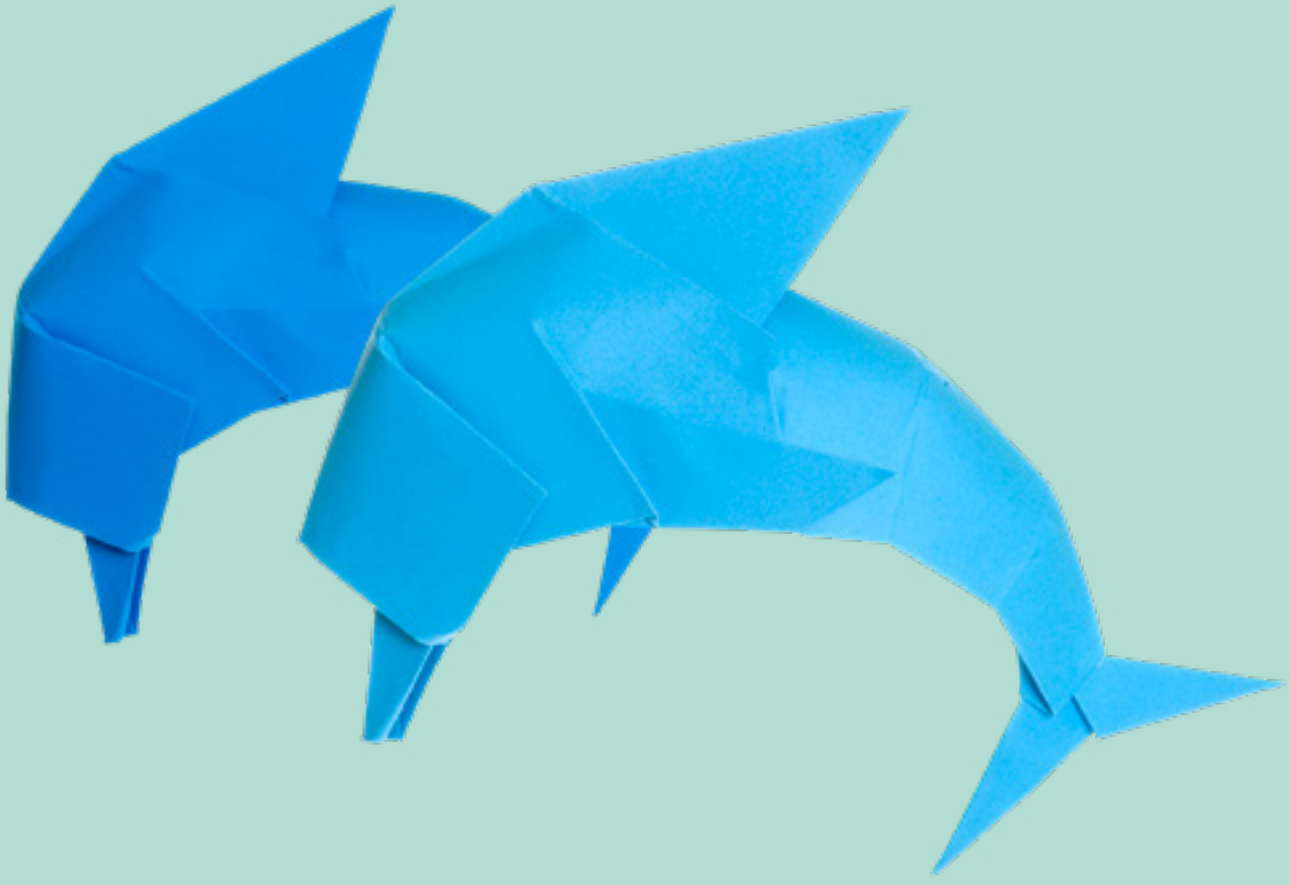
Pearson Edexcel

Level 1/Level 2 GCSE (9-1)

Mathematics (1MA1)



Chief Examiner Report

2019

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GCSE (9-1) Mathematics Chief Examiner Report

About the Chief Examiner Report

On behalf of Pearson Edexcel, I would like to congratulate learners and teachers on their results this year.

As with previous years, this year we have produced a Chief Examiner report which brings together the key information about the GCSE (9–1) Mathematics examinations this summer to inform teachers, learners and parents understanding. We have updated the style of this year's report to include more data and provide this information in a user-friendly format.

This is a general report, summarising and providing some overall detail. For specific detail relating to individual questions, mark schemes, centres are referred to the paper reports produced by individual Principal Examiners.

This report hopefully provides a clear overview about:

- **Overview of performance** – This includes any contextual information about the series itself and comparisons with last year's performance.
- **Data** – Setting out the most important data relating to the series in one place.
- **Paper by paper analysis** – Summarising the key information from each paper within the qualification, pulling out the key themes e.g. what went well and not so well.

Also included in the report is some useful information on our post-results support and services; this includes links to information on how and where to access:

- Results Plus
- Access to Scripts
- Principal Examiner Reports for Papers 1, 2 and 3

This report is accompanied by our Chair of Examiners video, which provides a top-level overview of the themes covered in this document. Please **click here** for the video.

Introduction

This was the third summer series, and fifth series overall, of the reformed qualification for Pearson Edexcel GCSE (9–1) Mathematics.

It is worth reminding centres that all reformed GCSE (9–1) Mathematics qualifications must adhere to the:

- Subject level Conditions and Requirements for Mathematics
- Subject level Guidance for Mathematics

These requirements determine details such as the content (and weightings), and Assessment Objectives (and weightings) and can help to explain why a certain proportion of questions require a written response or assess ratio, for example.

It is also worth noting, that it is not possible to assess all aspects of content in every examination series. Some content should be assessed at different levels over time, or within different assessment objectives. This may mean that a particular topic may not appear each year or may appear through a different question style. As GCSE Mathematics is available in both June and November, and content coverage is enabled across both series, so a topic may therefore be tested in November instead of June.

To support centres who want to try to ensure that their centre marking of past papers is as close to examiner-marked scripts as possible we have:

- provided since summer 2018, an additional guidance column in our mark schemes;
- provided since November 2018, examples of acceptable and non-acceptable responses to some questions, particularly those which elicit a written response from students;
- continued to provide exemplar student responses to some questions with examiner commentary on how mark schemes have been applied.

Whilst the above will help to improve teachers' understanding of our mark schemes, it is important to realise that these statements or responses are not exhaustive.

Furthermore, we also provide student-friendly mark schemes which are intended for use by students as a guide of good practice and in marking their own work. As these mark schemes are simplified, they do not show alternative methods, follow-through marks (marks that are awarded despite errors being made) and special cases – they are all covered in the formal mark schemes.

Overview of Performance

A big thank you to all teachers for all the work they have been doing with their students for the last 12 months. Overall the mathematical performance has improved this year; students are showing better awareness of what is expected of them and giving us a greater degree of evidence on which to award marks. Answers to response-type questions and to problem solving & multi-step problems have shown some improvement. Students are generally showing a greater degree of confidence in working through the papers. The work of centres in preparing students was clearly evident.

As always there were some differences in performance compared with last year. Students working at about the grade 4 boundary at Foundation were found to be showing greater confidence this year, evidenced by more consistent progress across the paper, and better attempts at those questions towards the end of the paper. This was not the case for these students on the Higher papers, who struggled after attempting the first few questions on the paper. An increase in performance was also seen in the weakest students. Confident starts were made in all the Foundation papers, and this was also evidenced by better attempts at the problem solving questions earlier in those papers. There was less of an increase in performance in the more able students. Whilst they made consistent approaches across the Higher papers in general, many struggled in some areas of content in the second half of the papers. The challenge for centres is to ensure good progress is made in all areas of content.

The Higher Papers continued to show differentiation at the highest grades. There will always be a debate about the issues of making the papers challenging, and yet not putting off students from considering GCE courses, that is acknowledged. A debate of similar significance is whether this can be achieved by having a larger number of demanding questions at the end of the paper, or whether this can be achieved by an expectation that these higher ability students need to obtain a much higher proportion of the marks throughout the paper, but particularly across a range of topics at Higher level. The latter aids accessibility for all. The collection of questions at the end of the Higher papers will continue to give adequate challenge for the brightest students, without necessarily putting off students of lesser ability taking the Higher papers.

The confidence with which students approached questions, at all levels, was impressive. The vast majority of students made an attempt at nearly every question on each of the three papers that they took. It was only towards the end of papers that some non-attempts were seen, which is not unexpected. The willingness of students to have a go, irrespective of the type of question, is commendable. Students have always found some difficulty in answering questions that require an explanation, a deduction, or a written response. It was noticeable that a much greater proportion of the students were prepared to make attempts at these types of questions, and indeed their performance was significantly better than last year.

Equipment

From the evidence of the papers, it remains a concern, however, that a noticeable minority of students lost marks through not having a calculator on calculator papers or failed to demonstrate use of basic equipment when required. This includes protractors and compasses. It is also suggested to centres that students need more assistance in using a calculator, in particular when interpreting and understanding a calculator display, and avoiding issues such as premature approximation, missing decimal points from the display, and transcribing figures incorrectly.

Presentation of work

It is disappointing that I have to report a further decline in the overall standard of presentation of work. This is nothing to do with showing working, but about how students present their work. This year there was a significant increase in the number of times students were seen to transcribe numbers incorrectly, either from the printed question, or even their own work. There was also an increase in cases where students truncated or rounded figures unnecessarily, within in their own work, or from their calculator. In most cases this will lose them their accuracy marks in a question.

At a basic level some students write 4's and 9's ambiguously, whilst 1's and 7's also present issues for examiners. Students who over-write work then make it illegible: please cross it out and write it again! Whilst the proportion of students attempting response questions has increased, the legibility of their responses has declined; this is not about their chosen words in their response, but more about whether the examiner can actually read the words they have written. If the response cannot be read, it cannot be marked.

Mathematical working

Centres continue to work hard encouraging students to show their working out. This is particularly important in those questions which clearly state "you must show all your working", "give reasons for your answer", "prove", etc. where even a correct answer will not get full marks, without the necessary supporting working out. This is more of an issue on calculator papers, where some students become over-reliant on performing the required process on their calculator without copying that process into the working space.

Multiple Methods

As mentioned last year, the other continuing issue with working out is in relation to multiple methods being shown. Students should not be discouraged from having multiple attempts to solve a question, or even drafting out a process before finalising their work. But examiners need to be clear the intended work the candidate wants marking. Before a candidate moves onto the next question, they should cross through (that is, not blanked out, scribbled over, rubbed out or in some other way defaced so as to be illegible) any working that they do not want marked, making sure they leave work that they do want marked. There was a continued increase this year in examiners reporting cases where they were faced with multiple methods.

Volumes by tier, grade boundaries & grade statistics

The table below shows the total number of results issued to students by tier. Centres now have a better understanding of standards, which assists them in making entry decisions. It is noticeable that the percentage taking the qualification at Foundation level rose from 55% to 58.5%.

	Number	%
Foundation	262291	58.5
Higher	196247	42.8
Total	458538	

The point was made last year that the set of papers for the reformed qualification were designed with the expectation that more students would be entered at Foundation tier than was previously the case. The change in the above figures reflect this and shows a greater confidence in centres in respect of entry patterns and assures a greater proportion of students experience a set of papers that better match their ability. Centres are complemented for having the confidence in the awards to make this adjustment.

Grade Boundaries

The table below shows the qualification-level grade boundaries at each tier

Mathematics													
Overall grade boundaries			**Max Mark**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**U**
1MA1	Mathematics (Foundation) Papers 1F, 2F & 3F	Subject	240					184	149	111	73	36	0
1MA1	Mathematics (Higher) Papers 1H, 2H & 3H	Subject	240	198	167	137	108	80	52	38			0

https://qualifications.pearson.com/content/dam/pdf/Support/Grade-boundaries/GCSE/1906-GCSE-9--1-subject-grade-boundaries.pdf

Here are the notional paper-level grade boundaries

Mathematics													
Notional component grade boundaries			**Max Mark**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**U**
1MA1	Mathematics (Foundation) Paper 1F	Raw	80					64	52	38	25	12	0
1MA1	Mathematics (Foundation) Paper 2F	Raw	80					61	49	36	24	12	0
1MA1	Mathematics (Foundation) Paper 3F	Raw	80					59	48	36	24	12	0
1MA1	Mathematics (Higher) Paper 1H	Raw	80	66	56	46	36	27	18				0
1MA1	Mathematics (Higher) Paper 2H	Raw	80	71	60	49	39	29	19				0
1MA1	Mathematics (Higher) Paper 3H	Raw	80	61	51	42	33	24	15				0

https://qualifications.pearson.com/content/dam/pdf/Support/Grade-boundaries/GCSE/1906-GCSE-9--1-notional-component-grade-boundaries.pdf

It is important to note that notional grade performance at component level plays no part in the determination of a qualification grade.

Cumulative grade distribution

JUNE 2019

Home/overseas: HOME

Subject: 1MA1 MATHEMATICS

			Cumulative number of students at specified grades and percentages									
Centre Type	Gender	Sat	9	8	7	6	5	4	3	2	1	U
Total All Students	M	233251	8082	21776	39017	60508	93786	141164	184976	212602	227614	233251
	%		3.5	9.3	16.7	25.9	40.2	60.5	79.3	91.1	97.6	100.0
	F	237632	5892	18875	37077	59801	94969	142299	187588	218024	232892	237632
	%		2.5	7.9	15.6	25.2	40.0	59.9	78.9	91.7	98.0	100.0
	M&F	470949	13974	40651	76094	120309	188755	283463	372564	430626	460506	470883
	%		3.0	8.6	16.2	25.5	40.1	60.2	79.1	91.5	97.8	100.0

https://qualifications.pearson.com/content/dam/pdf/Support/Grade-statistics/GCSE/grade-statistics-june-2019-provisional-gcse-9-1-specifications.pdf

		Cumulative Percentage by grade at each tier – June 2019								
Number of students		**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Foundation	**262291 (58.5%)**					7.8	33.3	66.3	87.6	97.6
Higher	**196247 (42.8%)**	7.0	20.4	38.4	60.7	85.0	98.0	99.5		
Total	**458538**	**3.0**	**8.6**	**16.2**	**25.5**	**40.1**	**60.2**	**79.1**	**91.5**	**97.8**

Foundation tier.

Paper 1F

What went well (these could be topics/themes or skills related	
1.	Q1 Common knowledge of time units. Work at the lowest level.
2.	Q2 An easy conversion to a percentage. Work at the lowest level.
3.	Q3 A question involving straight forward arithmetic. Work at the lowest level.
4.	Q5 A question in which the perception of what needed to be done was very clear. Work at the lowest level.
5.	Q10 a,b Easy, familiar algebra with no distractors.
6.	Q6 A familiar context (money) with simple arithmetic. Work at the lowest level.

What went less well (these could be topics/themes or skills related	
1.	Q13 Derivation of algebra is a weakness.
2.	Q14b Response questions students find difficult.
3.	Q20 An unfamiliar context in which the process of solution was not clear.
4.	Q27 Ratio problem solving is a weakness. Also work at the highest level.
5.	Q29b This is a topic in which knowledge is weak. Also work at the highest level.

Number

As this is a non-calculator paper, some students lost marks through basic arithmetic errors, for example 0 being given as 4 instead of 0 was seen many times. Multiplication by addition and then miscounting the terms was also a common error.

Recall of number types was done well when it was squaring or simple indices (question 15) but less well when it was prime numbers (question 4).

Whilst simple manipulation of number was usually done well if it was a standard process, this was not done well when understanding was challenged, for example with fractions in question 14(b). Here the two most frequent incorrect responses were that there are not two halves in one, and that there are only two halves in any number ie. in 48 there are two halves, and both are 24. Thus, finding half of 48 not the number of halves in 48.

This contrasted with question 19 where pure calculation with fractions was needed and therefore success was more frequently seen. Part (a) was usually answered well although some common mistakes were to change the denominator to 15 but forgot to multiply the numerator. In part (b) the most common mistake seen was for students to find a correct answer and not simplify fully i.e. leaving the answer as 3/6 or simplifying incorrectly. It is worth noting that some students wrote and tried to use KFC (Keep, Flip, Change). As this was multiplication rather than division no marks were gained by those students and this showed a lack of understanding of the concept of calculating with fractions. Students cannot always remember "taught methods" as this. Similarly in question 24 (HCF) many found prime factors but were not able to translate this into a correct final answer since they could only remember part of the process. The most successful students were those who used prime factor decomposition and a Venn diagram.

Algebra

Generally the simplest algebra (question 10) was done well, but when manipulation or multiplication was needed, weaknesses began to show. Work is frequently spoilt by students undertaking unnecessary simplification. In question 16 students tried to simplify their correct answer of $10m - 15$, commonly giving $15m$ and therefore losing the mark.

Ratio, Proportion and Rates of change

At the lower grades there was good understanding. In question 8 students were converting to percentages, comparable fractions or equivalent decimals.

The use of time in calculations still remains an area that students find difficult and centres are advised to revise this topic well with students. This was evidenced by poor work shown in question 9. Some students could not convert 1 and 1/4 hours correctly often using 1 hour 25 minutes, but in part (a) many students had trouble manipulating the speed-distance-time formula choosing to divide rather than multiply, with 90 ÷ 4= 22.5 being seen often.

Application of ratio in familiar contexts has improved over time, and question 23 is a good example of this. Many students appeared to read the question carefully and produced a simple well organised solution for full marks. Students should be advised to set out their working carefully with values and mark what values represent, again to aid their own working but also to ensure correct methods in longer question can be clearly seen and part marks awarded. A common error seen in part (b) was to confuse butter and flour and use 600g of flour so 3 packets.

Geometry and Measures

Simple area or perimeter is usually done well. Contexts can sometimes help students in solving the application of area of perimeter in problem solving questions, and question 18 was no exception, where many fully correct justifications were seen, where there were some well organised attempts clearly earning three method marks where an arithmetic error was obviously the only mistake, though some spoilt their approach by working with perimeter rather than area.

Geometric reasoning remains a weakness, with many students either using incorrect or insufficient explanation, for example in question 12(b) where 'Parallel lines' as a reason was a common misconception, along with naming an incorrect relationship such as alternate angles, and simply writing 'opposite' rather than 'vertically opposite' or 'opposite angles'

Probability and Statistics

Simple probability is usually well understood, but not when this understanding is tested by requiring a written response, such as in question 17 where many did not appreciate the fact that more trials meant a better estimate

Greater success was seen in question 21, where the most successful approach was to use a two-way table or a frequency tree, but others were also able to gain full marks, though it is imperative the students do show clearly their route through a problem l ike this. Some examiners found awarding marks difficult when working was haphazard, disorganised, or in the case where diagrams were drawn so small they were difficult to read.

Question 22 was also well answered though in part (a) some gave any two numbers that added to 0.8, showing misunderstanding of the question. In part (b) students related the number of cubes to the probability incorrectly, by assuming that if a probability of 0.2 is equivalent to 12 cubes, a probability of 0.4 must be equivalent to 14 cubes, showing misunderstanding of probability.

Paper 2F

What went well (these could be topics/themes or skills related	
1.	Q1 An easy conversion to a well known fraction. Work at the lowest level.
2.	Q2 Simple ordering. Work at the lowest level.
3.	Q3 Writing factors os a small number. Work at the lowest level.
4.	Q6 A familiar context (money) with simple arithmetic. Work at the lowest level.
5.	Q9 ai A familiar context (pictograms) with simple diagrams. Work at the lowest level.
6.	Q12 a A simple time duration that could be done using counting.

What went less well (these could be topics/themes or skills related	
1.	Q20 Inequalities remain a general weakness in which success is limited.
2.	Q25 Error intervals are a part of the content which is not well understood. Work at the highest level.
3.	Q24 Trigonometry is a part of the content which is not well understood. Work at the highest level.
4.	Q19 A problem that is complex because it draws several different parts of the content (scaling, accurate drawing, constructions). It also depended on students having the correct equipment (e.g. a compass).
5.	Q26 Ratio problem solving is a weakness. Also work at the highest level.

Number

It was surprising how many students were unable to write two million in figures in question 5.

In other questions it was alarming to see errors in arithmetic on a calculator paper.

Inequalities in number work are not well understood; in question 10 this was shown where the most common error here was to get the inequalities the wrong way around.

In contrast understanding of standard form is getting better year on year, as demonstrated by some very good answers in question 27.

Algebra

Derivation of algebra is a general weakness, even at a low level. For example, in question 7 incorrect answers of $y = 7$ and $7 + y$ were common. Equally simplification was not done well, with errors seen in question 8. Common errors included leaving in multiplication signs and confusing $3y$ with y^3. This came to a head in part (c) where many such errors were seen.

There is also evidence that simple substitution was not as good this year, having improved last year. In question 11 many students ignored the negative sign or were unable to deal with the addition of a negative number. An essential aspect of algebra that perhaps needs greater emphasis.

Simple graph work as in question 21 should be straight-forward, yet it is still a surprise that so many students plot the correct points and then fail to join them up. Disappointing also, to see that those with one or two incorrect plots failed to realise that a straight line was the correct answer. Students should be exposed to different scales as there is some evidence that the different scales used in this question confused some.

Ratio, Proportion and Rates of change

Unit conversion remains a weakness for some, as evidenced in question 4, where the mark was sometimes lost due to truncation or rounding. As in the first paper, dealing with time remains a general weakness, especially when they have calculators. In question 12b many students confused time notation with decimal notation and incorrectly wrote 9.00 – 7.22 = 1.78 or gave an answer of 1.38 or 1:38 showing an actual time and not a length of time.

Working with ratios is a recognised weakness, and even a simple ratio question like question 14 was answered badly. This is also the case when ratios are used in familiar contexts, as in question 17, where a significant number of students had no appreciation of proportion as a multiplicative relationship. Centres are advised to offer greater practice at using ratios and proportion in real life contexts. But it is also recognised that some contexts can offer better opportunities for students to show understanding. For example, question 18 was done far better than question 17, though again reading the question carefully is vital, since some students mixed up the values and therefore were unable to gain any credit.

Geometry and Measures

It was encouraging to see that problem solving skills in geometry showed some improvement this year. Questions 13, 15 and 23 are good examples of a problem solving question within this topic area, in which many students gained full marks, though some misreading led to lost marks. For example, in question 13 a significant number thought the whole shape was a square, whilst in question 15 many failed to read the question carefully, and simply found the area of the garden where flowers are grown. In question 23 some found the number of cups required to fill the whole container (2 marks maximum) and some found the number of cups needed to fill the final third of the container (3 marks maximum), showing misunderstand of what the question was asking.

In contrast the vast majority of students did not understand how to draw the locus of points a given distance from a point in question 19. There were also many who failed to attempt this question. This could be simply because they did not have the correct equipment.

Knowledge of trigonometry in question 24 was rare, and greater understanding of column vectors as in question 29 is needed.

Probability and Statistics

Pictograms are usually done well, and indeed were in question 9(a). But in part (b) many students failed to use the ratio of the numbers of records sold on Wednesday to the number of records sold on Thursday. It sometimes only takes a slight complication before students are unable to make progress.

Questions which require some explanation or interpretation of probability are usually not well answered, and indeed it was the case in question 16 and question 22(ii), where reasoning was frequently insufficient, confused, or ambiguous, or failed to use the correct probability language.

Paper 3F

What went well (these could be topics/themes or skills related	
1.	Q1 An easy question on rounding to the nearest hundred usually done well. Work at the lowest level.
2.	Q2 Identification of a simple multiple. Work at the lowest level.
3.	Q5 Writing a percentage as a fraction which does not require simplifying. Work at the lowest level.
4.	Q6 Working out a simple percentage of a context without any context. Work at the lowest level.
5.	Q11a A familiar context (money) with a calculator. Work at the lowest level.

What went less well (these could be topics/themes or skills related	
1.	Q4 Badly answered due to students thinking they were being asked for multiples of 3, rather than powers of 3.
2.	Q26a A lack of knowledge as to who a median can be found from a grouped frequency table.
3.	Q28 Angles in polygons is a part of the content which is not well understood. Work at the highest level.
4.	Q29 A problem that is complex because it draws several different parts of the content (surface area, circle mensuration, ratios, coverage). Work at the highest level.
5.	Q30 Manipulation of algebra is a weakness. Also work at the highest level.

Number

There is some weakness in the description of number types, as evidenced in question 4 where there was confusion about powers of 3 (which was read by many as multiples of 3). In contrast work finding a fraction of a quantity in question 8 was done better, though when placed in a context which required more thought, such as question 10, fewer students get through to the final answer. Calculators should be used sensible by students; in question 14 a significant number just put in the numbers without any though to process and lost all the marks if they did not write down their working.

Algebra

There is evidence that algebraic manipulation at a low level is being done better, as evidenced by answers to question 9. Students frequently struggle when answering response questions, but question 13 is an example where students are doing better than previously. This could be because sequences are a familiar area of maths for students, and probably well practiced in centres. Whilst some struggle with substitution into an algebraic formula, when that formula is written in words, as in question 15, there is evidence that the success rate is better, even when asked to use the formula in reverse, as in part (b). Rearranging formula and solving simultaneous equations have never been done well, and this remains the case this season, with a minority of students making headway with questions 19 and 30, where negative signs and order of process confounded students, but there were fewer trial and improvement approaches seen.

Ratio, Proportion and Rates of change

Ratio work is rarely done well, and even at the lower levels of work many students struggle. In question 12 students were unsure as to which numbers to put into a fraction. In question 17 few students were able to match the correct figures, or work with a correct scaling multiple. In question 22 there was much confused working with some figures matched with a correct operator, but equally many with an incorrect operator. Such work on ratio and proportion remains poorly done. In contrast the work in question 21 converting foreign currency was done better than in previous series, perhaps an indication of the work being done in centres. But the worst answered ratio questions are those where application of ratios is needed. It was clear in question 23 that whereas the part of the question regarding percentages and fractions was done well, students rarely gained the remaining marks linked to the ratio work. In recent series we have seen an improvement in work on compound interest, with fewer using simple interest methods, but the significant issue with question 25 on this paper was that the interest was asked for, rather than the total amount, which reduced the success rate. Students really should ensure they read carefully what is being asked for. Finding the correct multiple was a significant issue for some.

Geometry and Measures

This area of work is normally done well, unless the work is placed in a context which requires students to think through a problem. Question 16 involved work with simple lengths, yet few students were able to find the missing lengths and add together the correct lengths to find the perimeter. But more disappointing was question 20, where students could recognise the angles in the diagram, but could not match 45 and 60 to give the final answer. This could be simply because they did not recognise the angle *EBC*, even though marked on the diagram. Perhaps more work needs to be done on using 3-letter notation for angles. At Foundation students continue to struggle when aspects of geometry and measure are tested within multi-step problems, and this was certainly the case in questions 28 and 29, where few marks where earned.

Probability and Statistics

Working with a frequency table in question 18 clearly confused students. Many did not know which numbers to look at to identify the mode, and there was equal confusion as to which numbers to add to find the total. A similar situation also occurred in question 26(a). But there is evidence that centres are doing more work with Venn diagrams,

since question 24 was answered better than in previous series. There has been little improvement in drawing frequency polygons as in question 26(b), where incorrectly plotted points and failure to join the points with a straight line mean lost marks. Question 27 showed that few students were familiar with time series graphs.

Higher tier.

Paper 1H

What went well (these could be topics/themes or skills related	
1.	Q1 An easy question on probability usually done well. Work at the lowest level on a Higher paper.
2.	Q2 Application of ratios within the context of recipes usually done well. Work at the lowest level on a Higher paper.
3.	Q3 Using a standard process of finding the HCF. Work at the lowest level on a Higher paper.
4.	Q7 Finding perimeters of shapes. Work at the lowest level on a Higher paper.
5.	Q9 Using a standard process of multiplying two fractions. Work at the lowest level on a Higher paper.

What went less well (these could be topics/themes or skills related	
1.	Q8b Badly answered due to students being unable to round to 3 significant figures.
2.	Q13 A proof, requiring reasons to be given, which is a weakness.
3.	Q17 Angles in polygons is a part of the content which is not well understood. Work at the Ratio work in the context of algebraic manipulation, both of which present weaknesses in the work of students.
4.	Q18b A problem that relies on accurate manipulation of surds, which has been a weakness in the past. Work at the highest level.
5.	Q22 Probability which also requires derivation and manipulation of algebra, which are identified weaknesses in the work of students. Also work at the highest level.

Number

Weaker students struggled with simplifying and multiplying fractions, but the majority of students answered question 9 well. Centres also need to be aware that rounding to 1 significant figure is not always the most efficient method of estimating. In question 8 those students who rounded 63.5 to 60 and 101.7 to 100 in part (a) usually gained only one of the two marks because they could not deal with $\sqrt{6000}$.

Many questions revealed weaknesses in basic arithmetic. Students should be encouraged to check their calculations as a significant number of simple arithmetic errors were made, especially in the easier and more straightforward questions.

In finding the HCF in question 3 many used a taught method of finding the prime factors of 72 and 90 usually using factor trees, but it was not uncommon to find that students forgot what to do after this step. Effective use was made of Venn diagrams but some students were confused as to which section of the diagram represented the highest common factor.

Working out combinations as in question 16 is becoming a successful question for many students. Part (a) was answered well, but part (b) less so, due to students not being clear about which numbers to use.

There remains much misunderstanding about surds and their manipulation. In part (a) of question 18 common mistakes were to write $\sqrt{12}$ as $4\sqrt{3}$ or to write $\sqrt{3}+\sqrt{12}$ as $\sqrt{15}$ and give an answer of $5\sqrt{3}$. In part (b) many failed to deal correctly with the power and attempts to rationalise the denominator were also frequently flawed; commonly processing did not go as far as getting their answer in the required form.

Algebra

In question 10 fewer students than expected realised that the estimates of the solutions of the simultaneous equations could be found from the point of intersection of the two straight lines.

Question 13 was answered surprisingly poorly. Many students did not appreciate what is required in a proof and simply substituted different values of n into $n^2 - n$ and stated that the result was never odd. Many did not understand what was required to satisfy the conditions for a rigorous proof.

Algebraic manipulation remains a general weakness. In question 17 marks were sometimes lost through factorising $2x^2 - 3x - 5 = 0$ incorrectly. Some students could not write their equation (which was often $2x^2 = 3x + 5$) in a suitable form ready for solution. In question 19 a large number of students did not recognise this as a completing the square question or understand how to complete the square, even though this is a form of question where that will always be required. Stating the turning point in (ii) was far more successful, using their values.

The question 21 on functions showed improvement compared to previous years. Centres need to be aware that in part (a) use of inverse operations aided getting to the correct answer, but those who used flow charts were far less successful. Part (b) was very well answered considering that it is one of the more challenging questions on the paper. It was pleasing that many of the students who demonstrated knowledge of composite functions were able to give fully correct answers.

Ratio, Proportion and Rates of change

Although ratio was well understood in the earlier questions, for example question 2, many failed to get the correct answer because of arithmetical errors and rounded values. In this question many used the unitary approach. The longer ratio question 6 was answered quite well on this Higher paper, with many showing ratio methods. But it should be noted that students frequently tried different approaches in their attempts at a solution with the result that working out was often very difficult for examiners to follow.

The more standard proportional question 20 was usually more successful unless students used direct proportion instead of inverse proportion and vice versa. The other common error was where some students found the value of one constant and used it incorrectly in their second equation or used k as the constant of proportionality in both relationships and assumed that it had the same value in both equations.

Geometry and Measures

Weaker students struggled with understanding transformations and in particular translations.

In question 4 having recognised that the solid shape is a cylinder the challenge for some students was to draw a sketch of a cylinder, but the addition of extra lines meant that it then did not resemble the desired shape.

In question 14 the most successful students were those who had learned the exact values. Those who did not remember them used various strategies but these were not always successful and incorrect values were very common

But generally those questions which involved aspects of geometry were not well done. In question 12 there was generally a poor understanding of how to tackle the question. Whichever method was used the final hurdle of writing the volume of P as a fraction of the volume of R was a downfall. A common misconception was to assume that the volume of Q is 50% less than the volume of R and the volume of P is 50% less than the volume of Q.

In question 15 there were many common errors. The first common mistake was to use a radius of 6 cm instead of 3 cm. It was also not uncommon to see 3^2 instead of 3^3 substituted into the formula for the volume of a sphere. Having substituted correctly many students incorrectly found the total volume of a cone and a sphere, not the total volume of a cone and a hemisphere. It is encouraging that answering in terms of π was understood well. Students who used a value for π usually got into difficulties and made little progress.

Probability and Statistics

Questions involving a written explanation, such as in question 11, were not well answered.

Question 22 proved to be a challenging question. Many students failed to find a successful strategy and gained no marks. Working out was often messy and difficult for examiners to follow

Some understanding of probability was shown, but this was frequently spoilt by an inability to correctly derive equations and manipulate algebra. There were many attempts at representing the information in tree diagrams. These were generally unhelpful. It seemed that most students wanted to jump straight to probability tree diagrams and had no other strategies to use.

Paper 2H

What went well (these could be topics/themes or skills related	
1.	Q2 A straight-forward linear graph. Work at the lowest level on a Higher paper.
2.	Q3 An easy question on sampling. Work at the lowest level on a Higher paper.
3.	Q4 Working with the a cuboid volume. No complications and a familiar context. Work at the lowest level on a Higher paper.
4.	Q5 Simple trigonometry. Work at the lowest level on a Higher paper.
5.	Q8 Converting between standard form and ordinary numbers. Work at the lowest level on a Higher paper.

What went less well (these could be topics/themes or skills related	
1.	Q6 A question on error intervals. This is a recognised weakness of students in the past.
2.	Q13 Complex algebraic manipulation. Manipulation of algebra is a recognised weakness.
3.	Q16 Coordinate geometry. An unstructured problem. Work at the highest level.
4.	Q17 A problem involving application of ratios. This is a recognised weakness of students in the past. Work at the highest level.
5.	Q20 A problem involving both vectors and use of ratios. Use of ratios within another area of mathematics has been a recognised weakness of students in the past. Also work at the highest level.

Number

Work on stating error intervals remains a weakness, as shown in question 6, despite questions being written in a familiar way. Standard form is an aspect of content that continues to be done better year on year.

Algebra

The first question on inequalities showed good use of the inequality signs; the main errors were related to algebraic manipulation, though in part (b) too many students ignored the "+3" in drawing their inequality line; perhaps because they were not used to the inequality being written in this way. Weaknesses in algebraic manipulation haunted students in several questions, particularly questions 13, 15 and 16, where some understanding of what was needed was demonstrated by students, but the many errors in algebra shown prevented much progress being made. Expansion of brackets, factorising trinomials, rearranging equations are hallmarks of algebra questions on the Higher tier that students need to master.

The topics tested in question 14 have only appeared irregularly on papers to date, and the unfamiliarity to students was clear. In part (a) a large number failed to draw a tangent; for some reading the scales was a problem. In part (b) a greater proportion of students than previously made a good start, but the methods shown for finding the area under the curve was often crude. Many students attempted to use rectangles, and

whilst this does give an estimate, it is not a very good one; use of trapezia will give a better estimate

Ratio, Proportion and Rates of change

Application of ratios in problems continues to be a weakness. Question 7 was an early indication of this in the paper, where a good number of students were unable to find two parts of a four-part ratio using a multiplicative relationship. With questions that involve dividing in a ratio, where only one value is required, students need to be clear of the need to identify which is the value required by the question. The ratio question 17 was done far less well, with many unable to make any association between the two ratios. Some used the structure of a two-way table or a probability tree, and when this was the case, were often successful. Most other students worked with numbers of cubes, but struggled to find one of the correct pairs that would lead them to the number of large yellow cubes.

Ratios were also involved in question 9 within a geometry context, which posed a challenge to even the highest achieving students. It goes to show that students still sometimes struggle to apply skills such as the relationship between length and area scale factors to unfamiliar situations.

Geometry and Measures

The geometry problem question 4 was well answered, probably due to the fact the that calculation of the volume of this shape was simple as a good starter. Errors were largely linked to working with rather than of the total volume or rounding the answer up to 9 rather than down to 8.

Work on a sector in question 12 was also well done, with well-structured solutions which examiners could apply methods marks to. Knowledge of the relevant sector formulae was good.

Circle theorems were tested in question 18, and generally performance was similar to that in similar years. Students found greater success at working with the angles, but lost marks when it came to giving reasons for their working, which were frequently either badly worded, or inappropriate for their method. A common mistake in this question was to use a wrong circle theorem.

In question 19 it was apparent that many students did not know which angle they were trying to calculate. Nevertheless there were some good attempts seen which gained some method marks, with either the ratio of use of tan as the first step. This 3D problem was probably better attempted than in previous series, no doubt attributed to the work that centres have done on problems of this type.

Many also showed good understanding of vectors in part (a) of question 20, but only the highest ability students made any progress with part (b). Again, there is evidence of some increase in performance in handling vectors.

Probability and Statistics

The completion of a tree diagram in question 10 was done well, but too many failed to recognise “at least” in the demand in part (b), and therefore failed to consider being late on both days, even though they understood the probability aspects.

Cumulative frequency is usually done well, and indeed the majority gained most of the marks in question 11. Knowledge of cumulative frequency is a strength on the Higher tier.

Paper 3H

What went well (these could be topics/themes or skills related	
1.	Q1 A very familiar question on completion and use of a simple Venn diagram. Work at the lowest level on a Higher paper.
2.	Q3 Another very familiar question on identification of a median and drawing a frequency polygon. Work at the lowest level on a Higher paper.
3.	Q7 A simple question on carrying out a calculation using a calculator. Work at the lowest level on a Higher paper.
4.	Q8a Identification of an error in working out Pythagoras, which is well understood. Work at the lowest level on a Higher paper.
5.	Q11 Working with standard form, which is an area which is getter far better in performance.
6.	Q18a A very familiar question which requires expansion of three brackets, with an indication of the form the answer should be given in.

What went less well (these could be topics/themes or skills related	
1.	Q14 Badly answered due to the necessity of using ratios in calculation, which is a weakness.
2.	Q18b A question involving both inequalities and algebraic manipulation both of which are recognised weaknesses.
3.	Q20 Solving simultaneous equations, one of which is a quadratic, which involves several steps of algebraic manipulation, which is a recognised weakness.
4.	Q22 A problem that is complex because it draws several different parts of the content (coordinate geometry, trigonometry, solving quadratic equations). Work at the highest level.
5.	Q23 A problem that is complex because it involved both cosine rule and sine rule, and within the context of bearings, where a diagram had to be interpreted. Also work at the highest level.

Number

Many students showed good use of their calculator in question 7, but it was surprising how many were unable to round to 3 significant figures or truncated their answers unnecessarily. But most gained the full marks by writing their answers down accurately before trying to round.

Work involving standard form is now being done much better, and there was a high degree of success with question 11. The same can also be said with work involving indices, and in question 12 most students showed a high degree of understanding.

Many students are now able to identify appropriate bounds as in question 19, but then struggle to use them in given contexts, typically picking the wrong bound to use. Part (b) was not well answered, the most common incorrect approach by far was to add their answer to part (a) to 78.6003 and then divide by 2, accompanied by an explanation of this being the mid-point or the average. Centres may wish to highlight this misconception.

Algebra

Work on functions is done well when it involves substitution. In question 15 this was not the case; students appeared to have little knowledge about the content covered in this question and either did not attempt the question or revealed little understanding through their responses to the question. In general, little working was seen and students may have benefited from writing down the transformations represented by the given equation. Work on sequences is normally done well, and quadratic sequences should now be familiar to students. In question 16 students did show some improvement compared to previous series, but would do better by checking their answers by substitution.

When matching graphs in question 17 the graph of a trigonometrical function was identified correctly more frequently than the other graphs and the graphs showing one form of proportionality or another were the least well known.

Weaknesses in algebraic manipulation haunted students in several questions, particularly questions 15, 18(b) and 20, where some understanding of what was needed was demonstrated by students, but the many errors in algebra shown prevented much progress being made. Expansion of brackets, factorising trinomials, rearranging equations are hallmarks of algebra questions on the Higher tier that students need to master.

In question 22 students had to work with coordinate geometry, trigonometry and the solution of quadratic equations. Few students could see how to use the coordinates of *P* in order to derive an equation by either using the equation of the circle or by using Pythagoras's Theorem, but many who did were then thwarted by poor use of algebra.

Ratio, Proportion and Rates of change

Most students at this tier understand compound interest, but in question 2 a significant number gave the total amount, rather than the total interest. Many used a multiplier rather than a year by year approach, but this was dependent on having a correct multiplier; students frequently used an incorrect multiplier such as 1.15. In question 10 there was less success since students were unable to express their figures as a correct percentage interest rate. The most common errors seen were working out 20% of 8000, or using an incorrect reverse percentage process.

Work involving rates and proportion are not well answered, and the same was the case in question 9, where students regularly confused operators in calculations or linked numbers inappropriately.

Density was a topic which was not well understood at the start of this specification, but students are now more fluent in solving problems involving density. In question 13 about two thirds of all students realised the need to multiply the measures of density and volume of both ethanol and propylene. The most common error seen by examiners was for students to use division rather than multiplication in calculation.

Geometry and Measures

Geometry questions are not well answered, particularly those involving angles in polygons, and question 5 was no exception. There were several different routes, and many started with the total angles of either a hexagon or pentagon, and many gained marks for making such a start, but then became confused with the relationship between *BCD* and *CDE*.

Question 6 also showed many weaknesses in the work of students. Unfortunately, a significant proportion of candidats failed to understand the context and calculated the volume of the cylinder rather than the surface area, though this was made clear in the question. Other errors included calculating the surface area of only one end of the cylinder or combining the area of one or two ends with a volume or with an incorrect "area" found by calculating 1.6 by 1.8

In this paper students appeared to show better aptitude at giving answers to response type quesitons. Their explanations in question 8 were usually sufficient to gain both marks; it did help that the questions related to work that students were very familiar with.

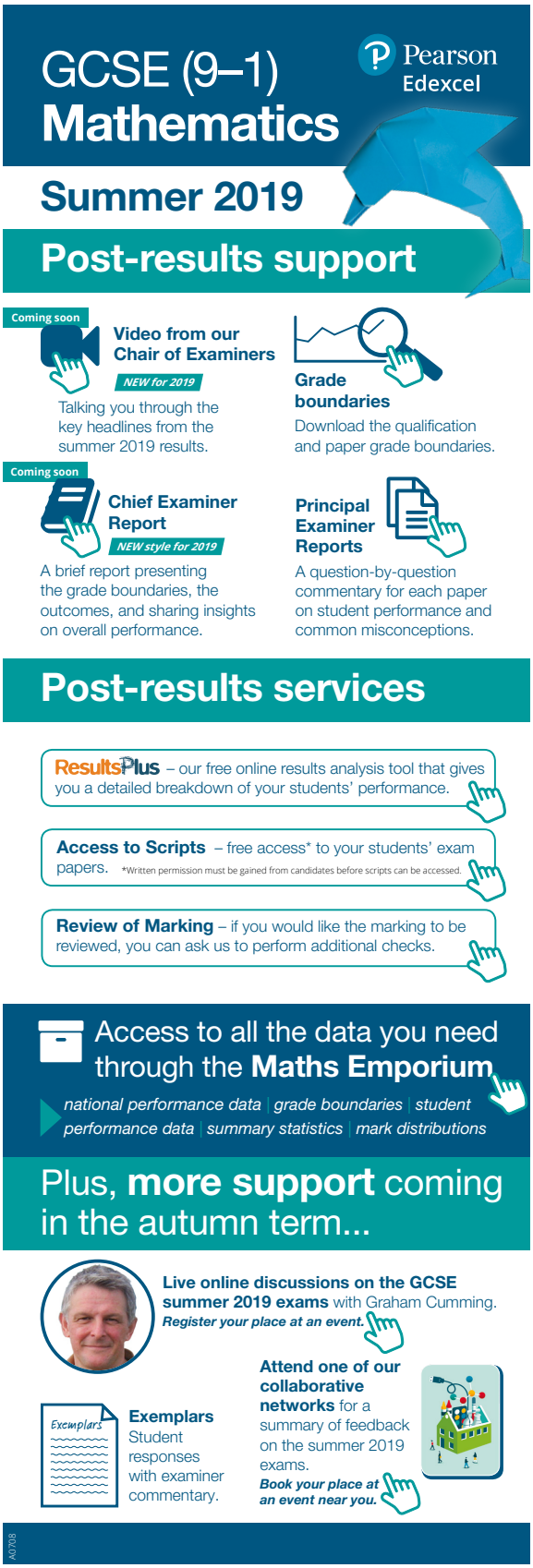
And again in question 14 many students struggled with the geometric concepts by making the false assumption that the triangles were right angled and then used trigonometry to fit such a situation. Having a ratio to deal with also inhibited progress for many. Examiners were surprised at the number of students who equated the area of one triangle to the area of the rectangle which led to the incorrect final answer of 18.

In question 23 students who had a good understanding of bearings together with applications of the sine rule and cosine rule were able to produce an accurate and concise solution to the problem, but these were in the minority. Finding the bearing of *A* from *C* instead of the bearing from *C* from *A* was seen quite frequently.

Probability and Statistics

Completion and use of Venn diagrams is now a strength of many students, as shown in question 1, but some remain confused by the notation used in part (b). Students also showed good knowledge of frequency polygons in question 3, but in question 4 it was clear that many students were unfamiliar with the features of time series graphs.

Many found question 21 a challenging question. Some students lost marks because they opted to work with percentages, either giving their final answer as a percentage, or rounding a recurring decimal to 1decimal place and hence introducing a rounding error. There were a significant number of students who incorrectly used the heights of the bars to represent frequencies.



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Concluding remarks

We continue to be the leading examination board for Mathematics qualifications, with more centres using our assessments than any other examination board. With this comes a responsibility to continue to work with all these centres in future development. To those ends we are always interested in listening to their views.

Alongside the individual paper reports I hope centres find this summary report useful. We offer such reports, and our support meetings in order that teachers can feel confident in preparing further cohorts for qualification. Support we feel is unrivalled.

It is clear that many centres are now feeling confident in using our GCSE (9-1) Mathematics qualification, but nevertheless their desire is always to continue making progress in enhancing results over time. Here at Pearson we will continue to offer guidance to support those aims.

Chief Examiner GCSE Mathematics
December 2019

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