Pearson
Edexcel

A level

Mathematics

Review of the question paper improvements

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Contents

Background and introduction

In 2020, we published A guide to our question paper improvements (March 2020) to highlight the changes made to our A level Mathematics question papers. This report (Review of the question paper improvements) aims to further illustrate the key improvements with evidence from the 2023 and 2024 exam series.

Since 2019 we have embedded four key principles to ensure our exams are more accessible and that all students have a positive exam experience.

These are:

- Helping candidates get off to a good start
- Providing more restart opportunities
- Unlocking trapped marks assessing standard techniques (AO1)
- Making language more accessible and reducing reading time

To assess the impact of these changes we have gathered feedback from teachers and students via surveys and focus groups[1]. We have also completed statistical analysis of question performance.

This report provides a comprehensive overview of the impact of the improvements using examples from the Summer 2023 and Summer 2024 A level Mathematics question papers and making comparisons to Summer 2019. The purpose of this analysis is to demonstrate if the changes have been effective in improving student experience of A level Mathematics.

[1] three surveys and two focus groups

1. Helping candidates get off to a good start

The aim of the key principle ‘Helping candidates get off to a good start’ was to give students more confidence as they start the assessment.

Research feedback from teachers and students via surveys and focus groups tells us that performing well at the start of the paper gives candidates more confidence in answering questions and reduces exam anxiety. This allows for candidates to demonstrate their full potential in an exam.

The initial report A guide to our question paper improvements (March 2020) stated:

> *We have put more questions that students perform well on at the start of the paper to give them confidence as they start the assessment. We have been able to do this because we now have more knowledge about which questions students find more accessible and more clarity about our demand targets.*

Changes to the early questions

We conduct a comprehensive review of candidate performance after each exam series. This allows us to reflect on successes and identify opportunities for improvement. This process provides valuable insights into which questions students find most accessible thus informing changes to question papers.

For example, changes we have made to the early questions are

- making sure they are short and concise
- assessing familiar topics so there are no surprises
- keeping problem-solving and modelling at a low-level.

Proportion of AO1 and AO3 at the start of the exam

Another key change to the question papers has been to amend the proportion of AO1 and AO3 marks at the start of the exam.

We have increased the percentage of marks assessing standard techniques (AO1) in the first five questions of each Pure Mathematics paper (01 and 02). We have also reduced the number of marks assessing problem solving (AO3) within the first five questions of each Pure Mathematics paper.

The proportion of AO3 marks within the first questions of the overall qualification has reduced by 13% (01) and 16% (02) from 2019 to 2024.

This table compares AO allocations in 2024 compared to 2019 for the first five questions of the Pure Mathematics papers.

Paper	AO1	AO2	AO3
9MA0-01	+ 18%	- 5%	- 13%
9MA0-02	+ 14%	+ 2%	- 16%

AO1 – Use and apply standard techniques

AO2 – Reason, interpret and communicate mathematically

AO3 – Solve problems within mathematics and in other contexts

This change allows candidates to demonstrate fundamental skills and build confidence with familiar concepts at the start of the exam.

Comparing early questions – 2019 and 2024

These two question examples demonstrate the changes to early questions from 2019 to 2024.

Example question from 2019

Summer 2019 Pure Mathematics Paper 2 Question 4

4.

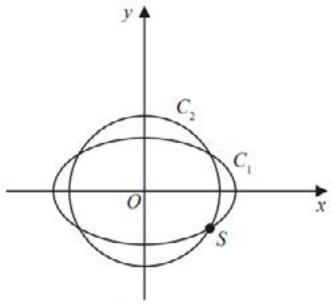


Figure 2

The curve C_1 with parametric equations

$$x = 10\cos t, \quad y = 4\sqrt{2}\sin t, \quad 0 \leqslant t < 2\pi$$

meets the circle C_2 with equation

$$x^2 + y^2 = 66$$

at four distinct points as shown in Figure 2.

Given that one of these points, S, lies in the 4th quadrant, find the Cartesian coordinates of S.

(6)

AOs	AO1	AO2	AO3
Marks	3	1	2

Key points

- Question with no guiding structure or scaffolding
- First mark is AO3 making it challenging to access
- Less familiar and challenging topic

Example question from 2024

Summer 2024 Pure Mathematics Paper 2 Question 4

4. A sequence $u_1, u_2, u_3, \ldots$ is defined by

$$u_{n+1} = ku_n - 5$$
$$u_1 = 6$$

where k is a positive constant.

Given that $u_3 = -1$

(a) show that

$$6k^2 - 5k - 4 = 0$$

(2)

(b) Hence

(i) find the value of k,

(ii) find the value of $\sum_{r=1}^{3} u_r$

(3)

AOs	AO1	AO2	AO3
Marks	3	2	0

Key points

- Scaffolded question with an opportunity to restart the question in part (b) using the 'show that' solution
- No problem solving
- Familiar topic

Impact of ‘helping candidates get off to a good start’

Since the changes we have made to our question papers, candidates achieved more of the available marks in the **first five questions** of each Pure Mathematics paper (01 and 02) and the **first two questions** from each of the applied papers (31 and 32) on average. This is demonstrated by the statistics below which compare 2024 performance against 2019 performance.

Candidates achieved

- **12% more of the marks available** in the first five questions for Paper 01 in 2024 compared to 2019
- **31% more of the marks available** in the first five questions for Paper 02 in 2024 compared to 2019
- **7% more of the marks available** in the first two questions for Paper 03** in 2024 compared to 2019

**the first two questions from Paper 31 and first two questions from Paper 32 combined

By putting more questions that students perform well on at the start of the paper we have seen candidates achieve more of the available marks across the start of every paper. Our research with teachers and students tells us that candidates are more confident in answering questions which supports them to demonstrate their full potential in the exam.

These statements are in reference to the 2024 exam papers:

> *First questions of pure were really good and everyone could answer them and make them feel confident for the rest of the paper.*
> Student comment

> *Nice starts to the papers warming up for the bigger questions.*
> Student comment

2. Providing more restart opportunities

The aim of the key principle 'Providing more restart opportunities' was to reduce potential barriers to candidates completing questions. This has been achieved by smaller mark allocations, greater number of 'show that' questions and removing the reliance of later question parts on earlier ones.

Smaller mark allocations

The initial report A guide to our question paper improvements (March 2020) stated that we are 'restricting ourselves, where possible, to writing questions worth a maximum of five marks.'

Smaller mark allocations allow for candidates to demonstrate their understanding of specific concepts or skills without being overwhelmed and introduces more restart opportunities.

We have succeeded in our aim to write questions worth a maximum of five marks where possible. The table below shows the number of individual question parts which exceed five marks comparing 2024, 2023 and 2019:

Part > 5 marks	2024	2023	2019
9MA0-01	0	2	2
9MA0-02	0	0	3
9MA0-31	0	0	0
9MA0-32	2	0	4
Total	**2**	**2**	**9**

Greater number of ‘show that’ questions

Using command word combinations such as ‘show that’ followed by ‘hence’ ensures that a single error does not disproportionately impact the overall performance of a question.

We have succeeded in our aim to write more ‘show that’ questions where possible. The table below shows the number of ‘show that’ questions comparing 2024, 2023 and 2019:

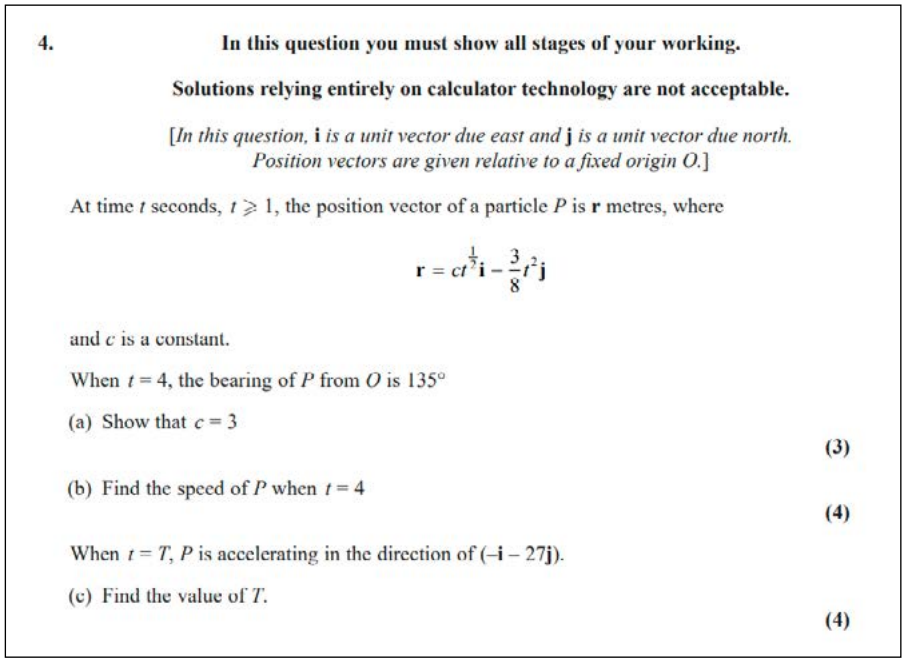
‘show that’ questions	2024	2023	2019
9MA0-01	9	10	9
9MA0-02	7	8	6
9MA0-31	0	2	1
9MA0-32	4	2	1
Total	**20**	**22**	**17**

This question from Summer 2024 Paper 32 allowed candidates to access parts (b) and (c) of the question by using ‘$c = 3$’ given via the ‘show that’ in part (a).

This restart opportunity allowed candidates to access marks in the question which may have previously been unavailable to them without the inclusion of the ‘show that’.

Example question from 2024

Summer 2024 Mechanics Paper 32 Question 4



4. **In this question you must show all stages of your working.**

Solutions relying entirely on calculator technology are not acceptable.

*[In this question, **i** is a unit vector due east and **j** is a unit vector due north. Position vectors are given relative to a fixed origin O.]*

At time t seconds, $t \geqslant 1$, the position vector of a particle P is $\mathbf{r}$ metres, where

$$\mathbf{r} = ct^{\frac{1}{2}}\mathbf{i} - \frac{3}{8}t^{2}\mathbf{j}$$

and c is a constant.

When $t = 4$, the bearing of P from O is 135°

(a) Show that $c = 3$ **(3)**

(b) Find the speed of P when $t = 4$ **(4)**

When $t = T$, P is accelerating in the direction of $(-\mathbf{i} - 27\mathbf{j})$.

(c) Find the value of T. **(4)**

The question analysis shows the highest mean % of marks achieved being in part (b).

Question	Part	Mean score	Max score	Mean %
4	a	1.74	3	58%
	b	**2.97**	**4**	**74%**
	c	2.18	4	55%

Questions remove the reliance of later question parts on earlier ones

Where the topic allows, questions either remove the reliance of later question parts on earlier ones or ask the question as a single large entity. Longer questions are broken into more manageable chunks.

We have succeeded in our aim to write more questions that either remove the reliance of later question parts on earlier ones or ask the question as a single large entity. The table below shows the number of 'question parts' comparing 2024, 2023 and 2019:

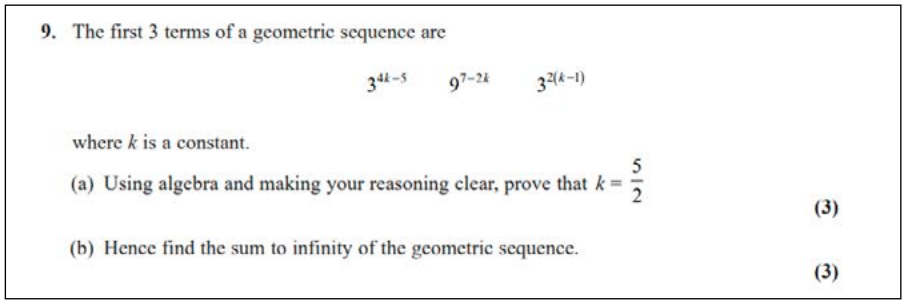
Number of 'question parts'	2024	2023	2019
9MA0-01	37	37	34
9MA0-02	35	33	35
9MA0-31	24	23	21
9MA0-32	18	16	13
Total	**114**	**109**	**103**

In this example from Summer 2024 Paper 01 the question is split into two 3-mark questions rather than a single 6-mark question.

> *This year's paper by separating into separate parts was really helpful.*
> Student comment

Example question from 2024

Summer 2024 Pure Mathematics Paper 1 Question 9



9. The first 3 terms of a geometric sequence are

$$3^{4k-5} \quad 9^{7-2k} \quad 3^{2(k-1)}$$

where k is a constant.

(a) Using algebra and making your reasoning clear, prove that $k = \frac{5}{2}$ **(3)**

(b) Hence find the sum to infinity of the geometric sequence. **(3)**

The value of *k* is given in part (a) which allows students the opportunity to succeed in later parts of a question they previously may not have been able to engage with if the value of *k* was not given in part (a).

The question analysis shows a higher mean score in part (b) of the question compared to part (a).

Question	Part	Mean score	Max score	Mean %
9	a	1.63	3	54%
	b	**2.15**	**3**	**72%**

By providing more restart opportunities with smaller mark allocations, a greater number of 'show that' questions and removing the reliance of later question parts on earlier ones we have reduced potential barriers to candidates completing questions to foster a more positive exam experience.

3. Unlocking trapped marks assessing standard techniques (AO1)

The aim of the key principle 'A new approach to assessing standard techniques (AO1 marks)' was to increase the number of items that assess AO1 in isolation. We have done this by releasing some of the AO1 marks that were tied into questions assessing other, more difficult assessment objectives. Releasing the 'trapped' marks in this way means that they are more accessible to all students.

This table shows the required Assessment Objective breakdown for A level Mathematics.

Assessment Objective (AO)		% in A level
AO1	Use and apply standard techniques	48–52
AO2	Reason, interpret and communicate mathematically	23–27
AO3	Solve problems within mathematics and in other contexts	23–27

Assessing AO1 marks in isolation

Assessing AO1 marks in isolation allows students to apply learned techniques and demonstrate their understanding of specific mathematical formulae or methods.

Previously, if a candidate struggled to access a question because an AO3 mark (which required problem-solving) was assessed before an AO1 mark, they were unable to demonstrate their knowledge of the standard technique.

Here is a comparison between a 2019 question and a 2024 question to demonstrate how some of the 'trapped' AO1 marks have been released.

Example question from 2019

Summer 2019 Pure Mathematics Paper 2 Question 2

2. The speed of a small jet aircraft was measured every 5 seconds, starting from the time it turned onto a runway, until the time when it left the ground.

The results are given in the table below with the time in seconds and the speed in $m\,s^{-1}$.

Time (s)	0	5	10	15	20	25
Speed ($m\,s^{-1}$)	2	5	10	18	28	42

Using all of this information,

(a) estimate the length of runway used by the jet to take off.

(3)

Given that the jet accelerated smoothly in these 25 seconds,

(b) explain whether your answer to part (a) is an underestimate or an overestimate of the length of runway used by the jet to take off.

(1)

Summer 2019 Pure Mathematics Paper 2 Question 2		
Mark	AO	Mean %
M1	3.1a	58
M2	1.1b	33
A1	1.1b	31

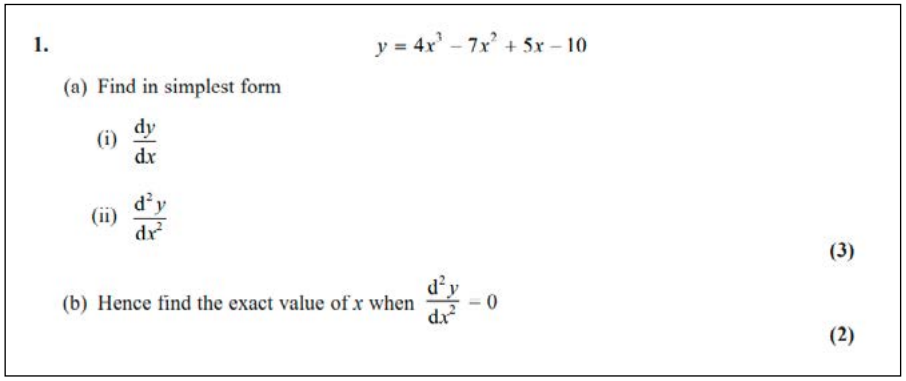
Question	Scheme	Marks	AOs
2	Time (s): 0, 5, 10, 15, 20, 25 / Speed ($m\,s^{-1}$): 2, 5, 10, 18, 28, 42		
(a)	Uses an allowable method to estimate the area under the curve. E.g.		
	Way 1: an attempt at the trapezium rule (see below)		
	Way 2: $\{s=\}\left(\frac{2+42}{2}\right)(25)\ \{=550\}$		
	Way 3: $42-2+25(a)\Rightarrow a-1.6\Rightarrow s-2(25)+(0.5)(1.6)(25)^2\{=550\}$		
	Way 4: $\{d=\}(2)(5)+5(5)+10(5)+18(5)+28(5)\ \{=63(5)=315\}$	M1	3.1a
	Way 5: $\{d=\}\ 5(5)+10(5)+18(5)+28(5)+42(5)\ \{=103(5)=515\}$		
	Way 6: $\{d=\}\frac{315+515}{2}\ \{=415\}$		
	Way 7: $\{d=\}\left(\frac{2+5+10+18+28+42}{6}\right)(25)\ \{=437.5\}$		
	$\frac{1}{2}\times(5)\times[2+2(5+10+18+28)+42]$ or $\frac{1}{2}\times[\text{"315"}+\text{"515"}]$	M1	1.1b
	$=415$ {m}	A1	1.1b
		(3)	

This question on the trapezium rule required candidates to realise that the length of the runway could be estimated by the area under the speed-time curve generated from the table of values given in the question. The first method mark in part (a) was given for 'using an allowable method to estimate the area under the curve'. If a candidate did not realise this, the AO1 marks in part (a) which assessed the use of the trapezium rule – a standard technique, could not be achieved.

This is a question on a different topic. It shows how only AO1 is assessed at the start of the question paper.

Example question from 2024

Summer 2024 Pure Mathematics Paper 2 Question 1



1. $y = 4x^3 - 7x^2 + 5x - 10$

(a) Find in simplest form

(i) $\frac{dy}{dx}$

(ii) $\frac{d^2y}{dx^2}$

(3)

(b) Hence find the exact value of x when $\frac{d^2y}{dx^2} = 0$

(2)

In Summer 2024, Pure Mathematics Paper 2 Question 1, assessed AO1 in isolation allowing candidates to demonstrate their knowledge of differentiation without problem solving or any context.

Summer 2019 Pure Mathematics Paper 2 Question 1		
Mark	AO	Mean %
M1	1.1b	100
M2	1.1b	99
A1	1.1b	98
M1	1.1b	99
A1	1.1b	94

We have succeeded in our aim to increase the number of items that assess AO1 in isolation and release 'trapped' AO1 marks. The table below shows a comparison between the percentage of AO1, AO2 and AO3 marks assessed within the first 5 questions of the paper in Summer 2024 Pure papers compared to Summer 2019 Pure papers:

	AO1	AO2	AO3
9MA0-01	**+18%**	-5%	-13%
9MA0-02	**+14%**	**+2%**	-16%

By increasing the number of items that assess AO1 in isolation we have released potential 'trapped' AO1 marks allowing students to apply learned techniques and demonstrate their understanding of specific mathematical formulas or methods. This makes the papers more accessible to students.

> *We felt the exams were much more accessible this year [2024]. Most students came out feeling like they had achieved something.*
>
> Teacher comment

4. Making language more accessible and reducing reading time

The aim of the key principle 'Making language more accessible and reducing reading time' was to ensure that all language used in A level Mathematics papers is accessible.

This supports Ofqual Guidance 'Validity – the overarching principle[2]' *"If a task is intended to measure basic numerical skills, the task should not require Learners to also negotiate complex language (for example, in the wording of the question)."*

Improvements from this work included the following:

- Employ concise, clear and straightforward language to describe simple, age-appropriate scenarios.
- Make more use of bullet points to reduce the number of words and to separate key pieces of information.
- Reduce the reading time required for each question, where appropriate.
- Remove questions where the reading time outweighed the available marks and replace them with questions containing simple sentence structures.

[2] Ofqual Handbook: General Conditions of Recognition (Updated September 2023)

[3] **Dyslexia friendly style guide** (British Dyslexia Association)

Employ concise, clear and straightforward language to describe simple, age-appropriate scenarios

We have taken steps to use concise, clear and straightforward language. This is illustrated by reduced word count when comparing exam series.

This table compares word count in 2024 compared to 2019.

Paper	2019	2024	
	Word count	Word count	% change
9MA0–01	1651	1327	**-20%**
9MA0–02	1573	1366	**-13%**

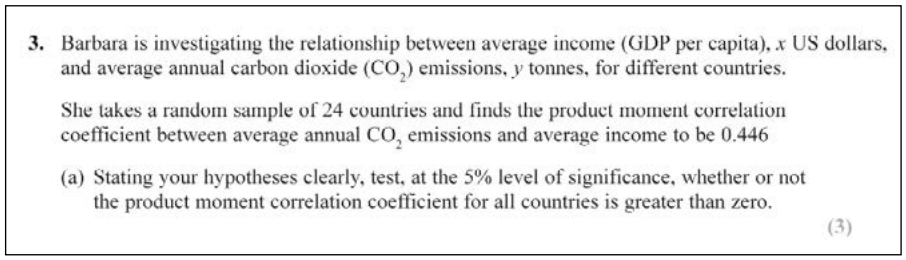
Make more use of bullet points to reduce the number of words and to separate key pieces of information

Incorporating bullet points into questions helps to organise information in a clear, concise and visual way. Bullet points provide a single piece of information helping candidates focus on one concept at a time which can help to reduce the cognitive load of the question. The use of bullet points rather than continuous prose is suggested by the British Dyslexia Association[3] to improve accessibility.

Here is a comparison between a 2019 question and a 2024 question to demonstrate the use of bullet points to separate key pieces of information.

Example question from 2019

Summer 2019 Statistics Paper 31 Question 3



3. Barbara is investigating the relationship between average income (GDP per capita), x US dollars, and average annual carbon dioxide (CO_2) emissions, y tonnes, for different countries.

She takes a random sample of 24 countries and finds the product moment correlation coefficient between average annual CO_2 emissions and average income to be 0.446

(a) Stating your hypotheses clearly, test, at the 5% level of significance, whether or not the product moment correlation coefficient for all countries is greater than zero.

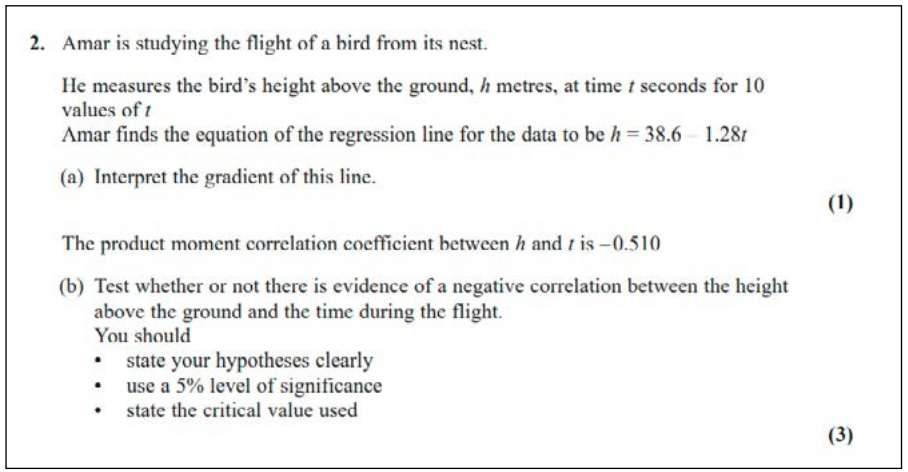
(3)

In part (a) of the question there is a single sentence with multiple pieces of information. This requires candidates to process the question along with the additional information.

> *Bullet points are really helpful. Usually you don't have time to read the question but bullet points and bold help to pick out key information.*
>
> Student comment

Example question from 2024

Summer 2024 Statistics Paper 31 Question 2



2. Amar is studying the flight of a bird from its nest.

He measures the bird's height above the ground, h metres, at time t seconds for 10 values of t

Amar finds the equation of the regression line for the data to be $h = 38.6 - 1.28t$

(a) Interpret the gradient of this line.

(1)

The product moment correlation coefficient between h and t is -0.510

(b) Test whether or not there is evidence of a negative correlation between the height above the ground and the time during the flight.

You should

- state your hypotheses clearly
- use a 5% level of significance
- state the critical value used

(3)

This question is on the same topic with similar requirements to the question asked in 2019. This question uses bullet points in part (b) to separate key pieces of information and make the requirements clearer.

This table compares number of bullet points used in 2024 compared to 2019.

Paper	2019	2024	
	Bullet points	Bullet points	% change
9MA0	3	12	+300%

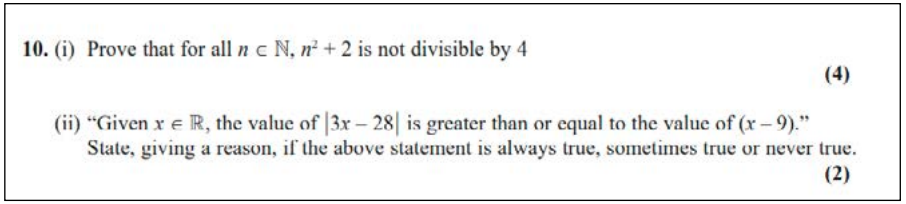
Reduce the reading time and remove questions where the reading time outweighed the available marks replacing them with questions containing simple sentence structures

The increased use of concise, clear and straightforward language and bullet points to present key information helps to reduce reading time. We have also simplified sentence structure and layout. Where appropriate, we write each new sentence on a new line, display equations and use diagrams to aid an understanding of the question and reduce transcription errors.

Here is a comparison between a 2019 question and a 2023 question to demonstrate how reading time has reduced by displaying the equation to help emphasise the key information and reducing the reading load by improving sentence ordering.

Example question from 2019

Summer 2019 Pure Mathematics Paper 1 Question 10



10. (i) Prove that for all $n \in \mathbb{N}$, $n^2 + 2$ is not divisible by 4

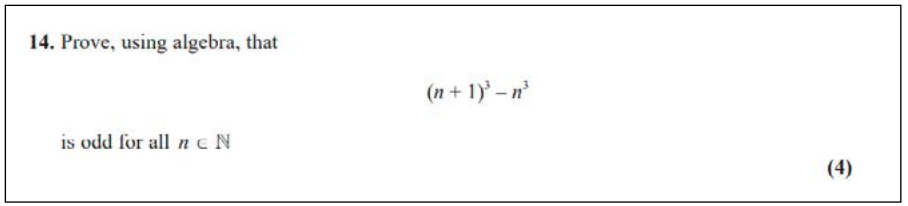
(4)

(ii) "Given $x \in \mathbb{R}$, the value of $|3x - 28|$ is greater than or equal to the value of $(x - 9)$."
State, giving a reason, if the above statement is always true, sometimes true or never true.

(2)

Example question from 2023

Summer 2023 Pure Mathematics Paper 1 Question 14



14. Prove, using algebra, that

$$(n + 1)^3 - n^3$$

is odd for all $n \in \mathbb{N}$

(4)

This table compares the number of diagrams, including graphs and tables used in 2024 compared to 2019.

Paper	2019	2024	
	Diagrams	Diagrams	% change
9MA0	16	19	+19%

Using bold in questions

Using bold in questions helps emphasise key information which a candidate must consider or address. The use of underlining and italics can make text appear to run together and cause crowding. Bold is preferred for emphasis on individual words (British Dyslexia Associate style guide[4]). The use of bold helps to break up long sentences which makes them easier to scan and reduces cognitive load.

[4] Dyslexia friendly style guide (British Dyslexia Association)

Here is an example of a question from 2024 which uses bold to emphasise that candidates need to find the number of rabbits in the wood by using information relating to foxes. Without the use of bold text, candidates may assume they are finding the minimum number of foxes.

Example question from 2024

Summer 2024 Pure Mathematics Paper 1 Question 12d

The number of foxes, F, in the wood during the same year is modelled by the equation

$$F = 100 + 70\sin(30t + 70)°$$

The number of foxes is at its minimum value after T months.

(d) Find, according to the models, the number of **rabbits** in the wood at time T months.

(4)

By ‘Making language more accessible and reducing reading time’ the A level Mathematics papers have been made more accessible.

What has been the impact of improving question accessibility?

We have embedded the four key principles exemplified in this report to ensure our exams are more accessible and thus students can access more of the marks at each grade.

The table (right) shows the average mark per student at key grades on both the Pure and Applied papers in 2019 and 2024.

	9MA0 Pure (01 & 02)		9MA0 Applied (31 & 32)	
Total marks	**200 marks**		**100 marks**	
Year	**2019**	**2024**	**2019**	**2024**
Mean score	97.26	116.80	50.85	62.85
A	123.02	146.13	65.80	81.02
C	77.67	95.74	40.22	52.59
E	38.80	51.75	20.06	23.27

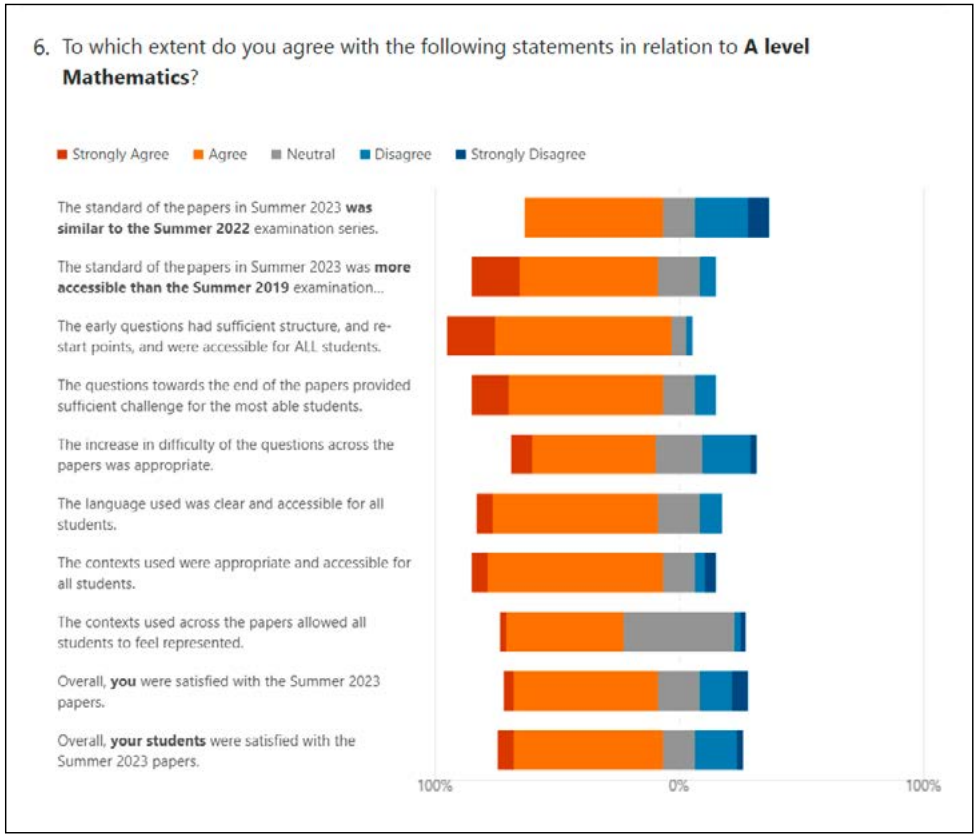
More accessible exam questions allow students to access more marks in questions of comparable difficulty.

Have the changes been effective in improving student experience of A level Mathematics?

To assess the impact of these changes we have gathered feedback from teachers and students via surveys and focus groups.

This survey from Autumn 2023 tells us that 77% teachers who responded to the survey agree (20% strongly/ 57% agree) that the standard of the papers in Summer 2023 was more accessible than the Summer 2019 examination series.

Overall, 68% agree (7% strongly/61% agree) that students were satisfied with the Summer 2023 papers.



Conclusion

This report aims to provide a comprehensive overview of the impact of the key improvements to our A level Mathematics question papers using examples from the Summer 2023 and Summer 2024 papers and making comparisons to Summer 2019.

The analysis demonstrates that the changes have been effective in improving student experience of A level Mathematics.

> *Students who got a B or C in 2019 felt like they weren't good at maths after the exam experience. Students this year who will leave with a B or C will feel as though they are good at maths for getting more questions right.*
> Teacher comment

> *All the questions were quite accessible in terms of knowing what you need to do.*
> Student comment

What students and teachers have said about our exams:

> *This year (2024) compared to other years they were very fair papers.*
> Teacher comment

> *For the majority of them you could understand the topic and know what methods you would need to use.*
> Student comment

> *The papers do reward hard work, if you put the time into working for A level Maths it does pay off.*
> Teacher comment

> *Although they weren't easy, they were accessible for anyone doing A level maths.*
> Teacher comment

We will continue to assess the impact of these changes by statistical analysis of question performance and gathering feedback from teachers and students.

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Get in touch with any questions about:

- our A level Mathematics and Further Mathematics qualifications
- the improvements we're making to our A level question papers.

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