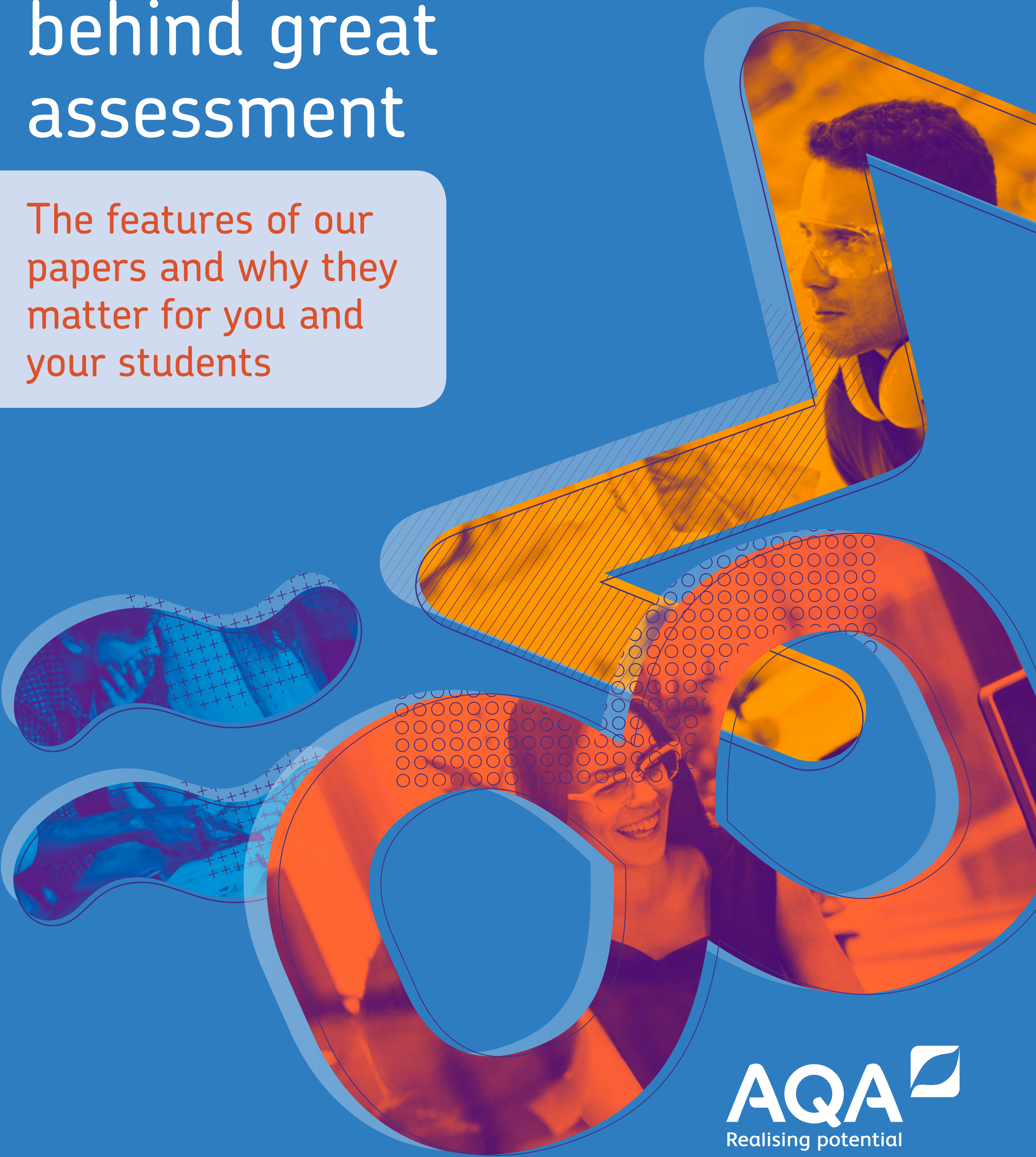
Specimen paper commentaries by our Chair of Examiners

A-level Maths
The thinking behind great assessment

The features of our papers and why they matter for you and your students



AQA
Realising potential

Meet Dan Rogan

Chair of Examiners

"We set questions that all students can access, while building in appropriate challenge for the strongest, so that we give every student the best chances of success.

Moving away from the modular approach, particularly for pure maths, challenged us to see what maths is about:

- learning new concepts
- combining them with existing techniques
- applying our understanding to problem solving in a wide range of contexts.

We want students to celebrate maths as a tool and as a discipline in its own right."

Four things you need to know about our papers

1 More opportunities for students to get the marks they deserve

Our new, better mark schemes introduce a new mark type, more marks for follow-through, credit for different approaches – we're doing more to make sure that students get the marks they deserve.

2 Papers for 21st century students

Modernised papers that:

- take advantage of what the latest calculators can do
- responded to research and best practice
- have a new layout designed to improve students' experience.

3 Our multiple-choice questions

Starting a paper with these questions is a winning formula for GCSE. And the research and evidence say they're a reliable test for students too. Since they're right for students, they're here to stay.

4 Keeping students' strengths at the heart

Students tend to be stronger at either Mechanics or Statistics.

We want well-balanced, fair assessment.

So separating Mechanics and Statistics and dividing out the Pure balances the papers for more even performance.

Our promise: These four features are at the heart of our aims for the qualification and will be in all our practice papers and in the live exams.

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Assessment objectives you can understand

Let's begin with a recap of the assessment objectives (AOs) that we must design our assessments in line with.

Our assessments must be a fine balance between ensuring appropriate coverage of the AOs, overarching themes and specification content, which were finalised for us by the DfE.

Below is an AO summary and breakdown. Keep returning to this as you read on to cement your understanding and confidence in how they're assessed.

AO	Weighting (approx %)		Overarching theme link
	A-level	AS	
AO1	50	60	
AO2	25	20	Mathematical argument, language and proof
AO3	25	20	Mathematical problem solving Mathematical modelling

		Description
AO1	**AO1.1a**	Select routine procedures
	AO1.1b	Correctly carry out routine procedures
	AO1.2	Accurately recall facts, terminology and definitions
AO2	**AO2.1**	Construct rigorous mathematical arguments (including proofs)
	AO2.2a	Make deductions
	AO2.2b	Make inferences
	AO2.3	Assess the validity of mathematical arguments
	AO2.4	Explain their reasoning
	AO2.5	Use mathematical language and notation correctly
AO3	**AO3.1a**	Translate problems in mathematical contexts into mathematical processes
	AO3.1b	Translate problems in non-mathematical contexts into mathematical processes
	AO3.2a	Interpret solutions to problems in their original context
	AO3.2b	Where appropriate, evaluate the accuracy and limitations of solutions to problems
	AO3.3	Translate situations in context into mathematical models
	AO3.4	Use mathematical models
	AO3.5a	Evaluate the outcomes of modelling in context
	AO3.5b	Recognise the limitations of models
	AO3.5c	Where appropriate, explain how to refine models

The details that make the difference

Let's see the elements that make better assessment by exploring some questions from our specimen papers.

See the summary box at the top of each question and then have a look at the extra left-hand annotations to help you understand the thinking that goes into writing our questions.

Better mark schemes

We've redesigned our mark schemes to help you and your students fully understand what's expected in order to gain marks. Here are the important changes you need to know:

- our marking instructions focus on the mathematical principles being assessed without being over-prescriptive of the techniques or methods to use
- the typical solution on the right-hand side of the mark scheme shows what a very good solution **could** look like, but doesn't describe what students **must** do
- we've introduced a new mark type for reasoning (R)
- a high proportion of marks are 'method' marks (M)
- you'll see how the assessment objectives are assessed with each mark allocated an AO
- we won't always need a particular method to be used in a student's solution for them to gain marks, however we also respect that some parts of the specification require a certain method to be assessed properly
- where marks are awarded for accuracy (A), a high proportion allow 'follow-through' (ft). This means students can still receive credit after an incorrect result if the next step has been completed successfully, and won't be penalised more than once for the same mistake.

The finer details

The instruction to "Prove…" implies a degree of rigour is required in the best of answers.

This question assesses a good blend of all three AOs.

The first mark is for explaining the link between the question and the method to use. Making this link explicit is a key change in this new specification and there are many occasions when students need to do this. You're probably used to helping students identify the link, but not so used to modelling the need to communicate it in writing.

The second and third marks are for differentiating – a routine procedure.

The next M1 mark is AO3 because there's a decision to be made about how to show the derivative is always positive.

AS paper 2, question 8

In this question, there is a clear link to be made between the concept of an 'increasing function' and the mathematical techniques used in the solution. We're very conscious of the increased rigour in this new specification, but students will still be rewarded for correct maths even if their solutions are not rigorous.

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

[6 marks]

Q	Marking instructions	AO	Marks	Typical solution
8	Explains clearly that $\mathrm{f}(x)$ is increasing $\Leftrightarrow \mathrm{f}'(x) > 0$ (for all values of x) or Explains $\Rightarrow \mathrm{f}(x)$ is increasing $\mathrm{f}'(x) > 0$ for all values of x This may appear at any appropriate point in their argument	AO2.4	E1	For all x, $\mathrm{f}'(x) > 0 \Rightarrow \mathrm{f}(x)$ is an increasing function $\mathrm{f}(x) = x^3 - 3x^2 + 15x - 1$ $\Rightarrow \mathrm{f}'(x) = 3x^2 - 6x + 15$ $\Rightarrow \mathrm{f}'(x) = 3(x-1)^2 + 12$ $\therefore \mathrm{f}'(x)$ has a minimum value of 12 therefore $\mathrm{f}'(x) > 0$ for all values of x **OR** for $\mathrm{f}'(x)$, $b^2 - 4ac = -144$ $\therefore \mathrm{f}'(x) \neq 0$ for any real x, so $\mathrm{f}'(x)$ is either always positive or always negative. $\mathrm{f}'(0) = 15$ therefore $\mathrm{f}'(x) > 0$ for all values of x **OR** $\mathrm{f}''(x) = 6x - 6$, which $= 0$ when $x = 1$ so min $\mathrm{f}'(x)$ is $\mathrm{f}'(1) = 12$ therefore $\mathrm{f}'(x) > 0$ for all values of x Thus, since, $\mathrm{f}'(x) > 0$ for all values of x it is proven that $\mathrm{f}(x)$ is an increasing function.
	Differentiates – at least two correct terms	AO1.1a	M1	
	All terms correct	AO1.1b	A1	
	Attempts a correct method which could lead to $\mathrm{f}'(x) > 0$	AO3.1a	M1	
	Correctly deduces $\mathrm{f}'(x) > 0$ (for all values of x)	AO2.2a	A1	
	Writes a clear statement that links the steps in the argument together, the deduction about a positive gradient for all values of x proves that the given function is increasing for all values of x	AO2.1	R1	

AS paper 1, question 11

This is a high demand, extended response problem solving question. There is little scaffolding, and minimal guidance beyond a start and end point. The solution requires the drawing together of different parts of maths. We have to include these types of question to meet the requirements of the specification, building on the problem solving strand in GCSE Maths.

You'll also see the 'R' mark used here.

The mark scheme for this question also indicates some potential developments since it was written.

The finer details

This addresses some of the attributes of a problem solving question provided by Ofqual; that the mathematical processes required aren't explicitly stated and/or two or more mathematical processes are required.

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]

The finer details

The first M1 mark is for turning the question and, particularly 'gradient', into the process of differentiating. This is a good example of a mathematical problem being turned into a mathematical process. The second M1 is similar, but this time the process is solving an inequality.

The actual solving of this inequality should be done directly from the calculator, which will give the correct notation. In future papers, we expect to reduce the M1 and A1 at this stage to just an A1. The whole question would only be worth 6 marks.

The final R mark shows the importance of linking the solution back to the context. When solving a problem we expect to see an explicit reference to the problem in some kind of concluding statement.

Q	Marking instructions	AO	Marks	Typical solution
11	Obtains $\frac{dy}{dx}$ for both the given curves – at least one term must be correct for each curve	AO3.1a	M1	$\frac{dy}{dx} = 6x^2 + 12x - 12$ $\frac{dy}{dx} = 60 - 12x$
	States both derivatives correctly	AO1.1b	A1	Chris's claim is **incorrect** when
	Translates problem into an inequality	AO3.1a	M1	$6x^2 + 12x - 12 \le 60 - 12x$ $2x^2 + 8x - 24 \le 0$ $x^2 + 4x - 12 \le 0$ $(x + 6)(x - 2) \le 0$
	States a correct quadratic inequality FT from an incorrect $\frac{dy}{dx}$ provided both M1 marks have been awarded	AO1.1b	A1	Critical values are $x = -6$ and 2 region: $x < -6$ → sign +; $-6 < x < 2$ → sign –; $x > 2$ → sign + $-6 \le x \le 2$
	Determines a solution to 'their' inequality	AO1.1a	M1	Chris's claim is incorrect for values of x in the range $-6 \le x \le 2$, so he is wrong
	Obtains correct range of values for x Must be correctly written with both inequality signs correct	AO1.1b	A1	
	Interprets final solution in context of the original question, must refer to Chris's claim	AO3.2a	R1	

AS paper 1, question 15

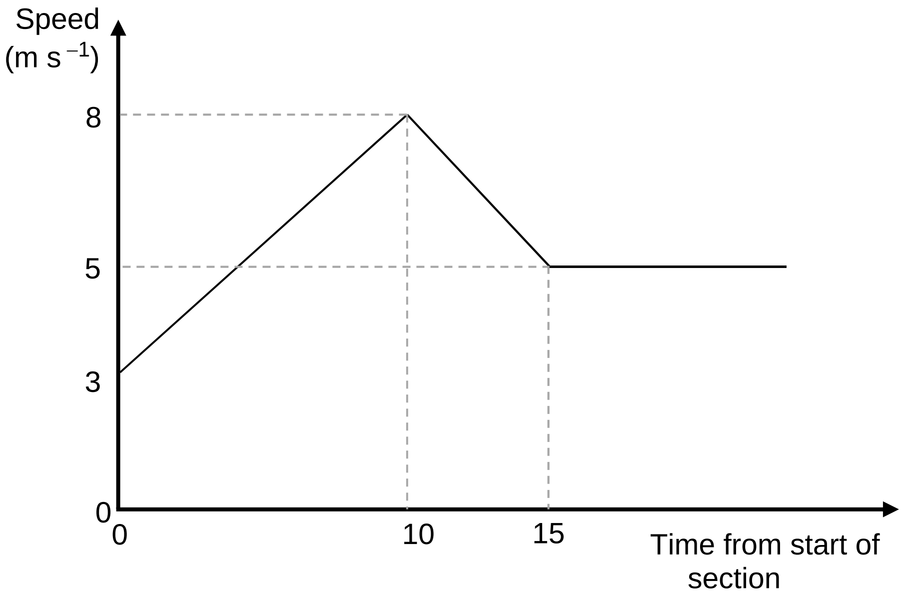
In this question, students are required to use the graph to extract information and perform a calculation in part (a) and solve a problem in part (b) (AO3).

The two answers required here illustrate the issue of units in Mechanics questions. In (b) students are asked to find the value of the variable T; units are not required or expected, but if included in the answer that would be fine. In (a) students are asked to find the acceleration, which is a quantity with units and we would expect units to be included in the answer. This kind of answer will be quite common in Mechanics questions and we will not penalise students every time units are omitted. We will expect to have one question where units are required and in others we would tend to condone the omission of units.

The finer details

This question uses a model given in the form of a graph. It shouldn't prove daunting to students because the context of the question and format of the graph will be familiar from GCSE.

15 The graph shows how the speed of a cyclist varies during a timed section of length 120 metres along a straight track.



15 (a) Find the acceleration of the cyclist during the first 10 seconds.

[1 mark]

15 (b) After the first 15 seconds, the cyclist travels at a constant speed of 5 m s^{-1} for a further T seconds to complete the 120-metre section.
Calculate the value of T.

[4 marks]

The finer details

Mechanics relies heavily on mathematical models, but not all of the processes in solving a problem are assessed by AO3. We see (a) as a routine calculation, hence AO1.

The problem in (b) can be better understood as a process of using the mathematical model presented in the graph and translating it into a mathematical process of solving a linear equation.

It's important to remember that mark schemes are working documents. When we mark live papers, our mark schemes evolve to take account of the way students actually answer questions so we reward them fairly for doing correct maths. For example, we might decide that the first A1 mark would be better as an M1 for a calculation that should lead to the correct distance travelled in the first 15s.

Q	Marking Instructions	AO	Marks	Typical Solution
15 (a)	Finds correct acceleration	AO1.1b	B1	0.5 m s $^{-2}$

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

AS paper 2, question 5

Here's an example of a problem solving question. See how we've utilised the mark scheme to make sure the marks can be accessed by students even if they make a mistake in their working.

One of the key steps in solving the problem is moving from 'real and distinct roots' to use of the discriminant and this has to be explicitly stated in the solution.

The finer details

Notice the phrase "possible values of", which avoids the leading "range of values" and gives a stronger problem solving feel to the question.

The words "Fully justify your answer" indicate that students need to give a detailed solution, in line with the Ofqual statement: 'justification and/or explanation of key steps in the working (are) required even where problems are otherwise fairly routine in nature.'

5 The quadratic equation $3x^2 + 4x + (2k - 1) = 0$ has real and distinct roots.

Find the possible values of the constant k

Fully justify your answer.

[4 marks]

The finer details

The AO2 'reasoning' mark in this question would be awarded for a clear statement that for distinct real roots the discriminant will be greater than zero.

This is a stand-alone mark so it's perfectly possible to get the other three marks without this one, but we would expect students to realise how important this full justification is.

Whilst we won't be marking their English, we expect to see accurate mathematical statements.

The use of 'their' indicates that follow-through will be applied, but not to the final A mark, otherwise a student could get full marks for a wrong answer.

Q	Marking instructions	AO	Marks	Typical solution
5	Forms discriminant – condone one error in discriminant	AO1.1a	M1	for distinct real roots, disc > 0 $4^2 - 4 \times 3 \times (2k - 1) > 0$ $16 - 12(2k - 1) > 0$ $28 - 24k > 0$ $k < \frac{7}{6}$
	States that discriminant > 0 for real and distinct roots	AO2.4	R1	
	Forms an inequality from 'their' discriminant	AO1.1a	M1	
	Solves inequality for k correctly Allow un-simplified equivalent fraction	AO1.1b	A1	

The finer details

We are using the existing LDS for exams in 2018 and A-level exams in 2019. We'll be introducing a new LDS for AS in 2019, which will then be used for AS and A-level in subsequent years.

Both parts of question 16 refer to the large data set, but only part (b) is considered to offer a material advantage, as indicated by the instruction "Use your knowledge of the Large Data Set to support your answer".

This topic is only a small part of the Statistics section of the specification.

AS paper 2, question 16

Here's an example of how we may assess the large data set (LDS). It assesses students' ability to explain their reasoning in both parts.

16 The table contains an extract from the Large Data Set.

	Units	2005-06	2007	2009	2011	2013
Confectionery	**g**	**122**	**126**	**131**	**130**	**123**
Chocolate bars - solid	g	31	31	30	31	34
Chocolate bars - filled	g	53	55	58	56	48
Chewing gum	g	2	3	2	2	1
Mints and boiled sweets	g	33	35	37	37	36
Mints	g	4	4	4	3	2
Boiled sweets	g	28	30	33	34	34
Fudges, toffees, caramels	g	4	3	4	3	3
Takeaway confectionery	g	0	0	0	0	0

16 (a) Bilal states that there is an error in the Large Data Set because the figures for Mints and boiled sweets in the 2007 column do not total to 35.

Give a reason why Bilal's statement may be incorrect.

[1 mark]

16 (b) Maria claims that there is no need to collect Takeaway confectionery data because the table shows that nobody purchases any of that category of confectionery.

State, with a reason, whether you agree or disagree with Maria's claim. Use your knowledge of the Large Data Set to support your answer.

[1 mark]

The finer details

A good answer to (a) might use actual values, eg 30.4 and 4.4.

There are two different ways to answer part (b) correctly: either knowing that elsewhere in the data set these lines aren't all 0, or from knowing that the figures are rounded, so some cells could read 0.4 or similar.

Q	Marking instructions	AO	Marks	Typical solution
16(a)	Explains that Bilal may be wrong with reference to rounding	AO2.4	E1	Bilal's statement is incorrect because the figures given in the dataset are rounded to integers and therefore the actual values may total to a rounded value that is not the total of the two component rounded values.
16(b)	States that Maria's claim is not supported Explains that the actual recorded consumption values for Takeaway confectionary are non-zero with reference to knowledge of the Large Data Set… OR Just because the values happen to be 0 in these four periods values will not necessarily always be 0, with reference to knowledge of the Large Data Set	AO2.4	E1	Maria's claim is not supported because the actual data values, not the zeros that appear in the table, for the consumption of Takeaway confectionary, are not equal to zero. Maria needs to understand that when using the LDS spreadsheet the decimal values are visible (to over ten decimal places), but that the summary data shown here is rounded to the nearest integer.

A-level paper 2, question 6

This example shows how we apply the mark scheme to questions that require students to sketch graphs.

Students don't need to draw graphs to scale, but they are expected to show relative positioning of intersections with axes.

The finer details

To answer part (b), students will need to sketch a graph. White space has been left for them to draw this diagram. Note that the question asks for the intersections with the axes to be labelled.

6 A curve *C*, has equation $y = x^2 - 4x + k$, where k is a constant.

It crosses the x-axis at the points $\left(2+\sqrt{5}, 0\right)$ and $\left(2-\sqrt{5}, 0\right)$

6 (a) Find the value of k .

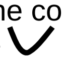
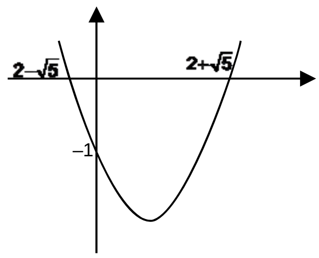
[2 marks]

6 (b) Sketch the curve *C*, labelling the exact values of all intersections with the axes.

[3 marks]

The finer details

Whilst not specifically mentioned here, we would allow follow-through for their value of k in (b) for the second B1. Once k is obtained they can find the coordinates of the minimum directly from their calculator, by solving the quadratic $x^2 - 4x + k = 0$

Q	Marking instructions	AO	Marks	Typical solution
6(a)	Uses either of the given coordinates in the given equation (accept product of the roots)	AO1.1a	M1	$k = 4(2+\sqrt{5}) - (2+\sqrt{5})^2 = -1$ **ALT** $k = 4(2-\sqrt{5}) - (2-\sqrt{5})^2 = -1$ **ALT** $k = (2-\sqrt{5})(2+\sqrt{5}) = -1$
	Obtains the correct value of k	AO1.1b	A1	
6(b)	Sketches a graph with the correct shape 	AO1.2	B1	
	Deduces correct relative positioning of intersections with axes (must see labels)	AO2.2a	B1	
	Deduces minimum lies to right of y-axis in fourth quadrant	AO2.2a	B1	

How we assess calculator use

Using calculators in exams is more important than it was in the old modular specification and we really embrace this development.

When the specification was being developed and the specimen papers written, the capabilities of what has rapidly become the standard calculator for AS and A-level Maths were not well known to us, because the calculator wasn't widely available. In developing the recently published Practice Papers Set 1 and writing live exam papers we are now very conscious of what the standard calculator can do.

Here's a list of what we expect students to be able to do with a calculator:

- solve quadratic equations
- find the coordinates of the vertex of a quadratic function
- solve quadratic inequalities
- solve simultaneous linear equations in two variables
- calculate summary statistics for a frequency distribution
- find the scalar product of two vectors
- find the angle between two vectors
- repeat an iterative process, including the Newton-Raphson method
- find binomial and normal probabilities
- find the z-value for a normal distribution
- calculate a definite integral
- calculate the derivative of a function at a given point.

We recognise that a calculator can solve any equation, using a numerical method, but we will tend to set questions that make this feature inappropriate.

When not to use a calculator

However, we'll be looking to include parameters in questions so that they cannot be done on a calculator, so that we test students' abilities to carry out particular techniques.

Look out for the instructions "Show that…" or questions that ask students to find "…the exact value of…" with the additional instruction to "Fully justify your answer." This means we require a non-calculator method with all steps clearly shown.

The finer details

These are low demand and designed to settle the student into the Mechanics section of the paper. Students should become familiar with this setup of our papers.

As students are required to use standard notation, for future papers, we'd now delete the first sentence as this is a further example of unnecessary wording.

Vectors will only be covered in the Mechanics section of the paper. This means there could be Pure maths vector questions in this section and there will be no vector questions in any other section of any exam paper. We decided that the Mechanics section was too brief without the inclusion of this topic.

AS paper 1, question 13

Many multiple-choice questions will be like (a), a straightforward AO1 question, but we can ask something more subtle such as (b).

Both (a) and (b) can be done entirely on a calculator using Pol(-20, 21) and reading off the value of the magnitude and $\theta = 133.6\ldots$
We could then say that this isn't an AO2 mark, because there is no deduction, but as it's a 1-mark multiple-choice question the method used isn't relevant for awarding the mark. This does show how a greater awareness of the use of technology can give a different perspective on a question.

13 (a) The unit vectors **i** and **j** are perpendicular.

Find the magnitude of the vector –20**i** + 21**j**

Circle your answer.

[1 mark]

-1 $\quad$ 1 $\quad$ $\sqrt{41}$ $\quad$ 29

13 (b) The angle between the vector **i** and the vector –20**i** + 21**j** is θ

Which statement about θ is true?

Circle your answer.

[1 mark]

$0° < \theta < 45°$ $\quad$ $45° < \theta < 90°$ $\quad$ $90° < \theta < 135°$ $\quad$ $135° < \theta < 180°$

Q	Marking instructions	AO	Marks	Typical solution
13(a)	Circles correct answer	AO1.1b	B1	29
(b)	Circles correct answer	AO2.2a	B1	$90° < \theta < 135°$

A-level paper 3, question 12

Here's another example of how we assess calculator use. No statistical tables are supplied for the binomial distribution so students must use a calculator to find the required probabilities. This move away from tables to effective use of technology is based on DfE requirements for the new specification: calculators are required to have this capability.

Part (a) is an extended response question that addresses all three AOs, but it is a standard example of a hypothesis test.

Part (b) requires students to identify two necessary assumptions and discuss their likely validity.

A question like this is not dissimilar from one in the old modular specification.

12 During the 2006 Christmas holiday, John, a maths teacher, realised that he had fallen ill during 65% of the Christmas holidays since he had started teaching.

In January 2007, he increased his weekly exercise to try to improve his health.

For the next 7 years, he only fell ill during 2 Christmas holidays.

12 (a) Using a binomial distribution, investigate, at the 5% level of significance, whether there is evidence that John's rate of illness during the Christmas holidays had decreased since increasing his weekly exercise.

[6 marks]

12 (b) State **two** assumptions, regarding illness during the Christmas holidays, that are necessary for the distribution you have used in part **(a)** to be valid.

For **each** assumption, comment, in context, on whether it is likely to be correct.

[4 marks]

The finer details

Students are required to use correct mathematical language and notation.

It's worth teachers and students familiarising themselves with the marking instructions for hypothesis testing questions. Marks are awarded for 'stating both hypotheses correctly', 'evaluating the model by comparison of relevant probabilities', 'inferring whether H_0 should be accepted/rejected' and 'stating a conclusion in context'. This pattern is designed to encourage clear communication from students.

Part (b) requires students to identify two necessary assumptions and discuss their likely validity.

Q	Marking instructions	AO	Marks	Typical solution
12(a)	States both hypotheses correctly for one-tailed test	AO2.5	B1	$X =$ number of Christmas holidays without illness since January 2007 $X \sim B(7, p)$ H_0 $p = 0.65$ H_1 $p < 0.65$
	States model used (condone 0.009 rather than 0.056) **PI**	AO1.1b	M1	Under null hypothesis, $X \sim B(7, 0.65)$
	Using calculator, 0.056 or better	AO1.1b	A1	$P(X \leq 2) = 0.0556$
	Evaluates binomial model by comparing $P(X \leq 2)$ with 0.05 **PI**	AO3.5a	M1	$0.0556 > 0.05$
	Infers H_0 accepted PI	AO2.2b	A1	Accept H_0
	Concludes correctly in context. 'not sufficient evidence' or equivalent required	AO3.2a	E1	There is not sufficient evidence that the John's rate of illness has decreased
(b)	States one correct assumption(s) regarding validity of model	AO3.5b	E1	**Assumption 1** The probability of illness remains constant throughout one's life **Validity** Not fully valid, as age has an impact on the immune system **OR** **Assumption 2** Annual results (of illness) are independent of one another **Validity** (Largely) valid. Trials are sufficiently far apart that an illness spanning two Christmases is unlikely. **OR** **Assumption 3** There are only two states, well and ill **Validity** Unclear. Grey area exists. eg does a mild sore throat count as ill?
	States corresponding correct description(s) of likelihood of validity in context	AO2.4	E1	
	States second correct assumption(s) regarding validity of model	AO3.5b	E1	
	States corresponding correct description(s) of likelihood of validity in context	AO2.4	E1	
	Max two assumptions with description of validity			

Clearer layout

Here are the biggest aesthetic changes to our question papers. Fonts, white space and answer space have all been improved to help students see all of the information they need to answer questions.

Changing all writing to Arial helps readability, backed up by research conducted by our in-house team, CERP (Centre for Education Research and Practice). This improves the exam experience, particularly for students with any reading difficulties.

Increasing the white space and space for answers after every question part reduces the risk of students missing question parts and missing out on marks, which has been a problem in the past. Where possible, the information required to answer a question will be on the same page as the answer space for the same reason.

A-level paper 1, question 10

Here's an example of a question split with answer lines for each part. This helps the student make sure each part is answered before moving on.

The finer details

Whilst (a) is typically a question students find more difficult, (b)(i) is very straightforward and precedes a more demanding (b)(ii).

10 The function f is defined by

$$f(x) = 4 + 3^{-x} \quad , \quad x \in \mathbb{R}$$

10 (a) Using set notation, state the range of f

[2 marks]

10 (b) The inverse of f is f^{-1}

10 (b) (i) Using set notation, state the domain of f^{-1}

[1 mark]

10 (b) (ii) Find an expression for $\mathrm{f}^{-1}(x)$

[3 marks]

Multiple-choice questions

We've introduced a new style of question to our A-level papers: multiple-choice. Each section of each paper will start with two or three multiple-choice questions. They will always be worth one mark with four possible answers, of which only one is correct. There are no working lines because we don't want to imply that students will receive credit for working, but working is often necessary and we will leave space for that.

Everyone can answer a multiple-choice question and it is important that they do, but that doesn't mean they will be easy. Multiple-choice questions will tend to be low or medium demand.

We've found we can use multiple-choice questions to test some of the more technical aspects of the specification, or to make efficient use of a calculator to solve a problem.

The finer details

We design papers with questions ranging from low to very high demand. Low demand questions are accessible to students who would achieve grade E and high to those achieving grade A. Question demand isn't linked to any particular topic in the specification.

A-level paper 2, question 10

This multiple-choice question is at the start of the Mechanics section and is low demand.

10 A single force of magnitude 4 newtons acts on a particle of mass 50 grams.

Find the magnitude of the acceleration of the particle.

Circle your answer.

[1 mark]

$12.5\ \text{m s}^{-2}$ $\quad$ $0.08\ \text{m s}^{-2}$ $\quad$ $0.0125\ \text{m s}^{-2}$ $\quad$ $80\ \text{m s}^{-2}$

The incorrect options listed here, called distractors, are incorrect answers where the calculation has been performed wrongly. The challenge in these multiple-choice questions lies in getting students to check their working.

Splitting applications between papers

Statistics and Mechanics are very different and require different techniques, whilst always having some overlap with Pure maths. We decided to split these applications between papers so that we give students a more comfortable exam in each case.

Paper 1
Pure

Paper 2	
Section A	**Section B**
Pure	Mechanics

Paper 3	
Section A	**Section B**
Pure	Statistics

Consistency in assessment

It's impossible to ensure that a paper will be exactly the same level of difficulty each year. By writing within the guidelines of the AOs and having consistent papers that follow the same pattern, we've created reliable assessments that will ensure we'll be as close as possible. Students will go into their exams knowing how their paper is going to be laid out.

Each section of a paper will begin with multiple-choice, and increase in demand throughout the rest of the section (we call this 'ramping').

To make marks available to all students throughout the whole paper, sometimes a more accessible part (a) is necessary to allow a more challenging part (b), which means that even the final questions on a paper could have marks accessible to all students.

AS paper 1, question 3

This question is the first non-multiple-choice question in the paper.
It's low demand so that students are eased into the exam.
In this question, (b) is designed to build on (a), but it could actually be tackled entirely from scratch, creating more accessible marks if students have struggled with (a).

3 (a) Write down the value of p and the value of q given that:

3 (a) (i) $\sqrt{3} = 3^p$

[1 mark]

3 (a) (ii) $\frac{1}{9} = 3^q$

[1 mark]

3 (b) Find the value of x for which $\sqrt{3} \times 3^x = \frac{1}{9}$

[2 marks]

The finer details

Students should be familiar with this question style from GCSE.

The question could be done using a calculator's equation solving feature – a perfectly valid method, but probably more effort than simply writing down the answers.

The finer details

The first mark is for selecting the method to use.

The second mark is awarded for carrying out that method.

Q	Marking instructions	AO	Marks	Typical solution
3(a)(i)	States correct value of p	AO1.2	B1	$p = \frac{1}{2}$
(a)(ii)	States correct value of q	AO1.2	B1	$q = -2$
(b)	Uses valid method to find x , PI	AO1.1a	M1	$\frac{1}{2} + x = -2$
	Obtains correct x , ACF	AO1.1b	A1	$x = -2.5$

The finer details

Students are required to understand set notation, as set out in the glossary in the specification. This has always tended to appear in questions, but it's more important that students notice and understand the sets $\mathbb{R}, \mathbb{Z}, \mathbb{Q}, \mathbb{N}$

AS paper 1, question 9

In this example, (b) follows on from (a) but if students differentiate from first principles more generally for x, rather than 3, then this is an equally valid method. The use of 'their' in (b) indicates that follow-through will be applied provided a correct mathematical method has been used.

9 (a) Given that $f(x) = x^2 - 4x + 2$, find $f(3 + h)$

Express your answer in the form $h^2 + bh + c$, where b and $c \in \mathbb{Z}$.

[2 marks]

9 (b) The curve with equation $y = x^2 - 4x + 2$ passes through the point *P*(3, –1) and the point *Q* where $x = 3 + h$.

Using differentiation from first principles, find the gradient of the tangent to the curve at the point *P*.

[3 marks]

The finer details

Remember that the typical solution doesn't show what must be written – it shows one way it could be done.

The final R mark will be earned for a well-communicated deduction. This is a typical feature in questions where we expect students to 'show' or 'prove' a result and it addresses the overarching theme of mathematical argument, language and proof.

Q	Marking instructions	AO	Marks	Typical solution
9(a)	Substitutes $3 + h$ to obtain a correct unsimplified expression for $f(3 + h)$	AO1.1a	M1	$(3+h)^2 - 4(3+h) + 2$ or $= 9 + 6h + h^2 - 12 - 4h + 2$
	Expresses simplified answer correctly in given format	AO1.1b	A1	$= h^2 + 2h - 1$
(b)	Identifies and uses $\frac{f(x+h)-f(x)}{h}$ to obtain an expression for the gradient of chord Mark can be awarded for unsimplified expression	AO1.1a	M1	Gradient of chord $= \frac{f(3+h)-f(3)}{h}$ $= \frac{h^2+2h-1+1}{h}$
	Obtains a correct and full simplification	AO1.1b	A1	$= h + 2$
	Deduces that, as h approaches 0 the limit of $\frac{f(3+h)-f(3)}{h}$ is 2 (Must not simply say $h = 0$ but accept words rather than limit notation) FT 'their' gradient provided M1 has been awarded	AO2.2a	R1	As $h \to 0$, $h + 2 \to 2$ Gradient of tangent $= 2$

AS paper 1, question 14

In this example we'd like to show our approach to the value of 'g' in Mechanics questions. We want students to know that there are different values of 'g' in common use. Whenever a value is needed we will state it at the beginning of the question. Its value implies that the answer to the question must be given to the same degree of accuracy as the quoted value of 'g'. (In the original version of the specimen papers submitted to Ofqual we gave an additional instruction to round to an appropriate degree of accuracy.) In Mechanics questions all other values are exact, avoiding the problem of appropriate accuracy.

14 **In this question use g = 10 m s^{-2}.**

A man of mass 80 kg is travelling in a lift.

The lift is rising vertically.

The lift decelerates at a rate of 1.5 m s^{-2}

Find the magnitude of the force exerted on the man by the lift.

[3 marks]

The finer details

Students can earn this mark even if they don't use the correct signs.

The accuracy must be 1 sf because that's the accuracy of the value of g.

Follow-through can be applied as long as the student has earned the first M1 mark.

Q	Marking instructions	AO	Marks	Typical solution
14	Applies Newton's 2nd Law to form a 3 term equation Award mark even if signs not correct	AO1.1a	M1	$F - 80 \times 10 = -80 \times 1.5$
	Obtains a correct 3 term equation.	AO1.1b	A1	$F - 800 = -120$
	Obtains correct reaction force. Must be given to 1 sf FT from incorrect 3 term equation provided M1 mark was awarded (condone omission of units)	AO1.1b	A1F	$F = 680 = 700$ (N) to 1 sf

The finer details

By using "Show that…" in questions we ensure we are assessing particular techniques and looking for a rigorous argument.
This approach also means students can still tackle (b) if they haven't completed (a) and (b)(iii) if they haven't completed (b)(i) and (b)(ii).
Finally, (c) and (d) can still be tackled regardless of success in earlier parts of the question.
This gives all students a good chance of picking up marks throughout the question.

A-level paper 3, question 3

This 13-mark question is broken up into six parts and applies both modelling and problem solving to Pure maths, rather than in a Mechanics or Statistics context.

3 A circular ornamental garden pond, of radius 2 metres, has weed starting to grow and cover its surface.

As the weed grows, it covers an area of A square metres. A simple model assumes that the weed grows so that the rate of increase of its area is proportional to A.

3 (a) Show that the area covered by the weed can be modelled by

$$A = Be^{kt}$$

where B and k are constants and t is time in days since the weed was first noticed.

[4 marks]

3 (b) When it was first noticed, the weed covered an area of 0.25 m^2.

Twenty days later the weed covered an area of 0.5 m^2

3 (b) (i) State the value of B.

[1 mark]

3 (b) (ii) Show that the model for the area covered by the weed can be written as

$$A = 2^{\frac{t}{20} - 2}$$

[4 marks]

3 (b) (iii) How many days does it take for the weed to cover half of the surface of the pond?

[2 marks]

3 (c) State one limitation of the model.

[1 mark]

3 (d) Suggest one refinement that could be made to improve the model.

[1 mark]

The finer details

Here are some tips for interpreting the mark scheme for this question.

The R marks in (a) and (b)(ii) are for a rigorous argument and the evidence for these marks will come throughout the solution.

Whilst not specifically stated here, we would only expect the R1 mark to be given if all other marks had been awarded, because a rigorous argument is exemplified by all the features for which other marks are given.

However, the R mark needs more than just the other marks and in both of these cases it's given for the final steps of working to reach the answer.

The typical solution demonstrates one style of presentation, but we won't require this particular notation. A rigorous argument can be presented in many ways.

Q	Marking instructions	AO	Marks	Typical solution
3(a)	Translates proportionality into a differential equation involving $\frac{dA}{dt}$, A and a constant of proportionality.	AO3.3	M1	$\frac{dA}{dt} \propto A$ $\Rightarrow \frac{dA}{dt} = kA$ $\Rightarrow \int \frac{1}{A}\, dA = \int k\, dt$ $\Rightarrow \ln A = kt + c$ $\Rightarrow A = e^{kt+c}$ $\Rightarrow A = Be^{kt}$ **AG**
	Separates variables	AO1.1a	M1	
	Integrates both of 'their' sides correctly	AO1.1b	A1F	
	Constructs a rigorous mathematical argument that supports use of the given model. **AG** Only award if they have a completely correct solution, which is clear, easy to follow and contains no slips.	AO2.1	R1	
(b)(i)	States correct value of B	AO1.1b	B1	$B = 0.25$ or $B = \frac{1}{4}$
(b)(ii)	Uses $t = 20$ and $A = 0.5$ to find k	AO3.1b	M1	When $t = 20$, $A = 0.5$ $\Rightarrow 0.5 = 0.25e^{20k}$ $\Rightarrow 20k = \ln 2$ $\Rightarrow k = \frac{1}{20}\ln 2$ $\Rightarrow A = \frac{1}{4}(e^{\ln 2})^{\frac{t}{20}}$ $\Rightarrow A = 2^{-2} \times 2^{\frac{t}{20}}$ $\Rightarrow A = 2^{\frac{t}{20}-2}$ **AG**
	Finds correct value of k	AO1.1b	A1	
	Substitutes 'their' k to get A in terms of t	AO1.1a	M1	
	Constructs rigorous and convincing argument to show $A = 2^{\frac{t}{20}-2}$ Using correct notation throughout. **AG**	AO2.1	R1	
(b)(iii)	Uses the model to set up correct equation and attempt to find t	AO3.4	M1	$2\pi = 2^{\frac{t}{20}-2}$ $t = 93.03$ days
	Finds correct value of t	AO1.1b	A1	
(c)	States any sensible and relevant limitation of the model that is specified in terms of the pond, area, weed, rate of change or time.	AO3.5b	E1	Model predicts that the area of weed will increase without limit and this is not possible since the area of the pond is 4π
(d)	Any sensible and relevant refinement to the model that is specified in terms of the pond, area, weed, rate of change or time	AO3.5c	E1	Introduce a limiting factor such as fish eating weed or rate of growth decreases as surface area covered

A-level paper 3, question 5

This is a structured question that addresses all three AOs. With a first part that's accessible to all students, (b) then provides no scaffolding, but allows follow-through on both marks, meaning students can still be awarded marks even if they've answered (a) incorrectly.

5 (a) Find the first three terms, in ascending powers of x , in the binomial expansion of $(1 + 6x)^{\frac{1}{3}}$

[2 marks]

5 (b) Use the result from part **(a)** to obtain an approximation to $\sqrt[3]{1.18}$ giving your answer
to 4 decimal places.

[2 marks]

5 (c) Explain why substituting $x = \frac{1}{2}$ into your answer to part **(a)** does not lead to a valid approximation for $\sqrt[3]{4}$.

[1 mark]

The finer details

Part (a) is routine; the typical solution shows use of ≈ but this isn't required by the marking instructions.

In (b) there is a decision to be made about how to start, which is AO3, but note this mark requires substitution as well as finding the value of x.

Part (c) requires explanation and addresses AO2.4; 'explain their reasoning'.

Q	Marking instructions	AO	Marks	Typical solution
5(a)	Uses binomial expansion, with at least two terms correct, may be un-simplified	AO1.1a	M1	$(1+6x)^{\frac{1}{3}} \approx 1+\frac{1}{3}\cdot 6x+\frac{1}{3}\cdot\frac{-2}{3}\cdot\frac{(6x)^2}{2}$
	Obtains correct simplified answer	AO1.1b	A1	$(1+6x)^{\frac{1}{3}} \approx 1+2x-4x^2$
(b)	Determines the correct value for x and substitutes this into 'their' answer to part **(a)**	AO3.1a	M1	$x=0.03$
	Obtains correct approximation for 'their' answer to part **(a)** FT allowed only if M1 from part **(a)** and M1 from part **(b)** have been awarded	AO1.1b	A1F	$\sqrt[3]{1.18} \approx 1+2(0.03)-4(0.03)^2$ ≈ 1.0564
(c)	Explains the limitation of the expansion found in part **(a)** with reference to $x=\frac{1}{2}$	AO2.4	E1	Although $\left(1+6\times\frac{1}{2}\right)^{\frac{1}{3}}=\sqrt[3]{4}$ $x=\frac{1}{2}$ cannot be used since the expansion is only valid for $\lvert x\rvert<\frac{1}{6}$

The finer details

This is a low demand question, but the challenge comes in the form of the answers.

It's a multiple-choice question that you'll find at the beginning of the paper. It's an effective way of testing students' ability to carry out a routine procedure.

We've left white space underneath for working should students need it, something we added after feedback from teachers.

Clearer language

A success at GCSE, we've made our A-level questions more accessible for students by removing unnecessary words.

We've also made sure that where we set problems in context. We describe the situation as clearly as possible so the mathematical content is clear, without giving too much away.

A-level paper 1, question 2

Low word count means students see the maths, not the words.

Our thinking has even evolved from the example shown here. In future questions like this, we'll remove the words 'A curve has equation'.

2 A curve has equation $y = \frac{2}{\sqrt{x}}$

Find $\frac{dy}{dx}$

Circle your answer.

[1 mark]

$\frac{\sqrt{x}}{3}$ $\qquad \frac{1}{x\sqrt{x}}$ $\qquad -\frac{1}{x\sqrt{x}}$ $\qquad -\frac{1}{2x\sqrt{x}}$

A-level paper 1, question 4(a)

Here's another example of where unnecessary language has been removed to make a question more accessible to students. In the previous specification, we'd have put a longer stem at the beginning of the question, giving context that the student didn't need. Now a student will see a clear stem and a clear instruction in part (a) to go on to answer the question.

4 $\quad p(x) = 2x^3 + 7x^2 + 2x - 3$

4 (a) Use the factor theorem to prove that $x + 3$ is a factor of $p(x)$

[2 marks]

The finer details

It's an Ofqual requirement that every set of assessments will have at least one question addressing AO3.3, AO3.4 and AO3.5.

We'll take you through the mark scheme on the next page to see what students need to do to answer this successfully.

A-level paper 2, question 17

This is the final question in the paper where an example question is set in context.

We use the word "actual" in evaluating models to mean 'think about the modelling assumptions and consider the impact of not having made them.'

You'll also see that we state the value of g at the start, so students can expect to see this at the beginning of all Mechanics questions that require a value of g.

17 **In this question use g = 9.81 m s^{-2}.**

A ball is projected from the origin. After 2.5 seconds, the ball lands at the point with position vector (40**i** – 10**j**) metres.

The unit vectors **i** and **j** are horizontal and vertical respectively.

Assume that there are no resistance forces acting on the ball.

17 (a) Find the speed of the ball when it is at a height of 3 metres above its initial position.

[6 marks]

17 (b) State the speed of the ball when it is at its maximum height.

[1 mark]

17 (c) Explain why the answer you found in part **(b)** may not be the actual speed of the ball when it is at its maximum height.

[1 mark]

The finer details

The first mark could be given at any stage in the solution.

The second mark is for translating the situation in context into a mathematical model.

The third mark is for using correct techniques.

The fourth mark is for using the mathematical model.

The fifth mark is for the correct calculation.

The final mark is awarded for the correct calculation and interpreting the solution to the problem in its original context, rewarding the completion of a complete strategy.

Answers must be given to three significant figures with appropriate units to match the value of g in the question.

Part (b) is given for using the model to state 'their' value.

Part (c) is given if the student recognises the limitation of the model used. Whilst the mark scheme limits this to horizontal velocity, a similar argument holds for vertical velocity.

Q	Marking instructions	AO	Marks	Typical solution
17(a)	Obtains correct horizontal component of the initial velocity	AO1.1b	B1	$2.5U = 40$ $U = 16$
	Forms equation to find vertical component of initial velocity	AO3.3	M1	$-10 = 2.5V - 0.5 \times 9.81 \times 2.5^2$
	Obtains correct vertical component of initial velocity	AO1.1b	A1	$V = 8.2625$
	Forms equation for vertical component of velocity at height 3 using 'their' derived values for U and V	AO3.4	M1	$v_y^2 = 8.2625^2 + 2 \times (-9.81) \times 3$
	Obtains correct component of velocity	AO1.1b	A1	$v_y = 3.067...$
	Correct final speed with units, correct for 'their' U and v_y FT applies only if both M1 marks have been awarded	AO3.2a	A1F	$v = \sqrt{16^2 + 3.067^2} = 16.3\,\text{m s}^{-1}$

(b)	States 'their' value of horizontal component of the initial velocity from part **(a)**	AO3.4	A1F	16 m s^{-1}

(c)	Explains that horizontal velocity has been assumed to be constant in their model and that this is not likely to be true, with valid reasoning	AO3.5b	E1	It was assumed that there were no resistance forces acting on the ball which is unlikely to be true in reality. The horizontal speed of the ball is likely to vary… air resistance would slow the ball down, wind might speed the ball up

Appropriate marks for questions

Some questions now have fewer marks than they had in the past. This is partly driven by the changes in assessment objectives but also in response to the DfE requirement to encourage use of technology.

An example of our interpretation is that we'll generally give just one mark for the solutions to a quadratic equation, and expect these to be found using a calculator unless there's a clear request for showing method.

AS paper 2, question 11

This shows how the level of difficulty can increase within a question. The first two parts are accessible to all students – they address recalling facts, terminology and definition – while parts (b) and (c) involve problem-solving.

We could have omitted (a) entirely, but that would risk making the question inaccessible to some students.

11 The circle with equation $(x-7)^2+(y+2)^2=5$ has centre *C*.

11 (a) (i) Write down the radius of the circle.

[1 mark]

11 (a) (ii) Write down the coordinates of *C*.

[1 mark]

11 (b) The point *P* (5, –1) lies on the circle.

Find the equation of the tangent to the circle at *P*, giving your answer in the form $y=mx+c$

[4 marks]

11 (c) The point *Q* (3, 3) lies outside the circle and the point *T* lies on the circle such that *QT* is a tangent to the circle. Find the length of *QT*.

[4 marks]

The finer details

There is no specific reference to this in the mark scheme, but evidence of correct methods could well appear on a diagram. We are allowing students to select a method to solve a problem.

Parts (b) and (c) include marks where follow-through will be applied so long as correct a mathematical method is used.

Both parts assess AO3 when a mathematical problem is being translated into processes.

Q	Marking instructions	AO	Marks	Typical solution
11(a)(i)	States correct radius CAO	AO1.2	B1	Radius $= \sqrt{5}$
(a)(ii)	States correct centre CAO	AO1.2	B1	*C* is (7, –2)
(b)	Finds gradient of the line through the points *P* and 'their' *C* (as found in part **(a)**) Condone one sign error	AO3.1a	M1	Gradient *CP* = $\frac{-1-(-2)}{5-7} = -\frac{1}{2}$
	Correct tangent gradient obtained from 'their' *CP* gradient	AO3.1a	M1	So tangent gradient = 2
	Uses a correct form for the equation of a straight line with correct coordinates of *P* and 'their' tangent gradient	AO1.1a	M1	$y - (-1) = 2(x - 5)$
	States correct final answer in required form ($y = mx + c$) FT from 'their' *C* found in part **(a)**	AO1.1b	A1F	$y = 2x - 11$
(c)	Identifies *QTC* as a right-angled triangle PI	AO3.1a	M1	*QTC* is a right-angled triangle so we can use Pythagoras
	Finds *QC* or QC^2 FT 'their' *C* found in part **(a)**	AO1.1b	B1F	$QC^2 = (7-3)^2 + (-2-3)^2$
	Uses Pythagoras' theorem correctly for 'their' triangle	AO1.1a	M1	$4^2 + 5^2 = (\sqrt{5})^2 + QT^2$
	Correct evaluation of length of *QT* FT 'their' *QC* and 'their' radius found in part **(a)**	AO1.1b	A1F	$QT^2 = 36$ so $QT = 6$

A-level paper 1, question 12

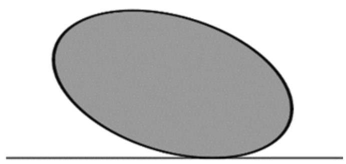
This is an A-level example of an extended response problem solving question. This is a high-demand question with no scaffolding. It highlights the importance of follow-through marks in determining how many marks a question should be worth and how they should be accessible to students of differing abilities.

12 A sculpture formed from a prism is fixed on a horizontal platform, as shown in the diagram.

The shape of the cross-section of the sculpture can be modelled by the equation

$x^2 + 2xy + 2y^2 = 10$, where x and y are measured in metres.

The x and y axes are horizontal and vertical respectively.



Find the maximum vertical height above the platform of the sculpture.

[8 marks]

The finer details

This question covers all three AOs.

You can see the first M1 mentioned will not necessarily appear first in the solution, but it might be shown on a diagram.

There's a stand-alone mark for identifying the condition for stationary points, because this is an essential part of solving the problem.

The final two marks allow follow-through provided students use a correct method. This use of follow-through marks is an important change from the old specification and meets DfE requirements.

An incorrect answer with correct methods could still gain up to 6 marks out of 8.

Q	Marking instructions	AO	Marks	Typical solution
12	Finds the difference between the maximum and minimum values of y	AO3.1b	M1	$x^2+2xy+2y^2=10$ $2x+2y+2x\frac{dy}{dx}+4y\frac{dy}{dx}=0$ Highest and lowest points occur when $\frac{dy}{dx}=0$ $\frac{dy}{dx}=0 \Rightarrow x=-y$ $y^2-2y^2+2y^2=10$ $y=\pm\sqrt{10}$ $\therefore$Height $=\sqrt{10}-\left(-\sqrt{10}\right)$ $=2\sqrt{10}=6.32$ m
	Uses implicit differentiation	AO1.1a	M1	
	Differentiates correctly	AO1.1b	A1	
	States stationary points occur when $\frac{dy}{dx}=0$	AO2.4	R1	
	Uses $\frac{dy}{dx}=0$ to find x in terms of y (or vice versa)	AO1.1a	M1	
	Finds $x=-y$	AO1.1b	A1	
	Deduces maximum and minimum values of y FT 'their' expression provided all M1 marks have been awarded	AO2.2a	A1F	
	States the height of the sculpture above the platform FT 'their' max and min values for y provided all M1 marks have been awarded	AO2.2a	A1F	

Notes

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Notes

About the author

Dan Rogan, Chair of Examiners

Dan has been teaching A-level Maths and Further Maths for almost 30 years and is really excited about the new A-level and the opportunities to make maths assessment better for students.

"It's great to be able to teach students with a clear, holistic view of how I would like them to develop over the next two years:

- by embedding a more rigorous approach in my teaching from the start of the course
- by embracing the greater use of technology in both teaching and assessment
- by emphasising links between topics I feel that I am helping students become better mathematicians."

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Head of Curriculum for Maths

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