Examiners' Report
Principal Examiner Feedback

Summer 2019

Pearson Edexcel GCE AS Mathematics

In Further Pure Mathematics 1 (9FM0/3A)

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General

This paper offered plenty of opportunity for candidates of all ability levels to demonstrate what they had learnt. There were also questions that offered a challenge to the more able, particularly the questions in the second half of the paper. Two points worth noting in general for candidates are,

- Care should be taken when copying work from one line to the next to avoid unnecessary errors
- Sketches can often be very useful for helping candidates understand a particular problem and will frequently help identify a suitable strategy for solving a problem

Question 1

Candidates found this an accessible question at the beginning of the paper with the majority achieving full marks. Many candidates made a successful start and the first two marks, for finding h and evaluating the y-values, proved to be attainable by almost all candidates. Subsequent mistakes seen included the use of an incorrect number of intervals and mislabelling of their ordinates so that their odds and evens were confused in the formula. Several attempts were seen to use the trapezium rule.

Question 2

This question was the first of its kind on the new specification and it was obvious that most candidates had a good knowledge of how Leibnitz's theorem was applied, with only a few attempts at repeated differentiation seen. There were very few candidates who were unable to make good progress in this question. Very few errors were seen in obtaining the derivatives that were required and there were similarly few errors seen in the structure of Leibnitz's theorem. The most common errors seen in this short question were errors when collecting terms to obtain the final answer, or transcription errors when candidates copied their expressions from one line to the next. For the candidates not familiar with Leibnitz Theorem, it was common to see no binomial coefficients present, or for them to be incorrectly attached to their terms.

Question 3

This was another question in which most candidates could make very good progress. Candidates appreciated the correct strategy required and found the first five derivatives, evaluated them at $x = 0$ and then substituted into the Maclaurin formula. A common error was to obtain $y'' = -2y\frac{dy}{dx}$ (losing the 1) but they were allowed to recover. Another error seen fairly often was the omission of the constant term in the second derivative but this did not prevent candidates from continuing to find the other derivatives required. Other errors noted by examiners included the miscopying of previous work and collecting terms incorrectly. It was also common to see the product rule applied incorrectly in the 4th derivative which then led to the middle term on the 5th derivative giving a coefficient of -4 or -6 instead of -8. In the subsequent work, there were errors in calculation of the values of the derivatives seen and also, less frequently, an incorrect structure for the Maclaurin series.

One calculation error seen on several candidates' work was in finding $y'' = 2$ (not 3). This gave the remaining derivatives as -6, 24 and -120 leading to the series $1 - x + x^2 - x^3 + x^4 - x^5$

A few candidates quoted a series expansion without 1 +… despite obtaining all the other coefficients correctly and this was a costly error.

Question 4

The first part of this question required candidates to produce the equation of a tangent to a parabola and then use the given point to find the coordinates of the two points where the two tangent touched the parabola. The most successful approach was to differentiate using the chain rule and then substitute in the given general P or Q coordinates to find an equation of the tangent at either P or Q. Candidates who drew a diagram realised that substituting in the given intersection point $R(-28, 6)$ would yield the p and q needed in order to obtain the specific coordinates of the points P and Q. Such attempts usually yielded the correct coordinates of those points. For others it was a case of resorting to simultaneous equations using their general tangent equations and then substituting in the coordinates of the point of intersection. However, candidates needed to work much harder in order to obtain the correct quadratic equations which yielded the values of p and q. The complexity of this algebra proved too much for some candidates. It was rare to see the resulting quadratic solved incorrectly.

The second part of the question involved finding the area of the triangle formed by the given point and the two points found in the first part. It was disappointing to see many candidates setting off to find this area without first doing a quick sketch to help them. Longer solutions involved using the cosine rule and then a triangle area formula. Concise, and simpler, solutions used the determinant method of finding the area of a triangle, enclosing the triangle in a rectangle and finding the area of the rectangle and subtracting the area of three right angled triangles and using one half of the modulus of the cross product of the vectors forming two of the sides of the triangle. It should be noted that the use of these more efficient ways of finding the area of a triangle were relatively rare.

Question 5

Most candidates could start to use the t formulae to express the given integral in terms of t. A minority of candidates forgot to change their dx in the integral to an expression involving dt. Candidates then proceeded to manipulate their integrand correctly to the required quadratic form.

The two routes from there involved either partial fractions or completing the square. The negative 't^2' term caused some problems as many candidates couldn't factorise the expression without bringing the minus out and this occasionally caused problems later on and such algebraic errors caused loss of 3 accuracy marks in the final part of the question.

When using the partial fraction method, a fraction with a denominator of $2t - 1$ was possible but few candidates could convincingly deal with changing this to $1 - 2t$ with $|2t - 1| = 1 - 2t$ seen with no justification. Others left their answer with modulus signs in thus losing the final mark since they had not reached the required answer. Other candidates expressed their denominator in the form $a^2 - x^2$ or $x^2 - a^2$ in order that a standard integral could be used. This method usually resulted in a term $\frac{1}{2} - t$ or $t - \frac{1}{2}$ in the denominator which frequently changed into the required $1 - 2t$ with no explanation so losing credit.

Question 6

Part (a) was poorly answered by a good number of candidates, with many incorrect attempts at applying both the product and chain rule seen. It was also common to see candidates trying to 'fudge' their answer to make it fit with the printed differential equation. The most successful approach seemed to be differentiating with respect to t after obtaining $\frac{dC}{dt}$. Differentiating with respect to a different variable seemed to cause difficulties in all but the more prepared candidates, despite the fact that this is a very basic element of calculus in A Level Further Mathematics. Some very poor responses were seen asserting that, for example, $\frac{d^2C}{dt^2} = \frac{d^2C}{dx^2} \times \frac{dx^2}{dt^2}$.

However, the majority of candidates made a sound attempt at part (b) with many fully correct solutions seen. There was a sound knowledge of the technique of solving a second order linear differential equation and only the occasional slip prevented a candidate from achieving the correct form for C in terms of x. Some candidates did not transform C into a function of t which did lead to some problems whilst attempting to fit their general solution to the initial conditions of the problem.

Part (c) was also well attempted with many fully correct solutions seen. By far the most common error here was to see candidates substitute -36 into an equation which had been differentiated with respect to x rather than t and in some instances also using x = 6 rather than ln6. However, some candidates rectified this by using -6 x 36 for the value of $\frac{dC}{dx}$ at $t = 6$.

Quite a few candidates also failed to give appropriate units in their final answer.

Question 7

In part (a), it was rare to see a correct strategy for the area of the quadrilateral. Candidates understood the idea of how to find the intersection of the two lines; only numerical slips prevented candidates getting the correct coordinates for the two points. The most successful candidates here drew a diagram of the situation and were then able to find the required area by splitting it up into smaller triangles and using the cross product. It was very common to see candidates attempt to evaluate a cross product which would produce the area of a single triangle and then write down the given answer. Another common problem, which a diagram would have avoided, was to add the areas of overlapping triangles.

In part (b) the strategy was generally well known. Errors involved the use of incorrect vectors even though the correct formula was written down. Candidates knew how the scalar triple product related to the required volume although a spurious 1/6 was seen in the formula at times. Of those candidates that correctly evaluated the scalar triple product many ignored the fact that its value could be plus or minus 2 and also the requirements of the question which asked for the values of *k*.

Question 8

There were few candidates who did not attempt this question which would suggest that the paper was of an appropriate length.

Candidates appreciated the strategy involved in finding the *x* coordinate of the point of intersection with the x-axis although some attempts were unnecessarily complex resulting from rearrangements of the tangent equation before setting $y = 0$. Many could then proceed to find the equation of the required line and the midpoint. It was disappointing to see slips in finding the mid-point where the *x* and *y* co-ordinates were subtracted rather than added.

Establishing the form of the equation of the locus caused difficulty for many and solutions were seen with much unhelpful algebraic manipulation. The strategy of finding cosh θ in terms of x and then substituting into the expression for y^2 from the mid-point was the most successful route; working on both sides of the required expression to achieve a common expression was also used. Generally, neither was completed with a great deal of success, many getting bogged down in the algebra. Even amongst those who were successful in this manipulation, it was common to see no reference to the values of p and q required. This was probably because many were pre-occupied with trying to obtain the equation of the locus of M. Of those who did attempt this part, $q = 4$ was seen but usually $p = 0$ was seen rather than $p = 2$.

Fully correct solutions to part (b) were extremely rare. Most candidates could not progress beyond finding the coordinates of the focus. It was rare to see any use of a diagram to help to understand what was required.

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