GCE EXAMINERS' REPORTS

MATHEMATICS (C1 - C4 and FP1 - FP3) AS/Advanced

SUMMER 2012

Statistical Information

The Examiner's Report may refer in general terms to statistical outcomes. Statistical information on candidates' performances in all examination components (whether internally or externally assessed) is provided when results are issued.

Annual Statistical Report

The annual Statistical Report (issued in the second half of the Autumn Term) gives overall outcomes of all examinations administered by WJEC.

MATHEMATICS

General Certificate of Education

Summer 2012

Advanced Subsidiary/Advanced

Principal Examiner: Dr. E. Read

Unit Statistics

The following statistics include all candidates entered for the unit, whether or not they 'cashed in' for an award. The attention of centres is drawn to the fact that the statistics listed should be viewed strictly within the context of this unit and that differences will undoubtedly occur between one year and the next and also between subjects in the same year.

Unit	Entry	Max Mark	Mean Mark
C1	3299	75	47.4

Grade Ranges

A	63
B	55
C	47
D	39
E	32

N.B. The marks given above are raw marks and not uniform marks.

C1

General Comments

Candidates found this year's paper to be more accessible than the corresponding papers of recent years. The majority of the questions were well answered; it was only questions 1 (d) (iii), 6 (b) and parts of question 10 which caused any problems.

Individual Questions

Q.1 It was only the very last part of this question which caused any real difficulty. Not all candidates realised ADC was a right angled triangle while others were unable to manipulate the surds correctly.

Q.2 Generally well answered, but in part (b), many candidates were unable to simplify $\frac{5\sqrt{63}}{\sqrt{7}}$

Q.3 Part (a) was well answered, as is always the case. Part (b) seemed to cause fewer problems than has been the case with similar questions in recent years.

Q.4 A straightforward binomial question. Most of the errors which occurred were sign errors.

Q.5 Although most candidates were able to answer part (a) correctly, many were then unable to use their answer to find the required stationary value of the given expression.

Q.6 Although the format of the discriminant question was slightly different this year, algebraic manipulation was generally good and many candidates were able to get full marks on part (a). Solutions of the quadratic inequality in part (b), however, were disappointing, as was the case last year.

Q.7 Differentiation from first principles continues to improve but some candidates still lose the final mark due to a mathematically incorrect statement.

Q.8 Almost all candidates are able to use the factor theorem to solve cubic equations on this paper. Most candidates were also able to get the correct answer for part (b), even though this particular application of the remainder theorem has not been examined in recent years.

Q.9 Candidates had few problems with this question.

Q.10 In part (a), some candidates were unable to deal with the absence of a constant term in the quadratic equation whose roots are the x-coordinates of the stationary points. In part (b), most, but not all candidates realised that their graph had to be that of a positive cubic, while in the final part, some candidates tried to use the quadratic formula to find the number of positive real roots of the given cubic equation.

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Unit	Entry	Max Mark	Mean Mark
C2	4652	75	41.3

Grade Ranges

A	58
B	50
C	42
D	35
E	28

N.B. The marks given above are raw marks and not uniform marks.

C2

General Comments

Candidates probably found this year's paper to be less accessible than the corresponding paper last year. There was no single question which was generally very poorly answered but many candidates lost marks on questions 2 (c), 3 (b), 5 (b), 8 (b) and to some extent, question 9.

Individual Questions

Q.1 The question on the Trapezium Rule was well answered, as is always the case.

Q.2 Part (a) caused few problems but in part (b), some candidates lost marks by transposing and dividing incorrectly. Most candidates realised that part (c) probably involved rewriting the equation in terms of $\tan\phi$ but again poor algebra led to incorrect solutions.

Q.3 In part (a), some candidates took the angle BAC itself rather than $\cos B\hat{A}C$ to be $\frac{2}{5}$
In part (b), we did not always see a diagram and not all candidates realised that there were two possible values for each of the angles XZY and YXZ.

Q.4 There were few problems in parts (a) and (b), but in part (c), many candidates did not simplify their expression correctly and consequently lost the final mark.

Q.5. Whereas most candidates earned the first two marks in part (a) by writing down two correct expressions involving a and r, only a minority were then able to proceed to eliminate a and derive the given quadratic in r. In part (b), the solution of this equation and the subsequent calculation of the sum to infinity were by no means universally well done.

Q.6. Generally well answered although in part (b), not all candidates realised that a triangle formed part of the required area. Others seemed quite happy to proceed with the x-coordinate of A as -9.

Q.7 As is always the case, some of the proofs in part (a) were at best unconvincing. Part (b) was generally well answered but in part (c), after correctly applying the rules of logarithms, some candidates were then unable to solve for x by correctly remove the logs on both sides of the equation.

Q.8 Part (a) caused no problems, but only a minority of candidates realised that the way to find the length of the tangent in part (b) was to use the fact that the angle between a tangent and a chord is a right angle and then apply Pythagoras' Theorem.

Q.9 Many candidates got full marks on this question but others thought that the shaded area was simply $\frac{1}{2} r^2\theta$.

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Unit	Entry	Max Mark	Mean Mark
C3	1771	75	50.1

Grade Ranges

A	59
B	51
C	43
D	35
E	27

N.B. The marks given above are raw marks and not uniform marks.

C3

General Comments

This turned out to be a slightly easier paper that last year's. The majority of candidates found almost all questions to be accessible but the algebraic manipulation in questions 9 and 10 was sometimes poor.

Individual Questions

Q.1 Part (a) caused very few problems. The answers given to part (b) were many and varied and to a large extent, incorrect.

Q.2 In order to find a counter-example in part (a), candidates had to choose either $\phi = 360 - \theta$ or $\phi = -\theta$. Some candidates did not seem to understand what was required and chose two angles whose cosines were different and whose sines were different. Part (b) was very well answered, as is usually the case.

Q.3 Part (a) caused very few problems, but in part (b), many candidates were unsure of how to deal with the constant a. It was also disappointing to note that only a small minority were able to gain full marks by fully simplifying their expression at the end of (b) (ii).

Q.4 Generally well answered.

Q.5 Very few problems arose here although in part (b), not all candidates were able to differentiate $e^{\tan x}$ correctly.

Q.6 All of part (a) was well answered and in part (b), most candidates were able to make a fair attempt at finding the value of the limit of integration a.

Q.7 In both parts, but particularly in part (a), it was not uncommon to see incorrect manipulation of the modulus signs. Another common error in part (a) was to show that $x = {}^{11}/_{3}$ was a solution and then give the final answer as $x = \pm\, {}^{11}/_{3}$.

Q.8 Many candidates got full marks on this question.

Q.9 In (a) (i), the majority of candidates were able to differentiate f (x) correctly but not all were then able to give a convincing reason as to why this derivative was always negative. In (a) (ii), many candidates thought that the range of f was $(0{\cdot}6, \infty)$ rather than $(0{\cdot}6, 1)$. Much of the algebra in (b) (i) was poor.

Q.10 Most of the errors which occurred here occurred when candidates tried to derive a simplified expression for gg(x). Those who managed to surmount this hurdle were then usually able to earn full marks although some candidates lost the final mark because they forgot to consider the negative root.

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Unit	Entry	Max Mark	Mean Mark
C4	2991	75	51.5

Grade Ranges

A	64
B	56
C	49
D	42
E	35

N.B. The marks given above are raw marks and not uniform marks.

C4

General Comments

Candidates found this to be a fairly straightforward paper and more accessible than last year's paper. The only question which caused any real difficulty was question 6(b).

Individual Questions

Q.1 Part (a) was well answered but in part (b), some candidates made errors when differentiating while others integrated the individual expressions.

Q.2 Universally well answered.

Q.3 It was only (b) (iii) which caused any real problems here. Some candidates argued that since the maximum value of both sin and cos was 1, the greatest possible value for k would be 23.

Q.4. Not all candidates were able to derive a correct expression for y^2 in terms of x. Those who did usually ended up with full marks.

Q.5 Most candidates used the binomial theorem correctly but not all were then able to carry out the required arithmetic manipulation to get the final result. Only a minority stated the correct range of values of x for which the expansion was valid.

Q.6 The vast majority of candidates were able to derive the equation of the normal in the given form. In part (b), the solution of the cubic equation was generally poor, in particular when compared with candidates' solutions to similar equations which appear on the C1 paper. It was also disconcerting to see so many candidates use the following method of solution:

$$p^3 - 7p - 6 = 0 \Rightarrow p^3 - 7p = 6 \Rightarrow p(p^2 - 7) = 6$$

$$\text{Thus either } p = 6 \text{ or } p^2 - 7 = 6 \Rightarrow p = \pm\sqrt{13}$$

Q.7 Part (a) caused few problems but part (b) was a little disappointing in that many candidates failed to express the integrand in terms of u.

Q.8 This was a generally well answered question but in part (b), only a minority of candidates were able to derive the expression for V^2 in the required form.

Q.9 Candidates are now very good at answering vector questions and this turned out to be one of the best answered questions on the paper.

Q.10 Many candidates still find proof by contradiction difficult and although performance has generally improved, there were still many who were unable to give a correct proof that 5 was a factor of b.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
FP1	238	75	50.9

Grade Ranges

A	63
B	55
C	47
D	39
E	32

N.B. The marks given above are raw marks and not uniform marks.

FP1

General Comments

The candidature was extremely variable with some candidates out of their depth at this level but also many candidates submitting excellent scripts. Solutions to the question on induction continue to be poorly presented by many candidates.

Individual Questions

Q.1 This question was well answered by most candidates. Some candidates expanded their initial result, correctly, into

$$\frac{n^4 + 2n^3 - n^2 - 2n}{4}$$

but were then unable to factorise this as required.

Q.2 Solutions to this question were generally good, although some candidates were unable to obtain the correct argument of z. It is important for candidates to realise that it is not true in general that if z = x + iy, then arg(z) = $\tan^{-1}\left(\frac{y}{x}\right)$. The correct result is that arg(z) is an angle whose tan is equal to $\left(\frac{y}{x}\right)$ but is located in the quadrant determined by the signs of x and y. In this question the correct procedure is to use the calculator to find $\tan^{-1}\left(-\frac{11}{2}\right)$ giving – 1.39 and then adding π to give 1.75 (or the degree equivalent).

Q.3 This question was well answered in general although some candidates were unable to express $\alpha^3 + \beta^3$ as $(\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$.

Q.4 Most candidates were able to determine the inverse matrix via the adjugate matrix although some candidates confused the adjugate matrix with the cofactor matrix and the matrix of minors. Some candidates solved the equation using a method not requiring the inverse matrix and were given no credit. Candidates should be aware that the term ‘hence’ means that the problem must be solved using a result obtained in the previous part of the question.

Q.5 This question was well answered in general. Candidates should, however, be advised to use a systematic method for row reduction.

Q.6 As reported in previous years, the presentation was often poor – indeed attempts at solutions using mathematical induction continue to be generally below what can reasonably be expected for candidates working for a qualification in Further Mathematics. The following sentences are taken from last year’s report but they still apply. Having established that the result is true for n = 1, the proof should start with a statement such as ‘Assume that the result is true for n = k’. Instead of this, many candidates just write ‘Let n = k’ or even ‘n = k’. The next line should then state something like ‘Consider, for n = k + 1’ followed by the appropriate algebra. Many candidates just write ‘Let n = k + 1’. Candidates should then round off the proof with something along the lines of ‘Assuming the result to be true for n = k implies that the result is true for n = k + 1 and since we have shown it to be true for n =1, the general result follows by induction’. Many candidates finish with an incorrect statement such as ‘Therefore true for k and k + 1 so proved by induction’.

Q.7 Most candidates were able to obtain correctly the matrix representing T. Solutions to (b), however, were sometimes disappointing with some candidates obtaining the equations $x' = y - 2$ and $y' = -x - 2$ but not then realising that for the fixed point, $x' = x$ and $y' = y$.

Q.8 Candidates were generally successful in (a) and (b) and it is pleasing to note that most candidates are confident using logarithmic differentiation. Some candidates, however, were unable to obtain the second derivative with some even differentiating x^x as $x \times x^{x-1}$, apparently forgetting what they had done correctly in (a). It was disappointing to note that only a few candidates, having shown correctly that

$$f''(x) = x^{x-1} + x^x(1 + \ln x)^2,$$

spotted immediately that, at a stationary point, the second term is zero and the first term is positive so that there was no need to evaluate $f''(x)$.

Q.9 Solutions to this question were often disappointing and it was the worst answered question on the paper. In (a), most candidates obtained correct expressions for u and v. In (b), however, many candidates were unable to make the required substitution to give the equation of the locus of Q. Most of the candidates who obtained the correct coordinates for C, namely $\left(-\frac{m}{2}, -\frac{1}{2}\right)$ were unable to find the equation of the locus of C as m varies, not realising that the answer is just $v = -\frac{1}{2}$. It would appear, paradoxically, that this question was so difficult because it was so easy.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
FP2	371	75	49.0

Grade Ranges

A	55
B	48
C	41
D	34
E	28

N.B. The marks given above are raw marks and not uniform marks.

FP2

General Comments

The standard of the scripts was generally good.

Individual Questions

Q.1 Most candidates solved this question correctly. The most common error, not seen very often, was to equate each expression for *f*(*x*) and its derivative for *x* = 2.

Q.2 Solutions to this question were generally good. Some candidates, having shown that the *u* limits were [1,e] then, for no apparent reason, changed to [0,e].

Q.3 Most candidates reached the stage $t(t^2 - 5) = 0$ but many then dropped the factor *t* and some even stated that $(t^2 - 5) = 0 \Rightarrow t = \sqrt{5}$. These errors meant that only part of the general solution was given.

Q.4 This was the best answered question on the paper with most candidates obtaining the correct partial fractions and performing the integration correctly.

Q.5 This question was well answered in general.

Q.6 Parts (a) and (b) were well answered by the majority of candidates. In (c), the oblique asymptote *y* = *x* – 6 was sometimes missed or given incorrectly as *y* = *x.* The graph was often drawn incorrectly even when (a), (b) and (c) had been answered correctly.

Q.7 Solutions to this question were disappointing and it was the worst answered question on the paper. In (a) (i), some candidates made algebraic errors in completing the square and in (a) (ii) and (iii), some candidates were unable to translate the focus and directrix correctly. In (b), most candidates found the correct quadratic equation but only a minority of the candidates realised that the gradients of the two tangents could be found by equating the discriminant to zero. Many candidates tried to solve the problem by finding the equation of the tangent at the general point on the parabola and making this pass through the origin but this was not accepted because the question stated ‘hence’.

Q.8 Solutions to (a) were good in general and it was pleasing to note that the more mathematically mature candidates were more able to give a well presented proof by induction than FP1 candidates. Solutions to (b) were generally disappointing. In (b) (i), many candidates wrote pages of algebra when all that was required was

$$\left(w(\cos\frac{2\pi}{3} + \mathrm{i}\sin\frac{2\pi}{3})\right)^3 = w^3(\cos 2\pi + \mathrm{i}\sin 2\pi) = w^3 = z$$

In (b) (ii), most candidates wrote down the real cube root of –8 correctly but few candidates used the result in (b) (i) to find the complex cube roots. Most candidates chose to use de Moivre’s Theorem to do this, which was acceptable since the question stated ‘otherwise’, although some candidates were unable to do this successfully. Candidates should be aware that ‘otherwise’ usually leads to a longer method. Here, all that was required was to find the first complex cube root in the form.

$$-2(\cos\frac{2\pi}{3} + \mathrm{i}\sin\frac{2\pi}{3}) = 1 - \sqrt{3}\mathrm{i}$$

and then either to conclude that the second complex cube root was the complex conjugate of the first or multiply by a further $(\cos\frac{2\pi}{3} + \mathrm{i}\sin\frac{2\pi}{3})$.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
FP3	187	75	47.9

Grade Ranges

A	52
B	46
C	40
D	34
E	29

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FP3

General Comments

The standard of the scripts was generally good with some excellent scripts. Some candidates were unable to handle the algebra involved in solving the question on polar coordinates and solutions to the question on the Newton-Raphson formula were often disappointing.

Individual Questions

Q.1 This was the best answered question on the paper. Some candidates obtained the correct result cosh1 – sinh1. Then they used their calculator to show that both this expression and 1/e were equal to 0.3678794412 correct to 10 decimal places, concluding therefore that cosh1 – sinh1 = 1/e. This was not accepted for the final mark.

Q.2 This question was well answered in general.

Q.3 Most candidates knew what had to be done and the first two derivatives were usually found correctly but algebraic errors were sometimes seen in the evaluation of $f'''(x)$. Some candidates expanded the given series into a power series in *x* and equated this to the Maclaurin series for $\tan^{-1} x$. This, however, is not a valid method.

Q.4 This question required considerable skill in trigonometric manipulation and some candidates were unable to carry this through. Candidates were sometimes unable to see the best method of solution. For example, in (a), the equation $2\cos 2\theta = \sin 2\theta$ had to be solved. The best method here would be to divide both sides by $\cos 2\theta$ to give $\tan 2\theta = 2$. A variety of other methods was seen, for example some candidates rewrote the equation in the form $2\cos^2\theta - 1 = \sin\theta\cos\theta$, squared both sides and replaced $\sin^2\theta$ by $1-\cos^2\theta$ to give a quadratic equation in $\cos^2\theta$. This is a valid method but its complexity invites algebraic errors. Candidates should be advised to take a little time to consider the available options.

Q.5 It has been pointed out in previous reports that some candidates are not aware that if $t = \tan(x/2)$, then $\mathrm{d}x$ has to be replaced by $\frac{2\mathrm{d}t}{1+t^2}$. All candidates should know this result and not have to derive it. Some candidates found difficulty with dealing with the integration of $\frac{1}{7-t^2}$. Although this is a standard result given in the information booklet, it involves either $\tanh^{-1} t$ or a slightly awkward logarithmic expression and some candidates were unable to convert a correct integrated result into the correct numerical value.

Q.6 Parts (a) and (b) (i) were well answered in general but some candidates failed to see the connection between the integral in (b) (ii) and their previous work.

Q.7 Questions on this topic are normally well answered so it was disappointing to note that this was the worst answered question on the paper with many candidates finding the manipulative work in (a) involving hyperbolic functions too difficult for them.

Q.8 This question was well answered in general. The most common error seen was taking the limits in the integrals to be $\pm\pi$, with these candidates thinking, presumably, that the graph provided in the question was a semi-circle.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
M1	2707	75	49.0

Grade Ranges

A	62
B	53
C	45
D	37
E	29

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M1

General Comments

This paper seemed to have been well received by most candidates. Excellent solutions to all the questions were seen. No particular question stood out as causing more problems than others. The standard of the questions is comparable to that of previous papers and there was no evidence that candidates found the paper too long to complete in the allocated time as most candidates managed to attempt all the questions on the paper.

Individual Questions

Q.1 Part (a) of this question was generally well done. Some sign errors were seen usually with the candidates taking downwards as the positive direction and failing to choose the correct negative sign for the acceleration.

Part (b) was also quite well done. However, many candidates failed to isolate the forces acting on the person, and a few had difficulty making the unknown mass M the subject of the consequent equation; an easy bit of algebra which should not be beyond the capabilities of candidates at this level.

Q.2 Both parts of the question caused problems only to the weakest candidates. The most common mistake is a sign error in the N2L equation in (a) such that friction assisted motion instead of opposing it, which lost all the marks available in the question.

Q.3 In part (a), the final velocities of the objects were expressed one in terms of the other. This is slightly unfamiliar to the candidates and caused problems to the weak candidates. Some presented a circular argument, substituting $v_2 = 7.2$ or $v_1 = 3.6$ into the conservation of momentum equation and then concluding that $v_2 = 7.2$ or $v_1 = 3.6$.

The usual sign errors were seen in parts (b) and (c).

Q.4 Candidates were free to calculate the common magnitude of the acceleration of the particles, $4g$, to be 3.92 ms^{-2} and proceed as normal. That is what most candidates presented as their solution which commonly led to a high score. Candidates who noticed that one of the equations gave the tension immediately had an easier time. The unknown mass caused some problems to candidates whose algebraic skills were poor.

Q.5 Part (a) of this question was well done generally.

In part (b), a significant number of candidates omitted either the friction or the component of weight down the slope in applying N2L to the object. No marks were awarded to candidates who wrote down a N2L equation which was not dimensionally correct or in which friction assisted motion instead of opposing it. Similarly, candidates who wrote $\sin\frac{5}{13}$ or $\cos\frac{12}{13}$ gained no marks at all.

Q.6 This turned out to be the least well done of all the questions on this paper. Some candidates were unable to make a decent attempt. Some extremely nice solutions using the triangle of forces were seen, though this method is not generally applicable.

Q.7 This was a high scoring question. Some minor errors with the value of t were seen in part (b) in the sketching of the v-t graph, perhaps caused by candidates not reading the question with sufficient care.

Q.8 This question was much better done than previous questions on this part of the syllabus, though this may be due to the fact that this question was easier than some previous questions on this topic. It would be most helpful if candidates drew a diagram labelling their points and forces and state clearly the point about which moment was being taken. This was not always easy for examiners to determine from the candidates' solution.

Q.9 Part (a) was well answered as usual and this particular problem posed no difficulties with signs. A very small number of candidates did not like the fact that there were three bits of lamina to combine together and tried to reduce the number to two, usually with disastrous consequences.

In part (b), very many candidates did not draw a diagram to assist their thinking and failed to identify the correct right angle triangle to use in writing down the required tangent, losing all three available marks.

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Unit	Entry	Max Mark	Mean Mark
M2	930	75	50.2

Grade Ranges

A	60
B	52
C	44
D	36
E	28

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M2

General comments

The standard of this paper is commensurate with past papers on this syllabus and candidates were on the whole well prepared for it. All the questions were assessable to the majority of candidates and there is no evidence that the time pressure was excessive as the majority of candidates managed to attempt all nine questions. The slight unusual elements in questions 7 and 9 ensure that these questions were not as well done as usual. Question 8 (c) on horizontal circular motion was also poorly done, but that is the expected response on questions on this topic.

Individual Questions

Q.1 This was a good question to begin the paper. Most candidates obtained full marks with a small number making an error in the integration of $4\cos 2t$, usually with the coefficient, though some very strange and incorrect integration were seen.

Q.2 Generally speaking, candidates remembered Hooke's Law and the formula for elastic energy and did well on this question.

Q.3 Apart from the few candidates who were not able to differentiate vectors, obtaining scalar answers, part (a) was well done by the majority. The commonest error is differentiating t to obtain 0 rather than 1. Many candidates failed to read the question with sufficient care and found the value of t when **r** is perpendicular to the given vector.

Part (b) was generally well done.

Q.4 This was a reasonably well done question with the commonest error in both parts being the omission of either the component of weight down the slope, or more often, the resistance of 600 N in the Newton second law equation.

Q.5 The modal mark for this equation would be 3 marks obtained by candidates finding the kinetic energy and the potential energy correctly. The work done by resistance is more often than not omitted. Even for candidates who remembered to use the Work-Energy Principle, there is often a sign error in the consequent equation.

Q.6 This question on projectiles was not as well done as usual. The unknown initial velocity V caused problems for many candidates. In part (c), many candidates did realise that that the most efficient solution involved using $s = ut + \frac{1}{2}at^2$, but there is often confusion with the value of s, using the incorrect $s = +5.4$ rather than the correct $s = -5.4$ when considering upwards positive motion.

Q.7 This question was not generally well done but it was no worse than expected with 7 (a) being rather better than 7 (b). Some candidates included the weight of the particle when considering N2L towards the centre of motion which is in the horizontal direction.

Q.8 Parts (a) and (b) were well done generally. Part (c) caused problems to very many candidates and a great many strange and incorrect attempts at a solution were seen. The most successful candidates simply found the position of the ship at $t = 50$ and divided that by the 40 s required for the boat to reach the ship. Many candidates thought that the boat started its journey at the point (8**i** + 7**j**) instead of at the origin.

Q.9 This question was well done as usual with the usual algebraic and arithmetic errors. Very few completely correct solutions were seen. Disappointingly, many candidates presented negative tensions as their answers in part (c) without realising that this is impossible. Some candidates thought the minimum tension must be zero which was incorrect.

MATHEMATICS

General Certificate of Education

Summer 2012

Advanced Subsidiary/Advanced

Principal Examiner: Dr. S. Barham

Unit Statistics

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Unit	Entry	Max Mark	Mean Mark
M3	252	75	51.8

Grade Ranges

A	58
B	50
C	42
D	34
E	27

N.B. The marks given above are raw marks and not uniform marks.

M3

General Comments

This paper attracts some extremely capable candidates who did not find the paper difficult and very many near perfect scripts were seen. It was certainly a pleasure to mark. However, there were also some extremely poor scripts. On the whole, very few mediocre scripts were seen. Almost all the questions were generally well done with candidates having most problems with the Statics question 6.

Individual Questions

Q.1 This was a well done question with the most common error being the omission of the minus sign when integrating $(t+3)^{-2}$. Some elementary numerical errors were seen, commonly, candidates were out by a factor of 10 on cancelling down 27000/600.

In part (b), a minority of candidates did not realise that an expression for the displacement can be obtained by integrating the expression for *v* with respect to *t* obtained in part (a).

Q.2 Most candidates had no problems with solving the pair of simultaneous equations in (a) and even those who did not manage part (a) were able to recover and made decent attempts at the rest of the question. Many candidates did not answer the question asked in part (b) but presented the maximum acceleration as their answer, probably because they did not read the question with sufficient care.

Q.3 Not many imperfect solutions were seen and these were usually due to minor errors in algebra. A few candidates tried to use the boundary conditions on the complementary function instead of first finding the particular integral and the general solution.

Q.4 .Candidates who realise that the acceleration *a* needed to be written as $v\frac{dv}{dx}$ were usually successful in presenting a near perfect solution. Candidates who did not use the correct form for the acceleration usually got very few marks. Some candidates used the boundary conditions $x = 0$, $v = 0$ in spite of the different values given in the question, while others assumed that the constant of integration is zero, which was not true in this instance.

Q.5 Few candidates had problems with this question though some had difficulties with finding the initial velocity of the released particle which was a pity as it was a bit of work from the M1 syllabus.

Q.6 Even candidates who presented perfect solution for the previous 5 questions had problems with this question. The most common error is the omission of the friction when taking moments about *B*, or the omission of the component of force $T\cos\theta$ when taking moments about *A*. Many numerical errors were seen with the calculation of the perpendicular distances and sign errors were also common.

MATHEMATICS

General Certificate of Education

Summer 2012

Advanced Subsidiary/Advanced

Principal Examiner: Dr. J. Reynolds

Unit Statistics

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Unit	Entry	Max Mark	Mean Mark
S1	3002	75	45.3

Grade Ranges

A	60
B	51
C	42
D	34
E	26

N.B. The marks given above are raw marks and not uniform marks.

S1

General Comments

The candidature was extremely variable with many candidates completely out of their depth at this level but also many candidates submitting excellent scripts. Solutions to the question on continuous distributions were again generally poor with many candidates showing poor skills in the use of calculus.

Individual Questions

Q.1 Part (a) (i) was well answered by the majority of candidates. Part (a) (ii), however, proved to be difficult for some candidates who failed to realise that $P(A \cap B)$ had to be found before $P(A \cup B)$ could be determined. Some candidates confused the terms 'mutually exclusive' and 'independent' and answered (a) the wrong way round.

In (b), some candidates failed to realise that $P(A \cap B)$ had to be found before $P(B \mid A)$ could be determined.

Q.2 Most candidates found $\mathrm{E}(X^2)$ correctly although some candidates thought that $\mathrm{E}(X^2) = (\mathrm{E}(X))^2$. Most candidates found E(*Y*) correctly although the calculation caused problems for many candidates with incorrect formulae seen, notably Var(*Y*) = 3Var(*X*) and Var(*Y*) = 9Var(*X*) + 4.

Q.3 Parts (a) and (b) were well answered in general. Some candidates failed to realise that (b) was intended as a signpost to solving (c), making the question much longer by evaluating the probabilities of the four possibilities WWR, WWB, BBR and BBW. Candidates who did this often made arithmetic errors.

Q.4 Part (a)(i) was well answered in general using the binomial formula. In (a)(ii), however, many candidates were unable to carry out the transition from B(10,0.75) to B(10,0.25) correctly. Part (b) was well answered in general although some candidates appear to believe that the terms 'more than' and 'at least 'are equivalent'.

Q.5 Questions on the use of the Law of Total Probability and Bayes' Theorem are usually well answered and this question was, by a large margin, the best answered question on the paper.

Q.6 Solutions to this question were disappointing in general and it was the worst answered question on the paper. Many candidates were unable to find the correct probabilities in (b) and (c). Even with the hint in (c), many candidates seemed not to realise that (d) had to be solved by summing an infinite geometric series.

Q.7 Part (a) required the calculation of two fairly straightforward Poisson probabilities and it was well solved in general. Part (b) required an indirect use of the Poisson table and many candidates were unable to obtain the correct answer. Fairly common answers were 17 or 19 which were one row away from the correct answer and 7 which was in the wrong tail of the distribution.

Q.8 Part (a) caused problems for many candidates who were quite unable to see any systematic method for determining the possible range of θ.

Algebraic errors were fairly common in (b) and (c).

The most common errors in (c)(ii) were to fail to realise that a 4 and a 2 could occur in two ways and to believe that a 3 and a 3 could occur in two ways.

Q.9 Solutions to this question were generally disappointing with many candidates showing a poor understanding of calculus. In (a), the integrations were often carried out incorrectly and limits were sometimes omitted completely. As reported on several previous occasions, the incorrect notation $F(x) = \int_1^x f(x)\mathrm{d}x$ was fairly common. Candidates should be encouraged not to use the same letter to denote both the upper limit and the variable of integration – this will only cause confusion to candidates studying mathematics to a higher level. As stated previously, the limits were often omitted – it is of course a valid method to state that $F(x) = \int f(x)\,\mathrm{d}x$ + C and then choose C so that either $F(x) = 0$ at the lower limit or $F(x) = 1$ at the upper limit. In (b) (ii), it was disappointing to see many candidates using integration to find the probability rather than using the cumulative distribution function as intended. It is of course a valid method to do that and it was given full credit if correct. Many candidates failed to solve (b) (iii) correctly and some rather strange reasons were seen to justify some of the answers.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
S2	877	75	51.1

Grade Ranges

A	60
B	52
C	44
D	36
E	28

N.B. The marks given above are raw marks and not uniform marks.

S2

General Comments

The general standard was good with a handful of excellent scripts. In general, however, continuity corrections continue to be a source of difficulty for many candidates with either incorrect or no correction being used. In some cases, the interpretation of *p*-values is unsatisfactory – candidates are recommended to use the guidelines in the specification. Also, some candidates fail to give a conclusion in context when this is asked for. It was clear from Q.3 that although most candidates are able to calculate a confidence interval, only a tiny minority really understand what they have found. It was extremely disappointing to note in Q.6 that many candidates were unable to carry out a fairly straightforward trigonometrical derivation.

Individual Questions

Q.1 This was well answered by most candidates and it was the best answered question on the paper. The most common error in (b) was to assume that, in the case of independence, because $E(XY) = E(X)E(Y)$, it was also true that $Var(XY) = Var(X)Var(Y)$.

Q.2 Most candidates answered (a) (i) correctly but in (a) (ii) some candidates found the lower quartile instead of the upper quartile.

Parts (b) (i) and (ii) were well answered in general but solutions to (b)(iii) were often based on an incorrect variance.

Q.3 Most candidates found the confidence interval correctly but answers to (b) were almost always incorrect. It is important for candidates to realise that if $[a,b]$ is a 90% confidence interval for some parameter θ, it is incorrect to say that θ lies in the interval $[a,b]$ with probability 0.9 for the simple reason that a,b and θ are all constants and you cannot make a probability statement involving only constants. It is important for candidates to realise that a 90% confidence interval is a realisation of a random interval which contains the unknown parameter with probability 0.9. Or to use more friendly language, if you repeat the process for finding a 90% confidence interval a large number of times, then 90% of these intervals will contain the parameter. This is a difficult concept at this level but confidence intervals are in the syllabus and therefore candidates need to understand what they are.

Q.4 This question was well answered in general. The most common error was the use of either an incorrect or no continuity correction in (b). It is important for candidates to realise that whenever a discrete distribution is approximated by a continuous distribution, then a continuity correction should be applied.

Q.5 This question was well answered in general, confirming that most candidates are confident in using the standard statistical tests. Many candidates lost the last mark by not giving the conclusion in context. It is important for candidates to realise that one of the assessment objectives, AO4, is concerned with the translation of a variety of contexts into mathematics and vice versa.

Q.6 This question was easily the worst answered question on the paper with many candidates unable to show that $X = 4\cos\theta$. This was intended to be a two-line exercise but attempts at solution were generally poor and often took up a page or more. A common solution involved the use of the cosine rule which is perfectly valid but could be regarded as a very large nutcracker to crack a very small nut. Some candidates failed to realise that integration was required to solve (b)(i), a not uncommon solution being that $E(4\cos\theta) = 4\cos[E(\theta)] = 4\cos(\pi/4) = 2\sqrt{2}$. It is important for candidates to realise that the E operator is not that friendly. Very few candidates solved (b)(ii) correctly with most writing that

$$P(X \le 3) = P(\cos\theta \le 0.75)$$

$$= P(\theta \le \cos^{-1}(0.75))$$

This is of course incorrect. Because cos is a decreasing function, the inequality should change direction. Most candidates therefore obtained the incorrect solution 0.46 instead of 0.54.

Q.7 Many candidates made a reasonable attempt at this question although arithmetic errors and incorrect continuity corrections were often seen.

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Unit	**Entry**	**Max Mark**	**Mean Mark**
S3	131	75	53.4

Grade Ranges

A	57
B	49
C	41
D	34
E	27

N.B. The marks given above are raw marks and not uniform marks.

S3

General Comments

The standard of the scripts was generally good with some excellent scripts. Statistical inference is well understood by most of these candidates although questions on estimation theory cause manipulative problems for some candidates. The question on the *t*-distribution was not so well answered as usual with many candidates using the normal distribution instead.

Individual Questions

Q.1 This question was well answered by the majority of candidates.

Q.2 This was the worst answered question on the paper with many candidates failing to realise that the *t*-distribution had to be used since the sample was small and the variance had to be estimated. This was disappointing since the *t*-distribution question has been well answered in previous years. Some candidates lost a mark by not giving the conclusion in context.

Q.3 Part (a) was a straightforward question on confidence intervals and it was well answered by the majority of candidates. Part (b), however, caused problems for some candidates who, having found the unbiased estimate for *p*, failed to see how the given information could be used to solve the remaining parts of the problem.

Q.4 This question was well answered in general. In (a), the variances should have been estimated by dividing by 49 although division by 50 was accepted in view of the large value of *n*. It was strange to see some candidates giving the variance estimates as fractions rather than decimals but this was of course accepted and it does remove the possibility of premature rounding.

Q.5 Candidates are generally well prepared for questions on this topic and most candidates found a and b correctly, almost invariably by first calculating S_{xx} and S_{xy}. As in Q.4, it was strange to see some candidates giving the values of *a* and *b* as fractions. This is of course perfectly acceptable and as in Q.4 it removes the risk of premature rounding. Candidates should, however, be advised to check that their answers are sensible in terms of the data. Here, for example, it is clear that the value of *b* is approximately 15 since the values in the *y* row increase by approximately that amount as *x* increases by 1. Giving the answer $b = \frac{5347}{350}$ makes it more difficult to carry out this check so candidates should look at the answer in decimal form before converting to a fraction.

Q.6 This was a fairly searching question on estimation theory although some excellent solutions were seen. Most candidates knew what had to be done but many made algebraic errors. Some candidates who were unable to solve (b) (i) and (ii) nevertheless carried on to give a correct solution to (b) (iii).

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