AQA

A-LEVEL
MATHEMATICS

Paper 3
Report on the Examination

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General Introduction to the November Series

This has been an unusual exam series in many ways. Entry patterns have been very different from those normally seen in the summer, and students had a very different experience in preparation for these exams. It is therefore more difficult to make meaningful comparisons between the range of student responses seen in this series and those seen in a normal summer series. The smaller entry also means that there is less evidence available for examiners to comment on.

In this report, senior examiners will summarise the performance of students in this series in a way that is as helpful as possible to teachers preparing future cohorts while taking into account the unusual circumstances and limited evidence available.

Overview of Entry

This paper provided the opportunity for all students to demonstrate their knowledge and skills in both pure and statistics sections, with the full range of available marks being scored.

Topics that were done well included:

- Exponential equation
- Factor theorem
- Sampling methods
- Venn diagram and probability tables

Topics which students found challenging included:

- Binomial distribution
- Combinatorics
- Geometric series
- Hypothesis testing
- Trigonometric proof

Comments on Individual Questions

Question 1 (multiple choice)

Only 57% of students scored in this question with 8 being the most common incorrect response.

Question 2 (multiple choice)

This question proved to be the most successful multiple-choice question in the Pure section with almost three quarters of students choosing the correct answer.

Question 3 (multiple choice)

This was the least well answered of all the multiple-choice questions on the paper with just 39% of students obtaining the correct answer. Students could not identify the nature of a function. There were attempts to draw a vertical or horizontal line, but this often led to the incorrect answer being circled.

Question 4

There was clear evidence of better understanding of the factor theorem in part **(a)** than in previous series and very few students attempted a long division method. Some students lost the final mark for not completing their reasoned proof by stating $\mathrm{p}(6) = 0$ which implies that x - 6 is a factor

In part **(b)(i)** nearly 82% of students gained the first two marks by obtaining the fully correct quadratic factor or first derivative. However, they could not progress further. Weaker responses were unclear about the nature of quadratic roots and those who used the derivative could not identify the coordinates of both turning points. Students should recognise that, as part of their proof, the final statement should refer to what they are required to establish. However, it was pleasing to see that the large majority of students scored the mark in part **(b)(ii),** identifying the coordinates of the intersection on the x-axis.

Question 5

A good proportion of students made good progress at the start of this question involving exponential modelling with 43% of students achieving full marks.

In part **(a),** most students began by setting out the equation to gain the first two marks. However, some arithmetic errors were seen with the use of the negative sign when making k the subject of the equation. Throughout the question, there was often confusion between N and N_0.
Not many could substitute their value of k and $N = 0.1N_0$ in the model to find t. Of those who obtained the correct value in hours, a significant minority did not convert their answer from hours to days.

In part **(b),** 54% of students scored the first mark for substituting t = 24 x 7 or 168 and their value of k in the model. However, they did not state the final answer in percentage form as requested. Nearly one fifth of students scored in part **(d)** where they showed good interpretation of an exponential limit in context. A common incorrect response was that the number of atoms approaches zero over time.

Question 6

Most students attempted all parts in this question with 61% scoring full marks in part **(a).** Students were able to deal confidently with a transformation in the form of f(-x) but for the transformation $a\mathrm{f}(x) + b$ in part **(b),** some calculated the coordinates correctly, but did not illustrate these points on the diagram. Only a few students used a ruler to draw these graphs.

Many unsuccessful attempts were seen in part **(c)** with only 5% obtaining the full mark. About 40% of students found the value of the gradient of at least one of the three parts of the function, but they could not progress further

Question 7

This question was not well attempted with only about one quarter of students achieving full mark in parts **(a)** and **(b)(i).** At the start of the question, many could not expand out $n!$, $(n – 2)!$ or $(n – 4)!$

correctly. Numerous incorrect attempts were made to reach the given quadratic equation including working backwards from the given answer.

In part **(b)(ii),** 77% of students solved the given quadratic equation correctly but few recognised that the value of n cannot be negative, leaving both values of n as their final answer.

Question 8

This question discriminated well ,but geometric series remains a significant area for improvement. In part **(a),** many students could not distinguish between the sum of a series and the n^{th} term of a series. Most could form an equation for the sum to infinity using the correct formula, but for the n^{th} term of geometric series, many used $\frac{a(r^n-1)}{r-1}$. They could not gain further marks from this point onward. However, when they used the correct formula, many went on to obtain full marks.

Part **(b)(i)** was poorly attempted with only 9% of students able to complete a reasoned argument by expressing all terms in powers of 2 and 3 and simplifying to show the required result. 70% of students scored no marks due to not being able to recall the formula for the n^{th} term of a geometric series.

Students did better in part **(b)(ii)** as they could confidently apply laws of logarithms correctly to gain the first two marks. However, there are still issues with the use of brackets as many omitted the brackets in this part.

Question 9

Two thirds of students were able to gain some marks in part **(a)** for using the correct equation for cosec2$\theta = \frac{1}{\sin 2\theta}$ and cot2$\theta = \frac{\cos 2\theta}{\sin 2\theta}$. However, not many were able to recall and use the identities for sin2θ and cos2θ.

In part **(b)** only 0.74% of students gained the mark as they could not deduce that on the LHS when $\cos\theta = 0$ then $\cot\theta$ = 0. Almost all students only explained the invalidity of the expressions on the RHS without explicitly stating that there was a contradiction between the LHS and RHS.

Question 10 (multiple choice)

This was the most well answered of all the multiple-choice questions on the paper with approximately 90% of students selecting the correct response.

Question 11 (multiple choice)

This question proved to be successful with three quarters of students choosing the correct answer. The most common incorrect answer was calculating the variance instead of standard deviation.

Question 12

It was pleasing to see that many students are familiar with the new Large Data Set involving cars. Some students did not understand that the median is a measure of central tendency in part **(a)** but

they can recall spread well. 52% of students scored at least one mark in part **(b)** where they gave correct responses based on facts they knew from the large data set. Common correct answers included: some values for CO_2 or CO are missing, the LDS has outliers and the data is not necessarily representative of England.

Question 13

A high proportion of students made good progress in this question involving probabilities in a two-way table. 96% and 93% of students scored the marks in parts **(a)(i)** and **(a)(ii)** respectively. 91% of students scored the first mark in part **(b)** for correctly finding the total number of male teachers. However, only three quarters of students scored full marks by using conditional probability. In part **(c),** students were able to state the probabilities needed, however, many assumed this involves a binomial distribution. Just under half of all students scored full marks for this part.

Question 14

Most students were able to gain at least two marks by stating the hypotheses and calculating the sample mean correctly. However, only 11% of students scored full marks. Students still struggle to use the correct notation for population mean as often this is confused with the sample mean. There is a significant gap in understanding of how to carry out hypothesis testing throughout the paper. Qualitative responses remain weak. Students commonly tried to use a test statistic or the probability method. Those who used these methods scored better than those who tried to define the acceptance region. Not many could conclude correctly in context using wording to indicate the conclusion is an inference such as ‘there is insufficient evidence to suggest that…’

Question 15

Nearly 80% of students scored both marks in part **(a),** showing good understanding of stratified sampling. Part **(b)** proved to be more challenging: most students scored the first mark for setting up an enumerated population using a valid numbering system. However, they were not able to make good progress from this point onward as they could not explain how to obtain random numbers. The most common approach was to use what must be a very large hat, but they did not refer to replacement. Only 14% of students scored the maximum available marks for this part.

Question 16

This question was not well answered with very few students being able to gain any marks Many students could not state the null and alternate hypotheses. The majority used r instead of ρ as the symbol for the population correlation coefficient. Students appeared to be very confused by the numbers given in the question and many did not know how to compare the given critical value 0.4622 with the given correlation 0.379 coefficient. Only 7% of students scored full marks despite all the required information being given in the question.

Question 17

Students did not score well on this question involving the normal distribution compared to previous exam series. In all parts, it was evident that students were trying to use their calculators. 31% of

students scored the mark in part **(a)(i).** However, two thirds of students scored the mark in part **(a)(ii).** In part **(b),** just over 35% of students could standardise correctly. Students were caught out by the reverse usage of the normal distribution in part **(c).** A common error was the use of 0.25 or 0.75 as their z-value. It was encouraging to see students drawing the bell-shaped diagram to represent their values.

Question 18

Many students did not attempt this question, especially parts **(b)(i)** and **b(ii**). About two thirds of students recognised that this question involved the binomial distribution and they were able to gain at least one mark in parts **(a)(i) , (a)(ii)** and **(a)(iii**). Throughout the question, a common mistake was to assume that P $(x < m)$ = P $(x \leq m)$. Only one quarter of students achieved full marks in part (b)(i) despite most being able to start it reasonably well. Part (b)(ii) was poorly answered. Students who attempted this part could not correctly compare 13 with their critical region from the previous part and often made an incorrect inference.

Concluding Remarks

It was pleasing to see that many parts were attempted with some success. There was a good balance of knowledge between the areas of pure mathematics and statistics with a similar mean score in both sections. However, many still find questions which require qualitative responses challenging especially in proofs and hypothesis tests. Students are still not taking full advantage of the probability functions on the calculator.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.