GCE

Rewarding Learning

Chief Examiner's Report
Mathematics

Summer Series 2024

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2024 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 microsite on our website at www.ccea.org.uk.

Contents

GCE MATHEMATICS

Chief Examiner's Report

Subject Overview

Candidates displayed good understanding of most topics across each of the units. Each paper contained questions which were accessible to all candidates, with more challenging and discriminating questions appearing towards the end of the paper.

The Pure Units continue to be very well answered and although there has been evidence of improvement in the Applied Units, there still appears to be some lack of confidence in the Statistics sections.

The key concerns raised across all units are for candidates to read questions more carefully and to show full development of their work. These are issues which are causing students to do unnecessary work, to lose marks by not providing convincing mathematical arguments or to lose marks by not giving answers in the required form.

Further development is needed in those questions which require interpretation, or explanation, and candidates should be advised to ensure that they answer these in context, rather than simply providing generic statements.

It is also disappointing to see so many candidates consistently fail to include a constant of integration in both Pure and Applied units.

An issue which has become more problematic recently is the use of erasable pens. The remnants of erased work are often still evident when papers are scanned and at times it has proved very challenging to read the replaced work. Candidates should be reminded that they should not be using these pens.

Assessment Unit AS 1 Pure Mathematics

Unit Overview

This paper allowed candidates of all abilities to demonstrate their strengths in the content studied, with the majority scoring well in Questions 1 to 6. Questions 7 to 9 were less structured and more challenging and were designed to test problem-solving skills.

Working was generally well structured and accurate. However common errors were still evident in basic working (algebraic/trigonometric), which undermined the ability to generate full solutions.

Candidates appeared to have sufficient time to answer all questions.

Q1 This was a standard vector question that was generally very well answered with most candidates clear about the use of magnitude and direction. A common error was an incorrect **j** component, but follow-through marks were applied to help candidates.

Q2 This was very well answered, given that this is a common type of question. The question was structured so that the various parts could link together. Errors were evident in the manipulation of the equation into the required form.

Q3 **(i)** This was a straightforward question involving circles, with the majority of candidates scoring most of the marks. The completion of the square method and the use of $x^2 + y^2 + 2gx + 2fy + c = 0$ were both seen, with common errors occurring in the manipulation of the equation to establish the radius.

(ii) This proved to be slightly testing for some, but the majority of candidates were able to set $y = 0$ and solve accordingly.

Some candidates lost marks by not considering both of the +/- aspects of solving the quadratic equation, whilst others lost the final mark by not giving their answer as coordinates.

Q4 **(a)** This was a standard question which was well answered. Candidates who used a long division approach generally did not get a full solution. Accuracy was tested in this question, with only a fractional or exact decimal answer being accepted.

(b) **(i)** This was a standard binomial expansion which was generally well answered. Common errors were mostly around the inability to deal with the powers of the kx term.

(ii) The set-up was generally good, but candidates either ignored or did not reference the possible $k = 0$ solution. Candidates who had errors in Part (i), could still get credit for their set-up in Part (ii). Too many candidates made errors in isolating the coefficients and often kept x in their set-up.

Q5 **(a)** This was a standard trigonometric identity with limited paths of progression.

Many candidates adopted the Mark Scheme approach, whilst a small number worked successfully from the RHS. A significant number of candidates scored 1/5 as they were unable to deal with $\frac{1}{\tan x}$ in terms of $\sin x$ and $\cos x$.

(b) The most common error in this standard trigonometric equation was an inability to replace $\sin^2 \theta$ correctly, often leading to an incorrect quadratic. Candidates with a correct quadratic equation = 0 generally obtained full marks by solving correctly and identifying $\cos \theta = -4$ as having no solutions.

Q6 **(a)** This standard log equation was very well answered. Some errors appeared in the manipulation of the equation, thus leading to an incorrect solution.

(b) This question caused some difficulty at the stage where ln was taken on both sides, but not dealt with correctly. Accuracy was also tested here, with candidates losing marks for a substitution with a heavily rounded k value.

Q7 **(i)** This was a standard max/min question in a familiar context, but invariably terms involving π cause difficulty. The majority of candidates were able to set out the perimeter and show the required result accordingly. As is common in these questions, there was some evidence of 'fiddles'.

(ii) Too many candidates did not read the question and considered the full area, as opposed to the area of the rectangle. Candidates were generally clear on the steps to apply but did so with errors evident in incorrect differentiation and the manipulation of $\frac{dA}{dx} = 0$ to get an exact value for x.

Q8 This question caused some difficulty given its unstructured nature. This style of question has appeared previously, and a lot of candidates did manage to generate a full solution. Some candidates adopted a log approach and gained some success, with only the most able seeing this through. More commonly, candidates who used a mixture of indices and logs did not reach a full solution. A common error was in the application of the division/subtraction rule on the RHS of the second equation where a double negative was not dealt with correctly.

Q9 **(a)** This question tested problem solving but the level of content made the question accessible. Too many candidates failed to deal with finding the equation of the quadratic and missed the negative x^2 aspect. Many proceeded to integrate their expression without considering where the curve met the line $y = 4$. Integration of terms was generally accurate, and candidates received credit for this. It was encouraging to see those candidates who were able to generate a full solution.

(b) Most candidates identified this question as the nature of roots but set it up using discriminant > 0. The majority of candidates were able to put in place some set-up, try to solve their quadratic and state their range(s). Common errors included the substitution into the discriminant, solving the quadratic equation and stating the correct range(s).

Assessment Unit AS 2 Applied Mathematics

Unit Overview

This paper was accessible to candidates with an appropriate gradient of difficulty in which a broad range of performance was evident. Many candidates appeared to be more comfortable answering questions in Section A (Mechanics) than in Section B (Statistics), which may be due to the clearer progression from Unit 2 of GCSE Further Mathematics than Unit 3.

Routine methods such as the use of the uniform acceleration formulae and calculation of the product-moment correlation coefficient were well understood and candidates were able to access most, if not all, of these marks. Candidates were a lot less confident answering questions in which interpretation and/or evaluation is tested (AO3). This was particularly noticeable in responses to Questions 3 Part (ii), Question 4 Part (iv), Question 5 Part (iii) and Question 6 Part (ii).

The language used in the paper appeared to be appropriate with no systematic misinterpretation of questions noted. Candidates appeared to have sufficient time to answer all of the questions, and some used extra paper to re-attempt several questions.

Q1 **(i)** This opening question was answered well overall. Most candidates were able to use the correct formula to find the acceleration, though a small minority treated the given velocities as forces and tried to use $F = ma$.

(ii) Though answered well in the main, some candidates did not find the resultant force at all and answered the question by finding the magnitude and direction of the acceleration, which was fine in the case of the direction. Some used trigonometry to find an angle but were unable to relate this to the context of the question.

Q2 **(i)** Practically every candidate drew the required graph correctly.

(ii) The time taken for Ben's journey was usually well done, but some struggled with finding the time taken for Adam, due mainly to the absence of a clear strategy. The most common approach seen was to work out that Adam ran 20 metres while accelerating and then set an expression for the distance travelled during the constant speed part of the journey equal to 80. A few used $T + 4$ for this where their work suggested $T - 4$ and some others tried to treat Adam's journey with uniform acceleration throughout.

Q3 **(i)** Diagrams were well drawn, and, in the vast majority of cases, candidates used straight lines with arrows to indicate forces. The most common errors here were to direct the frictional force down the slope and to direct the normal reaction vertically upwards, rather than perpendicular to the plane. A noticeable number of candidates changed the direction of the tension, even though it had already been marked on the diagram.

(ii) This question differentiated well between candidates with the full range of marks being awarded. Many candidates had practised this type of equilibrium problem well and were able to present an elegant, straightforward solution. Even many of those whose only error was to direct the friction the wrong way were able to demonstrate a good understanding of the required manipulation and arrive at a value for the tension.

Whilst most did try to resolve in two mutually perpendicular directions, this was done with varying success.

Q4 **(i)** This straightforward application of $v^2 = u^2 + 2as$ was answered correctly by virtually every candidate.

(ii) The only issues seen here were using the masses, instead of weights, for the particles and putting the tensions in the wrong direction, but this was otherwise well done by most candidates.

(iii) Those who had done similar problems before had no problem in setting up two simultaneous equations for A and B and solving them to find the value of m. Most candidates were at least able to get the first mark for trying to use $F = ma$.

(iv) This part was not well answered. Many candidates took the same value of a from Part (i), thus indicating that they had not realised that the particles had become disconnected. Even those who did correctly take $a = -g$ did not add the extra 2.5 metres to find the required minimum value of d.

Q5 This question required candidates to draw on background knowledge of cumulative frequency from GCSE, so marks ranged considerably from none to full inclusive.

Candidates who were most successful at this part produced a table with mid-points and frequencies to support their work. A common error was for candidates to conflate their knowledge of cumulative frequency with estimating the mean by using upper class boundaries instead of class mid-points. Some tabulated the cumulative frequencies but did not find the individual frequencies. A few knew to find the product of the total frequency (120) and the given mean (37.25) to arrive at 4470 but this was otherwise unsupported.

(ii) Candidates struggled with finding the variance and many blank spaces were seen here. Of those who did attempt it, a surprising number used an incorrect formula or method.

(iii) Candidates had trouble estimating the lower and upper quartiles for this part, which was most efficiently done using the diagram. Even though the formulae for the lower and upper limits were given, it was clear that many candidates simply did not know what to do here or what this question meant.

Q6 **(i)** Apart from substitution errors, this part was very well done by nearly all candidates.

(ii) Many candidates made a reasonable attempt to interpret their value of r from Part (i). Despite r being so close to zero, some still took the correlation to be negative and gave an interpretation accordingly. Since a formal cut-off point to justify a correlation between the variables based on the size of the sample is not required in this unit, candidates should try to use probabilistic language in this type of question, such as: "since r is very close to zero <u>there is unlikely to be</u> any correlation between the variables".

(iii) It was encouraging to note that many candidates realised that if r is negative then the gradient of the regression line should also be negative.

(iv) Again, many candidates correctly noted that a regression line would not be appropriate for this data since the value of r was so small.

Q7 **(i)** The question suggested using a Venn diagram and those candidates who used the approach as suggested in the Mark Scheme were practically all successful in obtaining the correct probability. Many types of Venn diagram, which were seen by examiners, were often unnecessarily complicated. Some chose to use a probability tree diagram and did so successfully. However, the additional conditionality which this approach required was not always taken into account with the denominators of the probabilities in the second stage of branches being 115. Many candidates were able to work out that 13 of the customers paid by card and had their candles gift wrapped just by manipulating the numbers stated in the question but found it difficult to present their work logically. Many who did correctly work out the 13 did not go on to use it in the required probability.

(ii) Most candidates noticed that either two-thirds of 115 was about 77 or, equivalently, that 77 out of 115 was about 2/3. Fewer were able to give a sensible reason why this figure might be unrepresentative. Many had not read the information at the start of the question which stated that the stall was only run during the first three weeks of December.

Q8 This question differentiated well between candidates of differing abilities. Most candidates were able to at least quote the structure of a binomial term, but some were unable to make any further progress. Many tried to form an equation from their expressions for $P(X = 1)$ and $P(X = 3)$ though some placed the 4 and 9 on the wrong sides. Several approaches were used to simplify and solve the equation obtained from the information in the question, from cancellation of non-zero factors from both sides to use of the factor theorem. Stronger candidates were able to demonstrate excellent skill in algebraic manipulation. It was good to note how many of these candidates explicitly ruled out –2 as a possible solution.

Assessment Unit A2 1 Pure Mathematics

Unit Overview

Overall, candidates appeared to find some aspects of this paper slightly more difficult as it tested some topics which have not been assessed since the introduction of the new specification. Recognising that this is a long paper with a wide range of topics being assessed, it is evident that many candidates focussed too heavily on recent past papers; a significant number of candidates demonstrated little understanding in areas of the specification that have not been asked in recent years such as using sigma notation and proving the sum of a geometric series. This was evident in Question 2 Part (a) and Question 4 Part (a) which should have been accessible to all, but many candidates could not answer them.

The paper was successful in allowing candidates with different abilities to respond positively and many of the questions could be answered using several alternative solutions and approaches.

Candidates were able to attempt most questions with the most able candidates achieving very high marks.

Q1 **(a)** Candidates generally answered this question well. However, a surprising number of candidates did not use the lowest common multiple when finding the common denominator, thus making their work much more difficult.

(b) Again, this question was generally answered well. A notable number of candidates, however, had difficulties in factorising basic quadratics.

Q2 **(a)** **(i) & (ii)** A lack of practice of this style of question was very evident, with many candidates struggling here, especially in Part (ii). The strongest candidates, however, had no issues with this question.

(b) This question was accessible to all candidates, with the majority achieving full marks. Unfortunately, poor algebra was often seen in this question e.g. $210 = a150 + b$, as well as incorrect and unnecessary changing of the case of the letter.

Q3 **(a)** **(i)** This was another question that was well answered by the majority of candidates. Candidates appear to be at ease with using the product rule.

(ii) Again, the quotient rule was very well attempted by most candidates, with the differentiation of the exponential term being the most common error. Quite a few candidates had the correct derivative but did not simplify their answer fully.

(b) **(i)** This question was well attempted, but candidates often omitted the factor of $\frac{1}{2}$ with the natural logarithm and the + with the exponential term. More often than not, the constant of integration $+c$ was omitted

(ii) This part proved challenging for many candidates. A surprising majority did not recognise this integral as the reverse of differentiation and, as a result, used methods not in line with the number of marks being awarded.

Alternative solutions carried out by substitution or repeated integration by parts were also accepted, but it is worth noting that the level of difficulty for such approaches was much greater than necessary. Candidates who tried to use substitution often failed in their attempt.

Q4 **(a)** It was evident that many candidates were not familiar with this proof. A lot of reverse engineering was observed in this question. Candidates needed to start this proof well to ensure full marks. For the candidates who did know the proof, it was an easy 5 marks.

(b) **(i)** This did not pose any difficulty for the vast majority of candidates.

(ii) Although very few candidates worked correctly with $\leq$ and $\geq$ in this question, its incorrect use was not penalised, and the majority of candidates arrived at the correct answer. A surprising number of candidates accessed full marks by simple iteration or trial and improvement.

(iii) Responses to this question, which tested the candidates' ability to reason, often lacked sufficient detail. A large number of candidates did not refer to why it would be a problem that the blocks were very small. Similarly, many failed to infer the impossibility of needing to use an infinite number of blocks. Many candidates appeared to know what to say but were unable to articulate it.

Q5 **(a)** **(i)** Candidates who did not know their trigonometric identities really struggled in this part. A wide variety of approaches was observed in this proof with some candidates going round in circles, unable to arrive at the required expression.

(ii) Those who successfully used Part (i) as their starting point and substituted the correct identity often went on to access full marks in this question. However, a surprising number of candidates did not know the identity for $\text{cosec}^2\,\theta$

(b) **(i)** Many candidates did not show the first two lines of the solution to explain the technique they were using. Full development of their work was essential in this question. Careless sign errors were made throughout this question.

(ii) This question was answered very poorly as a result of students failing to identify that the maximum is achieved when $\cos(\theta + 59.0°) = -1$. This was a very good differentiating question; the majority of candidates did not achieve more than 1 mark here.

Q6 **(i)** This question was generally well started with the majority of candidates attempting to take out the factor of $8\frac{1}{3}$. However many candidates made errors in doing so. Candidates were able to gain marks for the correct three terms in their binomial if a reasonable attempt at prior factorising was made.

(ii) This part caused problems for a lot of candidates despite being in the formula booklet. Many candidates incorrectly used $\leq$ in place of $<$ in their inequalities.

(iii) The majority of candidates were able to successfully find $x = 0.45$. However, of those who failed it was often as a result of having previously made an error in Part (i).

(iv) The majority of candidates knew to extend the binomial, but some just stopped at this statement. A number of candidates suggested Newton Raphson in this part, seemingly because they felt it should appear somewhere in the paper.

Q7 This question was attempted well on the whole. A lot of candidates achieved full marks here whilst a majority of candidates were able to gain at least 5 marks. Errors were mainly as a result of the careless use of $-\mathrm{d}u$ and not converting back to terms in x.

Q8 **(i)** This question on Partial Fractions was very well done by the majority of candidates. The "show that" element of this question caused problems for a small minority of candidates, who tried to start with the factors of 5 in their denominators, but then subsequently failed to equate numerators correctly.

(ii) This question was very poorly answered, with few candidates gaining full marks. Only the strongest candidates were able to separate variables correctly and recognise the need to use the partial fractions from Part (i) in this part. Many candidates did not make any use of Part (i) in their solution.

Q9 **(i)** This question was very well answered by the majority of students who differentiated implicitly and used the product rule correctly. Perhaps the "show that" element of this part ensured a much greater success rate in recognising the need to use the product rule when differentiating the $4xy$ term.

(ii) Generally, candidates found setting the denominator = 0 difficult, with very few candidates gaining full marks. A large number of candidates set $\frac{\mathrm{d}y}{\mathrm{d}x} = 0$ and did not appreciate that a vertical line has an undefined gradient.

Q10 **(i)** Very few candidates knew to obtain $\tan^2$ and $\sec^2$ and then use the identity $1 + \tan^2\theta = \sec^2\theta$. Many variations of alternative solutions were accepted. However, incorrect use of algebra or trigonometric identities meant that a significant number of candidates did not achieve full marks.

(ii) This question was generally well started. A majority of candidates were able to find the correct expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$ but some then had difficulty in finding the appropriate turning points. Some candidates did not seem to be familiar with the standard derivatives given in the formulae booklet and therefore chose to apply the product rule/quotient rule unnecessarily. Some candidates did not use parametric differentiation, as instructed in the question, but chose to differentiate implicitly. This was penalised accordingly.

Q11 **(i)** This part was well done by the majority of candidates. Some candidates found the necessary angles by opting to use the double angle formula to rewrite $\cos(2x)$ in terms of $\sin^2 x$ and/or $\cos^2 x$ and then taking the ± square root. This subsequently proved to be a little more challenging.

(ii) This question proved challenging with many candidates making errors in their integration by parts terms and the substitution of limits into their integral. A surprising number of candidates failed to recognise the need for integration by parts but were still able to gain 4 marks quite easily. Some candidates failed to read the word "exact" and left their final answer in decimal form.

Q12 (i) A majority of candidates were able to find the correct composite function, but a large number made mistakes in finding the domain and range correctly. Poor notation let candidates down throughout this question. The main issues arose through the incorrect use of letters and/or incorrect inequality symbols. x or y was often used for the range rather than the necessary gf(x).

(ii) Very few candidates earned the mark in this part as they did not include the membership of the real set statement which was explicitly required in this part. Again, the incorrect use of letters and/or incorrect inequality symbols for the range was observed many times.

(iii) This question was also answered poorly. The vast majority of candidates knew to set the expression equal to y (or x) but did not then attempt to use completing the square or apply the quadratic formula with an expression set equal to zero. Some reverse engineering was also observed. Many candidates tried to force their algebra to work in this part, because of the "show that" aspect of the question.

Assessment Unit A2 2 Applied Mathematics

Unit Overview

This was an effective paper that challenged students while still managing to be accessible to all. There were opportunities for all candidates to gain credit and the different ability levels of students were clearly displayed. The paper was well attempted by the majority of candidates and the most able students were able to achieve high marks.

In general, students appeared to be more competent in the Mechanics section in comparison with the Statistics section. Many candidates struggled to recall definitions correctly and to show full development of their working in the latter.

Candidates did not appear to struggle for time, as some were able to attempt a question, or questions, they were unsure of a number of times. Some students did leave a number of questions blank, but this seemed to be from a lack of understanding and/or preparation.

Q1 (i) This question was surprisingly poorly answered. Many errors arose from missing opposite directions and thus failing to change the sign of the velocities. Some candidates incorrectly used $mu - mv$ or $mu + mv$ while some who attempted to use $mu - mv$ did not use the same mass for each, or used the mass of particle B and were unable to progress any further. For those selecting the correct method and mass, some did not proceed to find the required magnitude.

(ii) This question was generally well answered with the majority of candidates able to use the Conservation of Momentum to correctly find the mass of particle B. Some candidates lost a mark due to incorrect signs on their velocities or for the inclusion of g in their equation.

Q2 (i) The slightly different layout of this question seemed to confuse some candidates. A small number of students interpreted this as a vectors question and introduced **i** and **j** components. Others incorrectly attempted to use the constant acceleration questions. For those that did recognise that they needed to use integration, the consideration of the constant of integration proved problematic and was either ignored or no reason was provided for it being equal to zero. Many candidates did not demonstrate how the speed of 9 m s^{-1} was obtained.

(ii) This part of the question was successfully completed by the majority of candidates. However, again, many omitted the constant of integration. A small number of students incorrectly attempted to use the constant acceleration equations here.

(iii) This part of the question proved challenging for numerous candidates, with many of them treating the situation as a whole and not considering the first three seconds separate from the remaining time. Only the stronger candidates seemed to make use of the connection with Part (ii). Many candidates did not know how to approach the question, while those that did correctly answer the question chose from a variety of methods such as setting up and solving an equation, using a velocity-time graph and a small number of students even used trial and improvement.

Q3 **(i)** This was generally well answered with most students obtaining both of the marks. Common mistakes were:

- No arrows on the forces.
- The force at B drawn perpendicular to the ladder.
- Friction acting in the wrong direction.
- An extra friction force at point B.
- An extra reaction force at the point where the man is standing on the ladder.

(ii) Most candidates were reasonably successful in this question and able to obtain between 5 and 9 marks. Many were able to use vertical and horizontal equilibrium, attempt to take moments about either A or B, use $\cos \alpha = \frac{3}{5}$ in their equation for moments and use $F_r = \mu R$. While quite a few candidates were able to achieve full marks in this question, common issues were forgetting to use distances in their attempt to take moments and confusing sin α and cos α. A small number of candidates attempted to take moments about C, with a few others not even knowing how to begin the question.

Q4 **(i)** In general, this was answered well, although a number of candidates did not fully explain their working. Some used an incorrect direction for gravity, and others obtained the answer via inefficient methods. A number of candidates who used the incorrect sign with g then attempted to manipulate their working to obtain the correct equation.

(ii) In this part of the question, a surprising number of candidates started again and failed to connect Part (i) and Part (ii) by not using the greatest height formula. Many students who went on to obtain the correct answer did not use an inequality. For those candidates who did use the greatest height formula, common errors were:

- Taking g as -9.8.
- Using the greatest height as either 9 m or 1 m.
- Rounding too early in their working and then obtaining a correct answer of 30°, but from incorrect working.
- Obtaining the correct answer but then failing to round to the nearest degree.

(iii) In general, this question was poorly answered. Although the majority of candidates knew they needed to use $s = ut + \frac{1}{2}at^2$, their signs were not consistent throughout and so only scored 1/4 marks. Some candidates misread the question as 5 degrees above the horizontal rather than below the horizontal.

Q5 **(i)** This part of the question was generally completed very well. A small number of students lost a mark by leaving their answer in the form $\mathbf{a} = -2t\mathbf{i} + -7\mathbf{j}$.

(ii) Again, this part of the question was generally completed very well. However, some candidates lost marks by forgetting to find the constant of integration or for failing to incorporate the constant of integration within their **i** and **j** components.

(iii) This part of the question was poorly completed. Candidates knew they needed to set the **i** and **j** components equal but instead used the components of displacement– perhaps because they had had just found an expression for displacement in the previous part.

When candidates did find the correct values for time, they did not test (or show evidence of testing) these values and then either used both in the next part of the question, or used one value of time but did not sufficiently explain why they had only taken this particular value.

(iv) Many candidates who were able to correctly obtain both times in Part (iii) then went on to find the speed at both times rather than at $t = 2$ only.

Q6 **(i)** Surprisingly, this was not completed well. Common incorrect answers were 0.05 and 1.645 or using the inequalities $r > 0.4973$ or $r < 0.4973$.

(ii) Many students neglected to write an inequality at all, or stated $r > 0.4973$. Many did not state that there was "sufficient evidence" in their answer.

Q7 **(a)** **(i)** This question was generally well done, but it was surprising to see how many students calculated the probability using the conditional formula, instead of using knowledge of independence to simply write down the correct probability. Candidates should be advised to take account of the number of marks allocated to each question.

(ii) Many candidates were able to answer this part of the question correctly, with a small number of students using a Venn Diagram.

A small number of students incorrectly stated that $P(A \cap B) = 0$ or did not state $P(A \cap B)$ at all.

(b) **(i)** This question proved to be a discriminating part of the paper. Despite the question advising candidates to use a tree diagram, a significant number of candidates used the conditional formula, with varying levels of success. Most candidates were able to achieve at least 1 or 2 marks. The use of a correctly drawn tree diagram usually led to full marks, but the most common mistake was starting off the first set of branches with X and Y instead of X and not X. Some candidates used a Venn diagram. Using this method, they were often able to get 0.12 and 0.56 but were then unable to progress much further.

(ii) As this part relied on Part (b)(i), candidates who had not completed the previous part correctly, often could not attempt Part (b)(ii) at all. Very few candidates were able to achieve full marks, but many candidates were able to obtain between 1 and 3 marks using follow-through from their previous answer.

Q8 (i) This was well attempted by most candidates. Candidates who found the correct *z*-score were generally able to standardise correctly and achieve all 4 marks. Candidates who made a mistake with the *z*-score were still able to achieve 2 marks and their mean value followed through to the remaining parts. The most common incorrect *z* value used was - 0.81. Some candidates also attempted to use 0.209 or 0.791

(ii) It should be noted that in the best solutions, candidates drew clearly labelled diagrams and stated the distribution clearly for each part. Some candidates were able to obtain the correct answer with little or no method shown and therefore could not obtain full marks since they did not show the full development of their working

(iii) Most candidates were able to achieve some marks in this question, but fully correct solutions were not common. A small minority of candidates used the binomial distribution to achieve the final 2 marks. Common mistakes in this question included a misread of $P(X > 89.5)$, multiplying their obtained probability by 2 rather than squaring and not rounding the final answer to 3 significant figures.

(iv) Only a minority of candidates achieved this mark. A lot of candidates did not realise that their answer should reference the independence of lengths. Some candidates realised that the events were independent but failed to state this in context of the question.

Q9 (i) This part of the question was generally completed well.

Common wrong answers included using 20% or using a letter other than *p*.

(ii) This question was not well answered. While most candidates appeared to know what the critical region was, a significant number were not able to define it correctly with reference to the test statistic.

(iii) It was clear that some candidates found this question to be very challenging. It was attempted by most candidates and proved to be a good discriminator. There were some excellent answers which showed full understanding of the topic, but other scripts showed little or no understanding. A significant number of candidates calculated either $P(X \leq 3)$ or $P(X \geq 3)$ and nothing else, rather than trying to find the critical region. Candidates' notation was unclear with a significant number mixing up the direction of the inequality. Some candidates stated the correct binomial distribution but then went on to try and perform calculations with the normal distribution.

(iv) Some candidates were successful in using their answer to Part (iii) to state that 3 is not in the critical region. The most common alternative approach was to calculate $P(X \geq 3)$ and compare it with 0.05. Candidates should be reminded that their decision is to reject or not reject the null hypothesis, as opposed to reject or accept the alternate hypothesis. Candidates also often omitted the "sufficient evidence" or "insufficient evidence" or "at the 5% significance level" statements in their conclusions.

Q10 This question was well answered by most candidates with many obtaining either full, or almost full, marks. The majority of candidates recognised that it was a hypothesis test for the mean of a normal distribution and were able to correctly calculate the test statistic. The most common solution was to compare the correct test statistic with the correct critical value, or to calculate P(z > 36) and compare this with 0.05. However, other methods were used correctly and achieved the appropriate marks. Common mistakes in this question were the use of the wrong letter in their null and alternative hypotheses, omitting the “sufficient evidence” or ‘”insufficient evidence” or the “5% significance level” or failing to give their interpretation in context of the question.

Contact details

The following information provides contact details for key staff members:

- **Specification Support Officer: Nuala Tierney**
  (telephone: 028 9590 6689, email: ntierney@ccea.org.uk)
- **Officer with Subject Responsibility: Lisa McFarland**
  (telephone: 028 9590 6711, email: lmcfarland@ccea.org.uk)

COUNCIL FOR THE **CURRICULUM, EXAMINATIONS** AND **ASSESSMENT**
29 Clarendon Road, Clarendon Dock, Belfast BT1 3BG
Tel: +44 (0)28 9026 1200   Fax: +44 (0)28 9026 1234
Email: info@ccea.org.uk   Web: www.ccea.org.uk

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