A LEVEL
MATHEMATICS

7357/2 Paper 2
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

With a much smaller number of entries compared with a usual exam series, it is difficult to draw meaningful conclusions about the overall standard of this paper. It was pleasing to see that almost the full range of available marks was scored, so the paper seems to have discriminated well between students of varying attainment levels. While many students were clearly very well prepared for this exam, a higher proportion of fundamental errors with basic numerical and algebraic manipulation was seen in this exam series. There was also a higher proportion of unattempted part questions on this paper in comparison with previous exam series.

Comments on Individual Questions

Question 1

While all four options were chosen, it was pleasing to see that very few students thought that $\mathrm{f}(x)=\mathrm{e}^{x}$ was decreasing. Over 60% of students selected the correct answer, with $\mathrm{f}(x)=-\mathrm{e}^{-x}$ being the most popular distractor.

Question 2

This question proved to be the most challenging multiple-choice question on the paper with around 30% of students selecting the correct answer. This points to a general lack of familiarity with standard graphs. The most common answer was $\cot x=0$, which could be because solving $\frac{1}{\tan x}=0$ on a calculator leads to an error. Another incorrect answer, $\ln x=0$, was selected by around 25% of students.

Question 3

A significant number of students attempted to apply the more general form of the binomial expansion and often tried extracting $2x$ as a factor to obtain $(2x)^{8}\left(1-\frac{3}{2x^{2}}\right)^{8}$. This was rarely successful as $2x$ was not raised to the power of 8.

Many students who used the intended form of the binomial expansion, for positive integer powers, were unable to identify that the coefficient of x^2 came from the product of $(2x)^5$ and $\left(-\frac{3}{x}\right)^3$. Those who did often lost the minus sign, incorrectly ending up with a positive coefficient.

Question 4

Many students used the small angle approximation $\tan 5x \approx 5x$ correctly. The approximation for cosine was much less successful. The most common errors seen were:

$\cos 4x \approx 4\left(1-\frac{x^2}{2}\right)$ and $\cos 4x \approx 1-\frac{4x^2}{2}$

The second of these errors was sometimes recovered from, with the 4 being correctly squared in subsequent working.

A significant number of students were unable to simplify negative terms correctly with the following error in the denominator seen frequently: $1-\frac{(4x)^2}{2}-1=\frac{(4x)^2}{2}$

Question 5

There was a choice of two straightforward substitutions and many students were able to make good progress on this question. Marks were often lost towards the end of a solution, after a successful substitution, through inconsistent use of limits or failing to explicitly substitute the correct limits and demonstrate how to arrive at the given answer.
Students who ignored the instruction to use a substitution were unable to gain any credit.

Question 6

The three main approaches to part (a), outlined in the mark scheme, were all seen and awarded full marks when completed correctly.
By far the most straightforward and successful method was to find the equation of the line through the centre of the circle, perpendicular to *L*, and then solve simultaneously to find the point of intersection of the two lines. Once the equations had been found, students could achieve full marks by solving the simultaneous equations using their calculators, although many chose to engage in some awkward algebraic manipulation which often led to incorrect answers.

Question 7

The majority of students made good progress on parts (a)(i) and (a)(ii), identifying the error and then correctly writing the proof, although some students did not give enough detail to obtain the second mark in part (a)(ii)
The required proof by contradiction for part (b) was rarely completed successfully. Some students correctly set up the initial assumption and then made no further progress.

Question 8

Most students started well on this question. Nearly 80% were able to eliminate t to find the required Cartesian equation in part (a)

A variety of correct methods for obtaining the gradient were seen in (b)(i), however the link between the gradient of the curve and $\tan\theta$ was often not explained.

It was evident that many students did not know the double angle identity for $\tan 2\theta$ required for (b)(iii). Some of those who did made errors simplifying the fraction which resulted from substituting the result given in (b)(i).

Question 9

This question proved to be very challenging for most students. Those who made the best progress on part (a) introduced their own variable for the radius of the cylinder.

The most common mistake in part (b) was seen from students who treated the constant radius R as a variable and attempted to find $\frac{\mathrm{d}V}{\mathrm{d}R}$ rather than $\frac{\mathrm{d}V}{\mathrm{d}h}$. Also, the phrase "Fully justify your answer." was overlooked by a significant number of students, who did not explain that a maximum value will occur when $\frac{\mathrm{d}V}{\mathrm{d}h} = 0$.

Question 10

This proved to be the most challenging of the multiple-choice questions in the mechanics section, with just over 50% of students selecting the correct solution. Nearly 40% of students chose "The vehicle's driving force exceeds the total force resisting its motion".

Question11

This was the most successful multiple-choice question in this section. Over 80% of students chose the correct answer, although each of the three distractors was chosen by some.

Question 12

This was another successful multiple-choice question with nearly two thirds of students selecting the correct answer. By far the most popular incorrect answer was 6.

Question 13

Many students made good progress with this question. Common mistakes included using incorrect distances or omitting g.
In part (b) there was a tendency for students to over-explain what uniform means rather than say how they had used it. The best answers were concise, stating that the weight acts at the centre.

Question 14

There were many completely correct solutions seen to part (a). The two most common mistakes were seen from students who integrated instead of differentiated and some who found the correct velocity did not find the magnitude of their vector to obtain the speed.

In part (b), many students correctly found the acceleration vector, but the justification of Bella's claim was attempted with varying degrees of success. The most concise solutions simply stated that the **j** component was constant so the acceleration could not be zero. Those students who formed a quadratic to find the magnitude often left their argument incomplete, simply stating there were no roots without justification.

Question 15

Many fully correct solutions were seen for part (a), with nearly 80% of students making some progress. The most common errors were caused by reading the values from the graph inaccurately or from attempting to find the area under the whole graph rather than the section for t between 20 and 100. The best solutions were very concise with values substituted directly into the formula for the trapezium rule, which is given in the formula book. However, there were many inefficient solutions seen where students split the graph into trapezia on the diagram and seemed unaware of the formula.

In part (b), students who gave insufficient detail, for example just stating "integrate", were not given any credit. A frequently seen error was to suggest the use of Newton-Raphson to find the area under the graph.

Question 16

While this question proved too challenging for a significant proportion of students, it discriminated well for those students who were able to make progress, with the full range of marks spread fairly evenly.

Over half of students made an appropriate start, determining a value for h by substituting the given conditions in $s = ut + \frac{1}{2}at^2$. However, a significant number of solutions were seen with inconsistent signs for acceleration and displacement leading to a negative distance.

The greatest obstacle was in linking the time for the two particles. Many students did not use $5 - t$ for the time of flight for particle *B* and were then unable to show the required result.

Question 17

The key to this question was to choose appropriate models to link the vertical and horizontal motion so that the time of flight could be eliminated. Various valid approaches were seen:

- Doubling the time to the max height
- Vertical displacement equated to zero in $s = ut + \frac{1}{2}at^2$
- $v = -u$ in the vertical direction in $v = u + at$

Often, however, students used inappropriate models, only using half the time of flight or using incorrect signs for u and v, which meant that they were unable to make any creditworthy progress. Many students who made good progress were unable to demonstrate clearly how $\sin 2\theta$ was introduced, or handled the inequality inconsistently, so did not achieve full marks.

Question 18

This was expected to be a challenging question, but it was pleasing to see that around 75% of students made some progress with part (a) and this part discriminated well, with the full range of marks seen.

Common errors included:

- Incorrect directions/signs used when resolving
- Treating the two particles as a single system rather than forming two equations of motion
- Some students did not include g in the value for acceleration

It was pleasing to see very few instances of sine and cosine being switched over when resolving the forces, which is often a common error in this sort of question.

In part (b)(i) most students made no attempt to remodel the situation to find the new acceleration, after the string had broken, and simply assumed the acceleration would change to g or remain at the value given in part (a). However, around 40% of solutions achieved some credit for using $v^2 = u^2 + 2as$ to obtain the distance.

Part (b)(ii) was poorly answered, with only around a quarter of students giving a necessary assumption. When asked for an assumption it is important to state something that is not already given in the question. Many said things like "the string is inextensible", which is more relevant to part (a) and not an assumption the student has had to make, as it is given in the question.

Question 19

This question proved to be very challenging with few students making any creditworthy progress. A common error was to attempt to use constant acceleration equations, making no attempt to form a differential equation, as instructed.

Many students were able to make better progress in part (b) as they could use the result given in part (a). A significant number of students achieved full marks in this part without completing (a).

Concluding remarks

It was encouraging to see that many students had clearly prepared thoroughly for this paper and some high scoring scripts were seen, with many students able to complete routine questions on many aspects of the specification with some success.

There is still a reluctance by some students to make best use of their calculator . For example, in question 6 the most straightforward and popular approach involved solving two linear simultaneous equations, which could easily be completed on all allowed calculators.

The multiple-choice questions were generally found to be very accessible by most students, although a small number of students left answers to these blank, which examiners found perplexing.

Students have demonstrated an improved understanding of the following aspects of the specification in this series:

- Small angle approximations
- Integration by substitution
- Variable acceleration – far fewer instances of inappropriate use of the constant acceleration equations were seen.

Topics which caused most difficulty included

- Proof by contradiction
- Optimisation
- Forming and solving differential equations

Many students lost marks through numerical slips and a lack of attention to detail, which are often indicative of insufficient practice of routine techniques.

Mark Ranges and Award of Grades

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