A-LEVEL
MATHEMATICS

7357/2 Paper 2
Report on the Examination

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General comments

Questions were well attempted with fewer unattempted parts seen than in previous years. Students showed sound understanding and knowledge of most of the topics examined. The standard of algebra showed improvement on the past as did skills relating to ‘proving’ or ‘showing.’
The quality of explanations had improved in pure mathematics.

Mechanics was more of a challenge to students, some of whom seemed to confuse themselves by not being clear about the method they were applying. This was particularly true in the moments question where many students did not state the point about which they were taking moments. Annotating solutions is not required to gain marks, but it is very helpful for students to clarify their thinking. For some questions, methods were applied which are not on the specification, for example use of the scalar product with vectors. This is permitted, but it was clear that student understanding was not always secure when applying such methods and consequently marks were often dropped.

Section A Pure Maths

Question 1

Two thirds of students chose the correct answer. The third option was the most often chosen incorrect answer. No option was left unchosen.

Question 2

70% of students chose the correct answer. The third option was the most often chosen incorrect answer, indicating that those students believed that the integrals should be added together without consideration of the signs. No option was left unchosen.

Question 3

This was the most successful multiple-choice question with almost all students choosing the correct answer.

Question 4

Well over 80% of students scored all three marks in part (a), showing a good understanding of indices and differentiation. When errors occurred, they were most often due to not being able to deal with the coefficients correctly, for example obtaining $\frac{x}{16}$ instead of $\frac{x}{4}$ or $8x^{-\frac{1}{2}}$ instead of $2x^{-\frac{1}{2}}$.

In part (b), two thirds of students scored both marks, with 80% obtaining at least one mark. Those who did not score both marks evaluated the gradient of the tangent incorrectly or found the equation of the normal, rather than the tangent, at $x = 4$. The could easily be obtained from a calculator using the numerical derivative function.

Part (c) was challenging, although 75% of students were able to equate their derivative to zero to score the first mark. There were many ways to show the required result and in fact it was not necessary to solve the equation. Full marks were awarded for a clear explanation that the terms $\frac{2}{\sqrt{x}}$ and $\frac{x}{4}$ are both greater than zero (given that x had to be greater than zero) and hence that their sum could not equal zero. Often an explanation included the comment "you cannot square root a negative" when the comment should have said "the square root cannot be negative." To complete the question, a concluding statement that "there are no stationary points" was required.

Question 5

Series questions continue to cause more difficulties than expected, especially when in context. Only 60% of students scored the mark in part (a). The incorrect answer of $4n + 10$ was often seen. A few students tried to find a sum of terms and others tried to model with a geometric sequence.

Half of students scored all 3 marks in part (b)(i). Some credit could still be obtained in this part if an incorrect linear expression had been used in part (a). Errors that occurred included rounding 28.5 to either 28 or 30, rather than the correct 29. Whilst it was inefficient, some students used a trial-and-error method successfully, listing all terms in the sequence to obtain full marks.

In part (b)(ii) to score full marks an explicit comparison had to be made to conclude that the coach was incorrect. This could have included an appropriate comparison of distances, lengths, or numbers of days.

Question 6

This was meant to be a straightforward question with early parts structured to aid students. Just over a half of students verified the value in part (a)(i). Too often there was inaccurate algebra or incorrect use of variables.

Part (a)(ii) proved more successful with two thirds of students obtaining the correct value of b.

A quarter of students related their value of b to the percentage increase in part (b), with others showing a lack of understanding of how the model works. It was common to see calculations using values from the table.

In part (c)(i), almost 70% substituted appropriate values into the relevant equation. However, only one third of students could then obtain a valid answer. Too often, 'millions' were missing, or pounds (£) were not stated.

In part (c)(ii) an answer in context that referred to sales was required. It was not enough to state that extrapolation is (in general) unreliable. Around one eighth of students gave an appropriate, contextual reason, often choosing to refer to a pandemic, for example.

Question 7

Part (a) was answered correctly by 90% of students with the most common error being to give the composite function $\mathrm{fg}(x)$.

In part (b) 40% of students correctly stated the domain, with common errors being $x > 5$ or $x \le 5$. The domain was not required to be given in set notation, so only the inequality was marked if students attempted to use such notation. Interval notation was also accepted.

About 75% of students scored at least two marks in part (c) and just over half scored all three marks. Inaccurate notation often lost the final mark with x, y or $\mathrm{f}^{-1}(x)$ being used instead of the correct $\mathrm{h}^{-1}(x)$.

Question 8

There were many sound attempts at the proof in part (a). Three quarters of students scored at least two marks, usually by stating or using the two relevant identities, namely, $\cos^2\theta + \sin^2\theta \equiv 1$ and $\operatorname{cosec}\theta \equiv \dfrac{1}{\sin\theta}$. Almost two thirds scored all four marks, which was a notable improvement on the standard seen with similar questions in the past.

In part (b) two thirds of students obtained the first mark by using the result proved in part (a). However only a sixth obtained at least two marks by considering the range of the sin or cosec function.

Part (c) was more successful than part (b). About two thirds of students obtained the first mark by using the result proved in part (a) and this time about a half obtained at least two marks. Many students did not realise that because θ was obtuse, $\cot\theta$ was negative. Some students worked with decimals when the question specified an exact (surd) answer so could not score full marks.

Note: due to an error on the modified versions of the paper, some students sat a slightly different version of question 8c that asked students to find the value of cos instead of cot. Whilst the question was still answerable, it required a different approach and it is possible that finding the value of cos could have been slightly harder for students. Therefore, for any students who sat a modified version of the paper that did not score full marks, we estimated the rest of the marks they would have achieved for this question, based on their performance on the rest of the paper. No marks have gone down as a result of this process.

Question 9

In part (a), 80% of students obtained both marks with the most common error being the coefficient of x^2 incorrectly simplified to $\frac{5}{8}$.

In part (b) 20% of students answered correctly using the word ‘valid’ or ‘invalid’ to explain the restriction on x given in the formulae booklet.

Most students started part (c) well and obtained the first mark by substituting $x = -\frac{1}{4}$ into their expression from part (a). Many evaluated this correctly but only a sixth were able to score all three marks by equating the exact value of $(1+x)^{-\frac{1}{2}}$ to the binomial approximation to deduce an approximation for $\frac{1}{\sqrt{3}}$. The mark scheme lists two answers and shows how 0.574 is obtained. The other answer, 0.580, is obtained by expressing $\left(1-\frac{1}{4}\right)^{-\frac{1}{2}}$ as $\frac{2\sqrt{3}}{3}$, to give $\sqrt{3} \approx \frac{441}{256}$ and then taking the reciprocal to give $\frac{1}{\sqrt{3}} \approx \frac{256}{441} \approx 0.5804988...$

Question 10

Part (a) was done very successfully with almost 95% of students obtaining the mark. When an error was made it was due to an incorrect sign.

80% of students explored a solution to part (b) and two thirds successfully found a counter example and demonstrated how it showed Peter was incorrect to score both marks.

Part (c) proved more demanding, but there was an improvement on previous series with 60% of students scoring the first mark for demonstrating an understanding of how to begin a proof by contradiction. The assumption required to give a contradiction was often stated as $\frac{a}{b} + \frac{b}{a} < 2$ rather than the correct $\frac{a}{b} + \frac{b}{a} \leq 2$. Students who completed valid algebraic manipulation using the former could still score a maximum of two marks. Less than 10% of students completed the proof correctly.

Section B Mechanics

Question 11

80% of students chose the correct answer. Option 2 was the most often chosen incorrect answer, suggesting that some thought it was necessary to multiply by the length to find the tension. No option was left unchosen.

Question 12

Two thirds of students chose the correct answer. Option 4, the other graph with a line of symmetry, was the most often chosen incorrect answer. No option was left unchosen.

Question 13

As both parts of this question were 'show that' requests it was important to clearly demonstrate how the result was obtained. Thus, in part (a) two marks were only possible if the appropriate values were clearly stated before substituting into a valid equation of constant acceleration. Furthermore, the acceleration due to gravity should not have a numerical value in this question.

For part (b) there was an even split between those using $v^2 - u^2 = 2as$ and only using the information in the stem of the question and those using $s = ut + \frac{1}{2}at^2$ with the result stated in part (a). About 60% of students scored the first two marks, but many then found it difficult to explain why the stated inequality was true. To do this successfully, students had to identify that the displacement obtained represented *MN* and comment that *N* was not on the Earth's surface and only a sixth of students did so.

Question 14

This year fewer students tried to apply an equation of constant acceleration to solve this problem, but this approach was still in evidence, with nearly one quarter of students scoring no marks by doing this or differentiating instead of integrating. Students who knew they had to integrate quickly scored two marks if all terms were integrated correctly. To achieve the final two marks students had to clearly show they knew how to apply the initial conditions to find the constant of integration and then go on to show the stated result. 50% of students scored all 4 marks.

Question 15

Being given the weight of the particle, rather than its mass, confused some students so that they had an incorrect normal reaction force. However, almost 60% of students scored all four marks. The best solutions contained clearly labelled diagrams involving the forces, D, W and F and algebraic equations such as $F = \mu R$, $R = W = mg$ and $D - F = ma$ before substituting values.

Question 16

As in the past, a vector question of this nature was very challenging. 60% of students scored the first mark by adding the two stated forces together, although some subtracted them. Having added the vectors together correctly, the success rate then fell very rapidly with just over 20% scoring any further marks. Using $\mathbf{F} = m\mathbf{a}$ in two dimensions was the more popular approach but even after forming a correct vector equation very few candidates continued by solving the appropriate pair of simultaneous equations. Those that favoured the ratio approach, using knowledge of parallel vectors fared worse, mainly because they set up two inconsistent equations.

Question 17

Moments questions continue to pose a significant challenge, with students often not stating the point about which they take moments. About a half of students scored both marks in part (a)(i). There were many attempts in which an equation contained too many ‘force times distance’ terms to be valid. There were some invalid attempts to take moments about two different points and then equate the expressions. Whilst students can form mathematically correct equations by omitting g, they were expected to show the given result using moments which requires terms of the form ‘force times distance.’

Part (a)(ii) proved slightly more successful with just under 60% scoring both marks. The easiest method here was to use the answer from part (a)(i) and resolve forces vertically.

Part (b) proved very challenging with students failing to clearly state that the ‘reaction force at Y had changed’ and that the ‘claim was incorrect.’ Justification could have been a reference to symmetry or calculation of the new reaction force at Y. Only 30% scored at least one mark.

Question 18

This vector question also proved challenging to most students. Part (a) was done well with students clearly understanding that speed is the magnitude of velocity.

In part (b) there were many invalid attempts which assumed the triangle was equilateral to prove that the stated angle was $60°$. A quarter of students scored one mark and only 10% scored both marks. The correct solution required use of standard trigonometry in right-angled triangles formed from the components of the velocity vectors. Several solutions used the scalar product, a topic from Further Mathematics, which was sometimes successful and given both marks.

Part (c) proved slightly more successful with a third scoring one mark and around 20% scoring further marks. Students were unsure of how to combine the initial position and displacement vectors to obtain the final answer.

Question 19

In part (a), almost 90% of students realised that the 2 newton force needed to be resolved and the first mark was awarded for sight of either component. Just under 50% of students scored all four marks. The best solutions came from clearly labelled force diagrams, rather than annotations of the diagram in the question, which led to correct equations being formed. They also clearly stated whether the whole system was being considered or just the engine or trailer. As the final answer was stated, working needed to be convincing and there was some evidence of answers being faked to fit.

In part (b)(i) 40% of students understood that the driving force was now zero. The main difficulty in this part was ensuring the signs of forces in equations were consistent and again those with clear force diagrams had an advantage in doing this. Around one fifth of students completed the question correctly to find the tension.

In part (b)(ii), 40% of students selected an appropriate constant acceleration equation and substituted in values to find the distance required to obtain the first mark. However, further marks needed the correct acceleration required from correct equations, and some students had different accelerations in (b)(ii) and (b)(i).

In part (c) only 15% of students gave a valid assumption about the rod that had not already been stated in the question. One third of students left this part unattempted.

Question 20

Concerns were raised that some students had missed this question. However, only 8% left this question unattempted with a significant proportion of those students leaving other mechanics parts unattempted. Seven other mechanics parts, and indeed seven other pure mathematics parts, had a significantly higher ‘not attempted’ percentage than this. There was an instruction to “Turn over for the next question” on page 33. In conclusion there did not seem to have been a significant issue.

80% of students scored marks for resolving the velocity into appropriate components, often showing this on the diagram. Success rates then dropped once an equation for the vertical motion was formed as signs were often muddled. The best solutions considered the start and end points of the motion as it was not necessary to split the motion into upward and downward parts. Students who employed such a method were rarely successful as they often made several errors and did not achieve a correct total time.

Many students picked up method marks towards the end for considering the horizontal motion of the dog with an appropriate time adjustment. Where this went wrong was when the adjusted time became $t+0.2$, rather than $t-0.2$ Hence, over a third of students scored 5 marks, typically just losing the two A1 marks. 20% scored six marks, losing the last mark as the final answer was not given to two significant figures, a requirement when g is given to that accuracy, and only 10% of students scored all seven marks.

Mark Ranges and Award of Grades

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