



Mathematical Methods 2025 v1.3

IA3: Sample assessment instrument

This sample has been compiled by the QCAA to assist and support teachers in planning and developing assessment instruments for individual school settings.

Student name	sample only
Student number	sample only
Teacher	sample only
Issued	sample only
Due date	sample only

Marking summary

Criterion	Marks allocated	Provisional marks
Foundational knowledge and problem-solving	15	
Overall	15	

Conditions

Technique	Examination — short response
Unit	Unit 4: Further calculus, trigonometry and statistics
Topic/s	Topic 1: Further integration Topic 3: Continuous random variables and the normal distribution Topic 4: Sampling and proportions
Time	90 minutes + 5 minutes perusal
Seen / unseen	Unseen
Other	The QCAA Mathematical Methods formula book must be provided. Notes and other resources are not permitted.

Instructions

- Show all working in the spaces provided.
- Write responses using black or blue pen.

Paper 1: Technology-free

- 2 minutes perusal time, 35 minutes working time
- No calculator or technology of any type is permitted.

Paper 2: Technology-active

- 3 minutes perusal time, 55 minutes working time
- Use of a non-CAS graphics calculator is permitted. A scientific calculator may also be used.

Paper 1: Technology-free

Total marks: 20

Simple familiar — total 12 marks

Question 1 (2 marks)

In a box of 100 old coins, there are 12 that originate from the 19th century.

In a random sample of 20 coins, 4 are found to be from the 19th century.

- a. Determine the population proportion p of the 19th century coins in the box.
- b. Determine the sample proportion \hat{p} of the 19th century coins in the box.

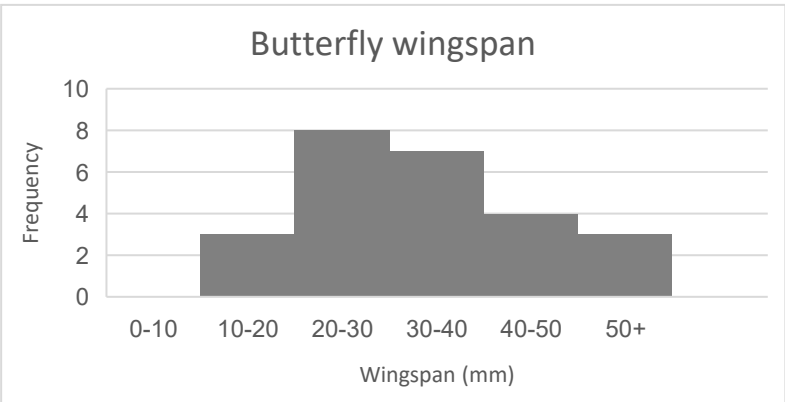
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Question 2 (3 marks)

Let X be the wingspan, measured in mm, of a colony of butterflies. The following histogram represents the summary of the wingspan measurements from the random sample of 25 butterflies.



Use the histogram to estimate:

- a. $P(20 \leq X \leq 30)$
- b. $P(X \geq 30)$

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Question 3 (4 marks)

Evaluate the following definite integrals.

a. $\int_1^4 6\sqrt{x} \, dx$

b. $\int_1^3 e^{2x} - \frac{1}{x} \, dx$

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Question 4 (3 marks)

Determine the area enclosed by the curve $f(x) = 6x - 3x^2$ and the x – axis.

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Complex familiar — total 4 marks

Question 5 (4 marks)

Let X be a continuous random variable with probability density function given as:

$$p(x) = \begin{cases} kx, & 0 \leq x \leq 2 \\ 0, & \text{otherwise} \end{cases}$$

Determine the variance of the variable X .

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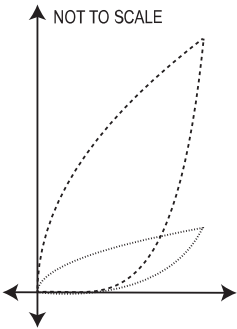
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Complex unfamiliar — total 4 marks

Question 6 (4 marks)

A student has lost their mathematics work due to a corrupt computer file. They still have the sketch of the design they were creating and remembered that in the design:

- to produce the smaller leaf, they used functions x^n and \sqrt{x}
- to produce the larger leaf, they adjusted the functions by increasing the power of the x^n by 1, as well as multiplying both functions by the same coefficient k
- the area of the small leaf was $\frac{7}{15}$, while the area of the large leaf was 2.



Determine the two functions used to design the larger leaf.

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Paper 2: Technology-active

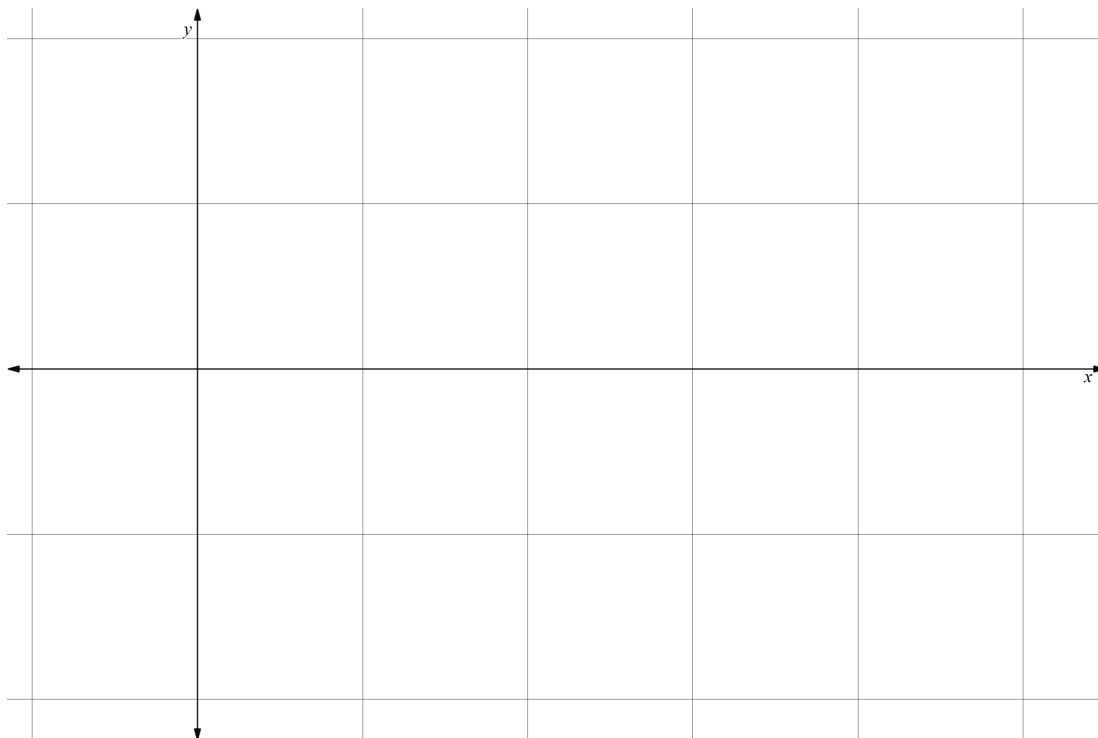
Total marks: 30

Simple familiar — total 18 marks

Question 7 (4 marks)

Consider the function $f(x) = \ln(x)$.

- Sketch the graph of the function $y = f(x)$ on the set of axes provided below and shade the area implied by the $\int_2^4 f(x) dx$.
- Use the trapezoidal rule, with 4 strips, to determine an approximation for the area identified in Question 7a. Show all substitutions made into the rule.
- Evaluate the reasonableness of your result by comparing your approximation with the value of the definite integral.



A series of 20 horizontal dotted lines spanning the width of the page, intended for handwritten notes or answers.

Question 8 (6 marks)

Billie surveys ten random samples each of n students with the question: 'Will Queensland win the next State of Origin?'

- a. Describe one way Billie can ensure randomness in the samples.

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The sample proportions of the students who replied 'yes' is given in the table below. The standard deviation of the sample proportions is 0.05.

Sample	1	2	3	4	5	6	7	8	9	10
\hat{p}	0.719	0.734	0.746	0.778	0.804	0.829	0.835	0.845	0.848	0.862

Determine:

- b. the mean of the sample proportions.
- c. the sample size used in each survey.

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Question 8 continued (6 marks)

To evaluate the standard normality of the distribution of sample proportions, Billie calculates the standardised value of each sample proportion using the rule $\frac{\hat{p} - p}{\sqrt{\hat{p}(1 - \hat{p})/n}}$.

Sample	1	2	3	4	5	6	7	8	9	10
\hat{p}	0.719	0.734	0.746	0.778	0.804	0.829	0.835	0.845	0.848	0.862
$\frac{\hat{p} - p}{\sqrt{\hat{p}(1 - \hat{p})/n}}$	-1.44	-1.19	-0.99	-0.42	0.08	0.62	0.75		1.07	1.44

Determine:

- d. the missing value for sample 8
- e. the percentage of samples where the standardised value, $\frac{\hat{p} - p}{\sqrt{\hat{p}(1 - \hat{p})/n}}$, of sample proportions is between -1 and 1.

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Question 9 (4 marks)

Rate of change of a certain population of ants over a 10-month period can be modelled by:

$$\frac{dN}{dt} = 50 \sin\left(\frac{\pi t}{20}\right)$$

where N is the population size and t is the time in months, $0 \leq t \leq 10$.

- a. Determine the change in population during the
 - i. first five months
 - ii. the last five months
- b. Comment on the change of population during this 10-month period.

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Question 10 (4 marks)

Let $X \sim N(50, 6^2)$.

Determine:

- a. $P(X \leq 42)$
- b. $P(45 \leq X \leq 53)$
- c. the value for a given that $P(X > a) = 0.28$.

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Complex familiar — total 6 marks

Question 11 (6 marks)

A two-phase statistical investigation has been performed to estimate the proportion of cars that are electric.

In phase A, a large number of random samples of 30 cars were collected. It was found that the sample proportions of the electric vehicles were normally distributed with a mean of 0.22.

For phase B, the sample size was increased. When compared to phase A, this did not change the mean of the sample proportions, but the standard deviation of the sample proportions reduced by 0.01.

Using the normal approximation, determine the probability that the next random sample in phase B will have less than 8 electric cars. Round your answer to 3 decimal places.

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Complex unfamiliar — total 6 marks

Question 12 (6 marks)

Let X be a continuous random variable representing the marks achieved by students in their Mathematical Methods exam. The probability density function for the variable X is given by:

$$f(x) = \begin{cases} ax^2(100-x), & 0 \leq x \leq 100 \\ 0 & , \text{ otherwise} \end{cases}$$

The passing mark for this exam is 50. The probability that a student will receive an A grade, given that they passed the exam, is equal to $\frac{1}{3}$.

Determine the cut-off mark for an A grade.

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Examination marks summary

Paper 1 (technology-free)	Simple familiar (SF)	Complex familiar (CF)	Complex unfamiliar (CU)
1	2		
2	3		
3	4		
4	3		
5		4	
6			4
Totals	12	4	4

Paper 2 (technology-active)	Simple familiar (SF)	Complex familiar (CF)	Complex unfamiliar (CU)
7	4		
8	6		
9	4		
10	4		
11		6	
12			6
Totals	18	6	6

Combined papers	Simple familiar (SF)	Complex familiar (CF)	Complex unfamiliar (CU)	Across all difficulty levels
Totals	30	10	10	50
Percentage	60%	20%	20%	100%

Instrument-specific marking guide (IA3): Examination — short response (15%)

Foundational knowledge and problem-solving	Cut-off	Marks
The student response has the following characteristics:		
<ul style="list-style-type: none"> consistently correct recall and use of mathematical knowledge; authoritative and accurate communication of mathematical knowledge; astute evaluation of the reasonableness of solutions; use of mathematical reasoning to correctly justify procedures and decisions; and fluent application of mathematical knowledge to solve problems in a comprehensive range of simple familiar, complex familiar and complex unfamiliar situations 	> 93%	15
	> 87%	14
<ul style="list-style-type: none"> correct recall and use of mathematical knowledge; clear communication of mathematical knowledge; considered evaluation of the reasonableness of solutions; use of mathematical reasoning to justify procedures and decisions; and proficient application of mathematical knowledge to solve problems in simple familiar, complex familiar and complex unfamiliar situations 	> 80%	13
	> 73%	12
<ul style="list-style-type: none"> thorough recall and use of mathematical knowledge; communication of mathematical knowledge; evaluation of the reasonableness of solutions; use of mathematical reasoning to justify procedures and decisions; and application of mathematical knowledge to solve problems in simple familiar and complex familiar situations 	> 67%	11
	> 60%	10
<ul style="list-style-type: none"> recall and use of mathematical knowledge; communication of mathematical knowledge; evaluation of the reasonableness of some solutions; some use of mathematical reasoning; and some application of mathematical knowledge to make progress towards solving problems in simple familiar situations 	> 53%	9
	> 47%	8
<ul style="list-style-type: none"> some recall and use of mathematical knowledge; and basic communication of mathematical knowledge 	> 40%	7
	> 33%	6
<ul style="list-style-type: none"> infrequent recall and use of mathematical knowledge; and basic communication of some mathematical knowledge 	> 27%	5
	> 20%	4
<ul style="list-style-type: none"> isolated recall and use of mathematical knowledge; and partial communication of rudimentary mathematical knowledge 	> 13%	3
	> 7%	2
<ul style="list-style-type: none"> isolated and inaccurate recall and use of mathematical knowledge; and disjointed and unclear communication of mathematical knowledge. 	> 0%	1
The student response does not match any of the descriptors above.		0



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