Examiners' Report/
Principal Examiner Feedback

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GCE Further Pure Mathematics FP3
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Introduction

This paper proved accessible to the candidates. The questions differentiated well, with most giving rise to a good spread of marks. All questions contained marks available to the E grade candidate and there also seemed to be sufficient material to challenge the A grade candidates also. The modal mark was full marks for all the questions except question 6.

Generally the standard of presentation was better than last year but in many cases the presentation was badly done and handwriting was hard to read, both by the examiners and in some cases by the candidate themselves. A number of errors were seen, caused by candidates misreading their own handwriting, with minus signs in particular being missed. Some very poor arithmetic was seen from some candidates.

Question 1

This proved a good starter with 70% of the candidates gaining full marks and only 12% gaining 2 or fewer marks. The most common error was in misusing/not using the formulae book. Many confused the ellipse and hyperbola formula from the formulae book, getting $e = \sqrt{7}/4$, this situation was further complicated by many giving $e = +/-5/4$. It is expected that candidates at this level should be aware that for a hyperbola, $e > 1$ (which is also given in the formulae booklet). Nearly all used the ae and a/e formulae correctly, but occasionally candidates confused a and b, or used a^2 instead of a.

Question 2

This proved a good source of marks for many with 73% gaining full marks and only 13% scoring 2 or fewer marks. The vast majority of the candidates identified the need to use the given formula for finding an arc length and carried out the differentiation, simplification and subsequent integration with a great deal of success. Some candidates did not recognize $1+\sinh^2 3x$ as $\cosh^2 3x$ and made not further useful progress. Since the form of the required answer was given, many candidates identified the need to convert terms such as $\sinh(3\ln a)$ into exponential form, though some omitted the factor of ½ leading to a final incorrect value of $k = 1/3$.

Question 3

This question was answered completely correctly by 58% of the candidates with only 7% gaining 3 or fewer marks. Many well-presented, accurate and efficient solutions were seen. The vast majority of candidates were able to form the vector product in part (a), although some used vectors such as **AB** or **CA** instead of **AC** and **BC.** A significant minority alarmingly calculated the vector product as $-9\mathbf{i}+24\mathbf{j}+6\mathbf{k}$. Another significant minority 'cancelled down' their answer getting $2\mathbf{i}-3\mathbf{j}+6\mathbf{k}$, leading to problems later. In part (b) most candidates knew that they needed the modulus of their vector product, although a few took a triple scalar product with one of the position vectors, finding a volume instead. A minority found the area by calculating the sides and an angle of the triangle. A few re-started and found a new (valid) vector product and its modulus. However a common error in this part of the question arose when candidates took out a factor of 5 from the vector product, thus reducing the area obtained by this factor. A few candidates also omitted the factor of ½. In part (c) most candidates recognised that the vector product they had found was the required normal to the plane, and many proceeded to find a correct value for *p* by using one of the given points. A few candidates showed some checking calculations, such as verifying that the original vector product was perpendicular to each of the original vectors by checking the scalar product was zero, or that the same value of *p* was obtained by using each of the original points. These checks were very worthwhile since marks can be lost by a slip in the initial calculations.

Question 4

In this question 69% of candidates gained full marks and only 9% scored 5 or fewer marks. In part (a), many of the candidates recognised the need to use parts twice and although the presentation of the solutions in a number of cases was untidy with inefficient use of bracketed terms, most were able to produce the printed result. Parts (b) and (c) were, in general, well answered although the given form for I_4 did lead to some candidates manipulating the values for I_0 and I_2 and correcting initial sign errors in their working.

Question 5

This question proved to be a good discriminator leading to a good spread of marks. 38% of candidates scored full marks and 10% gained 2 or fewer marks. In part (a) nearly all candidates applied the product rule correctly, but there were many variations seen for the derivative of arsinh $2x$. These were usually of the right form, but the factor of 2 was often missing in one or both positions, and sometimes the signs were incorrect. To start part (b) candidates were evenly split between those who rearranged (a) and those who used integration by parts. However there were a large number of candidates who were unable to integrate the $2x(1+4x^2)^{-\frac{1}{2}}$ term. Strong candidates recognised the form of this integral, and some managed to make an appropriate substitution, but many tried a variety of unsuccessful methods. A few candidates succeeded in solving part (b) by a substitution such as u = arsinh $2x$. Most were able to convert the arsinh term into log form.

Question 6

This question discriminated well leading to a good spread of marks. Only 3.8% gained full marks, 9% gained 3 or fewer marks and 24.8% of the candidates gained the mode of 9 marks.

In parts (a) and (b) were usually very well done with most differentiating successfully, finding the tangent and using $cos^2\theta + sin^2\theta = 1$ to obtain the printed answer. Only a few candidates used the faster method of putting $b = a$ in their answer to (a) to find the equation in (b). In part (c), the vast majority of the candidates recognised the need to solve the two line equations simultaneously but then failed to identify that the y coordinate of R was zero. Many got entangled in lengthy algebraic expressions. There was evidence that the need to find the coordinates of R in terms of a, b and θ caused confusion for a number of the cohort and the associated algebra often became untidy with careless errors frequently occurring. In part (d), a completely correct description of the locus of R was obtained only by a very small number of the candidates.

Question 7

This question discriminated well with a good spread of marks. Full marks were gained by 36.5% of the candidates, this was also the modal mark, and only 10% gained 5 or fewer marks. Most candidates were able to complete part (a) correctly. In part (b) most candidates were able to obtain the correct quadratic equation, though not all were able to solve it efficiently or correctly. There were also just a few who did not simplify the answer ln1 to get 0. The integration in part (c) caused a great deal of difficulty, and a wide range of methods were attempted. Few recognised the standard integral. Substituting $u = e^x$ generally proved successful, with some candidates then substituting tanθ for u, but many clearly invalid attempts were made such as 'splitting' the denominator or using a log, usually a getting some multiple of ln(e^{2x} +9). Very badly constructed algebra was seen on occasions, such as candidates trying to get the reciprocal of $e^x/2+9e^{-x}/2$, by stating this as being equal to $2/e^x+2e^x/9$. Those candidates who integrated correctly nearly always showed sufficient working to justify achieving the given answer.

Question 8

This question also differentiated well with a good spread of marks. 24% of the candidates gained full marks (the modal mark) and 11% gained 4 or fewer marks. In part (a), the need to form the characteristic equation and then solve the resulting cubic equation was well known by the vast majority of the cohort and many correct solutions were seen here. It is clearly important, in such work, for candidates to ensure that they are solving an **equation** and to include all necessary terms to justify the solutions found. In part (b), the equation **M.v =** 4.**v** was obtained by many of the candidates and the resulting equations obtained. However, the simultaneous solutions caused a number of difficulties with the elimination of z causing many of the candidates to obtain an incorrect eigenvector, with $\begin{pmatrix}0\\0\\0\end{pmatrix}$, $\begin{pmatrix}1\\2\\0\end{pmatrix}$ or $\begin{pmatrix}2\\1\\0\end{pmatrix}$ being particularly popular incorrect answers. In part (c), nearly all of the candidates used the two given vectors to form the position vector of a general point on the line L_1 and then applied matrix multiplication to find the position vector of a general point on line L_2 from which the equation of this line was found. Those candidates who tried to work with the vector product form of the line equation often produced worthless lines of working and the need to convert this form of the equation into the standard form $\mathbf{r} = \mathbf{a} + \lambda\mathbf{b}$ is vital if any success is to be achieved in questions of this type. A number of candidates did not give their final answer as a vector equation.

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