Examiners' Report

Principal Examiner Feedback

October 2020

Pearson Edexcel GCE Advanced Level in Further Mathematics

Paper 1: Core Pure Mathematics 1 (9FM0/01)

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General comments

The unusual nature of the series meant that the candidates sitting the paper were less well prepared than they would normally be. As such that were perhaps weaker performances in some areas, or blank pages or answers such as “not on my spec” to be given. But there were nevertheless some good performances and many areas where students could access marks.

Question 1

This question was generally well done with over half of the candidates gaining full marks and a mean score of 8 out of 10. Indeed, all gained the first B mark for the correct complex conjugate as another root, so got a start in the question.

The most common approach was the alternative method given in the mark scheme. Most managed to find the quadratic factor by considering the sum and product of the roots of the conjugate pair. Some sign or conceptual errors leading to errors in the $z^2 – 6z +17$ were seen. Having found the quadratic factor most tried to expand and consider coefficients of z.

Some attempted a long division method but these often could not complete to find the third root. Those who chose to apply the pair sum to find the third root were usually successful, and these usually found correct values for p and q by considering the sum and then the product of all three roots.

The Argand diagrams were well drawn, with almost all candidates gaining the B mark for the conjugate pair. The follow through mark meant that most could gain the second B mark even if they had made an error in (a). Scales were not expected on the Argand diagram although the relative positions of the roots needed to be realistic for the second B mark.

Question 2

(a) Most candidates realised that the integral was improper due to the infinite upper limit. Many however missed this part out or gave explanations with contrary reasoning. A common misconception was to state that the integrand was not valid when $x = 0$. Some said it was undefined when $x = \infty$, and these did not get the mark.

The straightforward integral in part (b) was done well by the majority although there were also some very disappointing attempts. Most used partial fractions and integrated successfully, gaining the first three marks. Many however made little progress from there as they did not realise that they needed to combine the logs in order to consider the limiting value. Many of those who did combine the logs did not complete the strategy to find the required area as they did not correctly find the limit of the improper term. The most common error was to assume the upper limit tended to 0.

Most candidates gained 3 or 4 marks in (b) and a minority dealt with the upper limit correctly and gained full marks. There was a wide spread of marks on this question making quite discriminating.

A very few chose to use Way 2 on the mark scheme, expanding the denominator and completing the square. These then used the formula to integrate. Sign errors when using the formula meant they could only gain the first two marks in (b).

Question 3

This was a standard Polar Coordinate question which was well attempted by the majority of candidates with bimodal peaks of 7 or 9 marks as the most common scores. Most started by finding the intersections of the two curves and gained the first 2 marks. Nearly all used a correct polar area formula and expanded at least one expression for r^2. A few only considered one curve and these lost 4 of the subsequent marks. A generous mark scheme awarded marks for correct expansions of both expressions for r^2, and most gained these marks. Some however forgot to square the 3 in curve C_2. Again, most realised they needed to use a double angle formula in order to reach an integrable form and this was done very well, with the integration of both expressions usually correct. Candidates who gained full marks up to this point often lost the last two marks by applying an incorrect overall strategy. This usually meant they used the wrong limits of integration. Some integrated from $\pi/6$ to $\pi/2$ which was fine as long as they remembered to double their answer. There were a few very pleasing concise and completely correct solutions.

Question 4

Overall, this proved one of the most challenging questions with a modal score of zero, and mean score of 4.6 out of 9. However, the second most common score was full marks, followed by 8 out of 9, and these three scores account for over 80% of the candidature.

(a) There were some pleasing responses to this vector question, with many gaining full marks. A popular approach to finding the normal vector to the plane was to use the vector product, although there were a few sign errors. The rest used a scalar product method to find the normal. A few used the Cartesian forms to eliminate one of the scalar parameters, although these often got bogged down with the algebra. Some gave the final answer in scalar product form, losing the last A mark. There were many who were very confused and gained no marks in (a)

(b) The easiest approach to this part was to use the parametric form for the line and to substitute into their Cartesian equation to find a value for the parameter, and most chose to use this method. Those who had not managed to do part (a) were still able to gain full marks in part (b) by using the parametric form for both the line and the plane. Some then used their calculators to solve their three equations in three unknowns successfully, which was fine. Most then substituted back into the line to find the correct intersection. Those who used the same parameter in both line and plane unfortunately gained no marks here.

(c) Provided they had found a normal to their plane in part (a), they were then able to apply a correct scalar product method to find the angle between the two planes. However, a few went on to find the wrong angle after a correct application of the dot product, by subtracting from90°. Some were very confused here and methods which were not considering the normal vectors to each plane gained no marks.

Question 5

This was another question with a model score of zero scored by 20% of candidates. The next most common score was 13 marks, as once started on the right track, there were many accessible marks. Very few achieved full marks for the question.

(a) This part was reasonable well attempted, with many scoring all three marks. Many started off by rearranging the first equation before differentiating to obtain an expression for y', while others started by differentiating the given expression for x'. Either way they usually managed to correctly achieve the required result. A few used verifications to prove the result. A common error was to give x'' as -5 + 10y' which could gain only the M mark.

(b) Most candidates who made progress in this part gained all six marks. They solved their auxiliary equation correctly and selected the correct form for the complementary function. Some did give this in terms of x, not t, and lost marks as a result, though some did recover in the final answer. Most used a correct form for the particular integral, although some just gave λ = 50 with no indication where it came from, losing the last two marks. The general solution was usually correct, starting with x =…and given in terms of t.

(c) Most realised they needed to differentiate their general solution, and the first Bft mark was usually gained for their correct and accurate method. The next mark was also attainable by the majority, as they realised, they needed to find an expression for y in terms of t and used an appropriate equation to do so. Many however lost the final accuracy mark, often by combining their constant terms incorrectly.

A small number of candidates attempted to revert to similar work as for parts (a) and (b), but for the variable *y* instead of *x*. As well as being a highly inefficient method, many of these also confused constant by calling their constants in each of the equations for *x* and *y* by the same letters, which also impacted how much they could score in part (d).

(d) The most common mark profile here was M1M1A0A0. Most used the initial conditions in their equations for x and y and found values for their constants but either due to earlier error or slips in algebra (finding B) both accuracy marks ended up being lost.

(e) Many candidates made a great effort in this final part of a very long question, although a few thought for one mark it was more trouble than it was worth! Those who gained the mark usually considered the behaviour of both x and y and came to a sensible conclusion. A few considered x' and y', which was also fine. Those who came to a conclusion based solely on the behaviour of either x or y did not gain the mark.

Question 6

Generally, these two proofs using induction were well attempted. Candidates are much better than they used to be at making correct statements and nearly all of them seem to have memorised the final conclusion! The double step induction in (ii) did cause some problems, but the modal mark here was 8, and only 1% of candidates scored fewer than 2 marks. The first two marks of each part were scored in most cases.

(i)

Most evaluated both sides to gain the B mark, though a few evaluated to get 8, and some other only evaluated one side, so these did not gain the mark. They usually stated the assumption and then made an attempt at the inductive step. Some struggled with the (k+1)th term, thinking they should add 12 to k(k+2)(k+3). Others lost the last 3 marks by expanding their expression to obtain a cubic and then showing no working to reach the final answer. Most realised they needed to show the expression explicitly in terms of (k+1) which was pleasing. There was also a minority of candidates who attempted to use summation formulae to prove the inductive step, losing the final 4 marks.

(ii)

Almost all gained the first two marks by showing the expression was divisible by 15 for n=1, and for their assumption. The fact that the question wanted them to prove the result for positive odd integers caused problems for many of the candidates, with most attempting to find f(k+1) having assumed true for n=k. These candidates could gain no further marks. For those who did realise the two-step induction was required there were many different approaches made. The most successful one was to find f(k+2), or f(k+2) − f(k) and quite a few did this. They then needed to extract f(k) and balance the remaining terms for the first A mark, and not all were able to do this. A few different approaches were possible. Alternatively, some started assuming f(2k+1), then found f(2k+3), which was fine for the first three marks, but again there was difficulty for many students in reaching a suitable form to prove the result. Though not many, there were some completely correct solutions which was very pleasing.

Question 7

There were many incomplete answers to this question, suggesting they may have run out of time. Once again, the modal score was no marks, by 22% of candidates. Aside from that the mark distribution was evenly spread.

(a) Most started by rearranging the differential equation and trying to find the integrating factor, usually successfully. They then usually went on to integrate and the majority gained the first three marks. Some forgot to multiple both sides by the integrating factor, so they just achieved the first B mark. Some used integration by parts on the right-hand side instead of expanding the brackets, and they were less successful. Only very few candidates omitted '+c' from the integrated equation.

The most common error was to use P=5000 when t=0 as the initial condition. Another common error was to rearrange to make P the subject and forget to divide their c by (1+t). But most did attempt to evaluate their P at t = 8.

(b) The entry seemed to be fairly evenly split in using either the main method on the mark scheme or the alternative method, though the main scheme method was probably the more common, though the alternative was actually much more straightforward. Either way, very few multiplied their answer by 1000 to find the correct rate of change of bacteria.

(c) Most candidates tried to give a context-based reason, such as the atmosphere might not permit growth, but did not relate it to the model. Since there was no information about the assumptions of the model, such answers could not gain credit. A few did realise the model predicted unlimited growth, and some even gave this rote answer without having solved to find an equation for P!