GCE EXAMINERS' REPORTS

GCE
MATHEMATICS C1-C4 & FP1-FP3
AS/Advanced

SUMMER 2017

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MATHEMATICS

General Certificate of Education

Summer 2017

Advanced Subsidiary/Advanced

C1

General Comments

Candidates' performance this year seemed to be very much on a par with that on the 2016 C1 paper. Most questions were well answered and there were very few parts of questions which caused general problems to the majority of candidates.

Individual questions

1. Most candidates found parts (*a*) and (*b*)(i) to be fairly straightforward. However, only a minority were able to earn full marks in (*b*)(ii). There were many examples of incorrect ratios being written down for cos *BCA*, possibly because of a poorly drawn sketch or the absence of a diagram altogether. Probably for the same reason, relatively few candidates were able to write down the geometrical name for triangle *ACD* in (*c*)(ii).

2. There were more mistakes than usual in this year's surds question. In part (*a*), the fact the denominator was negative led to incorrect signs in the final answer, whilst in part (*b*) there were several examples of candidates who were unable to deal with $4\sqrt{169}$, $3\sqrt{196}$ and even $5\sqrt{9}$.

3. Part (*a*) caused very few problems. In part (*b*), however, many candidates put their expression for $\frac{dy}{dx}$ equal to the gradient of the normal at *Q* rather than the tangent.

4. The only difficulty which arose here was that in part (*b*), some candidates were unable to correctly identify as a maximum the stationary value of what was a negative quadratic expression.

5. Most candidates knew the correct form of the binomial in part (*a*) although there were some minor errors of computation. In part (*b*), some of the equations involving the coefficients of x and x^2 also contained x itself.

6. It was disappointing in this question to see so many candidates who had first of all correctly found the critical values then giving their final answer as 'either $x \geq -4$ or $x \geq -{}^{3}/_{2}$'. Those who drew a sketch were more likely to get the correct final range of values for x.

7. It was only part (*c*) that caused any difficulty here and most of the errors which occurred were arithmetic errors. Many candidates got the correct answer by simply dividing the cubic expression by $2x + 1$. Others successfully applied the remainder theorem to find $f(x)$ when $x = -\,{}^{1}/_{2}$. Unfortunately, evaluating $f(-1)$ and then dividing by 2 is not a valid method. Relatively few tried to use their answer to part (*b*).

8. Part (*a*) was well answered, but in part (*b*), many of the facts about the stationary point were incorrect whilst some of the statements made by candidates did not involve the stationary point at all.

9. It did seem that this year more candidates were able to find the derivative of the given expression from first principles using correct and consistent notation throughout.

10. This turned out to be quite a straightforward question as far as parts (*a*) and (*b*) were concerned but in general, answers to part (*c*) were not as good. It was not uncommon to see candidates trying to apply $b^2 - 4ac = 0$ in some way or another in this part.

MATHEMATICS

General Certificate of Education

Summer 2017

Advanced Subsidiary/Advanced

C2

General Comments

Candidates found this C2 paper to be similar in standard to the corresponding paper last year. There was no evidence that the paper was too long, as the vast majority of candidates attempted every question. As usual, many candidates lost marks due to poor algebraic skills, particularly in questions 2, 3, 5 and 7. The attempts at questions 9(*b*) and 10 were generally disappointing.

Individual questions

1. The majority of candidates scored full marks on this question.

2. Part (*a*) was generally well answered, though a small, but significant, number of candidates failed to correctly factorise the quadratic in $\sin\theta$. Part (*b*) was generally well done, but some candidates wasted time by forgetting that the angles referred to a triangle.

3. The simplification of $-2x(x + 5)\cos 60^\circ$ caused the only problem in this question.

4. It was surprising that many candidates failed to gain full marks for this proof. They either failed to write down at least three pairs of terms that included both the first pair and the last pair, or missed out the summation line for $2S_n$. Part (*b*) was very well answered with very few candidates using terms instead of sums. In part (*c*) the presentation and notation used often lacked precision, and many candidates wrote down a lot of unnecessary equations before suddenly realising that $5d = 45$ and that the required term equalled 2129.

5. Part (*a*) was generally well answered though a few candidates used the 13th term and a few used S_{12}. The main error in part (*b*) was writing $100(1 – 1.2^n)$ as $100 – 120^n$. A large percentage of the candidates who derived $1.2^n = 31.948$ completed the question using logarithms or trial and improvement.

6. Part (*a*) was well answered and very few missed out the constant. Most candidates found $a = -4$ but were less convincing in proving that $b = 32$. A significant number of candidates gave the area of the triangle as -64 and even more made errors in using the limits correctly for the area under the curve.

7. The attempts at the proof seemed better this year, with most candidates scoring at least the first two marks. Very few correct solutions were seen for part (*b*). Although the power law was usually applied correctly, the plus sign between the second and third terms caused many candidates to apply the addition law instead of the subtraction law. A high level of success was seen in part (*c*).

8. Part (*a*) was generally well answered. In part (*b*), a few candidates had problems in expanding $(2x + 4)^2$, and the candidates who chose to factorise the quadratic, often forgot to state that due to the repeated root, the given line was a tangent. Candidates who used the discriminant were often more successful in producing a complete answer.

9. The majority of candidates scored full marks in part (*a*). The attempts at part (*b*) of the question were very disappointing. Very few candidates saw the need to express $R^2 - r^2$ as $(R + r)(R - r)$ in order to eliminate R and r, and derive an expression for K in terms of x and L. Some candidates substituted $R = r + x$ in both the expressions for L and K and a few were successful in deriving the required equation.

10. Part (*a*) had a mixed response with many candidates scoring 2 marks and many others scoring 0. The response to part (*b*) was also mixed, with most of the successful candidates stating that 29 999 998 was not a multiple of 3. Some candidates produced an alternative solution that all the terms of the sequence must end with 7 or 2.

MATHEMTAICS

General Certificate of Education

Summer 2017

Advanced Subsidiary/Advanced

C3

General Comments

This year, there was an increase of 3 in the mean mark and in general, candidates found the paper to be quite an accessible paper. However, there were questions which some candidates found difficult. These were 1(*b*), 5(*b*) and 6(*b*)(ii).

Individual questions

1. Part (*a*) caused very few problems but part (*b*) was poorly answered. One common error involved just multiplying the answer to part (*a*) by $-{}^{3}/_{2}$. Another was to write down $\int_5^7 \ln 3 \, \mathrm{d}x = \ln 3$.

2. Many candidates were able to earn full marks on both parts of this question.

3. There were very few problems in part (*a*). Although part (*b*) was also generally well answered, there were examples of candidates getting the wrong power of $(7 + 4t)$ in the denominators of both $\frac{\mathrm{d}y}{\mathrm{d}x}$ and $\frac{\mathrm{d}^2 y}{\mathrm{d}x^2}$. There were also some examples of the incorrect use of notation throughout part (*b*).

4. The majority, but not all, of the candidates were able to gain full marks in part (*a*). By now, most are very adept at using their calculators to carry out iteration but several candidates lost the final mark in part (*b*) as a result of an incorrect final statement.

5. Part (*a*) caused very few problems. In part (*b*), however, it was clear that many candidates did not know the derivative of $\cot y$, nor did they realise that this information was given in the Formula Booklet. Different methods were used to find this derivative, but even so some candidates were not awarded the corresponding mark because they then wrote down $\frac{\mathrm{d}y}{\mathrm{d}x} = -\mathrm{cosec}^2 y$. In order to give a complete solution to the question, candidates then had to substitute $1 + \cot^2 y$ for $\mathrm{cosec}^2 y$ and then x for $\cot y$. Not all were able to do this correctly.

6. In part (*b*)(ii), it was disappointing to see that many candidates were unable to take the hint given in the question. Many of the attempts at integration here were totally incorrect.

7. In part (*a*), some candidates, after carrying out algebraic manipulation, claimed that there were no counter-examples to the given statement. This unfortunately did not take into account the fact that x could be negative. The majority of candidates were able to earn both marks in part (*b*), although it was not uncommon to see $a = -2$, $b = 6$ given as a solution.

8. Generally well answered. Although there were some examples of poor algebraic manipulation, many candidates were able to gain full marks on this question.

9. Another well answered functions question. The part which caused most difficulty was, perhaps surprisingly, part (*b*).

MATHEMATICS

General Certificate of Education

Summer 2017

Advanced Subsidiary/Advanced

C4

General Comments

The candidates' response to the paper was less positive than the previous year. Whilst most candidates coped satisfactorily with the standard questions, their performance on the rest of the paper was more mixed. The questions which caused most problems were questions 3(*a*), 4 and 9 and to a lesser extent, questions 2(*b*), 5(*b*) and 7(*b*).

Individual questions

1. (*a*) Well answered, with most candidates getting full marks.

   (*b*) Although many candidates realised that there was an increase of $x^2 - 2x + 1$ in the numerator only a small number saw that they could factorise the quadratic and simplify the fraction. Many candidates expressed $\frac{x^2 - 2x + 1}{(x-1)^2(x+4)}$ in partial fractions and then used their answer to part (*a*) to arrive at the final answer. Quite a few candidates went back to the beginning rather than use their answer to part (*a*).

2. (*a*) Caused very few problems.

   (*b*) This was a poorly attempted question. In addition, some candidates had only one answer to the quartic equation $x^4 = 16$, consequently losing two marks.

3. (*a*) There was a mixed response to this question. Many candidates changed $\cos^2 x$ into $1 - \sin^2 x$ obtaining $8\sin^2 x - 14\sin x\cos x - 5 = 0$. After dividing through by $\cos^2 x$ and ending up with $-\frac{5}{\cos^2 x}$, the vast majority were not able to proceed. Many of them did not even divide the −5 by $\cos^2 x$. Nevertheless, quite a few candidates were awarded full marks for this question.

   (*b*)(i) Well answered, but some candidates lost unnecessary marks due to not expanding $\cos(\phi - \alpha)$ and not attempting to compare coefficients.

   (*b*)(ii) Many candidates were able to find the least value of the fraction, but they were not able (or they omitted) to state the value of ϕ for which it occurs.

4. There were only a few completely correct solutions to this question. Some candidates were unable to expand $(\cos x + \sec x)^2$ correctly and many did not know that $\cos x \times \sec x = 1$. Furthermore, quite a few candidates did not know how to integrate $\sec^2 x$ so they changed it to $\frac{1}{\cos^2 x}$ and then to $\frac{2}{\cos 2x + 1}$. It is important to note that the integral of $\sec^2 x$ is given in the Formula Booklet!

5. (*a*) Well answered, but a significant number of candidates left out the range of values of x for which the expansion was valid.
   (*b*) Only a few candidates realised that the expansion could be obtained by an appropriate substitution for *x* (i.e. $x = y + 2y^2$). It was disappointing to see many candidates splitting $(1+4y+8y^2)^{-\frac{1}{2}}$ into $(1+4y)^{-\frac{1}{2}} + (8y^2)^{-\frac{1}{2}}$.

6. (*a*) The vast majority of the candidates were able to derive the equation of the tangent in the required form.
   (*b*) The majority of the candidates were able to derive the equation $p^3 - 12p + 16 = 0$. It is important to note that there has been an improvement in the solution of the cubic equation by use of the factor theorem. However, there were many candidates who did not show any working, but simply stated that $p = 2$, $p = 4$ omitting to convince us that they know that $p = 2$ is a repeated root and that there is not another solution to the cubic. Many also failed to notice that $p = 2$ corresponds to the point (4*a*, 8*b*).

7. (*a*) Generally quite well answered.
   (*b*) Many failed to notice that simplifying $\int x^3 \times u^4 \times \frac{\mathrm{d}u}{2x}$ would enable them to directly substitute for x^2. Instead they expressed *x* as $\sqrt{u-1}$, but were not able to use the rules of indices/surds successfully in order to fully simplify their expression in *u*.

8. (*a*) Well answered.
   (*b*) Many candidates were able to work through to the penultimate line, but unfortunately quite a few were not able to express *N* in terms of *t* correctly.

9. (*a*) This was a poorly attempted question. A good number of candidates were able to write down the vector **BC**, but many candidates were not able to derive the vector equation of BC in the given form. Many candidates are still leaving out the **r** on the left hand side of the vector equation of the line.
   (*b*) Many candidates used λ in the vector equation of this line as well which caused problems in part (*c*) as candidates ended up with two equations in terms of λ only.
   (*c*) Some candidates attempted to compare coefficients of their vector equations, but only a few managed to arrive at the final solution and find the position vector of the point of intersection.

10. This was another poorly attempted question. Although this type of question has been asked many times, candidates are still failing to get full marks. This is mainly due to candidates skipping steps and claiming that 7 is factor of *b*, before stating that 7 is a factor of b^2.

MATHEMATICS

General Certificate of Education

Summer 2017

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 with very few arithmetic errors seen in determining the adjugate and inverse matrices.

2. Questions on this topic have been generally well answered in the past so it was a surprise to find that this question was the second worst answered question on the paper. Most candidates knew what had to be done but careless algebraic manipulation often led to errors being made.

3. This was the best answered question on the paper. The more common method was to find z in the form $x + \mathrm{i}y$ and hence the modulus and argument of z, rather than find the moduli and arguments of each of the three complex numbers in the question and use those values to find the modulus and argument of z.

4. Part (*a*) was well answered by most candidates. In part (*b*), however, some candidates found it difficult to explain why T had no fixed points.

5. This question was well answered by many candidates using just two row operations. Some candidates, however, seemed to have no set procedure to follow so that they required more than two operations although usually ending up with the correct answer. Most candidates knew how to solve part (*b*) but some made algebraic errors in finding the expression for x.

6. Questions on induction have not always been well answered in the past but solutions to this question were generally good. It was pleasing to note that the final conclusion mark was usually awarded.

7. Candidates in general are fairly confident in dealing with problems involving logarithmic differentiation and this question was well answered by most candidates.

8. This was the worst answered question on the paper. Candidates who wrote

$$x + \mathrm{i}y = \frac{1}{u + \mathrm{i}v}$$

were usually able to obtain expressions for x and y in terms of u and v. However, some candidates began with

$$u + \mathrm{i}v = \frac{1}{x + \mathrm{i}y}$$

and then found that they ended up with expressions for u and v in terms of x and y. Attempts to invert these expressions to give x and y in terms of u and v were usually unsuccessful. Solutions to part (*b*) were reasonably good with algebraic manipulation the main source of error. Solutions to part (*c*) were generally disappointing with few candidates realising that the best method was simply to put $w = z$ and simply solve the equation $z^2 = 1$. Many candidates put $u = x$ and $v = y$ and attempted to solve the resulting equations with limited success.

9. This was a question involving quite a lot of algebraic manipulation but it was well answered by many candidates. Answers to part (*a*)(ii) were often disappointing with some candidates stating that the result implied that there were two imaginary rather than two complex roots.

MATHEMATICS

General Certificate of Education

Summer 2017

Advanced Subsidiary/Advanced

FP2

General Comments

The standard of the scripts was generally good with some excellent scripts seen. It would appear, from answers to Q8(*b*)(ii), that most candidates appear to believe that $\int \frac{1}{x}\,\mathrm{d}x = \ln x$ instead of the correct $\ln|x|$.

Comments on Individual Questions

1. Most candidates realised that they had to compare $f(x)$ with $f(-x)$ but it was surprising to see a number of candidates reaching the wrong conclusion.

2. This was the worst answered question on the paper with many candidates failing to spot that the integrand needed to be split into $2 - \frac{3}{x^2+4}$. Candidates who split the integrand into $\frac{2x^2}{x^2+4} + \frac{5}{x^2+4}$ were able to integrate the second term but almost invariably not the first. The first term can be integrated using the substitution $x = 2\tan\theta$ but this was not generally realised.

3. This question was well answered in general, the most common error being an incorrect argument for –8i.

4. Part (*a*) was well answered by most candidates. In part (*b*), most candidates expanded $(z + z^{-1})^5$ correctly but some candidates then equated this to $\cos^5\theta$ instead of $32\cos^5\theta$. This error was followed through in part (*c*) although the final mark could not be awarded because $\frac{256}{15}$ was deemed to be an unacceptable value for $\int_0^{\frac{\pi}{2}} \cos^5\theta\,\mathrm{d}\theta$.

5. Most candidates knew that $\cos\theta - \cos 5\theta$ had to be changed into a product but a not uncommon sign error resulted in the incorrect equation $\sin 3\theta\,(2\sin 2\theta + 1) = 0$ instead of the correct equation $\sin 3\theta\,(2\sin 2\theta - 1) = 0$. At this stage, some candidates just cancelled the factor $\sin 3\theta$ thereby losing some roots.

6. Most candidates found the partial fractions and then used their result to evaluate the integral in part (*b*)(i). Very few candidates gave a correct answer to part (*b*)(ii) with the great majority stating that the reason that $f(x)$ could not be evaluated over the interval [– 2,0] was that this would involve calculating the logarithms of negative numbers. It would appear that almost the entire candidature is unaware of the result that $\int \frac{1}{x}\mathrm{d}x = \ln|x|$ so that the modulus signs ensure that logarithms of negative numbers are never required.

7. Most candidates found the equation of the normal correctly and then substituted $(as^2, 2as)$ to obtain $2as = -ats^2 + at^3 + 2at$. Candidates who then wrote this as $2a(s - t) = -at(s - t)(s + t)$ were generally successful. Those candidates who attempted to solve the equation as a quadratic in s were often unable to proceed to the final result.

8. This question was well answered in general although some candidates were unable to solve part (*e*).

MATHEMATICS

General Certificate of Education

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Advanced Subsidiary/Advanced

FP3

General Comments

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

Comments on Individual Questions

1. This question was well answered in general with most candidates either introducing exponential functions or using $2\sinh\theta + \cosh\theta = r\sinh(\theta + \alpha)$. Several other successful methods were seen including starting with
$$(2\sinh\theta)^2 = (2 - \cosh\theta)^2 \quad \text{or} \quad (2\tanh\theta + 1)^2 = (2\text{sech}\theta)^2.$$

2. This question was well answered in general. When faced with integrating $\dfrac{1}{3+2-t^2}$, candidates who completed the square in the denominator obtained the answer more quickly than those who introduced partial fractions.

3. This was the worst answered question on the paper. Most candidates were able to express the curved surface area in the form $2\pi\int_0^1 x^3\sqrt{1+9x^4}\,dx$ but many were unable to take this result any further. Candidates were expected to see that, apart from a constant multiplier, x^3 is the derivative of $1 + 9x^4$ and then proceed appropriately.

4. Solutions to part (*a*) were often disappointing with algebraic errors seen. Parts (*b*) and (*c*) were well answered in general.

5. This was the best answered question on the paper although many candidates were unable to differentiate $\tan^{-1}\left(\dfrac{1}{\tanh\theta}\right)$ correctly. Some candidates rewrote this as $\tan^{-1}(\coth\theta)$ which is easier to differentiate

6. Solutions to part (*a*) were often disappointing with some candidates splitting the integrand into $\tan^{n-1}x\tan x$ and then attempting unsuccessfully to use integration by parts. Solutions to part (*b*) were sometimes incorrect due to algebraic errors being made.

7. Parts (*a*) and (*b*)(i) were well answered by many candidates. In part (*b*)(ii), many candidates failed to realise that the integration had to be done in two parts and that the answer to part (*b*)(i) was intended as a hint to indicate what these two parts were.

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