Queensland Government | QCAA Queensland Curriculum & Assessment Authority

Queensland Curriculum and Assessment Authority

Specialist Mathematics 2025 v1.2

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
Exam 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 and statistical inference
Topic/s	Topic 1: Integration techniques Topic 2: Applications of integral calculus Topic 3: Rates of change and differential equations
Time	90 minutes + 5 minutes perusal
Seen / unseen	Unseen
Other	The QCAA Specialist Mathematics 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, 40 minutes working time
- No calculator or technology of any type is permitted.

Paper 2: Technology-active

- 3 minutes perusal time, 50 minutes working time
- Use of a non-CAS graphics calculator is permitted unless an analytical procedure is required. A scientific calculator may also be used.

Paper 1: Technology-free

Total marks: 21

Question 1 (3 marks)

Simple familiar

Use a suitable substitution to determine an antiderivative of the function $f(x) = 2xe^{x^2+3}$.

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Question 2 (3 marks)

Simple familiar

The curve $2x^2 + 3y^2 = 14$ passes through the point $A(1, 2)$. Determine the gradient of the curve at point A.

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Question 3 (5 marks)

Simple familiar (1 + 2 + 2 = 5 marks)

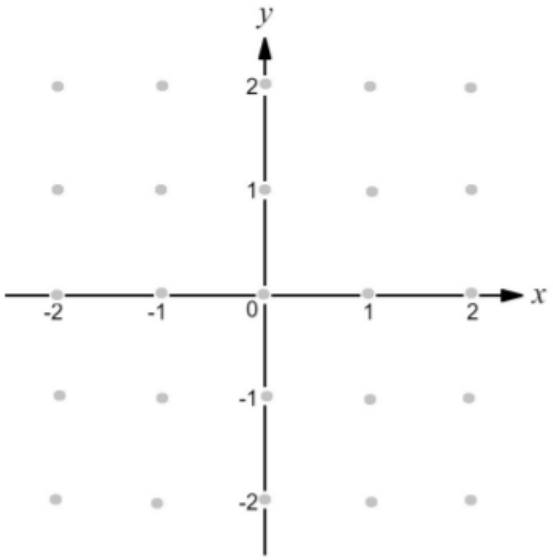
a. Given the differential equation $\frac{dy}{dx} = 1 - y$, complete the table below.

y	2	1	0	−1	−2
$\frac{dy}{dx}$					

Using the grid below:

b. sketch a slope field for the differential equation $\frac{dy}{dx} = 1 - y$ at all points indicated by dots using your results from Question 2a).

c. sketch an appropriate solution curve for $\frac{dy}{dx} = 1 - y$ given that $y = -2$ when $x = -1$.



Question 4 (4 marks)

Simple familiar

A spherical balloon is inflated such that the radius increases at a constant rate of 3 centimetres per minute.

Determine the rate at which the volume is increasing when the radius of the balloon is 5 centimetres. Include suitable units in your answer.

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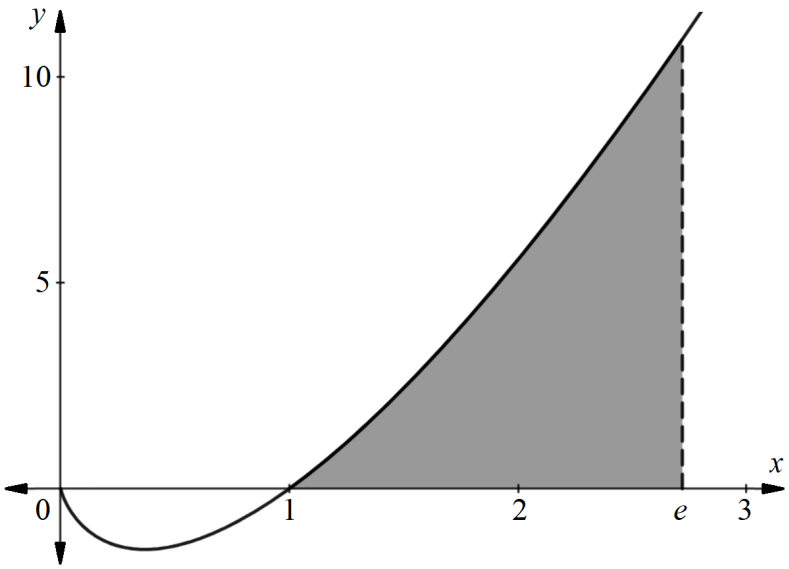
Question 5 (6 marks)

Complex familiar

Determine the shaded area under the curve $y = 4x \ln(x)$ between $x = 1$ and $x = e$ as shown in the diagram.



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Paper 2: Technology-active

Total marks: 29

Question 6 (4 marks)

Simple familiar (2 + 2 = 4 marks)

A random variable X can be modelled by the probability density function $f(x) = 0.04e^{-0.04x}$, $x \geq 0$.

a. Determine $P(5 < X < 10)$

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b. Determine $P(5 < X < 10 | X < 10)$

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Question 7 (4 marks)

Simple familiar

The cross-sectional area of a road cutting is modelled by the area between the x-axis and the function $f(x) = \dfrac{\ln(x + 0.1)}{2.1} - x + 7.1$ for $0 \leq x \leq 8$ metres.

Use Simpson's rule with four strips to determine the approximate area of the cross-section.

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Question 8 (7 marks)

Simple familiar (1 + 4 + 2 = 7 marks)

A volume of solid of revolution is formed by rotating the curve $y = \cos(x)$ between $x = 0$ and $x = \frac{\pi}{4}$ about the x-axis.

a. Express this volume as a definite integral.

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b. Use an analytical procedure to determine the exact value of your result from Question 8a).

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c. Use technology to verify your calculation from Question 8b)

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Question 9 (4 marks)

Complex familiar

Consider the differential equation $\frac{dp}{dt} = \sqrt{4 - p^2}$.

Given that $p = 0.5$ when $t = 0$, determine the value of p when $t = 1$.

Question 10 (4 marks)

Complex unfamiliar

The lifespan (months) of a type-A battery is a random variable T with probability density function

$$f(t) = \begin{cases} \lambda e^{-\lambda t} & , \quad t \geq 0 \\ 0 & , \quad \text{otherwise} \end{cases}$$

where λ is a positive constant.

The lifespan (months) of a type-B battery is a random variable T with probability density function

$$g(t) = \begin{cases} \frac{1}{9} t e^{-\frac{t}{3}} & , \quad t \geq 0 \\ 0 & , \quad \text{otherwise} \end{cases}$$

The expected lifespan of a type-B battery is twice that of the expected lifespan of a type-A battery.

Determine the probability that a randomly chosen type-A battery will work beyond the expected lifespan of the type-B battery.

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Question 11 (6 marks)

Complex unfamiliar

A certain function $y = f(x)$, where $-\frac{\pi}{2} < x < \frac{\pi}{2}$, has a gradient of $\left(y^2 - 11y + 30\right)\sec^2(x)$ and a y- intercept of 4.

Determine the value/s of a such that $f(a) = a$.

Examination marks summary

Paper 1 (technology-free)	Simple familiar (SF)	Complex familiar (CF)	Complex unfamiliar (CU)
1	3		
2	3		
3	5		
4	4		
5		6	
Totals	**15**	**6**	**0**

Paper 2 (technology-active)	Simple familiar (SF)	Complex familiar (CF)	Complex unfamiliar (CU)
6	4		
7	4		
8	7		
9		4	
10			4
11			6
Totals	**15**	**4**	**10**

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:		
• 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
• 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
• 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
• 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
• some recall and use of mathematical knowledge; and basic communication of mathematical knowledge	> 40%	7
	> 33%	6
• infrequent recall and use of mathematical knowledge; and basic communication of some mathematical knowledge	> 27%	5
	> 20%	4
• isolated recall and use of mathematical knowledge; and partial communication of rudimentary mathematical knowledge	> 13%	3
	> 7%	2
• 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