AQA

A-level
MATHEMATICS

Paper 1

Report on the Examination

7357

June 2018

Version: 1.0

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General

The paper discriminated well between students of varying abilities. While the cohort was reasonably small, students were fairly evenly spread across nearly the whole range of available marks. Students found the multiple-choice questions very accessible and many made good progress on some of the less structured, new style questions. There was no evidence that students were short of time with the majority making a complete attempt at all questions.

Some of the topics which caused greatest difficulty to students are new to the A-level maths specification. These included (8bi) Newton-Raphson, (14) proof of compound angle formulae and (15b) understanding of differentiation from first principles.

There was evidence of allowed calculator technology being used well by some students, but most missed opportunities to reduce the amount of routine manipulation required. This was most evident in questions 9, 10, 11, 12, and 13. Students (and teachers) should be confident that if a calculation can be done or an equation solved using allowed calculator functions then they will not be penalised for doing so, provided they are answering the question they have been asked. In cases where an exact value or a proof is required, calculators may be less useful but still provide a valuable check.

Some students had clearly understood the implications of the instruction “Fully justify your answer”, and there were very good examples of reasoning being explained and justifications for calculations used. Students who ignored this instruction often gave partial solutions and while they were able to score method and accuracy marks, they lost marks for explanation or reasoning.

Question 1 (multiple choice)

Almost all students selected the correct response for this multiple choice question. The most common incorrect answer was $\frac{dy}{dx} = -\frac{2}{x}$, but this was not significant in number.

Question 2 (multiple choice)

A high proportion of students selected the correct response for this question. Incorrect responses were split between the available options fairly evenly.

Question 3 (multiple choice)

This question was answered correctly by about half of all students. While this was a straightforward question, periodic sequences are a new topic on the specification, which may account for students’ poorer performance. This question can be done very easily through the efficient use of allowed calculator functions.

The most frequently seen incorrect answers were π and 2π in roughly equal proportion; very few students selected 8.

Question 4

This question was answered well by most students. Many scored 2 out of a possible 3 marks and could find the inverse function and state it in a correct form. The most frequent mistake seen was incorrectly stating the domain or missing it out altogether. The mark for the correct domain was independent and could be achieved without correctly finding $\mathrm{f}^{-1}(x)$, as it could be deduced from the range of $\mathrm{f}(x)$.

Question 5

Part (a) split students into two groups. Almost equal numbers scored full marks or no marks. Finding the gradient of a curve given in parametric form should be a well-practiced and routine technique. However, differentiating 2^t is new to this specification and this caught out many students.

Part (b) was completed more successfully. Students who took an approach similar to the typical solution given in the mark scheme, tended to complete the question and often scored full marks. Students who introduced logs, to make *t* the subject, scored the first mark for choosing a correct strategy. These students were often unable to manipulate their logs and failed to complete the argument correctly, which is what the third mark was for.

Question 6

This question discriminated well between lower and higher attaining students. The start of the question was accessible to most students. The later parts were more demanding and only the higher attaining students were successful.

Part (a) was completed successfully by a high proportion of students. Many selected a correct approach and manipulated the expression so that the binomial expansion could be applied. The most common error was to extract a factor of 2 instead of $\frac{1}{2}$ from the square root.

Those students who spotted the connection to the first part often did well on part (b). Full marks were available even if the first part of the question had gone wrong, provided $-x^3$ was correctly substituted into their three-term expansion. Sign errors were the most frequently seen mistakes.

In part (c) students could still achieve credit even if their previous answers had gone wrong. Simply substituting their three-term answer to part (b) to form the integral would achieve the first mark.

Very few students demonstrated the insight required for (d)(i) and this question was intended to distinguish the most able students. Those who attempted an answer often talked about the shape of the curve or the use of trapezia. Those who realised that the key was that all the terms were positive often score full marks.

The idea being tested in (d)(ii) was standard, but it was made more difficult by the context. Students were not directed to find the range of validity for their expansion, but had to make the connection for themselves. The first mark could be achieved provided they used their expansion from part (b).

Both parts of question (d) required explanation. Generally, this was not done well. Students needed to state a key fact which must be true/false and then explain the implications of this.

Question 7

In part (a) students had a choice of techniques to use and the first mark was awarded for using an appropriate technique to solve the problem. This was a "show that" question, which was an indication that a rigorous argument needed to be given. Those who compared gradients often failed to complete their argument with a statement such as "$m_1 \times m_2 = -1$ means that the lines are perpendicular, so ABC is a right angle."

Part (b)(i) was intended to help students to answer part (b)(ii). While most students seemed to know the correct theorem, it was usually poorly stated.

Part (b)(ii) was generally done well, with students making good progress. The main errors seen here were numerical slips or failing to give a justification for their answer. Many students showed clear working, gave an argument to show the distance from the centre to D was greater than the radius and concluded that D lay outside the circle.

Question 8

Part (a) was completed successfully by most students. A significant minority used $\frac{\theta}{2\pi} \times \pi r^2$ when finding the area of the sector, possibly demonstrating a lack of practice with the standard formulae.

Part (b) tested knowledge of the Newton-Raphson method, which is new to the A-level maths specification. Less than half of students were successful on this question, with many not realising that the method is used to solve an equation of the form $\mathrm{f}(x) = 0$. Students who did rearrange the given equation often scored full marks.

Question 9

Part (a) was completed very successfully, with around three quarters of students scoring full marks. The most common mistakes seen were using formulae for geometric sequences or the formula for U_n rather than S_n. Those who used the correct formulae were generally able to set up the correct equation and simplify correctly.

Part (b) discriminated well between students of differing abilities. Most who had been at least partially successful in part (a) made good progress in forming a second equation from the extra information. Elimination of either a or d from their simultaneous equations initially resulted in an unwieldy equation. This gave a perfect opportunity for students to make efficient use of technology and avoid several lines of routine manipulation. Unfortunately, many students chose to manipulate rather than solve directly, often resulting in errors. Students should feel confident that they will not be penalised for solving a quadratic equation on their calculators, unless full justification is explicitly requested.

Question 10

Part (a) was completed successfully by the majority of students. It was pleasing to see students being given relatively little structure and demonstrating that they could piece together the given information to solve the problem.

In part (b), around a third of students found difficulty in translating the problem given in context into the correct mathematical process. The most common mistake was not realising that the mass had to reach 280 mg before the next cup of coffee could be drunk. Some students failed to answer the question being asked and left their answers as 2 hours 56 minutes. This was another example where efficient use of a calculator could have helped some students.

Part (c) was testing the ability of students to criticise the model used in this context. Many students gave one word answers or incomplete sentences. While essays are not required in these types of question, and students should be encouraged to be concise, they do need to make themselves clear as examiners are not permitted to guess what they mean.

Question 11

Most students began part (a)(i) successfully forming an equation with $V = 0$ to achieve the first mark. Having started well, only around half of these students went on to demonstrate the algebraic maturity required to arrive at the given result.

Part (a)(ii) was completed successfully by many students. The majority scored fully marks.

In part (a)(iii) relatively few students identified that $T_0 = 38$ represented the current year. A significant number of students made no attempt at this question.

The most frequent mark for part (b) was 2/4, with many students starting well and evaluating **both** models at $t = 49$ or $t = 50$ and indicating that they were close together. Few students went on to correctly complete a change of sign argument, which would have shown the required result.

An alternative method was to form an equation from the two models and solve numerically using allowed calculator functions. This method was accepted as fully correct provided it was explained thoroughly, as shown in the mark scheme.

Question 12

Part (a) was well attempted and many students scored full marks. The question left students with the choice of how to approach the proof and inefficient but correct methods were often seen. Students who scored one mark often failed to complete the proof. Students should be in the habit of finishing any proof or “show that” question with a concluding statement which completes their argument.

While many students scored full marks on part (b) the most efficient method was rarely seen. Students who solved $p(x) = 0$ on their calculators and made use of the factor theorem to write down the correct factorisation could achieve full marks in one line.

Part (c) discriminated well between students of varying abilities. Many students could start the question by manipulating the given equation to form a cubic equation. Some students who went on to see the connection with the earlier part of the question made errors with their use of inequalities or failed to complete their argument with enough rigor.

Some students seemed to focus on the phrase “no real solutions” and were determined to try and use the discriminant of an incorrect quadratic.

Question 13

This question gave students complete choice as to how to go about solving the problem. Many good attempts were seen, with the full range of marks being scored. Different correct approaches were used and given credit. For example, some students modelled using the length and width of the rectangle, others used a radius and angle to form an expression for area using trigonometry.

Marks were often lost through students not fully justifying their answer. Some students failed to identify their variables or were inconsistent in their use. Others did not explain why they had differentiated or how they knew they had found a maximum.

Question 14

The proof of compound angle formulae is new to the A-level maths specification and many students found this carefully structured question very challenging.

Part (a) was an “explain why” question and it was not enough to simply identify $\cos A$ and $\sin B$ when a key part of the proof is to show that $\angle EFQ = A$. Some students achieved one mark with a partial explanation, but it was rare to see full marks.

Around half of the students completed part (b) successfully.

In part (c) only a minority of students could identify the limitations of the proof.

Many students ignored the direction given in part (d) and set about trying to prove the identity from scratch, with no success. Most students who began the argument correctly, replacing B with –B as suggested, scored full marks.

Question 15

Differentiation from first principles is new to the A-level maths specification and while many students seemed well practiced in the routine of part (a), only the strongest students could correctly explain how the gradient of the chord led to A being a stationary point.

The most frequent mistake seen in part (a) was the incorrect manipulation of negatives in the expansion of $(-4+h)^3$. Some attempts were too piecemeal and did not form coherent arguments.

The most common mistake in part (b) was to simply h=0, rather than explain that as h tends to zero the gradient of the chord approached the gradient of the tangent. The most successful students simply used correct limit notation to show that the gradient of the curve was zero at A and hence a stationary point.

Mark Ranges and Award of Grades

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