GCE

Rewarding Learning

Chief Examiner's Report

Further 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 that A2 units of the revised Further Mathematics specification were examined. It was also the series where only AS Unit 1 and A2 Unit 1 were mandatory units in AS and A2 Further Mathematics respectively.

Considering all the challenges, 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 reading and checking the full detail of the formats in which answers were to be given; the poor presentation of some written explanations and proofs; the lack of, or poor presentation of diagrams which would have assisted candidates in their working. Hopefully, next year's cohort will have the opportunity to gain much greater experience in these skills.

Assessment Unit AS1 Pure Mathematics

Unit Overview

This was the mandatory unit for AS Further Mathematics in Summer 2022.

The paper allowed all candidates to demonstrate a fair degree of knowledge, with many scoring highly. It was evident that the paper offered good differentiation between standards of responses.

Although candidates knew the general methods behind each question, their notation was often poor for Further Mathematics students. Many did not look out for the finer details of a question, such as giving a set of coordinates as an answer rather than a vector.

Q1 **(i) & (ii)** Both parts of this question were generally well answered. Most students applied the correct method and knew how to apply the fact that **AB** was singular.

Q2 **(i)** Many candidates gave the argument in degrees. For future reference, candidates are advised to give the argument in radians.

(ii) & (iii) These parts of the question were well answered.

Q3 **(i)** All candidates were able to find the sum and product of the roots.

(ii) A number struggled to expand the cubic and many did not factorise the resulting equation correctly.

(iii) The majority of candidates correctly found the sum and product of the new roots. However, a few candidates did not finish the question in the appropriate format.

Q4 **(i)** Many candidates did not recognise this transformation as a shear and many of those who did recognise it could not describe it fully.

(ii) Most candidates were able to set up a matrix equation. However, the biggest mistake after that was that they substituted expressions for x and y rather than X and Y into the given equation.

Some candidates found $\mathbf{S}^{-1}$ and successfully used it to find expressions for X and Y.

(iii) All candidates were able to attempt this part. However, many multiplied the matrices in the wrong order.

Q5 **(i)** Many incorrectly set the i-coefficient of the second line as 0, which led to a system of equations that gave inconsistent solutions. This was often overlooked in order to get an answer that seemed sensible to the candidate.

(ii) Generally, candidates knew to use the vector product and applied it correctly. Some did not use the correct vectors in the following vector equation of the plane, although follow through was applied from Part (i).

(iii) Many students did not recognise that the x and z coordinates would be zero at the y-axis.

Q6 **(i)** Most candidates scored full marks.

(ii) Many candidates did not consider that the determinant of the matrix was not equal to zero.

(iii) Generally well done, although many made small calculation errors for the matrix of minors. Fortunately, only a few candidates seemed to ignore the instruction in the question, and used their calculator, coming up with the correct matrix without any working out.

(iv) Quite a few candidates ignored “hence” and tried this part algebraically by simultaneous equations and were penalised accordingly. A number knew the correct method but were careless when setting up their matrix equations, post-multiplying by $\mathbf{M}^{-1}$ rather than pre-multiplying. However, in the main, this was well done.

Q7 **(a)** **(i)** All students were able to expand the bracket and recognised how to simplify the equation. However, many forgot the negative sign when comparing the imaginary parts of their (correct) equation. When getting final solutions, most recognised that a^2 or b^2 gave two solutions and so wrote ± but they did not invert the notation for the second value.

(ii) Incorrect notation from Part (i) had a knock-on effect in this part.

(b) Most candidates recognised that they needed to draw a circle and a perpendicular bisector. However, the standard of sketches was often very poor, with key points on the graph not being clearly indicated.

Q8 **(i)** Most candidates knew how to find vertex C but their notation was poor, often interchanging vectors and coordinates at will. However, students were penalised if their final answer was not written as a set of coordinates.

(ii) Most candidates used the vector product and scalar product, or the scalar triple product, however, the choice of vectors that went into them varied significantly. Many candidates also divided this ensuing value by 6 or 2 rather than 3.

(iii) This was a good question to distinguish the top students. Some candidates did not know where to start. Others knew roughly what to do but used incorrect vectors. Some had learned a formula for shortest distance and used it successfully.

Assessment Unit AS 2 Applied Mathematics

Unit Overview

This was the optional unit for AS Further Mathematics in Summer 2022 and thus there was a very small entry for this unit.

Overall candidates appeared well prepared for the examination, displaying few signs of being disadvantaged due to Covid. The standard of answers was very good, with every candidate being able to demonstrate their knowledge and preparedness. If there was a common weakness in responses, it was to spend a little too much time on Section A, leaving time pressure for their second section. In a small field, no one attempted Section D.

Section A: Mechanics 1

Characteristic of the section, as a whole, was the number of different, but equivalent, approaches taken to the conservation of mechanical energy problems. The approach used in the mark scheme, utilising the lowest point or a fixed point as a baseline for gravitational potential energy is to be recommended as a good basic approach to problems at this level.

Q1 A gentle conical pendulum question for starters.

- **(i)** A few candidates lost marks by not placing arrows on their force lines to denote the sense. The most common error was to include a fictitious force arising from central acceleration.
- **(ii)** This question was well attempted, with few candidates losing a mark.

Q2 The vast majority of candidates gained full marks on this question about an engine's power.

- **(i)** Well handled.
- **(ii)** A few candidates, while obtaining the correct expression for the engine's driving force, failed to correctly frame Newton's second law on the inclined plane.

Q3 Excellent attempts were made by a great majority of the candidates. Nearly every candidate was able to make headway in finding the work done by the force through integration. A small number, however, were unable to correctly implement the Work-Energy equation to find the particle's speed.

Q4 The application of the conservation of mechanical energy was well managed by most candidates.

- **(i)** Candidates used a number of correct approaches to account for the conservation of the three types of energy during the climber's descent. Those unable to gain full marks were able to pick up marks for correctly evaluating some energy terms.
- **(ii)** The inclusion of a non-zero kinetic energy term proved problematic for some. As before, most candidates were able to pick up marks for correctly evaluating some energy terms. Again, a number of equivalent approaches to the conservation of mechanical energy were followed in candidates' attempts.
- **(iii)** The model could be made significantly more realistic by including the effect of air resistance.

Q5 This inclined plane question, involving an elastic string, is most easily solved using energy. It introduced increasing complexity and was only correctly solved completely by a minority of candidates. Throughout the question, candidates were able to pick up marks by correctly evaluating a number of the energy terms.

(i) The first scenario necessitates candidates keeping track of the connection between the distance travelled down the plane and the corresponding vertical drop, not always correctly achieved.

(ii) On the whole, candidates were able to derive an expression for the friction in terms of the coefficient of friction. Only the best candidates were able to include the loss of energy due to friction into the energy equation correctly.

Section B: Mechanics 2

There is some evidence that candidates were more at home with the content of this section than with that of Section A. There appeared to be time pressure on some of the candidates at the end of the paper.

Q1 **(i)** Dimensions proved a gentle introduction with virtually every candidate obtaining full marks in the first part.

(ii) No candidate was prepared for the use of the relationship obtained to predict percentage changes in the dependent variable, frequency.

Q2 Again, virtually every candidate obtained full marks in this satellite motion question, correctly deriving the expression for angular speed and then using it to find the period of the satellite.

Q3 This vertical circle question was correctly answered using energy by almost every candidate. Only one failed to derive an expression for the velocity of the bob at the top of the circle using conservation of energy. From this expression, the condition on u is easily obtained.

Q4 This relative velocity problem to find closest approach of pupils on fixed trajectories caused difficulties. The problem is essentially of class exercise standard and is amenable to a straightforward approach. This must be evidence of under-preparation for the topic. Also worthy of note is the poor quality of diagrams by some candidates that must have impacted upon their solutions.

Q5 This question concerns equilibrium involving elastic strings.

(i) This part was very well attempted, though a few candidates lost a mark through incorrect labelling or omitting arrowheads.

(ii) The heart of this solution was to take vertical components across the diagram. Some candidates are to be commended for taking a whole system approach, equating twice the normal reaction sought with the total weight of the system.

(iii) The final part was correctly solved by only a small minority. There was evidence here of the effect of time pressure on candidates. It is difficult to be sure if the lack of full solutions was due to the conceptual demand or the absence of time for the necessary reflection to spot the method.

Section C: Statistics

There is some evidence that candidates were more at home with the content of this section that with that of Section A. There appeared to be clear evidence of time pressure on some of the candidates at the end of the paper.

Q1 **(i)** A common mistake was to call this stratified sampling. However the sampling frame is not known and the selection of individual responders is not random but chosen by the interviewer.

(ii) In describing the advantage of one technique over another, it is barely acceptable, at this level to merely use the terms “cheaper” or “faster” without describing why the method achieves this. For example, this method achieves a sample with characteristics in proportion to those of the population (80% home and 20% away supporters) by filling-up the desired quotas “on the hoof”. Stratified sampling achieves this by randomly selecting the correct proportion of interviewees from the corresponding strata in the entire population in advance of interview, a much more exhaustive process. So, quota sampling is faster.

Q2 This question was well practised and executed by the vast majority of candidates. High marks were obtained. In Part (ii)(b), a number of candidates did not understand the need to use the regression line of x on y instead.

Q3 **(i)** This question was wholly dependent on the candidate carefully comprehending the scenario, the difference of two tetrahedral scores. Answers to the remaining parts depended on a correct probability distribution in Part (i). Some candidates made careless mistakes that could have been avoided through greater care.

(ii) & (iii) Candidates demonstrated an excellent understanding of how to correctly evaluate the expectation and variance of this discrete probability distribution – or what they believed it to be.

(iv) Again, they coped excellently with the linear transformation of the discrete variable. High marks were obtained by most candidates in this question.

Q4 This unseen geometric distribution question unsettled a number of candidates, only half of whom produced acceptable responses.

(i) A number, although able to draw the probability tree, were unable to interpret it correctly. For them, the question ended here.

(ii) & (iii) These two parts, if attempted, were both well done.

Q5 Despite clear evidence of time pressure, this question was well attempted by most of the candidates.

(i) & (ii) These relatively trivial counting problems were easily dispatched in the main.

(iii) & (iv) The majority knew how to progress this section of the question on how to count the number of times the 2 vowels occur adjacent to each other.

(v) This last part, extrapolating from 7 letters to n letters was attempted by most. A smaller number obtained the correct final expression $\frac{2}{n}$.

Assessment Unit A21 Pure Mathematics

Unit Overview

Summer 2022 was the first time that this unit has been examined since the revised specification was introduced.

Under the Covid mitigations, Unit 1 was the compulsory unit at A2 level and it was evident that candidates had been well prepared for this examination.

The underlying mathematical principles were well understood and carried out. However, presentation and notation were often poor with the result that at times it became very difficult to follow the candidate's solution.

For the most part, candidates were able to complete the paper within the time allocation. However, some candidates used inefficient methods, especially in Question 8, and it was evident that this caused timing problems towards the end of the paper.

Q1 **(i)** This was well answered, with only a few minor errors arising.

(ii) The vast majority of candidates recognised this series as $\Sigma_{r=5}^{40} r^2(r+3)$ and were able to deal with it correctly.

The most common, albeit infrequent, error was to re-write this as $\Sigma_{r=1}^{40} r^2(r+3) - \Sigma_{r=1}^{5} r^2(r+3)$

Q2 There were two main approaches to this proof by induction.

The first was to use the method shown on the mark scheme and these responses tended to produce more convincing arguments.

The second was to use $u_{k-1} - u_k$ and try to show that this was divisible by 8 and hence how u_{k+1} was also divisible by 8. Whilst candidates may have known what they were trying to do, they could not produce a clear and coherent reason to justify their answer.

The quality of the final statement ranged from excellent "textbook perfect" responses to statements which made no sense at all.

Q3 **(a)** Most candidates knew how to approach this question. Many omitted the constant of integration in their final answer. This was not penalised in this exam series because of the Covid mitigations but would be penalised in future years.

Candidates should be advised to state clearly what they are using for u and $\frac{dv}{dx}$. Errors in the working, without clear statements of intent, resulted in few marks being awarded. It was impossible to know if the candidate had simply made an incorrect selection for u and $\frac{dv}{dx}$, made some error in their integration or differentiation or indeed if they did not know how to use repeated integration by parts.

(b) Most candidates did realise the need for $\lim_{t \to \infty}$, although this realisation sometimes only appeared in lines 2 or 3 of their working. This was one of the questions where notation was poor.

Q4 This question was reasonably well answered, although the candidate's selection of the limits of their integration was not always entirely convincing. A few candidates made errors in the use of the double angle formula.

Q5 **(i)** This was a routine partial fraction question which should have been very easily completed. However, a number of candidates did not fully factorise the denominator and therefore only obtained two fractions instead of three. Whilst this did not cause a severe loss of marks in Part (i) it did have an implication for Part (ii).

(ii) A surprising number of candidates did not appear to know how to apply the method of differences. Some of those who had not fully factorised in Part (i) did realise they needed to correct that answer. Others produced a series of very muddled terms.

Even those candidates who did have three fractions did not set up the stages in a sensible order and were not exactly sure how the terms cancelled out. Candidates should take time to consider the order in which they write each of the partial fractions so that they can easily identify the cancelling pattern. A small number of candidates started to list their fractions starting from $r = 1$ instead of $r = 2$

Q6 **(i)** Most candidates were able to differentiate each of the fractions and combine their answers to obtain the required result. Those who used the quotient rule on the second fraction tended to make very few errors. However, the candidates who re-wrote that fraction and used the product rule were much more likely to get incorrect answers.

(ii) Most candidates were able to complete the square and then relate their answer back to Part (i). Some candidates used a substitution of $u = x - 3$ to assist them in their working at this stage.

A small number of candidates omitted the factor of $\frac{1}{2}$, but could otherwise complete the question.

Q7 Most candidates were able to identify the appropriate integrating factor, with only some minor errors being made. A very small number of candidates did not multiply both sides of the differential equation by the integrating factor.

Candidates generally did take account of c and were able to calculate it correctly.

Although we did not penalise candidates in this series, it would be preferable if the final answer had y as the subject of the formula.

Q8 **(i)** The majority of candidates were able to find the correct second derivative.

(ii) Candidates should be advised to clearly state their values of u and v and their derivatives. This would not only help them considerably in terms of their management of the solution but also ensure that they gain method marks in the instance of an error in their final answer.

Generally, candidates did know how to apply Maclaurin's theorem with errors tending to be numerical. The factorial terms should be expanded to produce the final answer.

(iii) This part of the question was dealt with by quite a variety of methods. A small number of candidates did take note of the word "hence" and successfully replaced (x) with $(-x)$ to obtain the solution in a few lines.

Some candidates re-started Maclaurin's theorem for the new function. Others used, or derived, series for $e^{-x} \cos x$ and e^{-2x} and used them accordingly to find the new series. Others just switched signs without any explanation of why this should be appropriate. Depending on the method used, some candidates spent much more time on this question than they should. Candidates should be advised to look at the mark allocation and only use an appropriate time on each question.

Q9 **(i)** This question clearly divided candidates into two categories – those who knew how to approach the separation of the terms and those who had no real idea where to start. As mentioned in earlier questions it is important that candidates clearly state their starting terms of u and $\frac{dv}{dx}$. This would have allowed some candidates to pick up method marks where errors in their working could not otherwise be identified as minor error or not knowing how to use parts.

It is also important in a "show that" question that candidates do produce sufficient evidence of the work leading to the final answer. There appeared to be some who reverse-engineered the given answer and were not therefore awarded full marks.

(ii) This was generally well answered. However, it was slightly concerning that some candidates did not use the correct formula for the volume of revolution.

Q10 **(i)** This question was answered very successfully by the vast majority of candidates.

(ii) Only a small number of candidates realised the significance of the displacement remaining finite and were therefore able to gain all 3 marks. Most candidates only scored 1 out of 3.

Q11 **(a)** This was generally well answered. A few candidates did not multiply the 1st term by 2 when using the chain rule but were able to gain some follow through marks.

(b) **(i)** Most candidates knew how to approach this proof. Working was often disorganised and difficult to follow. Few candidates were able to explain why the root with the negative sign was not feasible. It was usually simply discarded.

(ii) Most candidates were able to make progress with this question, even if their working was again very disorganised. Some were able to legitimately use their calculators to assist in the intermediate stages of the solution.

Q12 **(a)** The quality of the working in this part of the question was very disappointing. There were few clear arguments produced in the finding of the 6 roots. Candidates also gave answers in forms other than the one specified.

The quality of many of the diagrams was poor. A sketch should be clearly labelled with some indication of the scale and positioning of the points. It was fortunate for many candidates that only 2 marks were allocated to the diagram.

(b) **(i)** This was generally well answered, but again candidates need to be aware that in a "show that" question their working must be well presented and convincing.

(ii) Most candidates knew what they needed to do. Some omitted the factor of 2 when substituting in for the cosine terms.

(iii) Most candidates were able to complete the integration provided Part (ii) was correct. Many omitted the constant of integration and although not penalised in 2022, this will not be true in future.

Assessment Unit A22 Applied Mathematics

Unit Overview

Summer 2022 was the first time this A2 unit was assessed since the introduction of the revised Further Mathematics specification. As part of the 2022 Covid mitigations this was an optional unit, which resulted in a much smaller number of entries compared with Unit 1.

There was an approximately even split of the cohort sitting the A/B and A/C combinations, with no candidates attempting Section D.

Each section tested a broad range of topics on the specification and incorporated a suitable variation in difficulty and style of question, ranging from the application of standard techniques to more demanding problems set in context, and from highly scaffolded questions to those with very little guidance. While each section included several questions (or part questions) that were accessible to all candidates, there was at least one discriminating question that stretched even the most able candidates. Generally candidates were well prepared for the paper with methods of solution demonstrating a good standard of development.

Section A: Mechanics 1

Q1 This was a standard question involving the centre of mass of rods, which afforded candidates the opportunity to settle in to the examination.

- **(i)** A number of candidates worked out the distance of the COM from PQ using moments, as opposed to simply writing it down from symmetry.
- **(ii)** Some candidates omitted the rod PT from the calculation, presumably because the x-coordinate of its COM from PT is zero. However, this meant that they also incorrectly omitted the mass of this rod from the total mass of the system when equating moments.
- **(iii)** There were very few issues with this part of the question. However, a sketch of the diagram, showing the angle to be calculated and the relevant dimensions, would benefit candidates.

Q2 A straightforward question on damped oscillations that, with the exception of the final mark, posed no significant problems to the majority of candidates.

- **(a)** Candidates were required to state the conditions in terms of p, q and r, i.e. in the context of the question, as opposed to writing down generic conditions.
- **(b)** **(i)** The general solution should be given using the correct variables from the problem i.e. with x and t as the dependent and independent variables respectively. Also, in the case of underdamping, with complex conjugate roots for the auxiliary equation, candidates should aim to give the general solution in the standard format i.e. involving an exponential term and a sum of sine and cosine terms.
  - **(ii)** Very few candidates were able to provide a suitable limitation of the model, specifically that it predicts that the pointer would oscillate indefinitely about O.

Q3 This question was answered very well, with a significant proportion of the candidates gaining full marks.

(i) One identified, although rare, error was resolving parallel/perpendicular to the plane.

(ii) Candidates should be advised that, rather than simply writing down the expression for v^2 they should also provide an explanation, e.g. 'if car about to slide up slope, then friction acts down slope', and show the replacement $\mu \rightarrow (-\mu)$ as part of their method.

(iii) In this part of the question, as with all questions requiring a result to be proven, it is important that candidates clearly show all steps involved in their method/working.

Q4 This question discriminated between candidates of differing abilities, with parts (i) and (ii) generally accessible to all, and part (iii) stretching the more able.

(i) This was very well answered.

(ii) Some candidates adopted an alternative method, which involved using $x = a \sin \omega t$ (or $x = a \cos \omega t$) to find the time at point C, and then finding the velocity at this time. A quicker approach was to use the relationship between the velocity and displacement $v^2 = \omega^2 (a^2 - x^2)$. In any event, a common mistake identified in parts (ii) and (iii) was to set $x = 0.4$ as opposed to $x = 0.6$ i.e. candidates failed to recognise that x is the displacement from the centre of oscillation.

(iii) A proportion of candidates struggled to gain full marks in this part. Even for those who did calculate the correct time from B to C (or C to O), some failed to correctly identify the relationship between this time, the period and the required elapsed time to return to C.

Q5 Considering that it was the final question in the section, many students were able to make reasonable attempts. That said, it was not without its issues, and there was a notable deterioration in presentation in this question, resulting in candidates losing marks as a result of careless algebraic manipulation and inaccurate working.

(i) A common mistake was to only consider the moment produced about A by one of the components of the tension T (vertical or horizontal), as opposed to finding the anticlockwise moment about A by multiplying T by the distance AF. This resulted in an incorrect expression for T, which was carried through the remainder of the question.

(ii) Some candidates began equating forces at various joints in order to find the missing forces in the rods. It was simpler, at this stage, to equate forces for the entire system. Also, when finding the direction of the reaction at A, it is recommended that a sketch is included showing the appropriate angle.

(iii) It may be easier if candidates initially assume that the forces in all the rods are of the same type (e.g. all tensions), and then state the type of each force (tension or thrust) based on the sign of the calculated force. Also, for problems like this, candidates should clearly identify the joint(s) at which they are equating forces, so as to avoid mistakes and ambiguity.

Section B: Mechanics 2

Q1 **(i)** This was answered very well, with a significant proportion of the candidates gaining full marks. Lost marks usually stemmed from candidates not correctly applying the properties of a couple to find P and Q i.e. a small number of candidates attempted to equate moments about a point or to find a resultant force.

(ii) A small number of issues arose with this question. The most common was candidates failing to identify and correctly calculate the perpendicular distance between O and the line of action of the three forces producing non-zero moments about O i.e. the perpendicular 'height' of the equilateral triangles.

Q2 **(i) – (iii)** These parts of the questions did not present any major problems, with the bulk of the cohort obtaining full marks.

(iv) This was poorly answered, with many candidates failing to identify that if the particle P did intersect the x-axis, then both the **j** and **k** components of the displacement would be zero at the same value of t. For the final two marks candidates were required to explicitly state/show that the value of t that makes the **j** component zero, does not simultaneously make the **k** component zero.

Q3 This question was answered very well, with a significant proportion of the cohort gaining high marks.

(i) & (ii) Where marks were lost in these parts it was usually a result of carelessness with directions/signs for the velocities. An annotated diagram may be of benefit in this regard.

(iii) In order to access the final mark in this part candidates were required to provide a reason for their conclusion i.e. show a clear comparison of the final velocities after the second impact.

Q4 **(i)** This was an accessible introduction to the overall question, with most candidates coping fairly well. That said, a small number of candidates were not able to recall the relationship between power and velocity, and, as such, made little progress. As with all questions requiring a result to be shown or proven, it was essential that all steps were clearly presented to gain full marks.

(ii) This proved challenging for the cohort, with only the most able scoring full marks. Specifically, some were unable to recall the relationship $a = v\frac{\mathrm{d}v}{\mathrm{d}s}$, and therefore failed to set up the differential equation. For those candidates who did make successful attempts, rather than evaluating a definite integral, most found the corresponding indefinite integral, and then used the boundary condition to find the distance.

Q5 **(i)** This question proved to be a discriminator, with some of the cohort either failing to recognise that the masses of the two constituent sections were proportional to the volume or using the incorrect formulae for the respective volumes. Others incorrectly used the COM of a triangle for the upper section, as opposed to a cone.

(ii) Candidates who struggled with Part (i) were still able to take the given result to progress and make reasonable attempts with Part (ii). The crux of this part was identifying that, at the point of toppling, the weight of the ornament would act through the outermost point of contact between its base and the inclined trolley. Clearly drawn, and labelled, diagrams would assist candidates in their working. Candidates are advised to clearly state both their conclusion and the applicable reason in problems of this type.

Section C: Statistics

Q1 Although this was designed as an introductory question, parts of it proved problematic for a number of candidates.

(a) Very few candidates defined the confidence interval correctly in terms of it enclosing the population mean.

(b) **(i)** Students require a clear understanding of the differences between the population variance, the sample variance, and the unbiased estimator for the population variance.

(ii) & (iii) These parts seemed to cause some confusion. Candidates are generally competent at finding a confidence interval when given a sample mean. However, finding the sample mean in Part (ii) or sample size in Part (iii) when given a confidence limit or width proved to be more problematic.

(iv) In this part, candidates lost marks by being too vague. For example, for the first mark it needed to be clear that it was the distribution of the sample mean that was assumed to be normal. For the second mark, $n \geq 30$ was required as the justification for using the Central Limit Theorem.

Q2 This was a standard question on 'Paired t-tests' that candidates proved to be well-versed in completing.

(i) Some candidates found $\overline{d}$ and S_d^2 using the statistical function on their calculator. This is acceptable; however, it is advised that candidates show the d^2 values in the table and the calculation of these parameters from the summary statistics quoted from the calculator. This enables them to gain some method marks in the event of a working error.

As with all hypothesis tests, it is important that all aspects of the test are clearly shown i.e. hypotheses, critical value, type of test, degrees of freedom etc. For the final mark, the conclusion should not state that the test proves/disproves the claim, only that it provides sufficient/insufficient evidence for such.

(ii) This was a routine assumption to be identified.

Q3 This question discriminated between candidates of differing abilities, with Part (ii) stretching the more able.

(i) When candidates are using their calculator to find a Normal probability they should be advised to clearly state the distribution being used and draw a sketch indicating the required area.

(ii) The most common errors arose in the calculation of the variance, for example subtracting Var($4S$) from Var(U), instead of adding. Some candidates did not show a clear understanding of the distinction between the sum and the multiple of Normal random variables.

(iii) Very few candidates picked up the final mark which required them to explicitly state that the assumption of independence is needed when calculating the variance.

Q4 Considering that this was not a routine question on hypothesis tests, it was pleasing that so many students scored highly. Many candidates demonstrated an understanding of the pertinent terms in a hypothesis test, e.g. critical region, acceptance region, test statistic etc. Some lost the final mark by failing to multiply by two, to take account of the fact that it was a two-tailed test.

Q5 Questions of this type involving statistical tests (e.g. goodness-of-fit, paired t, contingency table) are generally well answered, as candidates can follow a structured format.

(i) The quickest approach was to simply subtract the sum of the given four expected frequencies from 50. Some candidates found a by calculating $P(X = 4)$ for a suitable Binomial distribution.

(ii) When stating the hypotheses, it is expected that candidates explicitly state the parameters of the distribution (n and p in this case). The most common mistake in this part was not combining the $x = 0$ and $x = 1$ classes. As in question 2, the conclusion should not state that the test proves/disproves the claim, only that it provides sufficient/insufficient evidence for such.

(iii) & (iv) These did not pose any significant difficulty for the candidates.

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