GCE EXAMINERS' REPORTS

MATHEMATICS C1-C4 & FP1-FP3
AS/Advanced

SUMMER 2016

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MATHEMATICS

General Certificate of Education

Summer 2016

Advanced Subsidiary/Advanced

C1

General comments

This turned out to be a more accessible paper than last year's paper. There was an increase of almost 6 marks in the mean mark and most questions were generally well answered, with the possible exception of question 10.

Comments on individual questions

1. Parts (*a*) and (*b*) of this question caused very few problems. In (*c*)(i), only a few candidates were able to write down the equation of *BD* but attempts at finding the value of *m* in (*c*)(ii) were generally more successful. The most popular method of solution involved using the coordinates of *C* to find the equation of *CD* and then substituting in the coordinates of *D* to find the value of *m*.

2. Generally well answered, as is always the case. It was disappointing that some candidates did not check to see whether 13 was a factor of 65.

3. Even though the equation of the curve was marginally more difficult than is usually the case, this question caused very few problems.

4. There were many totally correct solutions to this question. Most of the errors which occurred here were either sign errors or arose as a result of incorrect evaluations of powers of $\sqrt{3}$.

5. It was only part (*c*) which caused any real difficulty. Most candidates were able to interpret the solution to part (*b*) as the points of intersection of the line and the curve but fewer were able to write down correctly the coordinates of the minimum point on the quadratic graph.

6. Part (*a*) was generally well answered, but in part (*b*), not all candidates realised that the first step had to involve expressing the given inequality in the form $ax^2 + bx + c \geq 0$. Consequently, some of the solutions to this part were totally incorrect.

7. This was a fairly straightforward question and it was only part (*b*) that caused any difficulty.

8. As is usually the case, the main reason for the loss of marks in part (*a*) was incorrect or inconsistent notation. Many got full marks in part (*b*) although some errors were made when candidates tried to express their final answer as a single fraction.

9. Many candidates were able to earn full marks in part (*a*). In part (*b*), however, only a minority tried to use their expression from part (*a*) and not all of these candidates actually went on to *multiply* together the three values which arose from their brackets. Hardly anybody got the correct answer by inserting 2·25 in the original expression for *f*(*x*). The few who used this method with $^{9}/_{4}$ instead of 2·25 were generally more successful.

10. This was probably the least well answered question on the paper. In part (*a*), it was disappointing that not all candidates were able to derive the given expression for *V* in terms of *x*. It was also clear that some candidates still do not realise that maximum/minimum value questions such as this involve differentiation. On the other hand, many candidates were able to get full marks, although some forgot to work out what the maximum value of *V* actually was.

MATHEMATICS

General Certificate of Education

Summer 2016

Advanced Subsidiary/Advanced

C2

General comments

Candidates' performance on this year's paper was slightly better than on last year's C2. The two questions which were least well answered were question 9 and, to a lesser extent, question 3. There were also parts of individual questions (noted below) which relatively few candidates were able to answer.

Comments on individual questions

1. This question caused few problems, as is always the case.

2. Many candidates got full marks on parts (*a*) and (*b*) although some only gave two solutions to part (*b*). In part (*c*), very few candidates were able to explain why there were no values of ϕ which satisfied the given equation.

3. Solutions to part (*a*) were generally good. In part (*b*), however, some candidates tried to evaluate the area of the triangle by first of all working out the size of one of the angles and were therefore unable to find the *exact* value of the area. Many candidates then used their answer to part (*b*) to find the length of *AD* while others used a method involving one of the angles of the triangle. A common error here was to assume that the perpendicular to *BC* bisected angle *A*.

4. Almost all candidates realised that part (*a*) of this question involved the use of an arithmetic series and were consequently able to earn the majority of the six marks available. Some candidates were able to write down the answers to part (*b*) while others solved the problem by introducing an *a* and a *d*. This was a valid method, even though it was not possible to find the actual values of *a* and *d*. No credit was given to candidates who assigned particular values to *a* and *d*.

5. Part (*a*) was in general well answered. In part (*b*), the majority of candidates were able to express the given information as two equations in *a* and *r* and then eliminate *a* from these equations. However, only a minority realised they also had to divide both sides by $(1 - r)$ in order to get an equation which they could then solve.

6. This was a relatively straightforward integration question which was well answered by the majority of candidates.

7. It was part (*c*) which caused the problem here as many candidates did not know what to do with the 'non-log' term. Some dealt with this by expressing 1 as $\log_d d$. While others first of all combined the log terms and then expressed the resulting log equation in terms of powers.

8. The majority of candidates found parts (*a*)(i) and (*b*)(i) to be fairly straightforward. Many candidates realised in (*a*)(ii) that shortest distance from a point to a circle lies along the line joining the point to the centre of the circle and were consequently able to use their answer to (*a*)(i) to find the required distance. In (*b*)(ii), only a minority realised that they had to use the coordinates of P or Q to find the radius of C_2.

9. Although there were many totally correct solutions to this question, a large number of candidates were unfortunately unable to write down the information given in the question in the form of a mathematical equation which they then had to solve. In particular, many expressed the fact that the area of one sector was 26 cm^2 *less* than the area of the other sector the wrong way around.

MATHEMATICS

General Certificate of Education

Summer 2016

Advanced Subsidiary/Advanced

C3

General comments

Candidates generally found this year's paper to be more accessible than the corresponding paper last year. There were some questions where candidates' performance was generally very good, but on the other hand, there were several marks on the paper which only a minority were able to earn.

Comments on individual questions

1. Part (*a*) caused very few problems. Most candidates realised that the solution to part (*b*) in some way involved the use of $\sec^2 x = 1 + \tan^2 x$, but only a minority were then able to manipulate the integrand correctly to derive the correct final answer.

2. Both parts were well answered.

3. This was another question where almost all candidates were able to gain full marks.

4. In part (*a*), some candidates left their final answer as $\frac{dy}{dx} = \frac{-1\sin 3t}{2\cos 3t}$ and consequently lost the final mark. In the same way, the third mark in part (*b*) could only be earned for either $\frac{d^2y}{dx^2} = -\frac{1}{8}\sec^3 3t$ or $\frac{d^2y}{dx^2} = \frac{-1}{8\cos^3 3t}$.

   Relatively few candidates were then able to express their final answer in terms of *y*.

5. Part (*a*) was very disappointing and only a small number of candidates were able to derive the trigonometric equation in θ from the information given in the question. On the other hand, most candidates were then able to carry on and earn full marks in part (*b*).

6. The only real difficulties which arose in this question involved the simplification of answers to parts (*b*) and (*c*). In particular, several candidates' final expression in part (*c*) contained the factor $[2 + (3x – 2)]$.

7. Almost all candidates did well on this question and there were many totally correct solutions to part (*b*).

8. Overall, all parts of this question were well answered. However, in part (*b*), very few candidates realised that since the L.H.S. of the equation was always positive, *x* had to be negative and consequently, hardly anyone was able to earn the final mark.

9. Part (*a*) caused few problems apart from the occasional algebraic slip. Not all candidates, however, were able to earn both marks for the domain of f^{-1}.

10. Most candidates were able to write down an expression for $hh(x)$ but poor algebraic manipulation often meant that this was the only mark they were able to earn in part (*a*). In part (*b*), many thought that the result of part (*a*) implied that $h^{-1}(x) = x$.

MATHEMATICS

General Certificate of Education

Summer 2016

Advanced Subsidiary/Advanced

C4

General comments

Candidates found this paper to be far more accessible than last year's C4 paper, there being an increase of almost 5 marks in the mean mark. The questions which caused candidates most problems were 3(*b*), 4(*a*)(ii) and 10.

Comments on individual questions

1. Part (*a*) caused few problems but not all candidates differentiated correctly in part (*b*).

2. This was another well answered question. In part (*b*), the majority of candidates realised that the result of (*a*)(ii) implied that only one of the two possible values which they had calculated was a valid root for the given equation.

3. Part (*a*) was straightforward but part (*b*) was poorly answered. Most candidates were able to derive the equation $3x^2y + 12y^3 = 0$ but were then unable to make any further progress. Rather than factorising, some just divided throughout by y, and were thus unable to show that the points (2, 0) and (– 2, 0) satisfied the required conditions. Hardly anyone noted that $x = 0$,
$y = 0$ was a solution of the above equation. Those who did then had to make the simple observation that (0, 0) did not lie on *C* in order to earn the third mark.

4. Most candidates were able to earn the first three marks in part (*a*) although some tried to substitute $1 + \tan^2 x$ for $\cot^2 x$. Many candidates seemed to have forgotten about the factor theorem and the methods used to solve the cubic equation $3\tan^3 x - 8\tan^2 x + 8 = 0$ were many and varied and mostly totally incorrect. In part (*b*), it was only the final two marks which caused any difficulty.

5. This question was generally well answered with many candidates obtaining full marks.

6. Apart from the occasional algebraic slip, part (*a*) caused very few problems. The main difficulty which candidates had in part (*b*) was expressing the integrand totally in terms of *u*. Those who managed to do this correctly usually went on to earn full marks.

7. Almost all candidates were able to set up the differential equation correctly but as is usually the case, only a minority were then able to derive the expression for V^2 in the given form. In part (*b*), not all candidates realised that they had to cancel A^2 from both sides of their equations and that the initial value of *V* played no role in their final answer. Another common error was to write $\left(\frac{A}{2}\right)^2 = \frac{A^2}{2}$.

8. Candidates are very good at answering vector questions of this kind. The only part which caused any real difficulty was (*b*)(ii). Most candidates knew that they had to evaluate the scalar product of two vectors but unfortunately not all were then able to choose these two vectors correctly.

9. There were many completely correct solutions to this question. Some candidates, however, were unable to expand $(\cos x + \sin x)^2$ correctly while others tried to integrate $\cos^2 x$ and $\sin^2 x$ separately. This was a valid method but it often led to errors which could have been avoided had the candidate used $\cos^2 x + \sin^2 x = 1$.

10. As is usually the case, only a small minority of candidates were able to earn full marks on this question. Unfortunately, many candidates were unable to get any further than $\left(x + \frac{1}{x}\right)^2 = x^2 + \frac{1}{x^2}$.

MATHEMATICS

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Summer 2016

Advanced Subsidiary/Advanced

FP1

General comments

The candidature was generally good with some excellent scripts seen.

Comments on individual questions

1. This question was well answered by most candidates.

2. This question was well answered by many candidates. Since (a) was not a ‘show that’, some candidates failed to obtain the correct **T** matrix.

3. This question was well answered in general. The most common error was a failure to extract common factors at the beginning in which case a quartic had to be factorised at the end which proved to be too difficult for most.

4. The most common error here was in determining arg(z_1). As in previous problems on this topic, some candidates think that arg(z) is just $\tan^{-1}(y/x)$ without realising that the correct quadrant has to be determined. In this case, some candidates gave an answer in the 4$^{\text{th}}$ quadrant instead of the 2$^{\text{nd}}$ quadrant. The intention was for candidates to use the results in (a) to solve (b) but many candidates used the Cartesian forms instead.

5. This question was well answered by many candidates. The most common error occurred in (a)(ii) where some candidates failed to spot what was required in order to show that no other value of λ resulted in a singular matrix.

6 This was the worst answered question on the paper. Most candidates realised that it would be appropriate to let the roots be $\alpha, \beta, \gamma \text{ with } \alpha\beta = 1$ but the necessary algebra defeated many candidates. It was pleasing to see some candidates obtaining the required result with just a few lines working but many candidates filled several pages going nowhere.

7. This was a slightly unusual question on induction and some candidates failed to see what had to be done. The presentation of induction solutions continues to be poor in the case of many candidates.

8. Candidates in general are fairly confident in dealing with problems involving logarithmic differentiation and the days when candidates might have thought that the derivative of a^x is xa^{x-1} are long gone. This question was well answered by many candidates.

9. Most candidates solved (a) correctly giving u and v in terms of x and y. In (b), the elimination of x and y to give the relationship between u and v was a step too far for some candidates.

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FP2

General comments

The standard of the scripts was generally good with some excellent scripts seen.

Comments on individual questions

1. This was the best answered question on the paper with most candidates solving it correctly.

2. This was the worst answered question on the paper, mainly because many candidates ignored the instruction 'Hence write down'. 'Hence' means using the previous result and 'write down' indicates that little or no work is required. In this case the intention was for candidates to realise that 3 – i was a root and then to multiply successively by i to give the other three roots. Many candidates used the standard method of converting 28 – 96i to modulus-argument form and proceeding from there. No marks were awarded for this approach.

3. Most candidates solved (a) correctly but in (b), some candidates were unable to integrate the expression given in (a).

4. Many candidates reached the equation $5t - t^5 = 0$ but many lost the roots $t = 0$ and/or $t = -\sqrt[4]{5}$.

5. Most candidates found correct partial fractions and most then went on to perform the integration correctly. The most common error was an inability to integrate $\frac{1}{x^2+4}$.

6. Solutions to (a) were sometimes disappointing with candidates unsure of what was required. Part (b)(ii) caused problems for some candidates who confused a,b with a^2,b^2 which resulted in incorrect answers for the eccentricity and foci.

7. To solve (c), many candidates showed that $f''(0) = 0$ and concluded therefore that the point (0,8) was a point of inflection. It is important for candidates to realise that $f''(0) = 0$ is not a sufficient condition for a point of inflection for which $f(x) = x^4$ is a simple counter example. Recommended methods for testing whether or not a stationary point is a point of inflection are either to examine the signs of $f'(x)$ or the values of $f(x)$ either side of the point. The graph of f was often poorly drawn with no indication of a stationary point of inflection. Some candidates found the determination of $f^{-1}(S)$ to be too difficult.

MATHEMATICS

General Certificate of Education

Summer 2016

Advanced Subsidiary/Advanced

FP3

General comments

The standard of the scripts was generally good with some excellent scripts. However, solutions to Q1 (a) were often much longer than necessary.

Comments on individual questions

1. Most candidates considered $x = r\cos\theta$ and some candidates simplified this to $\cos\theta + 2\sin\theta$. The subsequent work was then quite straightforward. However, many candidates left this in the form $\cos\theta + 2\cos\theta\tan\theta$ for which the subsequent work was algebraically more difficult and therefore liable to error.

2. This question was well answered in general although many candidates failed to make it clear that the process of differentiation repeats itself every four derivatives.

3. This question was well answered in general although some candidates made errors in the substitution of *t* into the integral.

4 This was the worst answered question on the paper with candidates finding (c) especially difficult. Few candidates realised that the condition for only one real root was that the smaller root of the quadratic equation being considered was less than one.

5. This was a reasonably well answered question with a variety of correct methods for performing the integral being seen.

6. Part (a) was not well answered by some candidates with errors in the differentiation often seen and sometimes even a failure to evaluate the derivatives at $x = 1$. Parts (a)(ii) and (b) were generally well done although some candidates lost marks for not making it clear that enough iterations were performed.

7. Part (a) required two integrations by parts to be performed and some candidates made algebraic errors doing this. The value of I_4 was usually found correctly with the most common error being an incorrect evaluation of I_0.

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