets students familiar with working with and manipulating large sets of data

It is too large to be taken into the exam: suitable extracts may be used in a question

Exam boards are required to set questions that should be likely to give a **material advantage** to Learners who have studied, and are familiar with, the prescribed data set

AQA are using…

Purchased quantities of household food & drink by Government Office Region and Country



Current status Maths

- First submitted to Ofqual in June
- First rejection received at the beginning of September
- Ofqual reported no issues with our overall assessment structure
- We are working with Ofqual on a number of changes, including:
  - Assessment Objective and Overarching Theme allocations
  - Mark scheme strengthening
- Second rejection received in December
- Still working on the Assessment Objective and Overarching Theme allocations
- Ofqual are supportive of our new mark scheme structure
- Re-submitted on 2 Feb
- Accredited on 27 February

CONTENT

Further Maths – key features generally

Key features

- 50% of the A-level content has been defined for us by the DfE – this is common across all exam boards.
- 20% of the AS content has been defined for us by the DfE – exam boards had to choose a further 10% of the A-level content to put into the AS content
- There is no Decision or Statistics featured in the defined content.
- The remaining 50% has been carefully selected by us.

Our proposed 50% Further Maths content

- With almost half of the content already prescribed that is pure for A-level, we decided to increase the pure content to make approximately two thirds. This will be compulsory content for all candidates.
- Our final third will contain optional content from mathematical applications.
- For AS we increased the pure content to half. This will be compulsory content for all candidates.
- The other half will contain optional content from mathematical applications:
  - Statistics
  - Mechanics
  - Discrete

Further maths content

- Builds on compulsory (DfE) Content
  - Further algebra and functions (section D)
  - Further calculus (section E)
  - Further matrices (section C)

- Additional pure topics
  - Trigonometry (section J)
  - Numerical methods (section K)
  - Coordinate geometry (section L)

- Optional Applications (study 2 from 3 of)
  - Mechanics (sections MA to ME)
  - Statistics (sections SA to SG)
  - Discrete (sections DA to DG)

Current status Further Maths

- First submitted to Ofqual in June
- Decision received at the beginning of September
- Ofqual reported no issues with our overall assessment structure
- We are working with Ofqual on a number of changes, including:
  - Assessment Objective and Overarching Theme allocations
  - Mark scheme strengthening
  - Level of detail of content
- Concentrating our efforts on getting Maths right first, resubmitted Further Maths in February.

SUPPORT & RESOURCES

Timeline

2016	2017	2018	2019
Submit to Ofqual in June	Free prepare to teach meetings spring/summer term	Summer series first exam for AS Maths and Further Maths	Summer series first exam for A-level Further Maths
Free launch meetings summer/ autumn term	First teaching of AS/A-level Maths and Further Maths	Summer series first exam for A-level Maths	

Resources and support from AQA

Choosing the right qualification

- Draft specification
- Draft question papers and mark schemes
- Specification at a glance
- Summary of changes

Planning your course

- Teacher support launch events
- Teacher support preparing to teach events
- Route maps

Results: reviewing and planning for improvement

- Enhanced Results Analysis
- Teacher support feedback meetings
- Examiner reports
- Candidate exemplars with examiner commentary

360° SUPPORT

Assess: preparing for exams

- Additional specimen question papers and mark schemes
- Topic Tests

Teaching your students

- Resources linked to topics in the specification and throughout the teaching year (plan, teach, assess, results)
- Command words used in exams
- Publisher textbooks and digital resources
- Direct access to subject teams
- Teaching Guidance

Resources and support from AQA

2 sets of additional specimen question papers –
first set available after accreditation, second set available early 2018

Teaching guidance – available after accreditation (draft extract from A-level Maths teaching guidance available on website now)

Route maps – available after accreditation
(draft AS Maths year 1, A-level Maths year 2 (power point version) available on website now)

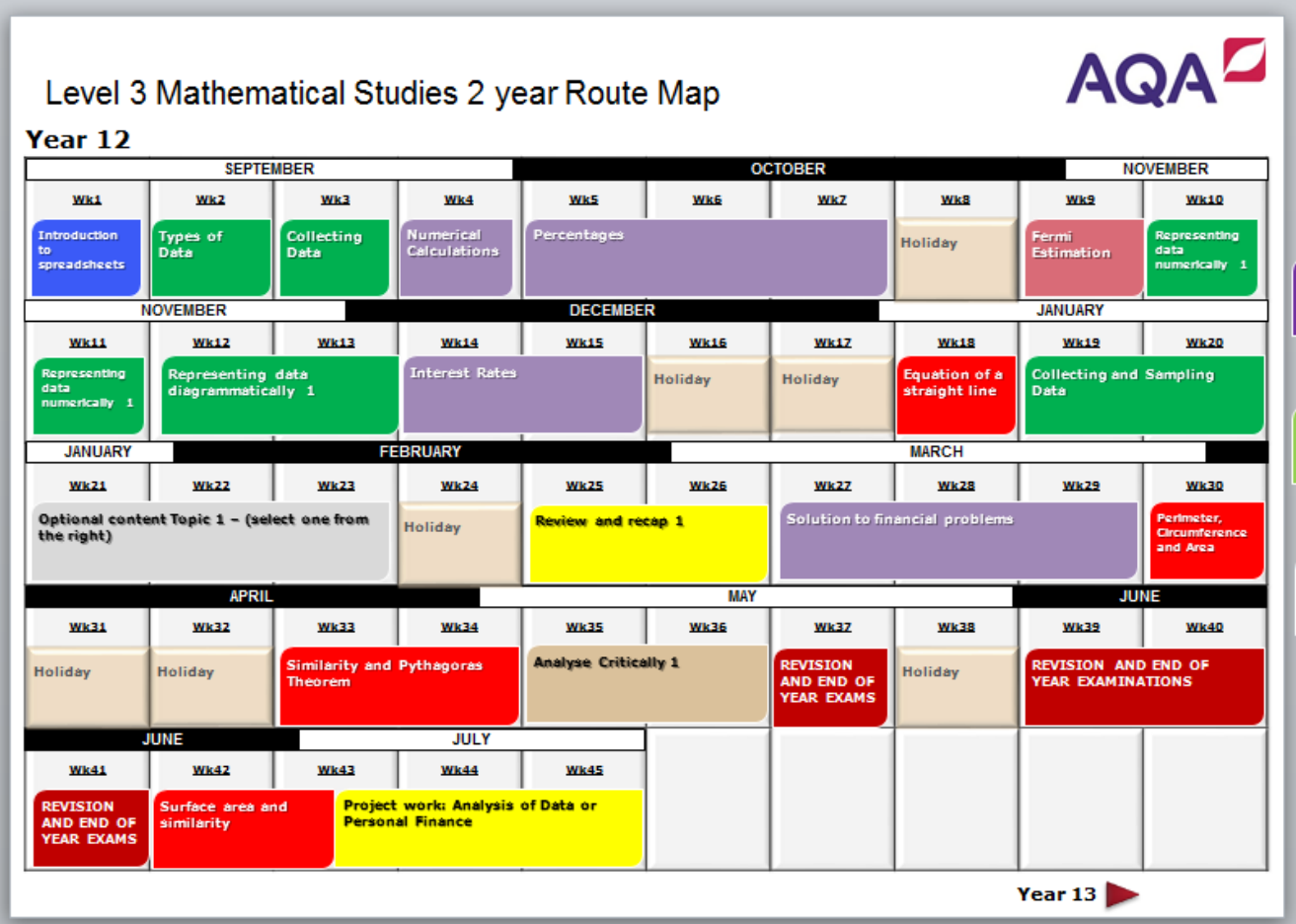
Topic tests – available after accreditation

E-library – available after accreditation

Textbooks – available after accreditation

Resources and support from AQA

- Drag your selected optional content topic 1 into the Route Map



AQA

A DETAILED LOOK AT PROBLEM SOLVING

New style Mark Schemes

- AQA reformed A-level and AS in Maths and Further Maths have mark schemes that look quite different.
- Rarely will any particular method be ***required*** in order to gain credit.
- A high proportion of marks are designated as ‘Method marks’.
- Where marks are awarded for accuracy, a high proportion of these marks allow ‘**Follow Through**’.

See Question 8 from A-level Maths paper 2

8 A curve has equation $y = 2x\cos 3x + \left(3x^2 - 4\right)\sin 3x$

8 (a) Find $\frac{\mathrm{d}y}{\mathrm{d}x}$, giving your answer in the form $\left(mx^2 + n\right)\cos 3x$, where m and n are integers.

[4 marks]

8 (b) Show that the x-coordinates of the points of inflection of the curve satisfy the equation

$$\cot 3x = \frac{9x^2 - 10}{6x}$$

[4 marks]

Overarching themes from the DfE

- All questions within A-level/AS Mathematics and Further Mathematics must be set in the context of the overarching themes.
- OT2 will be my focus today:

  Students should use their mathematical skills and techniques to solve challenging problems which require them to decide on the solution strategy and recognise when mathematics can be used to analyse and solve a problem in context.

Within OT2 we find the concept of a ‘Problem solving cycle’.

Problem solving cycle

- Specifying the problem
- Collecting information
- Processing and representing information
- Interpreting results
- Repeating the cycle if necessary
- Each set of assessment should include questions that require the use of multiple parts of this cycle

For example see Question 14 Maths A-level paper 1

Some Attributes of Problem solving questions

- It is not necessary for every problem solving task to exhibit all of the following attributes.
- At least one attribute should apply for a task to be regarded as problem solving.

Attributes of Problem solving questions

1. ***Little or no scaffolding***…

- little guidance will be provided beyond a start and end point
- mathematical processes required are not explicitly stated

For examples see Question 11 AS Maths paper 1 and Question 6 A-level Maths paper 3

11 Chris claims that, "for any given value of x, the gradient of the curve $y = 2x^3 + 6x^2 - 12x + 3$ is always greater than the gradient of the curve $y = 1 + 60x - 6x^2$".

Show that Chris is wrong by finding all the values of x for which his claim is **not** true.

[7 marks]

Attributes of Problem solving questions

6. ***Two or more processes are required, or the solution requires drawing together different parts of mathematics***

For example see Question 11 AS Maths paper 1

Attributes of Problem solving questions

2. ***Provision for multiple representations***

- such as use of diagram as well as calculations

For example see Question 15 Maths A-level paper 3

15 A sample of 200 households was obtained from a small town.

Each household was asked to complete a questionnaire about their purchases of takeaway food.

A is the event that a household regularly purchases Indian takeaway food.

B is the event that a household regularly purchases Chinese takeaway food.

It was observed that $P(B \mid A) = 0.25$ and $P(A \mid B) = 0.1$

Of these households, 122 indicated that they did **not** regularly purchase Indian or Chinese takeaway food.

A household is selected at random from those in the sample.

Find the probability that the household regularly purchases **both** Indian and Chinese takeaway food.

[6 marks]

Attributes of Problem solving questions

3. ***Results and/or methods need to be interpreted and/or evaluated***

- for example in a real world context

For example see Question 15 Maths A-level paper 1

15 The height x metres, of a column of water in a fountain display satisfies the differential equation $\frac{dx}{dt} = \frac{8\sin 2t}{3\sqrt{x}}$, where t is the time in seconds after the display begins.

15 (a) Solve the differential equation, given that initially the column of water has zero height.

Express your answer in the form $x = f(t)$

[7 marks]

15 (b) Find the maximum height of the column of water, giving your answer to the nearest cm.

[1 mark]

Attributes of Problem solving questions

4. ***A choice for the candidate of techniques to be used to solve the problem***

For examples see Question16 (b) (ii) A-level Maths paper 2 and

Question 7 AS Maths paper 2

7 Solve the equation

$$\sin\theta\tan\theta + 2\sin\theta = 3\cos\theta \quad \text{where} \quad \cos\theta \neq 0$$

Give **all** values of θ to the nearest degree in the interval $0° < \theta < 180°$

Fully justify your answer.

[5 marks]

Attributes of Problem solving questions

5. ***The solution requires understanding of the processes involved, rather than just application of techniques***

For examples see Question 9 A-level Maths paper 2 and

Question 8 AS Maths paper 2

8 Prove that the function $f(x) = x^3 - 3x^2 + 15x - 1$ is an increasing function.

[6 marks]

Problem solving and modelling

- AO3.3, 3.4 and 3.5 all relate specifically to mathematical modelling
- However it with sometimes be the case that unstructured, extended response, problem solving questions will involve the use of mathematical modelling

For example see Question 14 A-level Maths paper 1

Example AO3: Question 15 AS Maths paper 1

15(a)	Finds correct acceleration	AO1.1b	B1	$0.5\ \text{m s}^{-2}$
(b)	Identifies $5T$ as the distance travelled after the first 15 seconds	AO3.4	B1	Distance at constant speed $= 5T$
	Uses the information given to form an equation to find T (award mark for either trapezium expression separate, totalled or implied)	AO3.1b	M1	Distance in first 15 secs $= \frac{1}{2} \times (3 + 8) \times 10 + \frac{1}{2} \times (8 + 5) \times 5$ $= 55 + 32.5 = 87.5$ $5T + 87.5 = 120$
	Correctly calculates the distance for the first 15 secs	AO1.1b	A1	So $T = 6.5$
	Deduces the values of T from the mathematical models applied	AO2.2a	A1	

4 – use mathematical models

1b – translate problems in non-mathematical contexts into mathematical processes

Assessment Objective 1

AO1: Use and apply standard techniques **Learners should be able to:** ▪ **select and correctly carry out routine procedures** ▪ **accurately recall facts, terminology and definitions**			*50% (A level)* *60% (AS)*
Strands	**Elements**	**Coverage**	**Interpretation and definitions**
1 – select and correctly carry out routine procedures	1a – select routine procedures 1b – correctly carry out routine procedures	▪ Full coverage in each set of assessments (but not every assessment). ▪ No more than 10% of the marks for this assessment objective should be allocated solely to strand 2.	▪ **Routine procedures** includes multi-step as well as single-step processes. They should be familiar to the Learner (including, but not limited to, those stated in the specification) and there should be no significant background context given in the question/task that would have an impact on the Level of Demand. ▪ **Select** involves the recognition of a single- or multi-step process necessary to carry out a routine procedure (for example, solving a quadratic equation or integrating a function) in cases where the question/task does not make the required process clear. It should not be confused with the more complex decision-making required in AO3. ▪ Element 1a should normally be assessed in combination with element 1b. ▪ Within strand 2, individual questions/tasks may target each of facts, terminology and definitions in isolation, or in any combination.
2 – accurately recall facts, terminology and definitions	This strand is a single element		

AQA

Assessment Objective 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** ▪ **use mathematical language and notation correctly**	*25% (A level)* *20% (AS)*

Strands	Elements	Coverage	Interpretation and definitions
1 – construct rigorous mathematical arguments (including proofs)	This strand is a single element	▪ Full coverage in each set of assessments (but not every assessment). ▪ Taken together, strands 1 and 2 should comprise at least 50% of the marks for this assessment objective. ▪ No more than 10% of the marks for this assessment objective should be allocated to strand 3. ▪ No more than 10% of the marks for this assessment objective should be allocated solely to strand 5.	▪ A **mathematical argument** leads from premises to a conclusion, through rigorous and clear reasoning. It: ▫ may include one or both of calculations or algebraic manipulation, but is more than these alone, ▫ typically involves several steps, which are logical in nature and sequence, given the context, ▫ clearly identifies the principal results used where appropriate, and ▫ contains sufficient detail to allow the line of reasoning to be followed. ▪ **Deduction** means a process of reasoning from known results to conclusions that must be correct. ▪ **Inference** means a process of reasoning from relative or partial evidence to results that are likely to be correct. ▪ Strand 3 could apply to **arguments** provided to a Learner, or to arguments generated by them. It may include identifying:
2 – make deductions and inferences	2a – make deductions		
	2b – make inferences		
3 – assess the validity of mathematical arguments	This strand is a single element		
4 – explain their reasoning	This strand is a single element		

AQA

Assessment Objective 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** ▪ **use mathematical language and notation correctly**			*25% (A level)* *20% (AS)*
Strands	**Elements**	**Coverage**	**Interpretation and definitions**
5 – use mathematical language and notation correctly	This strand is a single element		▫ errors and/or omissions; and ▫ the values for, and/or conditions under, which an argument remains correct. ▪ In the context of strand 4, **explain** may include providing justification for a particular approach. Justification and/or explanation of key steps in the working should be required even where problems are otherwise fairly routine in nature. ▪ Strands 4 and 5 should normally be assessed in combination with strands 1, 2 and/or 3. Learners should be given multiple opportunities to demonstrate (and gain credit for) the skills required by these strands.

Assessment Objective 3

AO3: Solve problems within mathematics and in other contexts — *25% (A level)*, *20% (AS)*

Learners should be able to:

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

Strands	Elements	Coverage	Interpretation and definitions
1 – translate problems in mathematical and non-mathematical contexts into mathematical processes	1a – translate problems in mathematical contexts into mathematical processes 1b – translate problems in non-mathematical contexts into mathematical processes	▪ Full coverage of all elements except 2b and 5c in each set of assessments (but not every assessment). ▪ Elements 2b and 5c should be covered over the shortest period of time that is	▪ **Translate problems** may involve the Learner selecting and/or constructing appropriate mathematical processes. It may include identifying important features or variables. ▪ **Translate situations in context** may involve the Learner selecting and/or constructing appropriate mathematical models. It may also entail constructing a model of a specific situation, following the principles of an established modelling process. It may include identifying important features or variables. ▪ Within strands 2 and 5, **where appropriate** means where it is meaningful to do so in the context of the question/task. ▪ Within strand 2, evaluating the accuracy and limitations of a solution may (but need not) extend to the problem-solving process used in generating it.

Assessment Objective 3

AO3: Solve problems within mathematics and in other contexts **Learners should be able to:** ▪ **translate problems in mathematical and non-mathematical contexts into mathematical processes** ▪ **interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations** ▪ **translate situations in context into mathematical models** ▪ **use mathematical models** ▪ **evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them**	*25% (A level)* *20% (AS)*

Strands	Elements	Coverage	Interpretation and definitions
3 – translate situations in context into mathematical models	This strand is a single element	assessment objective. ▪ Taken together, strands 3, 4 and 5 should comprise at least 40% of the marks for this assessment objective.	▫ Information is not given in mathematical form or mathematical language, or results and/or methods need to be interpreted and/or evaluated (for example, in a real-world context) ▫ A choice of techniques to be used ▫ The solution requires understanding of the processes involved, rather than just application of techniques ▫ Two or more mathematical processes are required, or the solution requires drawing together different parts of mathematics ▪ Each set of assessments should include questions/tasks where Learners are assessed on their ability to solve complete
4 – use mathematical models	This strand is a single element		
5 – evaluate the outcomes of modelling in context,	5a – evaluate the outcomes of modelling in context		

AQA

Assessment Objective 3

AO3: Solve problems within mathematics and in other contexts **Learners should be able to:** ▪ **translate problems in mathematical and non-mathematical contexts into mathematical processes** ▪ **interpret solutions to problems in their original context, and, where appropriate, evaluate their accuracy and limitations** ▪ **translate situations in context into mathematical models** ▪ **use mathematical models** ▪ **evaluate the outcomes of modelling in context, recognise the limitations of models and, where appropriate, explain how to refine them**			*25% (A level)* *20% (AS)*
Strands	**Elements**	**Coverage**	**Interpretation and definitions**
recognise the limitations of models and, where appropriate, explain how to refine them	5b – recognise the limitations of models 5c – where appropriate, explain how to refine [models]		problems presented in an unstructured manner and which require the use of multiple parts of the problem-solving cycle (as defined in overarching theme 2 on page 4 of the Content Document). ▪ Within each set of assessments, there should be opportunities for both – ▫ extended questions/tasks that address strands 1 and 2 in combination, and ▫ extended questions/tasks that address strands 3, 4 and 5 in combination.