GCE

Rewarding Learning

Chief Examiner's Report

Mathematics

Summer Series 2022

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2022 series.

CCEA hopes that the Chief Examiner's report 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.

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GCE MATHEMATICS

Chief Examiner's Report

General

Summer 2022 was the first year since the introduction of the revised Mathematics specification that potentially had a full cohort sitting the A2 papers.

However, as a consequence of the Covid mitigations, only AS Unit 1 and A2 Unit 1 were mandatory units in AS and A2 Mathematics respectively.

Considering the challenging circumstances, students and teachers are to be commended for the efforts that were made in the preparation for and completion of these papers.

It was evident across all papers that candidates had a good understanding of most topics and were able to demonstrate their knowledge and ability.

However, there were some common strands across all the papers which were perhaps related to the lack of examination experience of these candidates. These included the lack of confidence in dealing with questions set in context or in unfamiliar settings. This was evident in both the Pure and Applied Units. In the Applied Units, it appeared that candidates were better prepared for one or other sections of the paper, perhaps as a result of interruptions to teaching and learning. Hopefully, next year's cohort will have greater experience in these areas.

Assessment Unit AS1 Pure Mathematics

Unit Overview

This paper allowed candidates of all abilities to demonstrate their strengths in the content studied.

There was a range of short/standard questions leading onto others that were less structured and more challenging in order to demonstrate problem-solving skills.

Those questions which provided challenge included:

- Q4 (ii) [Nature of roots]
- Q7 (b) [Binomial term independent of x]
- Q8 (b) [Maximum area under curve]

whilst Question 9(a) and (b) proved to be accessible with many candidates scoring marks in these last questions.

Working was generally well structured and accurate, however common errors were still evident in basic working which undermined the ability to generate full solutions.

There was no evidence of timing issues.

Q1 A standard three equations with three unknowns problem which was generally very well answered with most candidates using the most efficient method to solve.

There is still evidence of candidates getting non exact values and persisting in following through instead of checking for errors.

Q2 **(a)** This was generally well answered in the required form but there were some errors in algebraic manipulation.

In Part (ii), most candidates were able to link to Part (i) but some ignored 'hence' and used calculus.

(b) Numerical errors in percentages resulted in working marks being lost.

Many candidates realised the need to take natural logs and applied accordingly.

A common error was not giving the final answer to the required accuracy.

Q3 **(a)** There were many good attempts, but a common error was not identifying – 30° as one of the original solutions. Most candidates were able to take into account a change of range and apply correctly but there was evidence of missing or incorrect final solutions.

(b) Most candidates were able to use identities to try and simplify. There was some evidence of fiddles and working that lacked structure.

Q4 **(i)** This was very well attempted with the majority scoring full marks leaving the equation of the straight line in the required form. There were some minor errors in differentiation and manipulation. A small number of candidates did not recognise the need to apply differentiation.

(ii) Many candidates did not generate a full solution having set the equations equal. Any attempt at use of discriminant was credited whilst others used an acceptable alternative solution.

Q5 **(a)** This was well answered but with the usual errors in preparing the fractional term for integration.

(b) Again, this was well answered with candidates aware of the key steps. Most errors occurred in the substitution of – 1 and the subsequent manipulation.

Q6 **(i)** The majority of candidates were able to apply the factor and remainder theorems and generate equations accordingly. Errors occurred within the manipulation and the solution of two equations with two unknowns. Those who attempted to divide generally made little progress due to the algebraic nature of the expressions.

(ii) Many candidates were able to divide correctly and leave their answer as the three linear factors required.

(iii) Generally good attempts were made with most candidates realising a suitable substitution had to be taken. Errors in logs were evident and getting zero instead of no solution. Some candidates spotted the link back to Part (ii) but their work was less than convincing.

Q7 **(a)** This was well answered but common errors were made in the use of fractional terms. Errors were also evident where 2 was taken out as a common factor but was done incorrectly.

(b) Candidates found this a challenging question. There were some correct solutions but more typical was the generation of terms that did not go anywhere. However, there were some excellent algebraic solutions that involved the set-up of unknowns to solve. This was a good question for the more able candidates.

Q8 **(a)** This was very well attempted with the majority of candidates able to apply logs. One common error was not reversing the inequality sign in the last line of working but again plenty of candidates applied this and scored full marks.

(b) Very poorly answered given the fact that most candidates did not know what was being asked. Most incorrect work was focused on trying to calculate areas. A small number of candidates did get full marks.

Q9 **(a)** This was a very accessible question with most candidates able to score close to full marks. There was encouraging linkage between circles and coordinate geometry. There were some examples of acceptable alternative solutions.

(b) Again, this was an accessible question but candidates did not score as highly as in Part (a). Algebraic errors occurred when finding the hypotenuse but method marks were applied. There were some examples of alternative solutions and evidence of structured mathematical working.

Assessment Unit AS2 Applied Mathematics

Unit Overview

This unit was not mandatory for the Summer 2022 series and therefore the number of candidates taking this unit was significantly less than that for Unit AS1.

There was a wide range of outcomes with some excellent results and some instances where it was evident that the Mechanics Section was better known than the Statistics Section or vice versa. Since the level of challenge in each section was comparable, it is possible that at least some of these outcomes may be attributable to the disrupted learning experience of the candidates.

There was sufficient differentiation within each section of the paper to give all candidates the opportunity to demonstrate their understanding of each topic.

There was no indication of any issue with the time allocation.

Q1 This question was well answered. A number of candidates found the magnitude of the resultant force and then used this to find the magnitude of the acceleration. This was a perfectly acceptable alternative solution. The most common error was candidates finding the acceleration in vector form and forgetting to find its magnitude.

Q2 This question was well attempted. There were two main methods of solution: one was to set up the equation of motion for the complete system and the other was to start by working with the two vehicles separately. The former was the slightly more popular method. Some candidates could not correctly identify which vehicle the resistances acted upon and others omitted the tension in the tow bar. Otherwise, there were just minor calculation errors.

Q3 **(i)** Most candidates successfully completed the diagram. However, it is essential for all forces to be labelled and have an arrow indicating the direction. A number of candidates also included the resolved components of each force and although there was no penalty for this, it often became very difficult to decipher the diagram. The other common error was for the friction to be shown acting in the wrong direction.

(ii) Although many candidates were successful in finding the coefficient of friction, there were a significant number who struggled with resolving parallel and perpendicular to the plane. Many did not know how to deal with the 25N force and either ignored it or treated it as acting along the plane. The lack of structure in candidates' methods often resulted in very poor presentation and made it difficult to identify exactly what they were trying to do.

Q4 **(a)** **(i)** This question proved to be challenging for many of the candidates. Some could not deal with the three second time delay before the second ball was thrown upwards. Others simply found the maximum height of each ball and compared these but had no idea how to set up two general equations for the displacements of the balls. A small number of candidates successfully worked out the full details for Ball 1 at time $t = 3$ and then correctly used this as a new starting point to set up the general displacement equations. This was a perfectly correct, if somewhat time-consuming, method. This question showed that many candidates had a basic understanding of all the equations of motion but had difficulty in applying them in context.

(ii) There was a mixed range of responses to this question. A significant number of candidates found displacements and tried to use these to identify the direction of motion, rather than considering velocity.

(b) Only a very small number of candidates were successful in answering this question. Most started with a non-zero velocity which was obviously incorrect. Many drew curves rather than straight lines. It appeared that some were considering the displacement, rather than the velocity, of the ball bearing.

Q5 **(i)** Most candidates were able to identify at least some of the relevant reasons for cleaning the given data. However, others ignored the reference to "Kevin" and "his data" and simply listed generic reasons without applying them to the given spreadsheet.

(ii) This was generally well answered. However, some candidates did not use the boxplot data but returned to the spreadsheet which only formed part of the overall data set. It was concerning that a small number of candidates did not appear to be able to read off the quartiles from the boxplot. In addition to the necessary calculation, it is important that candidates provide a clear statement to "show" what is required.

Q6 **(i)** Almost all candidates were able to find the mean. The variance was well answered but there were some candidates who found the standard deviation and a smaller number who used incorrect formulae for the variance.

(ii) Almost everyone found the correct value of the product-moment correlation coefficient.

(iii) Many candidates assumed that there was weak positive correlation. It is vital to consider not only the "sign" of the PMCC but also its "size". Therefore, comments on the value should have contained a reference to the size of the number as well as the appropriate interpretation in context.

Q7 **(i)** Almost all candidates stated the correct probability.

(ii) This was very well answered. It was evident that many candidates were using the appropriate calculator function to answer this and other parts of the question. It is important for candidates to give some indication of how they are doing this. They could simply indicate they are using the binomial distribution and state the values of n and p. In the event of obtaining an incorrect answer then they could obtain some credit for a correct method.

(iii) Most responses to this question were good. However, a number of candidates were unsure about what "at most 10" meant and therefore included or excluded some of the necessary parts of the calculation.

(iv) Some candidates answered this very well, providing clear evidence for their answers. Other solutions were less convincing. Candidates should ensure they show the probabilities of the values of either side of their "suspected" mode in order to provide a complete argument. Others found the mean, even though the mean is not on this specification.

Q8 **(i)** Most candidates were able to show that this statement was true. However, some just played around with numbers and never wrote a final equation.

(ii) Very few candidates were able to fully complete this question. Some were able to make a start, but a large number were unable to make any progress. The candidates obviously had problems with the idea of independence and how to apply it in this question. This resulted in many simply playing around with a number of probability rules without making any further progress.

Assessment Unit A21 Pure Mathematics

Unit Overview

The standard of the question paper was fair leading to a good spread of results. Candidates could access most questions with the most able candidates achieving very high marks. Less able candidates could still gain marks for appropriate methods and within less complex topics. Overall, a good standard of response from candidates.

Q1 Most candidates achieved full marks in this question. A small number of candidates approached this like an AP rather than a GP. A few mistreated the mixed number values and calculated these like a product. It was unclear if this was due to misunderstanding of the way the information was presented or a misuse of calculator technology. A pleasing start for most candidates.

Q2 This question posed straight forward differentiation.

(i) & (ii) Most candidates recognised the need to use the product rule in Part (i) and the quotient rule in Part (ii). These questions were generally well answered with errors coming mainly from careless slips.

(iii) A significant number of candidates did not seem able to find the derivative of a ln term. This caused considerable difficulty in correctly answering this part.

Q3 **(a)** **(i)** This posed no difficulty for candidates with most clearly detailing the required knowledge to prove the identity.

(ii) This identity was carried into (ii) where the majority of candidates were able to achieve full marks by correctly solving the appropriate trigonometric equation to find the required angles. A small number of candidates made careless errors in their manipulation which led to incorrect solutions.

(b) **(i)** Most candidates were able to answer this question effectively, but some made assumptions about the material presented without knowing these to be true (e.g right angled triangles/equilateral triangles). Candidates had to clearly show their understanding here and were penalised for making unproven assumptions.

(ii) Most candidates achieved pleasing marks, although some did not leave their answer as an exact area. Others tried to follow through with an angle in degrees. A small minority of candidates did not know the formulae for sector or triangle areas.

Q4 Each transformation question was well attempted with the majority of candidates gaining full marks in Parts (i) and (ii). The third part was the most challenging and required detailed knowledge of the order in which to apply the two transformations.

Q5 This question was poorly answered by a number of candidates.

(i) The method of completing the square was poorly executed with significant errors in trying to remove a negative one and in gaining the correct completed square term.

(ii) & (iii) Only the best candidates seemed to be able to navigate Parts (ii) and (iii) where range and domain information was required. It should be noted again that candidates are required to list a range as a function of x, and a domain should be listed using x terminology.

(iv) This part enabled candidates to show what they knew about composite functions, though most struggled to achieve full marks and did not seem to see the connection between the first and final parts of the question.

Q6 **(i)** This was a standard partial fractions question with most candidates performing well. Some small arithmetic errors were the main cause of dropped marks. Very few candidates were unable to use the correct breakdown for their partial fractions.

(ii) This caused more difficulty for candidates with a significant number unable to correctly manipulate their partial fractions to arrive at correct binomial expansions. Some candidates did not use the correct expansion for negative powers in a binomial.

Q7 **(i)** This is a standard integral that should be covered routinely but still caused significant difficulty for some candidates. Errors like forgetting the correct substitution of cosine double angle formula and making sign errors when integrating were prevalent for some candidates.

(ii) This was well answered by most candidates who correctly recognised the need to use integration by parts with the majority able to correctly identify the correct parts to differentiate and integrate.

(iii) Only the better candidates managed to achieve full marks here. Candidates struggled to correctly substitute all their variables and therefore were unable to achieve the higher marks in the question

Q8 This contextual question was well answered by candidates.

(i) They recognised the need to separate variables to set up and solve this differential equation. Some errors were prevalent in their ability to remove the logarithm terms.

(ii) Candidates knew they had to use the conditions stated in the question to find the value of k and then use this to find the required time. Very few candidates used an inequality set up which would have been the preferred approach to solving this problem.

Q9 The differentiation aspect of this question was generally well attempted with a few small errors in correctly differentiating the product rule term. Most candidates were able to appreciate the relationship between the gradients of a tangent/normal and were able to use an appropriate method to find the equation of a straight line. Some numerical errors were present at various stages.

Q10 This was a more discriminating question that was only successfully completed by the most able candidates.

(i)–(iii) Candidates were able to display their knowledge of parametric differentiation in Part (i) though few were able to correctly apply their understanding of parametric equations to successfully answer all parts.

(iv) This question related to the Cartesian equation of the curve and was well attempted by several candidates.

(v) When candidates could not complete Part (iv) they were unable to access all the marks for the volume of revolution.

Q11 **(i)** This question required candidates to recognise the connection between the two curves and the positions of their points of intersection. Most candidates did this well. The majority of candidates then went on to complete their Newton - Raphson calculations effectively.

(ii) Candidates were able to correctly demonstrate the method required for finding the area between two curves. It should be noted that where candidates applied their limits in the wrong order or subtracted the equations of their curves in the wrong order, they had to show understanding of why their value was negative and correct this accordingly.

Assessment Unit A22 Applied Mathematics

Unit Overview

Since this was not a mandatory unit the number of candidates who entered this paper was much less than that for the compulsory A2 1 Unit.

There was a good range of outcomes with many candidates achieving pleasing results. It was evident however, that for some candidates there were gaps in their understanding and their ability to apply knowledge in context.

The paper allowed candidates to demonstrate their ability and there was no evidence that timing was an issue for any of the candidates.

Q1 **(i)** This was an easy starter question and was well answered by the vast majority of candidates.

(ii) Many candidates were able to find the correct impulse. However, there were two common errors. One was to find the impulse exerted on Q, rather than that on P. Another was to use two different masses in the $I = mv - mu$ equation.

Q2 **(i)** This was generally very well answered.

(ii) Most candidates were able to differentiate and find the acceleration. However, many were unable to deal with the "parallel to **i**" aspect of the question.

Q3 **(i)** Most candidates knew to integrate and were able to find an expression for **s**. However, some omitted the constant of integration and were unable to access the final mark.

(ii) Although this is not an unfamiliar question, it certainly started to discriminate between the candidates. A large number did not set $v = 0$ in order to find the turning point in the motion. Some simply found the displacements at $t = 0, 1, 2, 3$ and tried to use these to find the distance travelled. Others ignored the initial displacement of the particle. Only the most able candidates managed to correctly complete this question.

Q4 **(i)** Although many candidates were successful in answering this question, there was a significant number who worked with displacement instead of velocity.

(ii) This question divided the candidates into two very distinct groups – those who could easily complete the question and those who had little idea of how to approach it. One common error was to find the maximum height of the golf ball and try to use that to indicate whether the ball would clear the tree. These candidates did not appreciate that they needed to consider the vertical height when the horizontal displacement was 180m.

Q5 **(i)** Many of the diagrams were poorly completed. Arrows on the forces were omitted whilst reactions were added at C and D but the reaction at the hinge was omitted.

(ii) This question posed a significant challenge to many candidates. Part of the problem was that they had included extra forces and omitted necessary forces. Others could not find the angle between the string and the horizontal. Presentation was often disorganised and extremely difficult to decipher. However, some method marks could be gained for their attempts to take moments or resolve.

Q6 **(i)** Few candidates could provide a clear and coherent definition of the null hypothesis. However, many gained one mark for a partial description.

(ii) As in (i) few candidates could give a full explanation but many were able to gain one mark.

(iii) Surprisingly few candidates got this answer correct. Many stated $r \leq -0.5494$ or $r > -0.5494$

(iv) Again, most candidates were unable to gain both marks. Very few justified their conclusion by making reference to the value of r in relation to the critical region.

Q7 **(i)** This was well answered with many of the candidates obviously using their calculators. It is advisable that when candidates use their calculators, they state the distribution they are using and provide a sketch graph so that they can be awarded credit for their method in the event of writing down an incorrect final answer.

(ii) There were some very good responses to this question. However, some candidates found both quartiles but did not subtract to find the interquartile range. There was also a surprising number of candidates who did not appear to know how to approach the question.

(iii) There was a mix of responses to this question, with the most common error being to find P(104 < x < 130) rather than the probability required.

Q8 **(i)** There was a mixed response to this question. The most common errors were to omit the $\sqrt{50}$ term or to take 0.43 as the standard deviation rather than the variance.

(ii) A variety of correct methods were used to complete the hypothesis test. Candidates should be advised to show all the necessary stages in the test. Many did not state the null or alternate hypotheses. Others stated these as $H_0 = 3.5$, $H_1 > 3.5$ rather than H_0: $\mu = 3.5$, H_1: $\mu > 3.5$

Q9 All parts of this question were very well answered.

Q10 As in question 8, there were very poor, if any, statements of the null and alternate hypotheses. It is important that the hypotheses refer to $p = 0.15$ etc and that probability is stated as a decimal (or fraction) rather than a percentage. Candidates should also clearly state the distribution they are using. Some candidates calculated P($X = 6$) or P($X > 6$) rather than P($X \geq 6$). For those who were able to complete the test correctly, their final conclusions were usually well interpreted.

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