GCE EXAMINERS' REPORTS

MATHEMATICS C1-C4 & FP1-FP3
AS/Advanced

SUMMER 2015

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MATHEMATICS

General Certificate of Education

Summer 2015

Advanced Subsidiary/Advanced

C1

Principal Examiner: Dr E Read

General Comments

Candidates certainly found this to be a less accessible paper than last year's paper. Whereas some questions were well answered many marks were lost on 1(*d*), 4(*b*), 6(*b*), 9(*b*) and all of question 10.

Individual questions

Q1. The first three parts of this question were generally well answered, but in part (*c*), not all candidates realised that *D* was not the mid-point of *AB* and that consequently, *L* could not be the perpendicular bisector. In part (*d*), most candidates unfortunately assumed that *ABC* was a right angled triangle. Many of the relatively small number of candidates who got this part correct were helped by the fact that they had drawn a clear diagram.

Q2. Most of the errors which occurred in this question appeared at the end of part (*b*) where many candidates were unable to simplify $\frac{7\sqrt{14}}{28} + \frac{14\sqrt{14}}{8}$.

Q3. Part (*a*) caused very few problems and in part (*b*), most candidates realised that the given information implied that their expression for $\frac{dy}{dx}$ had to be put equal to – 8.

Q4. Part (*a*) was well answered but only a relatively small number of candidates were then able to use their answer to solve the quadratic equation in part (*b*).

Q5. Many candidates earned full marks in part (*a*). Some were then, however, unable to write down the correct answer to part (*b*).

Q6. Most of the errors made in part (*a*) involved incorrect signs. Some candidates had four positive coefficients whereas others had three negative coefficients. In part (*b*), many candidates had incorrect expressions for the coefficient of x^2. Others wrote down $2^n = 32$ but were then unable to deduce that $n = 5$.

Q7. This question was generally well answered but as is always the case, many candidates failed to earn the final mark in part (*a*) because of incorrect or inconsistent notation.

Q8. There were very few problems here although in part (*b*), some candidates used the factor theorem to show that $(x - 3)$ was a factor of the given polynomial whereas, in fact, this information had already been given in the question.

Q9. Part (*a*) was well answered but in part (*b*), very few candidates were able to give a clear explanation as to why the graph of $y = af(x)$ could not pass through the origin.

Q10. Overall, a disappointing question. In part (*a*), not all candidates were able to derive the given expression for L. Many candidates did get full marks in part (*b*) but others, having shown that $x = 40$ gave a minimum value for L, then forgot to find this minimum value.

MATHEMATICE

General Certificate of Education

Summer 2015

Advanced Subsidiary/Advanced

C2

Principal Examiner: Dr E Read

General Comments

Candidates' performance on this year's paper was roughly on a par with last year's C2. As is unfortunately usually the case, some candidates lost marks because of poor algebraic skills and this was particularly true in questions 2(*c*) and 5(*b*). The two questions which were least well answered were question 8 and question 9.

Individual questions

Q1. The majority of candidates were able to earn full marks on this question.

Q2. In order to earn the final mark in part (*a*), a statement was required to the effect that the roots of the candidate's quadratic lay outside the range of possible values for sin θ. 'Calculator error' was not sufficient. Part (*b*) was well answered but some of the algebraic manipulation in part (*c*) was poor.

Q3. Although there were many completely correct solutions to this question, some candidates did not realise that there were two possible values for angle ACB and consequently ended up with a maximum of three marks out of six.

Q4. Candidates find it more difficult to derive an expression for the sum of the first n terms of a particular arithmetic progression than to provide a proof for the general case with first term a and common difference d. On the other hand, parts (*b*) and (*c*) were generally well answered.

Q5. Many candidates solved part (*a*) by introducing r and a and then repeatedly using the formula for the nth term of a GP. Others deduced that the common ratio was 4 by dividing 2304 by 576 and then divided 576 by 4 three more times to give the fifth term. Most candidates made a fair attempt at solving the two simultaneous equations which arise in part (*b*) and there were many correct solutions to this part.

Q6. This was in general a well answered question but some candidates used incorrect limits when calculating the area under the straight line.

Q7. Although this type of proof has been examined many times before, some of the answers provided in part (*a*) were still totally incorrect. Many candidates were able to earn full marks in part (*b*) but unfortunately, errors such as

$$\log_a(6x^2 + 9x + 2) - \log_a x = \log_a 6x^2 + \log_a 9x + \log_a 2 - \log_a x$$

were not uncommon.

Q8. Although part (*a*) caused few problems, candidates had more difficulty in answering parts (*b*) and (*c*). It was, however, pleasing to note that there were more correct solutions to part (*c*) than there were the last time this particular topic was examined.

Q9. Solutions to this question were in general disappointing. Whereas many candidates were able to derive an expression for the area of the flower bed containing red roses, relatively few then thought of subtracting this area from πr^2 to obtain the area containing white roses. Most of the methods employed here were either cumbersome or totally incorrect.

MATHEMATICS

General Certificate of Education

Summer 2015

Advanced Subsidiary/Advanced

C3

Principal Examiner: Dr E Read

General Comments

Overall, candidates' performance on this year's C3 paper seemed to be roughly similar to what was the case on the corresponding paper last year. There was no individual question which stood out as having been poorly answered. Those part questions which did cause problems are noted below.

Individual questions

Q1. Part (*a*) was well answered but many candidates thought that the answer to part (*b*) was the reciprocal of their answer to part (*a*).

Q2. Part (*a*) caused very few problems, but only a small number of candidates realised that the essence of part (*b*) was that both $\sec \phi$ and $\operatorname{cosec} \phi$ must take values greater than or equal to 1 when $0° \leq \phi \leq 90°$.

Q3. Part (*a*) was standard and as such, well answered. In part (*b*), many candidates were able to derive a correct expression for $\frac{d^2y}{dx^2}$ by differentiating implicitly but only a minority then used the fact that $\frac{dy}{dx} = x^2y$ to rewrite their expression for $\frac{d^2y}{dx^2}$ in terms of x and y.

4. Most candidates were able to earn full marks in part (*a*) but others differentiated $\tan^{-1}t$ incorrectly. Those who expressed their final answer to this part as $t^{-1} + t$ were less likely to make errors in part (*b*).
Very few candidates were able to show that $\frac{d^2y}{dx^2} = 0$ implied that $x = \frac{\pi}{4}$.

Q5. Some of the graphs drawn in part (*a*) were poor although most candidates seemed to know the general form of the graph of $y = \cos^{-1}x$. Part (*b*) was well answered and only a small minority of candidates had their calculator in the wrong mode. Some, however, interpreted $\cos^{-1}x$ as $\sec x$.

Q6. In part (*a*), it was only (ii) which caused any real difficulty. Candidates' use of the quotient rule and subsequent simplification in (iii) seemed to be far better than has been the case in recent years. In part (*b*), however, some candidates did not answer the question as set and started off by expressing cot x as $\frac{\cos x}{\sin x}$.

No credit was awarded for solutions of this form.

Q7. Many candidates did not realise that in (*a*)(i), the integrand had to be simplified before any integration could be carried out. The remainder of the question was generally well answered, but marks were a little lower than is usually the case for the integration question.

Q8. Most candidates earned all three marks in part (*a*), but many then failed to use their answer in their solution to part (*b*).

Q9. Although this was a fairly standard question, much of the graph sketching was poor. In particular, some candidates' attempts to exhibit asymptotic behaviour was not totally convincing.

Q10. In this question, many realised that what was required in part (*a*) was two functions which differed only by a constant but some then went on to choose some unnecessarily complicated functions. Part (*b*) was very well answered and overall many candidates earned full marks on this question.

MATHEMATICS

General Certificate of Education

Summer 2015

Advanced Subsidiary/Advanced

C4

Principal Examiner: Dr E Read

General Comments

Candidates found this paper to be less accessible than last year's C4 paper, the questions which caused most problems being 2(*b*), 3(*a*), 4, 6(*b*) and 10. Candidates' solutions to 3(*a*), 4 and 6(*b*) were particularly disappointing.

Individual questions

Q1. This question was very well answered, as is normally the case with partial fractions questions.

Q2. Part (*a*) caused very few problems. In part (*b*), however, only a minority realised that if the tangent to C is parallel to the y-axis, then the denominator of $\frac{dy}{dx}$ must equal zero. Some candidates arrived at this same result by noting that if the tangent is parallel to the y-axis, then the normal must be parallel to the x-axis and thus the numerator of $\frac{dx}{dy}$ must be zero. A very small number of candidates solved this part by considering the equation of the curve C as a quadratic in y and then finding the condition required on x in order for this quadratic equation to have equal roots.

Q3. In part (*a*), it was disappointing to note that many candidates did not know the formula for $\tan(A + B)$, nor did they seem to realise that this result is in fact in the Formula Booklet. Not all candidates who had derived the correct quadratic equation

$$8\tan^2 x - 7\tan x + 1 = 0$$

were then able to solve this equation correctly. On the other hand, part (*b*) was generally very well answered.

Q4. Some candidates seemed to be unsure of how to deal with the constant m in part (*a*) and consequently integrated $(mx)^2$ as $\frac{m^3x^3}{3}$. There were also errors in part (*b*) when candidates tried to express their results in terms of a and b. Surprisingly many candidates thought that the volume generated was that of a sphere.

Q5. This question was generally well answered but not all candidates were able to show that the given expression was equal to $\frac{2\sqrt{2}}{3}$ when $x = 1$. As often seems to be the case, many candidates were unable to state the range of values of x for which the expansion was valid.

Q6. Part (*a*) caused very few problems. Solutions to part (*b*) were, however, very disappointing. Many candidates failed to find an expression of any kind for the gradient of the line *PQ* and the majority of those who did earn the first mark did not realise that they had to factorise $p^2 - q^2$ in order to be able to make any further progress.

Q7. Many candidates were able to earn the majority of the first eight marks. However, not all candidates realised the relevance of the result of part (*b*)(i) to part (*b*)(ii) and only a minority were then able to integrate the given expression by correctly expressing $\sin^2 x$ in terms of $\cos 2x$.

Q8. This was a very well answered question but some candidates unnecessarily lost a mark by not verifying that their solution satisfied **all** of the three equations which they had derived by comparing coefficients of **i**, **j** and **k**.

Q9. This question was not as well answered as is usually the case. One reason for this was that poor algebraic manipulation meant that some candidates failed to earn the final two marks in part (*b*). The majority of candidates were then able to write down two correct simultaneous equations in part (*c*) but many would have found the solution of these equations much easier had they divided throughout by $100A$.

Q10. In order to arrive at a contradiction, it was necessary in some way to introduce into the proof the fact that 4 was a factor of $a - b$. Only a minority did this. Most candidates merely tried to manipulate the equation $a + b = 4c$ and consequently were unable to make any progress in this question.

MATHEMATICS

General Certificate of Education

Summer 2015

Advanced Subsidiary/Advanced

FP1

Principal Examiner: Dr J Reynolds

General Comments

The candidature was generally good with some excellent scripts seen. The question on induction was, as usual, the worst answered question on the paper.

Comments on Individual Questions

Q1. This question was well answered by most candidates, although the layout was poor on some scripts.

Q2. This question was well answered by most candidates.

Q3. Part (a) was well answered in general. However, in (b), a fairly common error was made in determining arg(z). As pointed out in previous reports, some candidates think that arg(z) is just $\tan^{-1}(y/x)$ without realising that the correct quadrant has to be determined. Consequently, some candidates gave an answer in the 1st quadrant instead of the 3rd quadrant.

Q4. Part (a) was well answered by most candidates. In (b), most candidates realised that row reduction was required and this was usually carried out successfully.

Q5. Candidates who began by assuming that the roots were a, ar, ar^2 (or equivalent) were often able to determine the value of k successfully. Some candidates, however, began their solutions either with no relationship between the roots or an incorrect relationship, eg a, $2a$, $4a$ and they were unable to complete the question.

Q6. This question was well answered in general, although in (b), many candidates failed to realise that because $\mathbf{AB} = 3\mathbf{I}$, it follows that $\mathbf{A}^{-1} = \frac{1}{3}\mathbf{B}$. However, since 'otherwise' was allowed in (b), these candidates were allowed to find $\mathbf{A}^{-1}$ in the usual way although this used up valuable time. In (c), candidates who ignored the word 'hence' were given no credit.

Q7. Part (a) was well answered by most candidates but (b) caused problems for many. It was not uncommon to see scripts in which the candidates appeared to believe that because $\sum_{r=1}^{n} r = \frac{n(n+1)}{2}$, it follows that $\sum_{r=1}^{n} \frac{1}{r} = \frac{2}{n(n+1)}$. Even candidates who were proceeding correctly sometimes made algebraic errors along the way.

Q8. Most candidates solved (a) correctly. In (b), candidates who wrote the matrix as **A** throughout were often successful. However, many candidates wrote **A** in the form $\begin{bmatrix} 1 & 0 \\ 2 & 1 \end{bmatrix}$ which made the problem more difficult and many candidates failed to complete the proof with **A** written in this form. As in previous years, the presentation of the proof by induction was often poor.

Q9. Part (a) was well answered in general but (b) caused problems for many candidates who failed to solve the equation ln2 + cot$x$ = 0 correctly. Most candidates rewrote this equation in the form $x = \tan^{-1}\left(-\frac{1}{\ln 2}\right)$ and then used their calculators to obtain x = – 0.96. Many candidates then failed to realise that this value was outside the domain of f and that π needed to be added.

Q10. Most candidates understood what algebraic processes had to be employed to find the coordinates of the centre of the circle but many made algebraic errors along the way so that only a minority of candidates actually obtained the correct answer.
In (b), many candidates wrote down the equation of the locus when k = 1 but few identified it as the perpendicular bisector of the line joining the points (– 3,0) and (0,1).

MATHEMATICS

General Certificate of Education

Summer 2015

Advanced Subsidiary/Advanced

FP2

Principal Examiner: Dr J Reynolds

General Comments

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

Comments on Individual Questions

Q1. Part (a) was well answered by most candidates. Candidates who spotted the link between (a) and (b) generally went on to solve (b) correctly although some errors were made in the final integration. Those candidates who failed to see the link were unable to make any further progress.

Q2. This question was well answered by most candidates and it was the best answered question on the paper.

Q3. This question was well answered by most candidates. The only significant error, not often seen, was to forget to take the cube root of the modulus 2. Solutions to (b) were often disappointing with some candidates seemingly unaware how to proceed.

Q4. Candidates who combined the terms $\cos\left(\theta+\frac{\pi}{6}\right)$ and $\cos\left(3\theta+\frac{\pi}{6}\right)$ were generally successful in finding the general solution. Candidates who used the alternative method of using the cosine addition law, ie $\cos\left(\theta+\frac{\pi}{6}\right)=\cos\theta\cos\frac{\pi}{6}-\sin\theta\sin\frac{\pi}{6}$ etc, were generally less successful due to algebraic errors.

Q5. This was by far the worst answered question on the paper. Some candidates tried, unsuccessfully of course, to integrate $\mathrm{e}^{\sqrt{u}}$. It was clear from the scripts that many candidates do not understand this topic. Those candidates who do understand this topic were able to complete the question very quickly.

Q6. In (a), candidates were expected to derive the equation of the locus from first principles. Some candidates simply stated that the equation was $x^2=12y$ because the equation of the directrix was $y = -3$ but this was given no credit. Most candidates solved (b)(i), (ii) and (iii) correctly but were then unable to find the required angle.

Q7. Most candidates answered (a), (b) and (c) correctly. In (b), however, some candidates who showed that the stationary points satisfy the equation

$$\frac{1}{(x-1)^2}=\frac{4}{(x-2)^2}$$

converted this to a quadratic equation instead of taking the simpler option of deducing that

$$\frac{1}{(x-1)}=\pm\frac{2}{(x-2)}$$

Many candidates were unable to solve (e)(ii), unaware perhaps that the graph would be helpful in finding $f^{-1}(S)$.

MATHEMATICS

General Certificate of Education

Summer 2015

Advanced Subsidiary/Advanced

FP3

Principal Examiner: Dr J Reynolds

General Comments

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

Comments on Individual Questions

Q1. In (a), some candidates used the following incorrect hyperbolic identities.

$$\cosh(\theta + \alpha) = \cosh\theta\cosh\alpha - \sinh\theta\sinh\alpha$$

and $\cosh^2\alpha + \sinh^2\alpha = 1$

These led to incorrect values for r and α. In (c), the majority of candidates gave only one of the two roots of the equation. It is important for candidates to realise that the equation $a = \cosh b$ has the two roots $b = \pm\cosh^{-1} a$.

Q2. This question was well answered in general although some candidates made sign errors while carrying out the double integration by parts..

Q3. This question was well answered in general although some candidates made algebraic errors in carrying out the differentiation in (b)(i).

Q4. This was the best answered question on the paper with most candidates carrying out the differentiation successfully.

Q5. Parts (a) and (b)(i) were well answered in general. The integration required in (b)(ii), however, proved to be too difficult for many candidates who failed to spot how to integrate $\cos t \cos\frac{1}{2}t$.

Q6. Part (a) was well answered by those candidates who realised the relevance of the first part of the question. Those candidates who failed to see the link usually failed to obtain the reduction formula. For these latter candidates, it was not uncommon to see the following expressions used in an attempt to use integration by parts.

$$u = x^n, dv = \sqrt{4 - x^2}$$

$$du = nx^{n-1}, v = \frac{(4 - x^2)^{3/2}}{3/2 \times (-2x)}$$

Errors of this magnitude are quite unexpected at this level although similar errors were seen last year.

Q7. Most candidates knew what had to be done in this question but some candidates found the algebra and calculus required to be beyond their capabilities.

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