Rewarding Learning

CCEA GCE - Mathematics
Summer Series 2019 (Legacy)

Chief Examiner's Report

mathematics

Foreword

This booklet outlines the performance of candidates in all aspects of CCEA's General Certificate of Education (GCE) in Mathematics (Legacy) for this series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's section on our website at www.ccea.org.uk.

Contents

GCE MATHEMATICS (LEGACY)

Chief Examiner's Report

This report contains information on only 10 of the 13 papers offered this summer. The AS and some of the A2 modules of the New Specification were tested this year, so next year there will be no papers on modules C1, C2 or F1 as previously highlighted. The item level data will give you information on how your centre did in these papers.

It is always very pleasing to mark the very many papers produced by able and well prepared candidates.

Candidates continue to lose marks by failing to read questions carefully enough, as on M2 Question 1 where a number of candidates lost 4 marks by failing to complete either part of the question. It has been found that this is most likely to happen in the first couple of questions on a paper.

Algebraic manipulation continues to be difficult for many and over 6 papers, too many marks can be lost, e.g. in squaring brackets or factorising or cancelling. These can often lead to candidates being unable to complete a question.

Cancelling and so losing solutions in a trig. equation continues to happen.

Assessment Unit C3 Pure Mathematics AMC31

Overall this was a good paper which clearly identified candidates' strengths and weaknesses. Candidates displayed a range of abilities when answering this paper. The standard of answering was high in general with most candidates being able to respond successfully to the questions. There was a good range of difficulty in the questions allowing the better candidates to show their knowledge whilst giving less able candidates the opportunity to access marks for more straightforward work. Overall candidates performed well on the paper with only a small number not attempting all questions. Some questions stretched the more able candidates, with a small number of candidates scoring full marks. The more challenging questions were still accessible to less able candidates who were able to gain some marks. Rounding errors, incorrect trigonometric integration & differentiation and poor presentation of method were common issues in this paper. There was no evidence of misinterpretation or that candidates had insufficient time in which to complete the paper.

Q1 This question was answered well. Most candidates found the correct cross sectional area. However, many forgot to multiply by 500 to calculate the volume. A final read over the question after answering it is recommended to ensure this mark is not missed. Another common error in this question was an incorrect h value. Occasionally, errors occurred when transferring values from the question.

Q2 **(a)** Only a small number of candidates failed to gain full marks. A small number of candidates changed from an equation to an inequality. Setting up two equations was the preferred method of solution with fewer candidates choosing to square the equation.

(b) Again this question was well answered by most. A common error was to divide the quadratic $4x^2 - 16x - 20$ by 4 instead of factorising by common factor.

Q3 A very well answered question. The Binomial expansion was well executed with the $(2x)$ term being dealt with by most candidates. The coefficient using descending values $(-4)(-5)(-6)$ over the factorial was much better executed in this paper than in previous years.

Q4 **(a)** Most candidates had the correct basic idea of how to complete graph transformations but many failed to gain full marks as they extended their graph beyond the original shape of the function.

(b) This was a well attempted part with the majority of candidates trying long division. Whilst the majority of candidates recognised that this was an improper fraction, the main error was the candidates' inability to divide successfully algebraically. There were many errors with this element. Another error was mixing up the quotient and the remainder when attempting to establish their partial fractions. Of those candidates who failed to recognise the improper fraction, knowledge and use of partial fractions was evident and candidates did achieve some marks.

Q5 **(a)** The majority of candidates were able to prove this identity. A small number were unable to progress beyond $\frac{\cos\theta}{\sin\theta}+\frac{\sin\theta}{\cos\theta}$ but most recognised the basic trigonometric identities to begin with. Generally, if a candidate started with the right hand side of the identity, they did not achieve full marks.

(b) Again a well answered question. Common errors were misinterpreting the range and therefore including extra solutions and incorrectly replacing sec 2θ with $\tan^2\theta - 1$. Whilst not penalised, rounding was surprisingly poor in this question with 1.107 quite often being rounded to 1.12 and 0.4636 was occasionally rounded to just 2 significant figures. Some candidates lost marks for working in degrees or including extra solutions outside the given range.

Q6 **(a)** Many candidates found this question challenging and often had a final answer containing the parameter. For those who attempted it well, some tried to rearrange too far and in essence were wasting time doing so when this was not required. A minority of candidates were unable to recall the correct identity to use.

Either candidates were able to deduce what was required or not in Part (ii). Some candidates did not appear to understand what an asymptote was.

(b) This question was poorly answered. Candidates needed to take more care with their sketches to ensure that they use the range given. For those who knew how to sketch the cosec curve, a minority omitted to label the required y-values.

Q7 **(a)** The majority of candidates were able to apply the product rule successfully in Part (i). However, in Part (ii), whilst most recognised the need for the quotient rule, some recalled it incorrectly. A common error was in finding the derivative of cos 3x. Quite often either the minus was omitted and/or the derivative of the 3x.

(b) Whilst this was not answered particularly well, candidates were able to gain some marks for either their ability to differentiate the natural log or their ability to apply the chain rule for the derivative of $(1 + \sin x)^{\frac{1}{2}}$. Those who applied the third rule of logs in the initial stages were able to complete a less complex differentiation.

Q8 **(a)** This was a very poorly attempted question with many candidates failing to recognise the need for the use of the identity $\tan^2 x + 1 = \sec^2 x$. Candidates also struggled with integrating $\frac{3}{2x}$ with either failing to recognise the integral as a natural log or finding the incorrect coefficient.

(b) Most candidates were able to gain some marks in this question, with most recognising that at least integration was required. Generally candidates set the function equal to one to try to obtain the points of intersection. The candidates who failed to apply radians to this question were greatly hindered as they were trying to find the area under the curve and of the rectangle with 0° & 30° and 5° & 25° respectively. Candidates need to be aware that radians must be used for calculus. It was noted that presentation of method and structure of solutions was poor in this question.

Assessment Unit C4 Pure Mathematics AMC41

Generally, this was a paper which allowed less able candidates access to sufficient marks at the start while still stretching those at the top end of the spectrum, particularly in Questions 5(ii), 7 and 8. It was evident from candidates' responses that they had a general understanding of most of the concepts tested, enabling them to at least attempt parts of each question. Most candidates were able to make an attempt at all of the questions. The layout of their responses was logical and the development of their solutions was evident in most cases, except for Questions 4b(i) and 6(i), in which a number of candidates 'fiddled' to achieve the final result. Candidates still often struggled with correct notation, particularly with functions, vectors and when differentiating implicitly. It was very disappointing to note the number of candidates who omitted the 'dx' when integrating.

Q1 A very straightforward opener on functions - most candidates scored full if not nearly full marks in this question. Even if a candidate got Part (i) and Part (ii) mixed up, they could still get the correct answer for Part (iii).

Q2 This was a fairly easy Volume of Revolution question in which most A-Level candidates should have had access to full marks. 3 marks were immediately available to nearly all candidates for the setting up of the correct integral. Common errors included losing π, using 2π, using 180° and the poor expansion of squared brackets but the majority of candidates navigated these problems and gave their answer correctly to 3 significant figures or in terms of π.

Q3 In Part (i) many candidates calculated the direction vector $\overrightarrow{AB}$ but quite a number did not subsequently find its magnitude. Part (ii) was well attempted with most candidates successfully finding the required vector equation. However, there were still a number of scripts without a valid vector equation (or even without an equality at all) or which had the vectors written as coordinates or without brackets. In Part (iii) a large number of responses seemed to automatically find the acute angle between two vectors and used $\overrightarrow{AB} \cdot \overrightarrow{BC}$ (giving an answer of 74.1°). Top candidates realised they had to use two vectors either originating at B or going towards B. Less able candidates used the position vectors in error and were only awarded 1 mark for correct dot product.

Q4 In Part (a) the majority of candidates gained full marks by correctly using Integration By Parts. If wrong parts were chosen it was sharply penalised. Part b (i) caused unnecessary difficulties if candidates did not immediately change into sin 2x and cos 2x and yet this should have been a reasonably straight-forward identity to prove. Many tried several attempts and their layout and presentation were often messy and difficult to follow. Some tried to bluff solutions. In Part b(ii) only a very small number of candidates got it wrong, not recognising that it could be written as cot x, the answer to which was given in the formula booklet.

Q5 Question 5(i) was full marks for the majority of candidates unless they did not declare A and B at the start but only very few 'fiddles' were seen. Part (ii) was an excellent question to differentiate. A disappointingly high number of candidates failed to correctly separate the variables or recognise the need to use Part (i) before integrating but even then they still had access to a max of 5 marks. Many incorrectly integrated k to get ln (k). However, the stronger candidates were able to answer this question neatly and concisely in a small amount of working.

Q6 Nearly all candidates correctly differentiated implicitly. Very few got no marks for this question as most at least correctly differentiated the first and last terms to get $2x$ and $4\frac{dy}{dx}$. The most common error was with negative signs which were carefully scrutinised for 'fiddles' to get the correct final answer. It was interesting though that the follow-on in (ii) was not as well attempted. Candidates' algebra skills let them down, some went on to find the second differential, never setting $\frac{dy}{dx} = 0$, others could not cope with numerator and denominator. The substitution of x in terms of y or y in terms of x led to incorrect squaring or missing the +/- in solutions.

Q7 This should have been straightforward and yet because it did not state that it should be written in Harmonic Form the range of solutions was vast, most of which struggled to make progress if they did not use the correct harmonic form. Of those who did, the main error was in the sign chosen or the angle chosen and at the end many did not make allowances for a second solution. Most of those who chose to divide through by cos x or manipulate otherwise, made significant (and inexcusable, for an A2 candidate) errors in squaring and rewriting their equation so that they rarely arrived at the correct trig. equation to solve, losing all marks thereafter. Extra solutions were created if they did manage to work this alternate solution through for which they were given a penalty of one mark. This question differentiated the stronger from less able candidates.

Q8 This question definitely differentiated between the A/A* candidates and those below. The first 3 marks were easy to attain in this question and most responses were able to expand correctly. However, for weaker candidates this was as far as they could go. Many responses made some attempt at writing in terms of sin 2x and cos 2x but it was disappointing to see the number of mistakes in doing this and even more disappointing to see how many candidates did not know to change the $\sin^2 x$ and $\cos^2 x$ terms at all. The exact answer ensured that candidates did not simply use their calculator from the first line. However, a small number did use calculators showing no working method and were penalised heavily. Candidates who were particularly able gained all 10 marks fairly quickly here, though interestingly, some who had done little work earlier in the paper but clearly had learnt these integration methods also picked up marks. The usual issues arose in incorrectly squaring the brackets and a significant number of marks were lost. Some tried using Harmonic Form but few correctly took this method to its conclusion.

Assessment Unit F2 Pure Mathematics AMF21

This paper appeared to present challenge to the majority of candidates. Excellence was evident. With the exception of question 7 no single question presented particular difficulty across all centres. Coordinate geometry, in particular if involving a locus continues to produce difficulty. It used to be that induction could be relied upon to present difficulty to many. The techniques are now much better known and question 3 had a strong response. In summary, performance was uneven. Most candidates appeared to have just about enough time and overall presentation of work was good.

Q1 Given that the series was $\sum_1^n [(2r-1^2-(2r)^2)]$ which simplified to $\sum_1^n (1-4r)$ it was disappointing that a significant number failed to start, let alone complete the question. There were at least two other potentially successful approaches.

Q2 Largely well done with $\sin\theta$ more popular than $\cos\theta$.

Q3 With the exception of a few centres this question was successfully completed.

Q4 A standard question with most knowing the required method. Those who failed to complete the question were unable to evaluate $\int \sin^2 x \, dx$.

Q5 **(i)** Virtually all candidates were successful.

(ii) No specific method was asked for and, while the majority used the binomial theorem, a minority used Maclauren's theorem. Both can provide a solution but the work necessary is less using the binomial.

(iii) There was a tendency to quote individual values e.g. $x \neq \frac{2}{3}$ rather than give a range.

Q6 **(a)** A significant number did not know that if 2 + i is a root so is 2 – i.

(b) Disappointing that only around 50% of candidates managed to solve this equation correctly.

Q7 This question is best done using parametric coordinates $P(at^2, 2at)$ and $Q(at_1^2, 2at_1)$. As in past years many still seem not to know how to find a mid-point. Only the last two marks of the solution are difficult to acquire.

Q8 Parts (i) and (ii) were probably the best done parts of any question and provided a significant boost to marks for many candidates. In Part (iii) the first mark eluded some, but a majority were able to use $R\cos(t-\alpha)$ effectively to complete the question.

Assessment Unit F3 Pure Mathematics AMF31

This paper tested the breadth of the specification with a very gratifying response from the candidates. It gave every candidate the opportunity to demonstrate their knowledge at an appropriate level, while proving a good differentiator for the entire field. Candidates were able to make a meaningful attempt, with the vast majority producing scripts of a good standard. The candidates were, on the whole, more familiar with the calculus than the vector geometry material, bucking the usual trend. The very best candidates found challenge and scored well.

Q1 This is a standard question requiring the volume of a parallelepiped. A number of candidates found difficulties here, some calculating the differences between the position vectors of the edges. Approximately half the candidates found the triple product while the others formed the dot product with the cross product calculated as a determinant.

Q2 The two forms used for the equations of lines in $\mathbf{R}^3$ caused problems for some candidates. Most were able to form the cross product of the direction vectors of the two lines to find the direction of the normal to the plane. A small number expressed the final plane in Cartesian form, while others attempted to find the equation of a line.

Q3 The vast majority made a successful start to this question with the clear majority able to find the required derivative of the inverse sine function. Part (ii) was successfully despatched by nearly every candidate!

Q4 **(i)** The usual errors in proving an identity surfaced here. Nearly every candidate knew how to apply conjugate surd expressions, most successfully.

(ii) This bookwork derivation of the logarithmic form of the inverse cosh function was handled correctly by almost the entire field.

(iii) The vast majority of candidates applied a range of hyperbolic identities to form a quadratic in either cosh(x) or sech(x). A surprising number of candidates chose to form a quadratic in exp(x) to find the solution to one of its roots rather than use the expression for inverse cosh(x) from Part (ii).

Q5 **(i)** Widely different approaches were employed in this traditional question. The most favoured approach was to eliminate between the two Cartesian plane equations, in terms of one of x, y or z. They then formed a position vector from these expressions. Others found the direction vector of the line as the cross product of the normals to the planes and proceeded. A sizeable minority were able to achieve the last mark by presenting the line in the requested form, although this proved tricky for many.

(ii) Virtually the entire field of candidates found one of the angles between the planes.

Q6 **(a)** These two integrals proved the most demanding for the candidates in the paper.

(i) The integral of sech(u) led to a proliferation of ingenious attempts, culminating in 4 apparently completely different, yet correct, forms of the final integral.

(ii) Again there were a number of successful approaches to this integral, with most candidates exploiting the link to the previous part.

(b) Perhaps, as the substitution was given, this question led to a more unified development by the candidature, with a clear majority of candidates making successful attempts.

Q7 **(i)** This was essentially a hint for the following parts integration.

(ii) A clear majority of candidates were able to postulate the necessary splitting of the integral to be able to perform a successful parts development. The minority who incorrectly split the integrand into x^n times $(9 - x^2)^{-0.5}$ were only able to access 4 marks. The second watershed in the question was to spot that $(9 - x^2)^{0.5}$ can be written as $(9 - x^2)/(9 - x^2)^{0.5}$ and then form two separate integrals by splitting the numerator. This proved too much for quite a few.

(iii) This application of the reduction formula in Part (ii) involved detailed arithmetic when dealing with the limits. Nearly every candidate could make the two applications of the formula from Part (ii) to find expressions for I_4 and I_2. The integral for I_0, although specifically on the specification, was not recognised in this context by a sizeable minority. A few candidates clearly used calculator technology to evaluate the definite integral quoting the final result “from nowhere”. This approach gained them few marks as it did not show the full development of the answer. It was pleasing to see the number of candidates able to derive the final result in detail – no mean achievement!

Assessment Unit M1 Mechanics AMM11

This paper was accessible to all candidates and there was adequate time for completion. It covered a wide range of topics, skills and techniques and allowed for differentiation across all abilities. Topics such as moments and momentum provided greater challenge for some of the candidates. Whilst most candidates were able to perform the requisite techniques, only the most able were able to give reasoned explanations especially in Question 2(iv) and Question 7(iv). Presentation of work was varied and candidates should take more time and care in drawing diagrams as these are often the key to successful completion of the question.

Q1 This was a good starter question, with the majority of candidates achieving full marks.

Q2 **(i)** This was a simple force diagram which was correctly completed by most candidates. However, candidates should take care to add arrows to show the direction of the forces.

(ii) This part was generally well answered. However, a significant minority omitted to use F = ma horizontally and instead considered the system to be in equilibrium. Others failed to include the component of 40 N when resolving vertically.

(iii) This was answered correctly by almost all candidates.

(iv) Although candidates had some understanding of what would happen to friction as the angle of inclination of the rope was increased, they were often unable to provide a clear and concise reason for their answer.

Q3 **(i)** Candidates appeared to be unfamiliar with the drawing of a velocity-time graph and did not appear to realise that constant acceleration would result in a straight line graph. Only a small number of candidates were able to gain both marks for this question.

(ii) This part of the question was well answered, with the vast majority of candidates using equations of motion rather than relating back to the graph from Part (i). The most common error was to consider a time of 4s and take the displacement as 19.6m rather than 0.

Q4 **(i) and (ii)** Both parts of this question were successfully answered by almost all candidates. The most common error was to forget to use the 2nd derivative to confirm that the velocity was minimum.

Q5 **(i)** Although it was evident that candidates had some general understanding of the principle of conservation of momentum, this particular type of question caused problems for many of them. They failed to correctly identify the initial and final velocities for each of the bullet and the rifle. Others tried to use impulse as change in momentum but applied this incorrectly. A few candidates included g in their momentum equations. Most candidates did, however, recognise the need to convert a negative velocity in order to give the final answer as a speed.

(ii) Again, many candidates showed some understanding of impulse as change of momentum but were unable to apply this correctly. Some used both masses in their change of momentum calculation. Others did not appreciate that this was a new stage of motion and that the final velocity of the rifle was now zero.

Q6 **(i)** As with Question 2 the common error in this part was the omission of arrows on the forces. Surprisingly some candidates did not draw the weight of 3g as a vertical force, but instead drew it perpendicular to the plane.

(ii) This was a familiar type of pulley question and it was perhaps surprising to see so many confused attempts. Problems arose when candidates used equilibrium for one or both particles. However, most candidates were able to access at least some of the marks.

(iii) The key to successful completion of this question was to appreciate that after the string broke the acceleration of the particle would change. Then it was just a case of using equations of motion and F = ma to link the stages of motion together. However, many candidates did not recognise the changes in motion and were unable to access many of the marks.

Q7 Completion of a clear and correct diagram was often critical to the solution of the remainder of this question. A common error was to label the reactions at A and B with the same letter, thus causing problems in the later calculations. A number of candidates applied friction to the wrong point or had friction acting downwards at B. Others used the weight as Wg.

(ii) If a clear diagram had been completed then this part was usually successfully answered. Some candidates tried to used moments only, rather than resolving at least once and were therefore unable to obtain a value for the reaction at A.

(iii) This again was successfully completed if candidates had shown forces in the correct directions in Part (i). Omitted or incorrect forces resulted in little progress in this part of the question.

(iv) Candidates showed some understanding of what they were trying to show. However, they often did not provide a suitable degree of rigour in their proof. Demonstration by verifying with some numerical values is not enough to achieve full marks in a "show that" question.

Assessment Unit M2 Mechanics AMM21

Candidates taking this paper were able and had been well prepared on the whole. Candidates continue to fail to read questions carefully enough especially those at the start of the paper and so lose 'easy to gain' marks. For the modelling assumptions they need to think about what is being asked and not just give the standard 'treat the mass as a particle' response. The paper appears to have been of an appropriate length with all candidates being able to tackle all questions.

Q1 A very well answered question. However, a number of candidates failed to read the question thoroughly enough and in Part (i) omitted the direction and/or in Part (ii) did not find the distance. The constant of integration was sometimes left out in Part (ii). In Part (i) a diagram with the angle marked on or an exact statement of direction was required.

Q2 This question involved a constant acceleration. So the easiest method of answering was to use a constant acceleration equation. Those who used this method were usually successful although a number did make a mistake when finding the acceleration from F = ma. An alternate method was to use integration but this method had to be applied twice and constants of integration had to be considered. This approach led to more errors as the question progressed. Again some candidates failed to complete their answer by failing to find the position vector relative to O. Others subtracted the (**i-j**) instead of adding it.

Q3 Part (i) was well answered with only a few candidates failing to remember that a change of sign was required for the PE of the 3m mass. A significant number of candidates did not consider both masses in Part (ii) and so did it incorrectly. In Part (iii) a number gave an assumption that did not apply to 'x' or some said that A had moved the same distance up as B had moved down.

Q4 In this question Parts (i) and (iii) were very well answered. It was very pleasing to see in Part (iii) candidates' clear reasoning as to why F would decrease. The differential equation in Part (ii) should have been easy to solve but incorrect integration and/or errors when using the limits led to too many marks being lost.

Q5 Practically all candidates answered Parts (i) and (ii) correctly. In Part (iii) it was often difficult to follow the candidate's work. The markers commented that in this question candidates showed the least understanding of the topic being tested. A few mixed up sine and cosine. Only a small number of able candidates were able to find the work done by friction.

Q6 This question did differentiate between candidates of varying abilities with some confusing directions or trying to work with both horizontal and vertical velocities at the same time. The answer to Part (i) was given in the question and whilst most were able to find the correct answer, a number of 'fiddles' were seen. Part (ii) was reasonably well done. The methods used in Part (iii) were often correct but the velocities used were often incorrect.

Q7 If a candidate had drawn a correct diagram in Part (i) with the same tension used for both masses and had split into separate masses when answering Part (ii) then, bar silly mistakes, they should have gained full marks. However, many failed to use $a = 0$ for A, could not find an expression for the radius of the circle B moved in or did not use components for T when working with B and failed to complete the question. A number even had A moving in a circle and not B. If an answer > 1 had been found then perhaps candidates should have checked their working.

Assessment Unit M3 Mechanics AMM31

This paper was done well by the majority of candidates, many of whom were clearly well prepared. There were very few less able candidates and they were able to respond to parts of most of the questions. There was evidence that some candidates – not always the less able ones – were under time pressure at the end of the examination.

Q1 Part (i) was done well by nearly all candidates. There were three different ways to split the lamina but all fitted the given mark scheme. A very few candidates misread the question as a framework but were awarded marks if they used correct method in their working. Some candidates had problems in Part (ii) trying to add the particles to the lamina. In Part (iii) a small number found the angle with the horizontal and lost marks accordingly.

Q2 Only the better candidates did well in this question. A surprising number either reversed A and B or did Part (ii) before (i). In Part (ii) many candidates gave themselves extra work by applying the Cosine Rule twice when solving their vector triangle. A very few attempted to use a vector approach: none were successful.

Q3 Part (i) was done successfully by nearly all. In Part (ii) a sizeable minority measured GPE as positive in the downwards direction. This then led to problems in Part (iii). Good candidates did well in this question.

Q4 Many candidates got full marks in both parts of this question. The majority of even less able candidates could integrate accurately in Part (a)(i); some tried integration again instead of work-energy in Part (a)(ii) – and some of these succeeded! In Part (b) the majority correctly used the dot product (notation was not always accurate but errors were not penalised). Part (b)(ii) was done well.

Q5 Part (i) done well by most. Commonest errors were giving the value of the amplitude instead of d and stopping at the value of ω instead of finding T. Part (ii) was done well. A surprising number found t when x = 2 and used this value to find v and f instead of using standard equations. In Part (iii) most were able to identify the time correctly but comparatively few went on to find the correct time interval.

Q6 The majority of candidates gained the first 7 marks in Part (i) but did not think clearly about how to combine their equations to find the requested quantities. Many found the correct quantities in reverse order; there was no penalty for doing this.

Assessment Unit M4 Mechanics AMM41

There was a small entry this year. The majority of candidates were able to attempt all of the questions; although there was evidence that some were under time pressure at the end of the paper, the supervising examiner was surprised at the number who had difficulty with basic algebra (transforming equations) and trigonometry (recognising a 3-4-5 triangle).

Q1 This question was done well by nearly all. Some candidates gave themselves more work than was intended by proving the triangle was right-angled. There were many different methods of finding the force in the rod AB but all fitted the given mark scheme and nearly all were successful.

Q2 A straightforward example of the use of the Method of Dimensions. Very few used units instead of dimensions. However, notation was sloppy in many cases.

Q3 Done well by nearly all.

Q4 Part (i) caused no problems. In Part (ii) some candidates effectively found the height of the satellite above the Earth instead of its distance from the centre of the Earth. This question exposed the limitations some had in performing basic algebraic operations.

Q5 Part (i) was done well by nearly all. Part (ii) discriminated between candidates with less able ones unable to deal accurately with the banking.

Q6 Part (i) was done well by nearly all. Notation of integration was variable although the calculus used was correct so was not penalised. Part (ii) was done well. In Part (iii) some weaker candidates found the angle with the horizontal.

Q7 Part (i) was straightforward and done perfectly by nearly all. Part (ii) caused some difficulty for candidates who used notation for velocities that they had already used in Part (i). More able candidates did well. Part (iii) Many candidates did not understand the significance of the given value of e and so had velocities in the wrong direction. Good candidates were able to find the correct critical values of the final inequality, but very few interpreted them correctly.

Assessment Unit S1 Statistics AMS11

In general the candidates responded well to the questions in this paper. It was an accessible paper for candidates of all abilities, covering most of the specification. Even the less able candidates were able to make some attempt at most of the questions and managed to pick up marks. Most candidates were able to understand what was expected of them and a large number of candidates produced accurate responses. The stronger candidates were given the opportunity to demonstrate their knowledge and understanding of each topic. In particular they were challenged to show the depth of their knowledge through reasoning and thought. The terms mutually exclusive and independent were often confused.

Q1 Part (i) This was a straightforward discrete random variable question that the vast majority of candidates were able to answer successfully. The majority of the candidates knew how to set up the equation for E(x). Part (ii) Some mistakes were made by substituting the wrong value for a. In Part (iii) there were 'follow through' marks available which enabled candidates to get full marks in this part for knowing how to find E(y) and Var(y) and doing so correctly. Some candidates did struggle in Part (iii) to apply their knowledge of working out the Var(y). Some also lost marks for substituting in 10.7 for Var(x) leading to an inaccurate answer.

Q2 Most candidates successfully answered this whole question. Sometimes a longer calculation than necessary was performed in Part (ii) (adding all relevant binomial probabilities rather than 1 minus the other outcomes) resulting in mistakes. Also in Part (ii) a few candidates left out P(X = 8). In Part (iii) a number of candidates did recognise it was a conditional probability question. However, they struggled to know what numbers to put into the fraction. The most common error was to multiply in the (correct) bottom line to the (otherwise correct) top line. Sometimes a single binomial formula was used with n = 7 and x = 5.

Q3 This was the least well answered question.

Parts (i) & (ii) The candidates knew how to set up the equation for converting to the standard normal distribution. However, they found it difficult working backwards from the table. Common errors were to treat probabilities like z-scores or to incorrectly obtain z-scores from probabilities, inaccurately or with too much rounding. The main problems occurred in Parts (iii) and (iv). Some candidates struggled to relate the Inter-quartile range to the normal distribution and some used incorrect methods to try to find the lower quartile. Many candidates left these two parts out.

Q4 Parts (i), (ii) and (iii) were generally well done. A majority of candidates knew to use the Poisson distribution. They coped well with the changes in lambda and a good proportion achieved full marks in this question. In each part of this question, a small number of candidates did not use the correct value for lambda which meant that marks were lost. In Part (iv) some candidates appeared not to understand the question and made interesting attempts to work out the probability. A number chose the wrong method; they decided to work out the probability for week 1, week 2 and week 3 and then add all of these probabilities.

Q5 Nearly all candidates started to consider integration in order to arrive at the value of k. In Part (ii) fewer candidates were able to sketch the graph correctly. It was concerning that candidates at this level did not know the basic shape of a quadratic graph. Some did not label the axes of the graph correctly. Commonly the correct parabola was drawn but continued beyond plus/minus one. In Part (iii) a large number did not state the value of E(X) with an appropriate reason. Some candidates tried to calculate the value of E(X) rather than knowing the solution from seeing the graph. Even candidates who were not able to complete Part (iii) were then able to gain marks in Parts (iv) and (v) as they understood how to correctly use the equation to find a probability and the Var(X). Parts (iv) and (v) were well answered. However, some candidates in Part (iv) put in the wrong limits and in Part (v) some candidates forgot to work with the $[E(X)]^2$ in order to get the value for Var(x).

Q6 Many of the candidates did not seem to know the probability equations for mutually exclusive and independent events or if they did mixed them up. Of those who could set up the equations some struggled to work out the solution. Although if the correct quadratic was found in x (and k terms), it was not always solved correctly. Factorising was an issue. However, many candidates were able to score 3 marks out of 4. Part (ii) was less well done than Part (i).

Q7 Generally candidates had no problem working out the mean or standard deviation. Most achieved full marks in Part (i). Part (ii) was where problems arose as the majority of candidates found it difficult to give four specific answers. Many candidates got two out of the four reasons correct. Quite a few of the candidates were comparing the mean and standard deviation scores or stating other external factors. Candidates are more used to being asked about what to do to compare two data sets and some just answered in that mode. Other comments/assumptions were made about boys playing more games than girls or about primary vs secondary school age groups and their supposed gaming habits which were not relevant to the question being asked.

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Candidates performed well in this paper. High marks were frequent and in general scripts were well presented, with no single question causing significant difficulty to all candidates. In statistical terms when the Central Limit Theorem applies and consequently when to use or not use $S^2 = \frac{n}{n-1}S^2$ was the most common error. Accuracy was sometimes threatened when candidates failed to recognise that to give an answer to 3 significant figures requires working to 4 or more significant figures. However, in summary the cohort produced an impressive performance. Time appeared to be adequate but not excessive.

Q1 A distinct variety of reasons were given, often at substantial length. It should have been noted that the population was defined and answers should start from that premise, not try to redefine it. Bullet points would be preferred rather than essays.

Q2 **(iii)** A few interpreted "the average mass of the apples" as "the average mass of the bag of apples". Variance sometimes incorrect.

(iv) The most common error was using $\overline{X} = N(200,125)$.

Q3 Surprisingly the confidence interval was stated incorrectly on several occasions. Some wanted to use $S^2 = \frac{n}{n-1}S^2$

Q4 A question generally well done by candidates.

Q5 **(i)** Using X = 3A + 2B rather than X = A + A + A + B + B caused some to use an incorrect variance.

(ii) Follow through was applied to candidate values of the variance.

Q6 6(i) and 6(ii) were generally well done.

In 6(iii), incorrect evaluation of the variance of this large sample was the most frequent error.

Q7 The principal errors were in $\sum d$, $\sum d^2$ and in the formula for the t-test. However, the majority recognised the t-test and competently came to the correct conclusion.

Q8 Parts (i) and (ii) were usually calculated correctly.

In Part (iii) some failed to use $y = 4x$. Comments on breaking even and profit etc. were common. A few also correctly pointed out that, as 14 was not within the range of x values, any conclusion should be viewed with caution. It is extrapolation.

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