Questions matter

A-level

Mathematics

7357/2 Paper 2

Report on the Examination

7357
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General

Students again showed sound understanding and knowledge of most of the topics examined and performed slightly better in the mechanics section this year than in the pure section. The understanding that a moment is a force multiplied by a distance was better this year; however, students still struggled to apply this knowledge to solve the given problem.

The trend that questions were well attempted continued again this year with nearly half as many non-attempted parts as last year. A small number of students did not attempt each multiple-choice question.

The number of numerical and sign errors made by students this year was higher than in previous years and many students would have benefited from checking numerical work with their calculators.

Students were clearly using the formulae booklet when required.

Throughout the whole paper, questions which required students to explain were often not well reasoned. Students are reminded that they should finish with a statement or expression replicating what they have been asked to show or prove.

Questions which required one reason, or one or two assumptions were often answered with many more reasons. This approach is fine if every reason is correct. Students are reminded that examiners are to 'withhold marks for final accuracy and conclusions if there are conflicting complete answers or when an incorrect solution (or part thereof) is referred to in the final answer,' under the choice ruling in the mark scheme.

Section A Pure Maths

Question 1

This question performed as an easy opener for most with over 90% of students choosing the correct response.

Question 2

Nearly half of students chose the correct response for this question and the most common incorrect choice was 253.

Question 3

Just over 50% of students gave the correct response with the most common incorrect choice being the second one.

Question 4

Students completed this question better than last year's logarithms question with just over two-thirds scoring full marks, and only around 10% scoring no marks.

For those students not scoring any marks, the two most common errors seen were:

- taking different logs of each side
- attempting multiple steps at once with at least one error, meaning no marks could be awarded.

The most common fully correct method was to begin by taking log to base five of both sides.

Question 5

This question was done well with approximately 90% achieving at least one mark and approximately 70% going on to score full marks. Students who applied the quotient rule directly often achieved two or three marks on this question.

Students who wrote the equation as $y = x^2(\sin x)^{-1}$ often struggled to apply the chain rule to $(\sin x)^{-1}$ which resulted in no marks.

Approximately 10% of students achieved two marks on this question, and this was often for incorrect attempts at simplifying a correct expression. The most common misconception was 'simplifying' $x^3 \cos x$ to $\cos x^4$ and similarly with the term involving $\sin x$.

Question 6

Most students understood the context of this question and attempted to expand the brackets and apply $\cos^2\theta + \sin^2\theta = 1$. A few students made numerical and sign errors whilst doing this.
Those who correctly expanded the brackets often went on to score well with about 60% of students scoring four or more marks. Approximately 40% of students scored five marks.

Only about 15% of students went on to score full marks for explaining that because θ is obtuse they were choosing their positive solution. This explanation was often supported by a drawing of the sine curve or referencing a correct CAST diagram.

Question 7

In (a) just over 50% of students showed the required workings before finishing with the correct equation involving T_3. The most common incorrect response was to simply write $T_3 = (T_2 + 50) \times 1.002$ and jump to the required solution without any intermediate steps.

In (b)(i), students struggled to fully understand the context with approximately 40% of students scoring zero and around 40% picking up one mark. Most students who scored two marks then went on to score full marks.

The two most common mistakes were:

- choosing the first term as 50
- using n = 10, confusing months and years.

Both these mistakes were condoned for the first mark.

Part (b)(ii) was answered well overall with the most common answer being that interest rates are unlikely to remain fixed for the whole 10 years.

Students who did not score often only put one word such as ‘inflation’ or ‘interest’ with no further explanation. Some students tried explaining that the bank would round or approximate the money each month, but this was not accepted.

Question 8

Nearly all students obtained the required equation for part (a)(i).

The setup for part (a)(ii) following on from (a)(i) was understood by most students with just under 15% obtaining no marks. Nearly 80% of students used the two equations in a and b from part (a)(i) and obtained at least two marks with over half of students achieving three marks.

The students who did not achieve the third mark often failed to properly reason from $\log 24 - \log 3$ to $\log 8$. This being a ‘show that’ question meant students had to show use of the log law by writing $\log \frac{24}{3}$. A very small number of students incorrectly wrote $\frac{\log 24}{\log 3}$.

Part (a)(iii) required students to put the given expression for b either into their (a)(i) equation or the given equation for a. Just over 80% of students were able to do this.

In (b) approximately 75% of students scored marks by identifying that $x \leq 0.25$ and substituted this into the original equation with their a and b. Approximately half of students who scored one mark did not score the second mark. This was often for incomplete or missing conclusions. The most common incorrect conclusion was that the model does not work at all rather than not working for monkeys less than one week old.

Question 9

In (a) students scored well in both parts with approximately 90% of students scoring the first mark in both parts. Students were clearly using the correct formula from the booklet. In both parts some students mistook the denominator of the third term of the formula to be ‘one point two’, rather than the product of one and two.

The most common mistake in part (a)(i) was forgetting to square the 3 as part of the $(3x)^2$ term, which was then repeated in (a)(ii).

In (a)(ii) the two most common errors were:

- not correctly factorising the 2 out of $(2-3x)^{-1}$, by not realising the 2 should also be to the power of minus one
- omitting the negative sign from $-3x$.

The final mark could be awarded to students who didn’t correctly deal with the power of two but had a correct expansion of $(1-1.5x)^{-1}$ and then stated a common ratio of $\frac{3}{2}x$.

In part (b) most students identified this as a partial fractions problem with nearly 95% scoring marks and approximately 80% full marks. The most common errors involved incorrect evaluation after substitution of a negative number or fraction rather than a misunderstanding of the method.

Part (c) was the most difficult part of this question. In (c)(i) approximately 50% of students scored the first mark, identifying that they had to multiply their expansions from (a) by their P and Q values from (b). Approximately 20% achieved both marks. The omission of $\frac{1}{3}$ and inaccuracies when expanding brackets were the two most common errors here. A small number of students did not follow the instruction of 'using your answers to parts (a) **and** (b).' This approach was allowed if they showed a complete method involving their full expansions from part (a) being multiplied by $12x$ or $36x$.

In (c)(ii) approximately 75% of students did not give the correct range of values for which the binomial expansion was valid. The most common incorrect answers were:

- $x \neq \frac{1}{3}$ or $x \neq \pm\frac{2}{3}$
- $\frac{1}{3} < x < \frac{2}{3}$

A small number of students forgot to include the modulus signs around x.

Question 10

The modal mark on this question was 2, achieved by approximately 50% of students. This was for correctly differentiating twice to achieve $f'(x) = 2x - 2\sin x$ and $f''(x) = 2 - 2\cos x$ .Most students then just stated that $f''(0) = 0$ therefore there is a point of inflection. However, $f''(0) = 0$ only implies there could be a point of inflection and students must then complete a sign test either side of $x = 0$ using either the first or second derivative.

Approximately 20% of students scored at least three marks on this question, with roughly half of these students scoring full marks. The most common causes for dropping the final mark were confusion when interpreting the sign change tests or working in degrees.

Students were allowed to use quite a large range of values for x either side of zero for their sign test, but it is better to choose values closer to the given x value or risk being penalised.

Question 11

In (a) students often reasoned incorrectly, just stating 'because $k > 3$' without being explicit that 3 is not in the interval. Approximately 40% of students scored one mark.

Students again struggled to provide a reasonable explanation in part (b)(i) with approximately 70% of students scoring zero. They had to reason that y was both greater than 3 and less than x and that this contradicted x as the smallest value in the interval (3, 4). Students often failed to reference that y was in the interval and simply stated it was less than x. Some even explicitly gave an example where x or y was outside the interval.

In (b)(ii) students were better at proof by contradiction than in previous years. Approximately 70% of students scored the first mark using the correct proof from the teacher in (b)(i) as a template. To achieve the first mark students had to explicitly state the interval $3 < k < 4$ and not just write the word 'interval.' Those who did not achieve the second mark either did not reference the variable in the fraction, or copied the teacher's fraction from step 2 in (b)(i). The third mark was a stand-alone mark for sight of the required inequality and the word 'contradiction'. Approximately 20% of students were able to achieve full marks with very few scoring 3 marks.

Section B Mechanics Section

Question 12

Approximately 95% of students gave the correct response.

Question 13

Nearly 70% of students gave the correct response. The most common incorrect choice was that the acceleration of the car is always positive.

Question 14

Nearly all students substituted $t = 4$ into the expression for r and achieved –8 metres in (a).

Nearly 85% of students compared $6t - 2t^2$ with 0. However, only 50% scored full marks with common mistakes being:

- rearranging to get $6t = 2t^2$ and dividing by t, ignoring $t = 0$
- not using strict inequalities
- not spotting the negative coefficient of t^2 and writing the solution as two separate regions.

Question 15

Students were very good at realising they needed to use Newton's 2nd law; only about 5% of students scored no marks, while 65% achieved full marks.

The most common error was to find the difference between $\mathbf{F_1}$ and $\mathbf{F_2}$, rather than their sum, to find the resultant.

Nearly 10% of students obtained $a + 4 = 12b$ and $b + 23 = 3a$ but did not correctly solve this pair of simultaneous equations because of a sign error when they rearranged them.

Question 16

Students had to show their workings and find d to 3 significant figures before then stating it was approximately equal to 54, although $d = 54$ was condoned.

Approximately 80% of students achieved the third mark, but 30% missed the final mark because they either did not

- show all steps

- state d to 3 significant figures before rounding
- write d anywhere within their conclusion.

Some students struggled with the context of the question and instead of adding 0.1 to 0.5 they just used 0.1 seconds for the time of the second apple.

The most common correct approach was to work in metres throughout with g = 9.8 m s^{-2} and then convert to centimetres at the end.

Question 17

Moments continues to be a topic that students struggle to fully comprehend. This year more students knew that a moment is 'force × distance' than in previous years, with approximately 65% of students scoring the first mark and a quarter scoring full marks. Far fewer students failed to include g when using mg this year.

The two most common correct approaches were either to take moments around the centre, which can be seen in the typical solution, or to take moments around A or B and resolve vertically. The second approach gave the equation $R_A + R_B = mg$ and then using the given information that $2R_A = R_B$ this could be simplified to $3R_A = mg$. This could then be substituted into a correct moments equation around A or B which would then simplify to $L - x = 0.2$.

Question 18

Students were much better this year at understanding that they needed to differentiate the expression for displacement twice to get an expression for acceleration in (a). Approximately 85% of students scored at least one mark and approximately 60% scored full marks.

There were two common mistakes that stood out on this question:

- differentiating p to 1 and not realising that it should be treated as a constant and differentiated to 0
- differentiating the exponential term incorrectly; this was often due to the negative sign but also 0.2^2 was incorrectly evaluated to 0.4 .

Approximately 80% of students correctly differentiated the $2x$ term and substituted the given values for a and t into their equation and gained two marks.

Approximately 10% of students didn't achieve the final mark and this was normally for:

- not giving q to more than 2 significant figures or as an exact expression before stating the given answer
- not writing q anywhere within their conclusion and just relying on many floating equals signs.

Students had to finish with $q \approx 82$ using the correct symbol '$\approx$' which was given in the question. Using '=' was not condoned.

In (b) approximately 80% of students scored the first mark with approximately 75% scoring both marks. The most common mistake was not understanding the word 'initial' and using t = 3 instead of t = 0.

Question 19

In part (a)(i) two marks were only possible if the appropriate 'suvat' values were clearly stated before being substituted into a valid constant acceleration equation. Approximately 90% of students scored the first mark with approximately 60% scoring full marks. As the command word for this question was 'verify' rather than 'show that' students could use $s = 2.5$ and complete their argument by showing one of the other three values to be correct.

In (a)(ii) students were required to write two distinct assumptions. Approximately 90% of students scored one mark and approximately 40% scored full marks. The assumption 'the ball experiences no air resistance because it is a particle' was a common single assumption seen and only scored one mark. Students must treat these two assumptions separately: it is incorrect to state that there is no air resistance **because** it's modelled as a particle.

Some students suggested an assumption that the ball does not hit anything before reaching the maximum height, which was not credited. If you are trying to verify a claim that a toy can shoot to a maximum height of 2.5 metres, you would test this in a place where this is possible.

In part (b) approximately 75% of students scored the first mark with 50% scoring full marks. The most common reason for not scoring more than one mark was incorrectly stating that the initial velocity was $7\cos 79$ rather than $7\cos 11$.

Question 20

In part (a) approximately 90% of students scored the first mark with 80% going on to get two marks. The majority of those who only scored one mark subtracted the position vectors in the wrong order or made a numerical error. The final mark was only achieved by approximately 30% of students as the final statement was normally incomplete and either missing P and Q completely or was incorrectly given as P is perpendicular to Q.

In (b) approximately 35% of students gained the mark. However, most of these students did not spot that the given velocity vector was Q's average velocity along its path and not a constant velocity. The mark was given if a student stated that the speed of Q could change within the three seconds or that it could have accelerated during the three seconds. Students were not credited for simply stating it could have had a different velocity. This is because in (a) it stated that Q moved in a straight line and 'different velocity' could imply otherwise. If a student did use change of velocity in their argument, they could achieve the mark if they included that all velocities were in the direction of $(3\mathbf{i} + 4\mathbf{j})$.

Part (c) proved difficult with approximately 50% of students scoring no marks. Approximately 20% of students either deduced that R travelled 12 metres past X or that the speed of P was 5 m s^{-1}. Students who scored both marks often deduced that P travelled 5 metres and identified 5, 12 and 13 as a Pythagorean triple. The most successful approaches normally involved a diagram to help visualise this problem. Less than half of the students who scored four marks were able to gain the final mark by concluding that P and R moved along parallel lines. Some did not conclude at all. An alternative approach successfully used algebraic distances for XR and PR and then concluded by using gradients of the form m and $\frac{-1}{m}$. Some Further Maths students successfully used the dot product.

Question 21

In (a) approximately 25% of students were able to articulate that $80g - T$ was the resultant force and refer to $F = ma$. The most common response just explained that you subtract T as it is going in the opposite direction to $80g$. Most did write about $F = ma$ but this alone was not enough for the mark with a clear reference to resultant force needed.

Part (b) was completed correctly by approximately 80% of students who knew to multiply $50g$ by $\cos 60$. Most students attempted this part and the common mistake made was to forget to include g and to equate R to $50\cos 60$.

Part (c) involved students realising that they had to resolve parallel to the slope for box M and then use the answers to the two previous parts. This part was completed well with approximately 75% of students scoring the first mark.

Many of the students who scored no marks simply wrote $F \le \mu R$, but μR had to be used to obtain a mark. A small number of students jumped straight to a combined 'equation of motion' for both particles and this approach was penalised as this was a 'show that' question and required the proper setup. Students doing this could only score the first two B marks. Approximately 40% of students scored five or more marks with less than half of these scoring full marks. Often no reason or an incomplete reason as to why $\mu = 1$ was used led to the loss of the final mark.

Part (d) required students to provide one modelling assumption which they used throughout the whole question. The two most common incorrect assumptions were:

- the boxes were modelled as particles —the particle model is not required for the calculations done here
- the rope is rigid.

Nearly 60% of students gave one of the correct four assumptions.

As mentioned in the general summary, a number of students listed more than one assumption. If there was a single incorrect assumption, then they scored zero marks.

Mark Ranges and Award of Grades

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