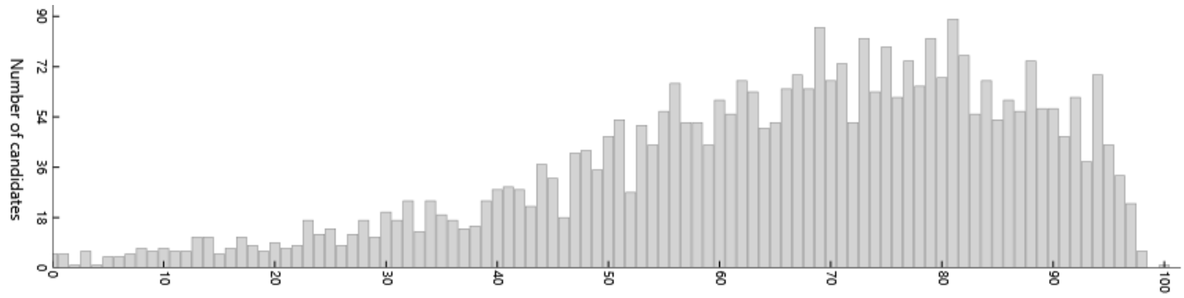
Government of **Western Australia**
School Curriculum and Standards Authority

2022 ATAR course examination report:
Mathematics Methods

Year	Number who sat	Number of absentees
2022	3590	65
2021	3997	55
2020	4094	60
2019	4050	60

The number of candidates sitting and the number attempting each section of the examination can differ as a result of non-attempts across sections of the examination.

Examination score distribution–Written



Summary
The examination consisted of two sections, Section One: Calculator-free and Section Two: Calculator-assumed. Most candidates were able to access all of the questions. The mean for Section One was higher than the mean for Section Two, although the difference between the means was less than it was for the 2021 examination. The mean score of 65.43% was 2.39% lower than in 2021.

Attempted by 3588 candidates	Mean 65.43%	Max 100.00%	Min 0.00%

Section means were:			
Section One: Calculator-free	Mean 66.34%		
Attempted by 3588 candidates	Mean 23.22(/35)	Max 35.00	Min 0.00
Section Two: Calculator-assumed	Mean 64.94%		
Attempted by 3583 candidates	Mean 42.21(/65)	Max 65.00	Min 0.00

General comments
Candidates generally performed well in the examination. There appeared to be a few specific areas of content weakness, however candidates did well across most questions requiring a calculation to be performed. In general, questions requiring a written response, and/or a conclusion to be drawn, were poorly answered.

Advice for candidates
- Include appropriate units in responses to questions involving a context/application.
- Ensure that your calculator is set to radian mode when dealing with trigonometric functions.

- Ensure you reflect on outputs in order to recognise obvious errors. For example, if you use your calculator to differentiate $f(x)=\sin(x)$ and it returns $f'(x)=\dfrac{\pi}{180\cos(x)}$ or $f'(x)=0.017\cos(x)$, then it should be obvious that something has gone wrong. If you recognise that the answer does not make sense, if necessary check the settings of the calculator (degrees instead of radians) and correct this.
- Ensure when identifying sources of sampling bias you do not combine multiple sources into one. For example, time and location are two separate sources of sampling bias.
- Ensure you do not skip key steps in questions asking for you to 'show' a result.
- In the Calculator-assumed section, ensure you state equations that you are solving and provide key outputs from your calculator (e.g. derivatives) to make your solution procedure clear to markers.

Advice for teachers

- Ensure that students are familiar with the application of the fundamental theorem of calculus in combination with the chain rule (syllabus items 3.2.16 and 3.1.8).
- Focus on the interpretation of context/application-based questions, both in terms of students' ability to understand the question and identify/utilise key pieces of information, and in terms of their ability to draw conclusions from their calculations.
- Focus on clarity and conciseness in explanations.
- Encourage students to reflect on output from their calculator to identify obvious errors.

Comments on specific sections and questions

Section One: Calculator-free (54 Marks)
Candidates generally performed well in this section, with the majority of questions answered by most of the candidates. Some notable areas of weakness related to the fundamental theorem of calculus, the application of the inverse relationship between exponentials and logs, showing a given result, and interpretation of/drawing a conclusion from calculations.

Question 1 attempted by 3582 candidates Mean 6.36(/9) Max 9 Min 0
Part (a) was answered well, with most candidates demonstrating they understood that the second derivative was the rate of change of the first derivative. In part (b), most candidates generally recognised that the integral yielded a $\ln(g(x))$ form, with a common error being an inability to substitute $f(1)=\ln(32)$ and using log laws to simplify. In part (c), a large number of candidates were unable to apply the fundamental theorem of calculus correctly.

Question 2 attempted by 3552 candidates Mean 4.03(/6) Max 6 Min 0
Part (a) was generally well completed, with the most common error being a lack of understanding of signed area. In part (b), candidates who separated the integral into two parts were generally more successful than those who attempted to translate the graph.

Question 3 attempted by 3580 candidates Mean 8.14(/11) Max 11 Min 0
Part (a) was answered well with the main error being missing units. Part (b) was answered correctly by most candidates, with the main errors being arithmetic. In part (c), most candidates recognised the need for conditional probability, however, some were confused by the application. In part (d), most candidates determined the Uniform Toys probability correctly, with the most common error being the interpretation to determine which company should be chosen. In part (e), most candidates gave the correct parameters, but some incorrectly identified the distribution as normal instead of binomial. In part (f), most candidates substituted correctly into the formula, but very few were able to evaluate the answer as a fraction.

Question 4 attempted by 3572 candidates Mean 7.92(/12) Max 12 Min 0
Part (a)(i) was answered well, with most candidates reading the graph correctly. Part (a)(ii) proved to be more challenging, with most candidates able to determine that $\log_2(x) = 1.4$ but unable to progress further. Part (b) was answered well by candidates who recognised the vertical translation by 3, with mixed success for candidates who tried to fit points to an equation. Part (c)(i) was answered well using log laws, while in part (d) candidates generally graphed the shape well but some did not demonstrate sufficient accuracy in indicating key points such as $(3,1)$ and $(5,2)$.

Question 5 attempted by 3523 candidates Mean 3.10(/5) Max 5 Min 0
Most candidates were able to plot the intercept and minimum turning point, but many did not recognise a horizontal inflection point as an option for a stationary point. Very few candidates achieved full marks, with many incorrect variations plotted.

Question 6 attempted by 3549 candidates Mean 6.27(/11) Max 11 Min 0
Part (a)(i) was well-attempted with most candidates recognising and using the product rule correctly. In part (a)(ii), many candidates applied the concept of linearity and integrated trigonometric functions correctly, however, few candidates explicitly showed the application of the fundamental theorem of calculus and therefore did not achieve full marks. In part (b)(i), many candidates wrote a correct integral (including limits) but used an incorrect antiderivative. In part (b)(ii), as in part (b)(i), candidates stated the correct integral but did not identify the result from part (a)(ii) as the antiderivative.

Section Two: Calculator-assumed (100 Marks)
Candidates generally performed well in this section. The main areas of weakness were in the interpretation of questions and calculations in the contexts provided. Questions requiring candidates to provide a written response (reason, interpret, explain) were consistently answered poorly. Many candidates demonstrated that they did not reflect on the output of their calculator and therefore missed opportunities to identify obvious errors (e.g. calculator in degrees mode). Most candidates did well in questions relating to standard calculations.

Question 7 attempted by 3442 candidates Mean 6.19(/10) Max 10 Min 0
Part (a)(i) was answered well. Some common errors related to candidates likely having their calculator in 'degree' mode, and/or solving $D(x) = 0$ instead of $D(x) = -2$. Most candidates were able to follow through with their integral in part (a)(ii). Part (c) was well answered with good use of the calculator and the second derivative test to show a maximum. Candidates in 'degree' mode did not appear to recognise the incorrect derivative expressions provided by their calculator.

Question 8 attempted by 3493 candidates Mean 5.09(/10) Max 10 Min 0
In part (a) most candidates were able to accurately calculate the mean, however, the integral for the variance was poorly evaluated using the calculator. Some candidates did not include units, despite the inclusion of units being explicitly mentioned in the question. Part (b) was answered poorly. A vast majority of candidates appeared not to understand what the question was asking. Most candidates were able to solve for the height in part (c), but did not show the adequate working required to obtain full marks.

Question 9 attempted by 3541 candidates Mean 8.67(/14) Max 14 Min 0
Part (a) was answered well with parameters stated. Candidates used their calculator well in part (b), with most stating at least one correct probability. Part (c) was answered correctly by many candidates, but a lack of complete working meant that many did not achieve full marks. Part (d) was answered well by the majority of candidates. Part (e) was answered poorly, with a lack of clear working and use of algebra. The idea of expected value was generally not recognised in this question. Many candidates correctly recognised that no

change occurred in part (f), however, did not achieve full marks due to a lack of clarity in the reason provided.

Question 10 attempted by 3537 candidates Mean 6.72(/9) Max 9 Min 0
In part (a), many candidates equated the displacement to zero. A common error was that candidates stated $t = 0$ as the solution rather than the first time of return. Most candidates recognised velocity as the derivative of displacement and used their calculator correctly. Some responses showed that the calculator was incorrectly in 'degree' mode. In part (c), many candidates solved for when the velocity was zero. However, they were then unable to substitute that value correctly to determine the displacement, or they were unaware of what the question was asking. Part (d) was answered well, with the most common error being a lack of units.

Question 11 attempted by 3548 candidates Mean 8.86(/11) Max 11 Min 0
Part (a) was well answered with most candidates using differentiation. Part (b) was also well answered using calculus and the calculator, however most candidates forgot to verify that they had found a maximum (e.g. using the second derivative test). Part (d) was well answered by equating the displacement to 100, with a common error of not eliminating the second solution.

Question 12 attempted by 3522 candidates Mean 10.18(/16) Max 16 Min 0
Part (a) was generally well done with the common error being not rounding to three decimal places. Part (b) was answered correctly by most candidates. Part (c) was not well answered with many candidates unable to identify the correct distribution or unable to calculate the parameters. Part (d) was well answered with good use of the calculator and presentation of appropriate working. In part (e), most candidates stated increased sample size as a method, but only a few recognised lowering the level of confidence. In part (f), the most common error was not using $\hat{p} = 0.5$ to determine the maximum margin of error, but the rest of the calculation was generally clearly shown. Part (g) was not well answered with many candidates unable to conclude that there was not enough evidence to reject the claim, despite stating that the confidence interval contained the claimed proportion.

Question 13 attempted by 3487 candidates Mean 8.52(/12) Max 12 Min 0
In part (a), most candidates identified the distribution as normal but were unable to calculate the variance. In part (b), most candidates were able to identify sources of bias, but the explanations often lacked essential detail and/or lacked logical flow. In order to explain a source of sampling bias, it must be explained how a sub-group of the population is likely to be either under-represented or over-represented in a sample because of that particular bias source. Simply saying, for example, 'the sample was taken between 9 am and 10 am and so does not represent the entire population' is not an explanation. An example of a solid explanation was 'the sample was taken between 9 am and 10 am which means that people who work in 9 to 5 jobs are less likely to be selected in the sample' as it explained how the bias was introduced. Issues such as 'leading questions' were not sources of sampling bias, but a source of bias in the study design. Sample bias related solely to the process of selecting a sample. Part (c) was answered well with a clear use of formula. Part (d) was answered well with a good use of the calculator to convert the z-score to a confidence percentage.

Question 14 attempted by 3457 candidates Mean 7.61(/13) Max 13 Min 0
Part (a) was answered very well with the main error being not writing the answer as a percentage. Part (b) was also well answered with good use of calculator. In part (c) candidates struggled to derive an expression that was linear in x, however most recognised that the graph was a straight line. In part (d) the most common error was forgetting the negative sign of the gradient. Part (e)(i) was discriminating with many candidates using

natural logs instead of base 10 logs. Part (e)(ii) was not well attempted, and those successful at finding the rule could not explain the result in terms of the change in intensity.

Question 15 attempted by 3357 candidates Mean 3.11(/5) Max 5 Min 0
In part (a) most candidates recognised that the fundamental theorem of calculus was needed but failed to use the chain rule and hence missed the factor of π. With follow through, most candidates were able to use the increments formula to achieve full marks in part (b).