



GCE Examiners' Report

Further Mathematics

GCE

Summer 2024

Introduction

Our Principal Examiners' report provides valuable feedback on the recent assessment series. It has been written by our Principal Examiners and Principal Moderators after the completion of marking and moderation, and details how candidates have performed in each unit.

This report opens with a summary of candidates' performance, including the assessment objectives/skills/topics/themes being tested, and highlights the characteristics of successful performance and where performance could be improved. It then looks in detail at each unit, pinpointing aspects that proved challenging to some candidates and suggesting some reasons as to why that might be.¹

The information found in this report provides valuable insight for practitioners to support their teaching and learning activity. We would also encourage practitioners to share this document – in its entirety or in part – with their learners to help with exam preparation, to understand how to avoid pitfalls and to add to their revision toolbox.

Further support

Document	Description	Link
Professional Learning / CPD	WJEC offers an extensive programme of online and face-to-face Professional Learning events. Access interactive feedback, review example candidate responses, gain practical ideas for the classroom and put questions to our dedicated team by registering for one of our events here.	https://www.wjec.co.uk/home/professional-learning/
Past papers	Access the bank of past papers for this qualification, including the most recent assessments. Please note that we do not make past papers available on the public website until 12 months after the examination.	Portal by WJEC or on the WJEC subject page
Grade boundary information	Grade boundaries are the minimum number of marks needed to achieve each grade. For unitised specifications grade boundaries are expressed on a Uniform Mark Scale (UMS). UMS grade boundaries remain the same every year as the range of UMS mark percentages allocated to a particular grade does not change. UMS grade boundaries are published at overall subject and unit level. For linear specifications, a single grade is awarded for the subject, rather than for each unit that contributes towards the overall grade. Grade boundaries are published on results day.	For unitised specifications click here: Results, Grade Boundaries and PRS (wjec.co.uk)

¹ Please note that where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

Exam Results Analysis	WJEC provides information to examination centres via the WJEC Portal. This is restricted to centre staff only. Access is granted to centre staff by the Examinations Officer at the centre.	Portal by WJEC
Classroom Resources	Access our extensive range of FREE classroom resources, including blended learning materials, exam walk-throughs and knowledge organisers to support teaching and learning.	https://resources.wjec.co.uk/
Bank of Professional Learning materials	Access our bank of Professional Learning materials from previous events from our secure website and additional pre-recorded materials available in the public domain.	Portal by WJEC or on the WJEC subject page.
Become an examiner with WJEC.	We are always looking to recruit new examiners or moderators. These opportunities can provide you with valuable insight into the assessment process, enhance your skill set, increase your understanding of your subject and inform your teaching.	Become an Examiner WJEC

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Executive Summary

The examination papers in GCE Further Mathematics were generally of a similar standard to previous examination series. As is always the case, some questions were more demanding in some topics than in previous series, whilst others were less demanding. What was noticeable this year, and to some extent also in the previous two series, is that many candidates embarking on the AS / A2 Further Mathematics course are either unable to recall, or are unable to apply, their knowledge and understanding of AS / A2 Mathematics, which consequently impacts on their ability to successfully answer questions requiring this pre-requisite knowledge.

There are some areas of the subject content that are not well understood each year and this year was no exception. This includes topics such as the exponential distribution, vertical circles, and calculus of hyperbolic functions. Other topics that are specific to units are listed in the individual unit reports. Similarly, there are certain skills that are lacking each year which can prove costly, e.g. algebraic manipulation and the reluctance to draw diagrams, particularly in the Further Mechanics papers.

What was evident this year was that questions that were set in a non-standard format, i.e. in context, both mathematical and non-mathematical, proved challenging for candidates. They struggled to translate the information given in the question into the relevant mathematical processes. These problem-solving styles of questions require a deeper understanding of the underlying mathematics, than simply following routine processes and procedures.

Although there were candidates who scored some low marks on the exam papers this series, there were also some excellent solutions seen to all questions in all six GCE Further Mathematics units, e.g. summation of series (Unit 1), discrete probability distributions (Unit 2) vertical circles (Unit 3) and centre of mass of composite bodies (Unit 6).

Areas for improvement	Classroom resources	Brief description of resource
Pre-requisite knowledge from GCE Mathematics Unit 1 and Unit 3	Past papers, including legacy papers	Questions to help consolidate and strengthen GCE Mathematics Unit 1 and Unit 3 skills, e.g. algebraic manipulation.
Exponential Distribution	WJEC Resource, available here .	Notes, worked examples, and questions with worked solutions.
Vertical Circles	Past papers, including legacy papers	The topic of vertical circles is inherited from the legacy specification, so legacy past papers and resources can provide a bank of questions.

FURTHER MATHEMATICS

GCE

Summer 2024

AS UNIT 1 FURTHER PURE MATHEMATICS A

Overview of the Unit

The candidates performed consistently well on this paper and there were some excellent scripts seen. However, as in previous series, poor algebraic skills were apparent and often proved costly. There was little evidence of a pattern in the responses to this year's paper – some candidates performed well at the start, only to falter somewhat towards the end, whilst the opposite was true for others. In many responses, poor use of the Formula Booklet was evident and a lack of preparedness to show sufficient working.

Questions on the following topics were well answered:

- Expressing complex numbers in trigonometric form (Q1)
- Solving polynomial equations with real and complex roots (Q2)
- Loci in an Argand diagram (Q6)

Some candidates had difficulty with the following content:

- Using formulae for the summation of a finite series (Q5)
- Transformations in matrix form (Q8)
- Transformations of lines and curves (Q4)

Areas for improvement:

- Algebraic manipulation
- Familiarisation with the Formula Booklet in order to make better use of it in an exam

Comments on individual questions/sections

- Q.1** This question was well answered by many candidates, with the majority using the first method in the mark scheme. However, some candidates incorrectly dealt with i^2 , whilst others failed to calculate the argument correctly, often noting an angle in the fourth quadrant.
- Q.2** Whilst many complete solutions were seen for this question, often candidates showed little working, if any, for solving the quadratic equation. Candidates are reminded that simply stating solutions to polynomial equations is unlikely to lead to full credit.
- Q.3** This question was well attempted, although some candidates did not appreciate the repeated root stated in the question. Those candidates who successfully formed an equation often divided throughout by α , without stating a reason why this was acceptable, consequently, losing a mark. Few candidates used the second or third methods given in the mark scheme.
- Q.4** Disappointingly, this question was not the highpoint it could have been for many candidates. Often candidates failed to reach the given expression for v and had an incorrect expression for u . Those candidates who reached correct expressions in part (a) often continued to gain full marks in part (b).

- Q.5** This question was not well-answered by many candidates and, often, few marks were awarded. Many candidates could not form an expression in Σ -form, despite the mark scheme condoning the use of k , rather than $(k - 1)$. Those candidates who did so correctly often continued to score high marks. However, some candidates did not show sufficient working to solve their quadratic equation, thereby, losing marks.
- Q.6** This question was often begun well in part (a), with the majority of candidates gaining the marks for forming equations in (x, y) for the loci. However, errors in squaring brackets, or calculating the modulus with i included, were seen, leading to more difficult expressions to work with later. In part (b), some excellent sketches were seen, however, some candidates seemed unaware of the geometric nature of the loci in this question.
- Q.7** Most candidates were able to gain at least the first three marks of this question, by looking at $n = 1$ and considering $n = k$ and $n = k + 1$. Many candidates continued to work with $n = k + 1$ correctly, to reach an expression of the form $7(Ak + B)$. However, candidates are reminded to be more attentive to their algebraic manipulation, particularly in proof questions, as some creative manipulation was seen to reach the required expression.
- Q.8** Some good responses were seen to this question, although they were very rare, with candidates often using the first or third methods in the mark scheme. Those candidates who progressed to reach two trigonometric equations often did not appreciate all the possible angles, usually solving $\cos 2\alpha = -\frac{15}{17}$, without dealing with the two possible values between 0° and 360° . Furthermore, candidates did not use $\sin 2\alpha = \frac{8}{17}$ to discern the correct value of α . Part (b) was well-answered.
- Q.9** Part (a) was well answered by the majority of candidates, with errors, when they arose, usually coming from poor arithmetic with negative numbers. Part (b) was often well-answered; however, some candidates seemed unaware of the content in the Formula Booklet. Candidates regularly verified that points B and C lay on the given planes, but few candidates were able to state a valid equation of a plane containing the points B and C .

FURTHER MATHEMATICS

GCE

Summer 2024

AS UNIT 2 FURTHER STATISTICS A

Overview of the Unit

The standard of responses this year was slightly better than last year, with many candidates scoring 60 marks or more. Fewer candidates seemed daunted by the knowledge, skills and understanding required at this level and excellent responses were seen for all questions. Once again, the question assessing discrete probability distributions (Q6) proved challenging, and as did the question assessing the exponential distribution (Q1). The questions involving hypothesis testing (Q3, Q5) were, on the whole, well answered, as was the question assessing linear regression (Q4).

Questions on the following topics were well answered:

- Calculating and interpreting Pearson's product moment correlation coefficient and the least squares regression line (Q4)
- Understanding and using the chi-squared test for independence (Q5)

Some candidates had difficulty with the following content:

- Constructing discrete probability distributions (Q6)
- Understanding and using the exponential distribution (Q1b)

Areas for improvement:

- Giving explanations, justifications and interpretations of results, in context
- Being able to extract the necessary information in a question set in context, in order to translate it into the relevant mathematical processes

Comments on individual questions/sections

Q.1 This question contained a part assessing the exponential distribution, which, unfortunately, contributed to the overall standard of response being poorer than it might otherwise have been. Part (a) was generally well answered, with the most common error being the calculation of $P(X \leq 2)$, rather than $P(X < 2)$. The justification required in part (ii) needed to be given in context, rather than simply stating "I was given a mean rate."

In part (b)(i), the exponential distribution was not well understood and many candidates used $\lambda = 2.15$ to calculate $E(X) = \frac{1}{2.15} = 0.4651$, which they then added to 11:00 a.m. Whereas in part (b)(ii), candidates failed to use $\lambda = 2.15$ and instead used $\lambda = 4.3$.

Part (c) was relatively well answered, but part (d) was less well answered. Many candidates seemed unaware of any approximations and simply stated B(950,0.02) from part (c).

- Q.2** Responses for this question were mixed, with many excellent answers seen, but also a number of poorer responses given. All the common, expected errors were seen, including finding $F(0.75)$ in part (a), integrating $F(x)$ in both parts (a) and (b), omitting “0 otherwise” and stating $f(x) = 1 \quad x > 2$ in part (c), and calculating $\int xF(x)dx$ in part (c). The piecewise nature of the function was better understood this year, although some candidates still combined the two parts of $f(x)$ to give one function that covered the entire range.
- Q.3** This question was well attempted by the majority of candidates. There were no consistently common errors, other than failing to combine classes. It would be preferable to see hypotheses appearing at the beginning of the hypothesis test, rather than near the end, but they were still credited wherever they were seen.
- Q.4** This was the best performing question on the paper. The vast majority of candidates were able to calculate the Pearson’s product moment correlation coefficient and the linear regression line. Good attempts were given for the parts involving interpretation.
- Q.5** This was the second best performing question on the paper. The majority of candidates scored well in parts (a) and (b). In part (c), candidates’ comments should have made reference to the tables on pages 16 and 17, i.e. they should have considered the chi-squared contributions along with the observed and expected frequencies, not simply the observed frequencies. The more depth of detail, particularly in context, given in a response, the more likely it is to be credited with marks.
- Q.6** This was the most poorly answered question on the paper. Just over 5% of candidates did not attempt this question. There were many and varying errors. Candidates struggled with finding the values for the profit. Many failed to take into account the cost of making the unsold cakes when the number of cakes sold was 5, 6 or 7. This led to values of £200, £240, £280 and £320 for the profit.

Many candidates were completely unable to engage with a probability distribution and of those that did, many also struggled with assigning values of p , $2p$, and $0.7 - 3p$ to the number of cakes sold or the profit. Others thought it was a Poisson distribution; these candidates, of course, did not earn any credit. There were several fully correct solutions, which was always a pleasure to see.

FURTHER MATHEMATICS

GCE

Summer 2024

AS UNIT 3 FURTHER MECHANICS A

Overview of the Unit

The paper was very well received and many high scoring scripts with exemplar responses were seen. The paper appeared to be accessible to almost all candidates, with very few marks that were only obtainable by the most able candidates.

Attempt rates were consistently high, supporting the fact that sufficient time was available to complete the paper. The pattern observed in the facility factors – 77% on Q1, 75% on Q2, 67% on Q3, and ending with 51% on Q7 – suggests that the earlier questions in the paper were highly accessible to candidates, and this will have contributed to the overall good performance of this paper. This also reinforces the fact that this was a much more accessible paper than that of Summer 2023.

Questions on the following topics were well answered:

- Momentum and impulse for one-dimensional collisions (Q1)
- Hooke's law and conservation of energy (Q2)
- Calculation of work done in a vector setting (Q3)
- Circular motion for a conical pendulum (Q4)

Some candidates had difficulty with the following topics:

- Recognising when to use the scalar product to deal with perpendicular vectors (Q5(b))
- Using the power equation in conjunction with a combination of forces on an inclined plane (Q6)
- Understanding and interpreting the direction of forces in a rigid rod when an attached particle is moving in a vertical circle (Q7(c))

Areas for improvement include:

- The use of exact values from calculators, to avoid loss of accuracy due to premature approximation. Also, candidates should be prepared to work in terms of g .
- Use of diagrams. Many candidates remain reluctant to draw a simple sketch that could enhance their understanding of the question. Also, with the introduction of question-and-answer booklets this series, candidates could simply annotate the diagrams that are provided in the question (Q2, Q4, Q7).
- Explanations and signposting in solutions.

Comments on individual questions/sections

- Q.1** This was the most successful question on the paper. It was encouraging to see candidates sketching a diagram before embarking on the numerical calculations. Candidates who used the ratio method to find e , the coefficient of restitution, were less successful, as sign errors were much more common.

The most notable misconception was in part (c)(i), where candidates were not aware that 'coalesce' implies that the coefficient of restitution is zero. Many candidates chose to write $e = 1$. Despite this, most candidates who made this error correctly determined the combined speed in (ii). Disappointingly, very few candidates provided helpful signposting in their solutions, such as 'Using Conservation of Momentum' and 'Using Restitution'.

Q.2 Part (a) provided a gentle start to the question. In part (b), almost all candidates correctly identified that conservation of energy was required with three energy forms. However, many candidates did not consider the two required terms of elastic energy in their resulting equation. Further issues stemmed from not stating a clear reference point for potential energy. A simple statement such as, 'taking $PE = 0$ at A ', would certainly help to eradicate some of these errors. The complexity of the problem could have been mitigated by taking a sensible reference point. For example, working relative to the lowest point that the mass reaches only requires one potential energy term, whereas working relative to A requires two terms.

Q.4 This question did not have the familiar scaffolding often seen in previous series. Nevertheless, it was extremely well answered, demonstrating that candidates have a strong understanding of circular motion in the case of a conical pendulum. However, candidates still remain reluctant to use exact values from their calculators.

Q.5 Part (a) was generally well answered, with the majority of candidates using Newton's second law, before integrating to find the velocity.

In part (b), almost all candidates understood how to calculate the dot product of two vectors, but solutions often contained careless errors, possibly due to one of the vectors not having a \mathbf{j} component.

Q.6 The most successful candidates approached this question by drawing two separate diagrams: one for 'up the slope' and another for 'down the slope'. Many candidates did not take account of the deceleration whilst moving down the slope. Disappointingly, a significant number of candidates used a rounded value of the acceleration to calculate the power, leading to inaccuracy in the final result.

Q.7 Overall, this vertical circle question was the least successful question on the paper. Very few candidates managed to achieve full marks, mainly due to difficulty in interpreting the direction of forces in the rigid rod. Many candidates incorrectly stated that the rod was exerting a thrust when $T > 0$. The most successful candidates considered a simple sketch of $y = \cos \theta$ to assist with this problem.

FURTHER MATHEMATICS

GCE

Summer 2024

A2 UNIT 4 FURTHER PURE MATHEMATICS B

Overview of the Unit

The candidates performed consistently well on this paper and there were some excellent scripts seen. However, as in previous series, poor algebraic skills were apparent and often proved costly. Unfortunately, candidates often seemed unready to use skills from AS/A2 Mathematics in this Further Mathematics paper, such as completing the square and differentiating trigonometric functions by using the chain rule. Furthermore, candidates also seemed unready to consider the most efficient method to answer a question, often completing unnecessary rearrangement of expressions.

Questions on the following topics were well answered:

- Coupled first order differential equations (Q10)
- Solving three linear simultaneous equations using matrices (Q6)
- Roots of a complex number (Q1)

Some candidates had difficulty with the following content:

- Calculus of hyperbolic functions (Q8, Q5b)
- General solution of trigonometric equations (Q9)

Areas for improvement:

- Algebraic manipulation
- Familiarisation with the Formula Booklet in order to make better use of it in an exam
- Recall of knowledge, skills and understanding from AS/A2 Mathematics, which is an expectation for this unit

Comments on individual questions/sections

- Q.1** Part (a) was answered well by many candidates, though not all could calculate the modulus and argument correctly. However, part (b) was less successful, with many candidates going no further than stating the roots as coordinates. Many candidates seemed unaware that the roots, when connected, formed an equilateral triangle and so attempted other methods to find the required area, including finding the area of a rectangle and subtracting three right-angled triangles. A minority of candidates used $\frac{1}{2}ab \sin C$, with others preferring to use alternative methods, including Pythagoras' Theorem to calculate the lengths for $\frac{1}{2} \times \text{base} \times \text{height}$.

- Q.2** The majority of candidates used the Formula Booklet expansion of $\cosh x$ effectively to gain full marks in part (a), although some careless algebraic errors were seen, such as $\left(\frac{x}{2}\right)^2 = \frac{x^2}{2}$. In part (b), candidates often gained three out of the five marks available – they correctly obtained the required quartic equation, but did not show any method to solve this and were consequently penalised. However, they often chose the correct value for x and gained the final mark. Part (c) was often disappointing, as candidates were not sufficiently precise with the limits used, failing to appreciate that the two integrals had different limits.
- Q.3** This question was well-answered by the majority of candidates. However, a common error was not dividing 5 by $\cos x$ at the outset, which proved costly later. Other errors included not being able to simplify $\frac{5}{\cos^2 x}$ into a form that could be integrated, as well as not being able to integrate $4 \sin x \cos x$ or a related form.
- Q.4** This question often began well in part (a), but was less successful in part (b). Often, candidates were able to set up the workings for part (b) correctly and used an identity correctly for $-24 \cos^2 \theta$, but candidates seemed unaware of the link with part (a) to obtain an integrable form for $16 \cos^4 \theta$. Candidates often used $(\cos^2 \theta)^2$ to attempt to reach a form to be integrated, but algebraic errors were seen regularly. In part (c), candidates performed fairly well; however, a minority were ready to differentiate $4 \cos^3 \theta$, preferring to use various identities to change this. Those who did so correctly were able to access the remaining marks, but errors were often seen, restricting the marks that could be earned.
- Q.5** Part (a) was a highlight of the paper, with few errors in the decomposition into partial fractions. However, some errors were seen in the integration, as some candidates seemed unaware of the need to split the term $\frac{-3x-1}{x^2+1}$. Unfortunately, part (b) was disappointing, but both methods given in the mark scheme were seen in equal measure. However, many candidates seemed unable to recognise the need for a suitable substitution and, therefore, made little progress.
- Q.6** This question was another highlight of the paper, particularly part (b), with all methods given in the mark scheme seen and the correct answer obtained regularly. However, in part (a), candidates were often unable to give the required geometric interpretation in sufficient detail to earn the two marks available.
- Q.7** Both (i) and (ii) in part (a) proved successful for many candidates. However, disappointingly, errors were often seen when completing the square. Part (b) was less successful. Some candidates failed to recognise that the numerator was a derivative of the denominator, whilst some of those who reached $\ln|4e^{-2x} - 5|$ were unable to work with the limit of infinity. On many occasions, candidates were penalised for incorrectly using brackets in the logarithmic terms, as they conveniently ignored the negative sign to reach an answer.
- Q.8** In this question, candidates often gained 4 marks in part (a), losing the mark for justifying their choice of the positive square root in both methods given in the mark scheme. In part (b), each method given in the mark scheme was seen regularly, but, in each case, careless errors proved costly. Furthermore, candidates regularly divided through by e^x , or a similar term, without justifying why this was possible, losing an accuracy mark. Most disappointing were those candidates who incorrectly rearranged the equation in the question, with no marks available following this.

- Q.9** This question was interesting in that there was little pattern to the responses. Some candidates recognised the need for summation and double-angle formulae and succinctly reached the correct solutions. Other candidates seemed to go round in circles without much progress being made. Those candidates who successfully reached the correct equation $2 \sin 4\theta \cos 2\theta = 2 \cos 2\theta$ often continued to gain full credit.
- Q.10** This question was a highpoint for many candidates, with the majority of candidates gaining double-digit marks. In part (a), candidates' responses were split fairly evenly between the two methods given in the mark scheme, and both approaches were equally successful. The vast majority of candidates were able to use the answer given in part (a) to successfully answer part (b). However, some careless arithmetic errors proved costly for some candidates.

FURTHER MATHEMATICS

GCE

Summer 2024

A2 UNIT 5 FURTHER STATISTICS B

Overview of the Unit

The standard of responses this year was considerably better than last year, with many candidates scoring 60 marks or more. Candidates were well equipped, and appropriately prepared, for the rigour of the paper, with excellent responses seen for all questions. Questions 1 and 2, assessing confidence intervals and the Wilcoxon test respectively, were very well answered. Many candidates lost marks on the parts of questions that required providing explanations. The questions involving reverse calculations – e.g. Q4(c) where candidates had to find n , and Q7(d) where candidates had to find σ – proved to be the most challenging questions.

Questions on the following topics were well answered:

- Wilcoxon signed-rank test (Q2)
- Confidence intervals for the mean of a normal distribution (Q1)
- Mann-Whitney U test (Q6)

Some candidates had difficulty with the following content:

- Confidence intervals for the difference between the means of two normal distributions (Q4)
- Reverse calculations – Q4c where candidates had to find n , Q7d where candidates had to find σ

Areas for improvement:

- More depth in explanations, justifications and interpretations of results, for questions set in context
- Being able to extract the necessary information in a question set in a non-standard format, in order to translate it into the relevant mathematical processes

Comments on individual questions/sections

- Q.1** Overall, this was a very well answered question. Fewer candidates than expected used the student- t distribution. The vast majority were able to answer parts (a) and (b) with very little trouble. In part (c)(ii), several candidates stated that 'only 95% of confidence intervals contained the true mean, so this could be one of the 5% that did not contain the true mean'. This is true; however, since the mean was so far outside the confidence interval, this did not earn any credit.
- Q.2** This was the best performing question on the paper. The vast majority of candidates were able to score well on this question. Both worded and symbolic hypotheses were accepted, but candidates had to use the word median, mean or average in hypotheses that were expressed in words.
- Q.3** This question was also well attempted by the majority of candidates. Calculating the confidence interval was fairly standard, with only a minority of candidates using the incorrect z value or estimated standard error.

- Q.4** This was the most poorly answered question on the paper. The hypotheses were generally correct. Many candidates found themselves in difficulty once they had calculated the standard error of the difference in means. Of those who continued, some candidates disregarded the two-tailed nature of the test, as expected.

The biggest difficulties came in part (c). The first method mark was for showing the working to calculate the standard error for the difference in means and using 3 as the difference of means. Of the candidates who recognised that this was the correct method, only a small number were able to continue. Another common error was to use 0.01 instead of 0.005, leading to an answer of $n = 99$ or $n = 100$.

- Q.5** This was a long question with potential for numerous errors. Part (a)(i) was generally very well answered, with only poor notation for $E(U)$ or the lack of limits that let candidates down. In (a)(ii), many candidates were only able to progress to calculating $\text{Var}(X) = \frac{3\alpha^2}{80}$. Others were able to calculate $\text{Var}(U)$. Only a minority of candidates considered the standard error and only the most able were able to state $n = 15$. A common incorrect answer at this stage was $n = \frac{1}{15}$.

In part (b) a common error was to subtract $\frac{16}{9}\text{Var}(\bar{X})$, as well as stating that $\text{Var}(U)$ was the better estimator, rather than U .

- Q.6** Overall, this question was very well answered. The main difficulty appeared to be stating the hypotheses.

- Q.7** Parts (a) and (b) were generally very well answered. Candidates were able to standardise in part (a) and use -1.282 correctly, although some omitted the negative sign which led to an incorrect answer. Common errors for part (b) included not dividing the standard deviation by 8, or multiplying both the mean and standard deviation by 8, leading to $Y \sim N(160.8, 9.6)$.

In part (c), many candidates correctly multiplied the variances by 3 before adding them, although almost as many candidates incorrectly multiplied by 3^2 .

FURTHER MATHEMATICS

GCE

Summer 2024

A2 UNIT 6 FURTHER MECHANICS B

Overview of the Unit

The paper was very well received and many high scoring scripts with exemplar responses were seen. The paper appeared to be accessible to almost all candidates, with very few marks that were only obtainable by the most able candidates.

Attempt rates were consistently high, supporting the fact that sufficient time was available to complete the paper. The pattern observed in the facility factors – over 65% on Q1-Q3 and ending with 55% on Q7 – suggests that the earlier questions in the paper were highly accessible to candidates, and this will have contributed to the overall good performance of this paper. The Summer 2024 paper was much more accessible than that of Summer 2023.

Questions on the following topics were well answered:

- Momentum and impulse for collisions using 2D vectors (Q1)
- Forming and solving differential equations (Q2)
- Moments and centre of mass for a 2D composite shape using semi-circles (Q3)

Some candidates had difficulty with the following topics:

- Calculating the angle of deflection using either basic trigonometry or the scalar product result (Q1(c))
- Application of the appropriate displacement formula for Simple Harmonic Motion (Q4(c))
- Deriving a given centre of mass using volume of revolution (Q6(a))
- Using moments and centre of mass for a 3D composite shape in context (Q6(b))

Areas for improvement include:

- The use of exact values from calculators, to avoid loss of accuracy due to premature approximation. Also, candidates should be prepared to work in terms of g , where possible.
- Use of diagrams. Many candidates remain reluctant to draw a simple sketch that could enhance their understanding of the question. Also, with the introduction of question-and-answer booklets this series, candidates could simply annotate the diagrams that are provided in the question.
- Explanations and signposting in solutions.

Comments on individual questions/sections

Q.1 Candidates' performance in 2D vector collision questions continues to improve and, consequently, many high scoring responses were seen. This question on this topic was more accessible in this series, than in previous series. However, several misconceptions remain. In part (b), restitution was often erroneously applied to whole vectors, for example,

$$e = \frac{(6\mathbf{i} + \mathbf{j}) - (-4\mathbf{i} - 5\mathbf{j})}{(-4\mathbf{i} + 7\mathbf{j}) - (6\mathbf{i} - 3\mathbf{j})}$$

Consequently, some candidates had to deal with much more demanding, and often meaningless, equations. The most successful candidates annotated the diagram provided in the question with 'before' and 'after' vectors.

For part (c), only the most able candidates who opted to sketch a simple diagram managed to achieve full marks. The majority of correct solutions considered the angle of deflection using basic trigonometry. The scalar product result was seldom used.

- Q.2** This extended question on differential equations was very successful. Notably, only a small number of candidates used $t + c = \frac{9}{3\sqrt{g}} \tanh^{-1}\left(\frac{v}{3\sqrt{g}}\right)$, possibly since the 'log result' appears first in the Formula Booklet.
- Q.3** This was the most successful question on the paper. Some candidates had trouble interpreting the requirements of part (b), which was a synoptic moments question.
- Q.4** Candidates have always demonstrated a strong understanding of Simple Harmonic Motion and this question, which was set in context, was no exception. For part (c), scoring 3 marks out of 5 was common, as many candidates did not recognise that the given scenario needed to be split into two separate cases.
- Q.5** Candidates continue to be adept at answering questions involving rigid bodies and hence many fully correct solutions to part (a) were seen. Candidates were less successful in securing full marks in part (b), due to incorrectly applied inequalities. The most successful candidates used equality here.
- Q.6** This was the least accessible question on the paper, yet, on average, candidates secured over 55% of marks available for the question. In part (a), many candidates needlessly derived the equation for the volume of the region, thus wasting valuable examination time. This was disappointing since there was an exemplar in the Unit 6 Sample Assessment Materials, and a question of a similar nature was set in Summer 2019. Furthermore, some responses were ambiguous, as it was not clear whether the π 's had been cancelled – for example,

$$\bar{x} = \frac{\int_0^b xy^2 dx}{\frac{2}{3}a^2b}$$

In part (b), the least effective solutions were where candidates had not constructed a table detailing the masses of the shapes, together with their corresponding distance from a fixed point.

Two approaches were seen: one working relative to the ground and one working relative to the top of the pot. However, candidates were reluctant to state this. As a result, many candidates' solutions became convoluted, as they appeared to work with both reference points. In a small number of responses, the 'tree' and 'pot' were treated as though they had equal density.

Supporting you

Useful contacts and links

Our friendly subject team is on hand to support you between 8.30am and 5.00pm, Monday to Friday.

Tel: 029 2240 4251

Email: mathematics@wjec.co.uk

Qualification webpage: <https://www.wjec.co.uk/qualifications/mathematics-a-as-level/>

See other useful contacts here: [Useful Contacts | WJEC](#)

CPD Training / Professional Learning

Access our popular, free online CPD/PL courses to receive exam feedback and put questions to our subject team, and attend one of our face-to-face events, focused on enhancing teaching and learning, providing practical classroom ideas and developing understanding of marking and assessment.

Please find details for all our courses here: <https://www.wjec.co.uk/home/professional-learning/>

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