Queensland Curriculum and Assessment Authority

Specialist Mathematics 2025 v1.2

IA2: 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 3: Further complex numbers, proof, vectors and matrices
Topic/s	Topic 1: Further complex numbers Topic 3: Vectors in two and three dimensions Topic 5: Further matrices
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.
- Use of a non-CAS graphics calculator is permitted unless an analytical procedure is required. A scientific calculator may also be used.

Simple familiar — total marks: 30

Question 1 (5 marks)

The position vector for a particle with a parameter t is given by $\boldsymbol{r} = (t+1)\hat{\boldsymbol{i}} + 2t^2\hat{\boldsymbol{j}}$

a. Use an analytic procedure to determine the corresponding Cartesian equation of the path of the particle.

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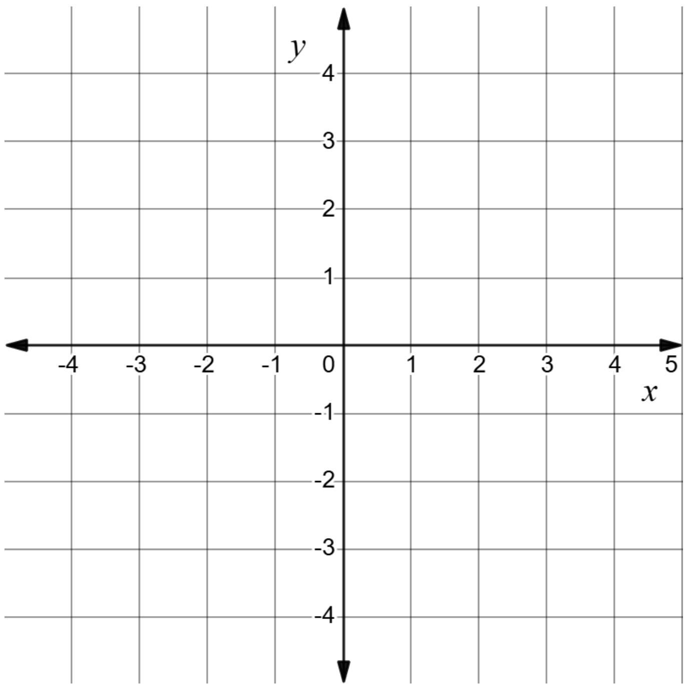
b. Sketch the graph of the path of the particle on the Cartesian plane indicating the turning point and y-intercept.



Question 2 (7 marks)

Consider triangle OAB where O is the origin, A is $(-2,-3, 3)$ and B is $(3, 4,-3)$.

a. Determine $\overrightarrow{AB}$.

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b. Use your result from Question 2a) to determine a vector equation of the line, l, that passes through A and B.

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c. Express line, l, as a Cartesian equation.

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d. Use a vector method to determine the area of triangle OAB.

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Question 3 (6 marks)

Two complex numbers are $z_1 = 2\,\text{cis}\left(\frac{\pi}{3}\right)$ and $z_2 = 4\,\text{cis}\left(\frac{\pi}{4}\right)$.

a. Use an analytic procedure to calculate $\frac{z_1}{z_2}$ leaving your result in simplified polar form.

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b. Consider the statement: $\left(\frac{z_1}{z_2}\right)^6$ is a purely imaginary number.

Use De Moivre's theorem to evaluate the reasonableness of the statement.

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Question 4 (6 marks)

Let $\boldsymbol{A}=\begin{bmatrix}1 & 0 & -1\\ -1 & 1 & 2\\ 3 & 1 & 0\end{bmatrix}$ and $\boldsymbol{B}=\begin{bmatrix}2 & 1 & 0\\ -1 & 2 & 1\\ 0 & 1 & 3\end{bmatrix}$.

a. Calculate $\det(\boldsymbol{B})$.

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b. Explain why $\boldsymbol{B}$ is classified as a non-singular matrix.

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c. Calculate $\boldsymbol{A}^{-1}$.

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Consider the matrix equation $\boldsymbol{XA}=\boldsymbol{B}$ where $\boldsymbol{X}$ is a matrix of dimension 3×3.

d. Use matrix algebra to solve the matrix equation for $\boldsymbol{X}$.

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e. Verify your result from Question 4d)

Question 5 (6 marks)

Consider the polynomial $P(z) = z^3 + (2-6i)z^2 - (9+12i)z - 18$.

a. Show that $z = -2$ is a root of $P(z)$.

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It follows that $P(z) = (z+2)\,Q(z)$.

b. Given $Q(z)$ has the form $z^2 + bz + c$, determine the values of b and c.

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c. Determine the root/s of $Q(z)$.

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d. Use your results to fully factorise $P(z)$.

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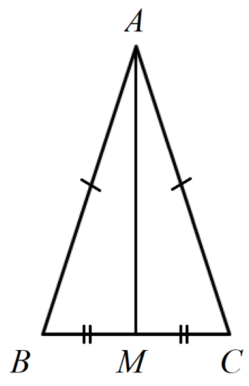
Complex familiar — total marks: 10

Question 6 (5 marks)

Points A, B and C form an isosceles triangle as shown.

Point M is the midpoint of side BC.



Let $\overrightarrow{AB} = \boldsymbol{p}$ and $\overrightarrow{AC} = \boldsymbol{q}$.

Use this information to prove that $\overrightarrow{AM}$ is perpendicular to $\overrightarrow{BC}$.

Question 7 (5 marks)

Consider a system of three linear equations in three variables x, y and z as shown.
Each equation contains a constant value involving λ where $\lambda \neq 0$.

$$x - 2y + 2\lambda z = -5$$
$$-x + y + \lambda^2 z = 2$$
$$2x - 3y + \lambda^3 z = 5$$

Use a Gaussian technique to determine the value/s of λ for which this system of equations has no solutions.

Complex unfamiliar — total marks: 10

Question 8 (5 marks)

The force exerted on a charged particle of magnitude q in an electromagnetic flow can be calculated using the Lorentz relation, which states $\boldsymbol{F} = q\left(\boldsymbol{E} + \boldsymbol{v} \times \boldsymbol{B}\right)$, where $\boldsymbol{F}$ is the force, $\boldsymbol{E}$ is the electric field strength force, $\boldsymbol{v}$ is the velocity of the particle and $\boldsymbol{B}$ is the magnetic force.

The following quantities are constant: $q = 1$ and $\boldsymbol{B} = \begin{pmatrix} 3 \\ -2 \\ 1 \end{pmatrix}$.

The remaining vector quantities have a relationship based on parameters a, b and c such that

$\boldsymbol{v} = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$ and $\boldsymbol{E} = \begin{pmatrix} 2a \\ b \\ 3c \end{pmatrix}$.

Determine the speed of the particle when $\boldsymbol{F} = \begin{pmatrix} -2 \\ -6 \\ 1 \end{pmatrix}$.

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Question 9 (5 marks)

Let w be the complex number that satisfies the following two conditions:

- $w^3 = 1$
- the imaginary component of $w > 0$

The polynomial $P(z) = z^3 + az^2 + bz + c$ has roots at 1, $-w$ and $-\overline{w}$, given $a, b, c \in \square$.

Determine the values of a, b and c.

Examination marks summary

Question number	Simple familiar (SF)	Complex familiar (CF)	Complex unfamiliar (CU)
1	5		
2	7		
3	6		
4	6		
5	6		
6		5	
7		5	
8			5
9			5
Totals	**30**	**10**	**10**
Percentage	**60%**	**20%**	**20%**

Instrument-specific marking guide (IA2): 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