INTUITION EDUCATION

HSC 2026 · PREDICTED PRACTICE PAPER

2026 HSC Mathematics Extension 2

Original practice material — not a NESA paper

Total marks: 100

GENERAL INSTRUCTIONS

- Reading time — 10 minutes
- Working time — 3 hours
- Write using black pen
- Calculators approved by NESA may be used
- A reference sheet is provided at the back of this paper
- For questions in Section II, show relevant mathematical reasoning and/or calculations

Section I — 10 marks (Questions 1–10)
Attempt Questions 1–10. Allow about 15 minutes for this section.

Section II — 90 marks (Questions 11–16)
Attempt Questions 11–16. Allow about 2 hours and 45 minutes for this section. All answers to Section II are to be written in the **Section II Writing Booklet**, in the pages set aside for each question.

HOW THIS PAPER WAS BUILT

This full-length practice paper was synthesised from a six-model AI consensus (Fable, Opus, GPT-5.6 Sol, Gemini 3.1 Pro, Grok, DeepSeek) over 118 question-level predictions for the 2026 HSC Mathematics Extension 2 examination. Every consensus cluster with agreement probability ≥ 0.55 is realised as a question below (plus the 0.52 induction slot, which all six models predict as a type), with the remaining marks drawn from the panel's watch list; all questions are original Intuition Education compositions in NESA style — no question is reproduced from a past HSC paper. A prediction provenance table follows the marking notes.

Answers and marking notes are published as a separate PDF — sit the paper first, then download the solutions from intuitioneducation.com.au/hsc-2026/maths-extension-2.

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Section I

10 marks — Attempt Questions 1–10 — Allow about 15 minutes for this section

Use the multiple-choice answer sheet for Questions 1–10.

Question 1

Consider the statement:

> "If a whole number n is a multiple of 6, then n is a multiple of 3."

Which of the following is the **contrapositive** of this statement?

A. If n is a multiple of 3, then n is a multiple of 6.

B. If n is not a multiple of 3, then n is not a multiple of 6.

C. If n is not a multiple of 6, then n is not a multiple of 3.

D. n is a multiple of 6 and n is not a multiple of 3.

Question 2

Consider the statement:

$$\forall x \in \mathbb{R},\ \exists y \in \mathbb{R} \text{ such that } y^3 = x.$$

Which of the following is the **negation** of this statement?

A. $\forall x \in \mathbb{R},\ \exists y \in \mathbb{R}$ such that $y^3 \neq x$

B. $\exists x \in \mathbb{R}$ such that $\exists y \in \mathbb{R}$ with $y^3 \neq x$

C. $\exists x \in \mathbb{R}$ such that $\forall y \in \mathbb{R},\ y^3 \neq x$

D. $\forall x \in \mathbb{R},\ \forall y \in \mathbb{R},\ y^3 \neq x$

Question 3

What is the principal argument of $z = -1 - \sqrt{3}\,i$?

A. $\dfrac{2\pi}{3}$

B. $\dfrac{4\pi}{3}$

C. $-\dfrac{\pi}{3}$

D. $-\dfrac{2\pi}{3}$

Question 4

Which of the following is a vector equation of the line through the points $A(1, -2, 3)$ and $B(3, -1, 1)$?

A. $\underset{\sim}{r} = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix}$

B. $\underset{\sim}{r} = \begin{pmatrix} 3 \\ -1 \\ 1 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$

C. $\underset{\sim}{r} = \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix} + \lambda \begin{pmatrix} 2 \\ 1 \\ -2 \end{pmatrix}$

D. $\underset{\sim}{r} = \begin{pmatrix} 2 \\ 1 \\ -2 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ -2 \\ 3 \end{pmatrix}$

Question 5

A particle moves in a straight line so that its velocity is $v = x^2 + 1$, where x is its displacement in metres and v is in $\mathrm{m\ s^{-1}}$.

What is the acceleration of the particle, in $\mathrm{m\ s^{-2}}$, when $x = 1$?

A. 2

B. 4

C. 8

D. 5

Question 6

A particle moves in simple harmonic motion with

$$v^2 = 12 + 4x - x^2,$$

where x is its displacement in metres and v is in $\mathrm{m\ s^{-1}}$.

What is the amplitude of the motion?

A. 4

B. $2\sqrt{3}$

C. 16

D. 2

Question 7

The polynomial $P(x) = x^3 - 7x^2 + 17x - 15$ has real coefficients, and $2 + i$ is a zero of $P(x)$.

What is the third zero of $P(x)$?

A. 3

B. -3

C. 5

D. 1

Question 8

Which of the following is the correct form of the partial fraction decomposition of $\dfrac{3x+5}{(x-1)(x^2+4)}$, where A, B and C are real constants?

A. $\dfrac{A}{x-1} + \dfrac{B}{x^2+4}$

B. $\dfrac{A}{x-1} + \dfrac{B}{x+2} + \dfrac{C}{x-2}$

C. $\dfrac{Ax+B}{x-1} + \dfrac{C}{x^2+4}$

D. $\dfrac{A}{x-1} + \dfrac{Bx+C}{x^2+4}$

Question 9

What is the value of $(1+i)^{10}$?

A. $-32i$

B. $32i$

C. 32

D. -32

Question 10

Which of the following best describes the set of points z in the complex plane satisfying $|z-1| = |z+i|$?

A. A circle with centre $\dfrac{1-i}{2}$

B. The line $y = x$

C. The line $y = -x$

D. The ray $\arg z = -\dfrac{\pi}{4}$

Section II

90 marks — Attempt Questions 11–16 — Allow about 2 hours and 45 minutes for this section

Answer the questions in the Section II Writing Booklet, in the pages set aside for each question. Extra writing pages are provided at the back of the booklet. For questions in Section II, your responses should include relevant mathematical reasoning and/or calculations.

Question 11 (15 marks) — Start on the page marked "Question 11" in the Writing Booklet *(15 marks)*

(a) Let $z = 3 - i$ and $w = 1 + 2i$.

(i) Find $\bar{z}\,w$. **(1 mark)**

(ii) Express $\dfrac{z}{w}$ in the form $x + iy$, where x and y are real. **(2 marks)**

(b) Express $\sqrt{3} - i$ in exponential form, and hence express $\left(\sqrt{3} - i\right)^7$ in the form $x + iy$, where x and y are real. **(3 marks)**

(c) Find the angle between the vectors $\underset{\sim}{a} = \begin{pmatrix} 2 \\ -1 \\ 2 \end{pmatrix}$ and $\underset{\sim}{b} = \begin{pmatrix} 1 \\ 3 \\ -2 \end{pmatrix}$, correct to the nearest degree. **(2 marks)**

(d) The points $A(1, 2, -1)$ and $B(3, 1, 1)$ are given.

(i) Find a vector equation of the line ℓ through A and B. **(1 mark)**

(ii) Determine, with reasons, whether the point $C(7, -1, 5)$ lies on ℓ. **(2 marks)**

(e) Prove by contradiction that $\log_2 3$ is irrational. **(3 marks)**

(f) Solve $z^2 + 9 = 0$. **(1 mark)**

Question 12 (15 marks) — Start on the page marked "Question 12" in the Writing Booklet *(15 marks)*

(a)

(i) Find the real constants A, B and C such that

$$\frac{2x^2+x+2}{(x-1)(x^2+4)} = \frac{A}{x-1} + \frac{Bx+C}{x^2+4}.$$

(2 marks)

(ii) Hence find

$$\int \frac{2x^2+x+2}{(x-1)(x^2+4)}\,dx.$$

(2 marks)

(b) Using the substitution $t = \tan\dfrac{x}{2}$, evaluate

$$\int_0^{\frac{\pi}{2}} \frac{dx}{1+\sin x+\cos x}.$$

(3 marks)

(c) A particle moves in a straight line so that

$$v^2 = 27 + 18x - 9x^2,$$

where x is its displacement in metres and v is its velocity in $\mathrm{m\ s^{-1}}$.

(i) Show that the particle moves in simple harmonic motion, and state the centre and the period of the motion. **(2 marks)**

(ii) Find the amplitude of the motion and the maximum speed of the particle. **(1 mark)**

(iii) Find the maximum magnitude of the acceleration of the particle. **(1 mark)**

(iv) Find the total distance travelled by the particle in one complete period. **(1 mark)**

(d) Use mathematical induction to prove that $2^n > n^2$ for all integers $n \geq 5$. **(3 marks)**

Question 13 (15 marks) — Start on the page marked "Question 13" in the Writing Booklet *(15 marks)*

(a) For $n \geq 0$, let

$$I_n = \int_0^1 x^n e^x \, dx.$$

(i) Using integration by parts, show that $I_n = e - nI_{n-1}$ for $n \geq 1$. **(3 marks)**

(ii) Hence evaluate I_3. **(2 marks)**

(b) Sketch the region in the complex plane where the inequalities

$$|z - 2| \leq 2 \qquad \text{and} \qquad |z| > |z - 2i|$$

hold simultaneously, showing the coordinates of any relevant intersection points and clearly distinguishing included and excluded boundaries. **(3 marks)**

(c)

(i) Prove that $\dfrac{a+b}{2} \geq \sqrt{ab}$ for all real $a, b > 0$. **(1 mark)**

(ii) Hence prove that, for all real $a, b, c > 0$,

$$(a+b)(b+c)(c+a) \geq 8abc.$$

(3 marks)

(d) Find the coordinates of the point on the line

$$\underset{\sim}{r} = \begin{pmatrix} 1 \\ 0 \\ -1 \end{pmatrix} + \lambda \begin{pmatrix} 2 \\ 1 \\ 2 \end{pmatrix}$$

that is closest to the point $P(3, -1, 2)$, and hence find the shortest distance from P to the line. **(3 marks)**

Question 14 (15 marks) — Start on the page marked "Question 14" in the Writing Booklet *(15 marks)*

(a) In triangle OAB, the points A and B have position vectors $\underset{\sim}{a}$ and $\underset{\sim}{b}$ relative to O. The point C is the midpoint of OA, and the point D lies on AB with $AD : DB = 2 : 1$. The line segments OD and BC intersect at X.

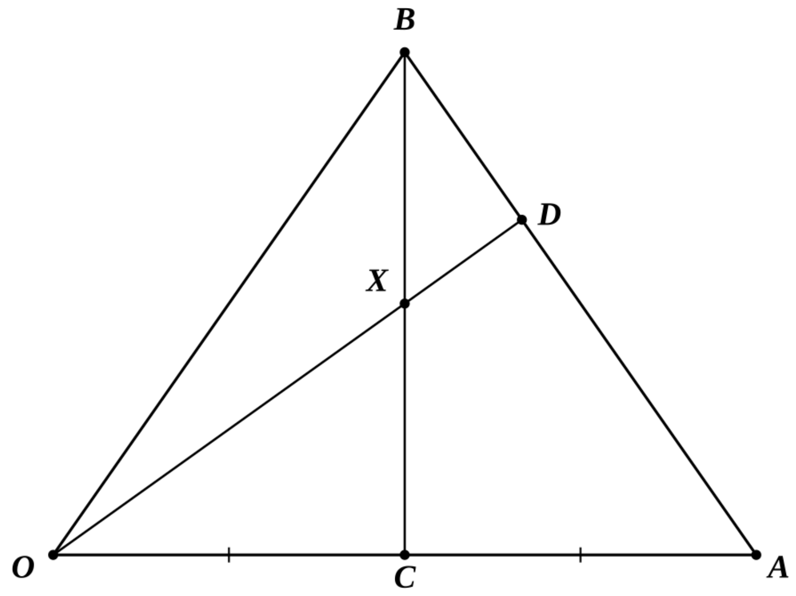

DIAGRAM PROVIDED IN THE EXAM

(i) Show that $\overrightarrow{OD} = \frac{1}{3}\underset{\sim}{a} + \frac{2}{3}\underset{\sim}{b}$. **(1 mark)**

(ii) By expressing $\overrightarrow{OX}$ in two different ways, prove that X is the midpoint of BC, and find the ratio $OX : XD$. **(3 marks)**

(b)

(i) Using De Moivre's theorem and the binomial theorem, show that

$$\sin 5\theta = 16\sin^5\theta - 20\sin^3\theta + 5\sin\theta.$$

(2 marks)

(ii) Hence show that $x = \sin\frac{\pi}{5}$ and $x = \sin\frac{2\pi}{5}$ are roots of the equation

$$16x^4 - 20x^2 + 5 = 0.$$

(2 marks)

(iii) Hence show that

$$\sin\frac{\pi}{5}\sin\frac{2\pi}{5} = \frac{\sqrt{5}}{4}.$$

(2 marks)

(c) The polynomial $P(x) = x^3 - 5x^2 + 11x - 15$ has real coefficients, and $1 + 2i$ is a zero of $P(x)$.

Find the other two zeros of $P(x)$. **(2 marks)**

(d) Solve the equation

$$z^2 - (3+i)z + 2 + 2i = 0,$$

giving your answers in the form $x + iy$, where x and y are real. **(3 marks)**

Question 15 (15 marks) — Start on the page marked "Question 15" in the Writing Booklet *(15 marks)*

(a) A particle of mass m is projected vertically upwards from the ground with speed u. It experiences a resistive force of magnitude mkv^2, where v is its speed and k is a positive constant. The acceleration due to gravity is g.

(i) Taking upwards as positive, the equation of motion on the way up is $\ddot{x} = -\left(g + kv^2\right)$. Using $\ddot{x} = v\dfrac{dv}{dx}$, show that the maximum height reached is

$$H = \frac{1}{2k}\ln\left(1 + \frac{ku^2}{g}\right).$$

(3 marks)

(ii) Using $\ddot{x} = \dfrac{dv}{dt}$, show that the time taken to reach the highest point is

$$T = \frac{1}{\sqrt{gk}}\tan^{-1}\left(u\sqrt{\frac{k}{g}}\right).$$

(3 marks)

(iii) After reaching its highest point the particle falls back to the ground. Write down the terminal velocity of the falling particle, and explain why the particle lands with speed less than this terminal velocity. **(2 marks)**

(b)

(i) Find the four solutions of the equation

$$z^4 = -8 + 8\sqrt{3}\,i,$$

giving each solution in the form $re^{i\theta}$ with $-\pi < \theta \leq \pi$. **(2 marks)**

(ii) Plot the four solutions on an Argand diagram, and describe the figure they form. **(1 mark)**

(iii) Express the solution lying in the first quadrant in the form $x + iy$, where x and y are real. **(1 mark)**

(c) The Argand diagram below shows the unit circle and a complex number z with $|z| > 1$.

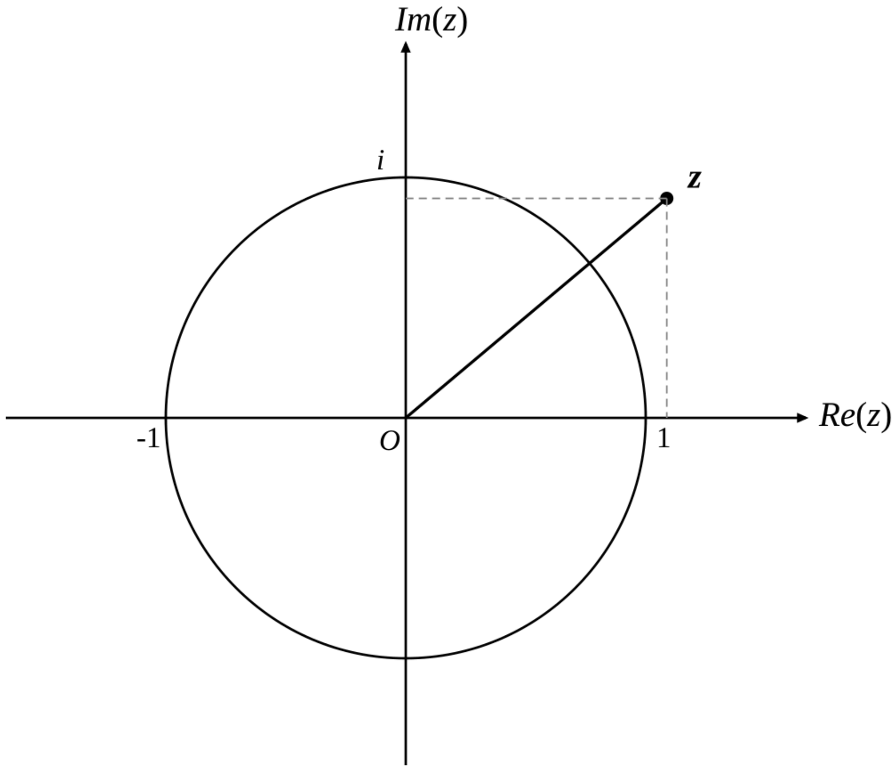

DIAGRAM PROVIDED IN THE EXAM

On a copy of the diagram, locate approximate positions of the points representing

$$\text{(i) } \bar{z} \qquad \text{(ii) } i\bar{z} \qquad \text{(iii) } \frac{z^2}{|z|},$$

without performing any calculations, briefly justifying the position of each point. **(3 marks)**

Question 16 (15 marks) — Start on the page marked "Question 16" in the Writing Booklet *(15 marks)*

(a) Let z and w be complex numbers.

(i) Using the fact that $|v|^2 = v\bar{v}$ for any complex number v, prove that

$$|z+w|^2 + |z-w|^2 = 2|z|^2 + 2|w|^2.$$

(2 marks)

(ii) Suppose $|z| = |w| = 1$. Prove by contradiction that at least one of $|z+w|$ and $|z-w|$ is greater than or equal to $\sqrt{2}$. **(2 marks)**

(iii) Find values of z and w with $|z| = |w| = 1$ for which $|z+w| = |z-w| = \sqrt{2}$, justifying your answer. **(1 mark)**

(b) A car of mass m is travelling at speed u along a straight horizontal road when its brakes are applied. While braking, the car experiences a total retarding force of magnitude $m(c+kv)$, where v is its speed and c and k are positive constants, so that its equation of motion is $\ddot{x} = -(c+kv)$.

(i) Using $\ddot{x} = v\dfrac{dv}{dx}$, show that the distance travelled by the car in coming to rest is

$$D = \frac{u}{k} - \frac{c}{k^2}\ln\left(1 + \frac{ku}{c}\right).$$

(3 marks)

(ii) Using $\ddot{x} = \dfrac{dv}{dt}$, show that the time taken for the car to come to rest is

$$T = \frac{1}{k}\ln\left(1 + \frac{ku}{c}\right).$$

(2 marks)

(c) Let

$$I = \int_0^{\pi} \frac{x\sin x}{1+\cos^2 x}\,dx.$$

(i) Using the substitution $u = \pi - x$, show that

$$2I = \pi\int_0^{\pi} \frac{\sin x}{1+\cos^2 x}\,dx.$$

(2 marks)

(ii) Evaluate $\displaystyle\int_0^{\pi} \frac{\sin x}{1+\cos^2 x}\,dx$. **(2 marks)**

(iii) Hence find the exact value of I. **(1 mark)**

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