INTUITION EDUCATION

HSC 2026 · PREDICTED PRACTICE PAPER

# 2026 HSC Mathematics Advanced

*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 11–31)**
Attempt Questions 11–31. Allow about 2 hours and 45 minutes for this section.

## 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 190 question-level predictions for the 2026 HSC Mathematics Advanced examination. Every consensus cluster with agreement probability ≥ 0.55 is realised as a question below, 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-advanced.

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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

What is the domain of the function $f(x) = \dfrac{1}{\sqrt{4 - x^2}}$?

A. $[-2, 2]$

B. $(0, 2)$

C. $(-2, 2)$

D. all real $x$, $x \neq \pm 2$

### Question 2

The point $(4, 3)$ lies on the graph of $y = f(x)$.

Which point must lie on the graph of $y = f(2x) + 1$?

A. $(8, 4)$

B. $(2, 4)$

C. $(2, 3)$

D. $(8, 7)$

### Question 3

A data set of nine house prices has mean $\$620\,000$ and median $\$580\,000$. A tenth house, sold for $\$3\,000\,000$, is added to the data set.

Which of the following best describes the effect?

A. The median increases by more than the mean.

B. The mean and the median increase by the same amount.

C. Neither the mean nor the median changes.

D. The mean increases by more than the median.

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**Question 4**

What is the range of the function $y = 3 - 2\cos(4x)$?

A. $[1, 5]$

B. $[-5, 5]$

C. $[1, 3]$

D. $[-1, 5]$

**Question 5**

The table shows values of the functions $f$ and $g$ and their derivatives at $x = 1$ and $x = 2$.

| $x$ | $f(x)$ | $f'(x)$ | $g(x)$ | $g'(x)$ |
|---|---|---|---|---|
| 1 | 7 | 4 | 2 | 6 |
| 2 | 5 | 3 | $-1$ | 8 |

Let $h(x) = f(g(x))$. What is the value of $h'(1)$?

A. 24

B. 18

C. 3

D. 30

**Question 6**

What is the domain of the function $f(x) = \ln(3 - x)$?

A. $x > 3$

B. $x \leq 3$

C. $x < 3$

D. $x \neq 3$

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**Question 7**

The table shows the probability distribution of a random variable $X$.

| $x$ | $0$ | $1$ | $2$ |
|---|---|---|---|
| $P(X = x)$ | $0.2$ | $0.5$ | $0.3$ |

What is $E(X)$?

A. $1.0$

B. $1.1$

C. $1.5$

D. $1.7$

**Question 8**

The lifetimes of a type of battery are normally distributed with mean $20$ hours and standard deviation $5$ hours.

Using the empirical rule, approximately what percentage of batteries have a lifetime between $15$ hours and $30$ hours?

A. $68\%$

B. $95\%$

C. $81.5\%$

D. $84\%$

**Question 9**

Which of the following functions is odd?

A. $f(x) = x^3 - x$

B. $f(x) = x^3 + 1$

C. $f(x) = x^2 - x$

D. $f(x) = |x - 1|$

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### Question 10

The diagram shows the graph of $y = f'(x)$, the **derivative** of a function $f$.

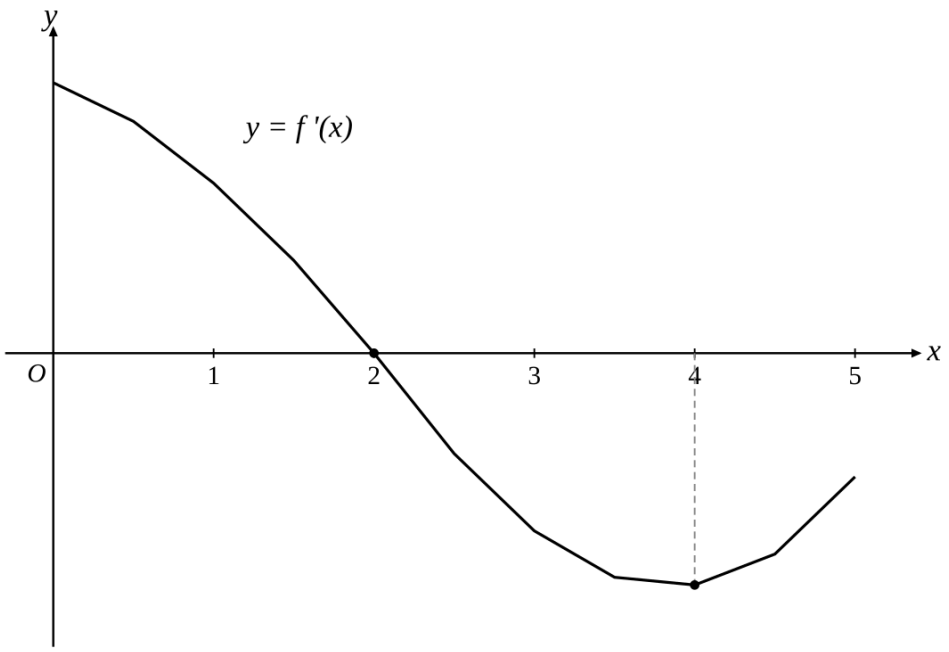



DIAGRAM PROVIDED IN THE EXAM

Which statement about the function $f$ is correct?

A. $f$ has a local minimum at $x = 2$.

B. $f$ has a point of inflection at $x = 2$.

C. $f$ is increasing at $x = 3$.

D. $f$ has a local maximum at $x = 2$.

## Section II

**90 marks — Attempt Questions 11–31 — Allow about 2 hours and 45 minutes for this section**

Answer the questions in the Section II answer booklet. Your responses should include relevant mathematical reasoning and/or calculations.

### Question 11 *(3 marks)*

An arithmetic sequence begins $6,\ 11,\ 16,\ \ldots$

**(a)** Show that $2026$ is a term of the sequence, and find which term it is. **(2 marks)**

**(b)** Find the sum of all the terms of the sequence from $6$ up to and including $2026$. **(1 mark)**

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**Question 12** *(3 marks)*

The table shows the probability distribution of a random variable $X$, where $k$ is a constant.

| $x$ | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $P(X = x)$ | 0.1 | 0.3 | $k$ | 0.2 |

**(a)** Find the value of $k$. **(1 mark)**

**(b)** Find $E(X)$ and the standard deviation of $X$. **(2 marks)**

**Question 13** *(2 marks)*

Prove that $\dfrac{1}{1+\sin\theta} + \dfrac{1}{1-\sin\theta} = 2\sec^2\theta$, for $\cos\theta \neq 0$. **(2 marks)**

**Question 14** *(3 marks)*

Let $h(x) = \dfrac{3}{x^2+2}$.

**(a)** State the domain of $h(x)$. **(1 mark)**

**(b)** Explain why the maximum value of $h(x)$ is $\dfrac{3}{2}$. **(1 mark)**

**(c)** Hence state the range of $h(x)$. **(1 mark)**

**Question 15** *(4 marks)*

**(a)** Differentiate $y = x^2 \ln x$. **(2 marks)**

**(b)** Hence find $\displaystyle\int x \ln x \, dx$. **(2 marks)**

**Question 16** *(4 marks)*

A factory has three machines, $A$, $B$ and $C$, which produce items in the ratio $5 : 3 : 2$. Of the items produced, $2\%$ of machine $A$'s, $4\%$ of machine $B$'s and $5\%$ of machine $C$'s are defective.

An item is selected at random from the factory's output.

**(a)** By drawing a tree diagram, or otherwise, show that the probability that the selected item is defective is $0.032$. **(2 marks)**

**(b)** Given that the selected item is defective, find the probability that it was produced by machine $C$. **(2 marks)**

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**Question 17** *(6 marks)*

The table gives the future value of an annuity of $\$1$ per period, for various interest rates per period.

| Number of periods | $1\%$ | $1.5\%$ | $2\%$ |
|---|---|---|---|
| $16$ | $17.258$ | $17.932$ | $18.639$ |
| $20$ | $22.019$ | $23.124$ | $24.297$ |
| $24$ | $26.973$ | $28.634$ | $30.422$ |

**(a)** Leo deposits $\$2000$ into a savings account at the end of every quarter for $5$ years. The account earns interest at $6\%$ per annum, compounding quarterly.

Find the value of Leo's account at the end of the $5$ years. **(2 marks)**

**(b)** Mia wants her account to be worth $\$80\,000$ after $6$ years. Her account earns interest at $8\%$ per annum, compounding quarterly, and she will make equal deposits at the end of every quarter.

Find the size of each quarterly deposit, correct to the nearest cent. **(2 marks)**

**(c)** Find the total amount of interest Mia's account will earn over the $6$ years. **(2 marks)**

**Question 18** *(2 marks)*

Using the definition $f'(x) = \lim\limits_{h \to 0} \dfrac{f(x+h) - f(x)}{h}$, find the derivative of $f(x) = x^2 - 3x$. **(2 marks)**

**Question 19** *(2 marks)*

The loudness of a sound, in decibels (dB), is given by $L = 10 \log_{10}\left(\dfrac{I}{I_0}\right)$, where $I$ is the intensity of the sound and $I_0$ is a reference intensity.

**(a)** A concert measures $95$ dB and normal conversation measures $65$ dB. How many times more intense is the concert than normal conversation? **(1 mark)**

**(b)** Sound $P$ is $6$ dB louder than sound $Q$. Show that sound $P$ is approximately $4$ times more intense than sound $Q$. **(1 mark)**

**Question 20** *(3 marks)*

The parabola $y = x^2$ is translated $k$ units to the right and $k$ units up, where $0 < k < 5$, so that its equation becomes

$$y = (x - k)^2 + k.$$

The translated parabola passes through the point $(5, 11)$.

Find the value of $k$, justifying your rejection of any invalid solution. **(3 marks)**

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**Question 21** *(3 marks)*

The table shows the values of a function $f(x)$ at five equally spaced values of $x$.

| $x$ | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| $f(x)$ | 2 | 2.9 | 4.4 | 6.5 | 9.2 |

**(a)** Use the trapezoidal rule with these five values to estimate $\displaystyle\int_0^4 f(x)\,dx$. **(2 marks)**

**(b)** The graph of $y = f(x)$ is concave up on $0 \le x \le 4$. State, with a reason, whether the estimate in part (a) is greater than or less than the exact value of the integral. **(1 mark)**

**Question 22** *(6 marks)*

Consider the curves $y = x^2 - 4x$ and $y = 2x - x^2$.

**(a)** Show that the curves intersect at $x = 0$ and $x = 3$. **(2 marks)**

**(b)** Determine which curve lies above the other for $0 < x < 3$. **(1 mark)**

**(c)** Find the exact area enclosed between the two curves. **(3 marks)**

*Questions 11–22 are worth 41 marks in total.*

**Question 23** *(5 marks)*

A machine fills bags of rice. The masses of the bags are normally distributed with mean $505$ g and standard deviation $6$ g.

The table gives values of $P(Z \le z)$ for a standard normal variable $Z$.

| $z$ | 1.0 | 1.2 | 1.4 | 1.5 | 1.6 |
|---|---|---|---|---|---|
| $P(Z \le z)$ | 0.8413 | 0.8849 | 0.9192 | 0.9332 | 0.9452 |

**(a)** Find the probability that a randomly selected bag has a mass less than $514$ g. **(1 mark)**

**(b)** Find the probability that a randomly selected bag has a mass between $499$ g and $514$ g. **(2 marks)**

**(c)** In a shipment of $2000$ bags, how many bags are expected to have a mass greater than $514$ g? **(1 mark)**

**(d)** The lightest $8.08\%$ of bags are rejected by a quality check. Find the maximum mass of a rejected bag. **(1 mark)**

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**Question 24** *(4 marks)*

The number of bacteria in a culture is modelled by $N(t) = 800e^{kt}$, where $t$ is the time in hours and $k$ is a positive constant. After $5$ hours there are $1200$ bacteria.

**(a)** Show that $k = \dfrac{1}{5}\ln\dfrac{3}{2} \approx 0.0811$. **(1 mark)**

**(b)** Show that after $10$ hours there are exactly $1800$ bacteria. **(1 mark)**

**(c)** Find the rate at which the number of bacteria is increasing when $t = 10$, correct to the nearest whole number per hour. **(1 mark)**

**(d)** Find the time at which the number of bacteria first reaches $3000$, correct to one decimal place. **(1 mark)**

**Question 25** *(5 marks)*

A hiker walks $9$ km from $P$ on a bearing of $040^\circ$ to $Q$, then $7$ km from $Q$ on a bearing of $150^\circ$ to $R$.

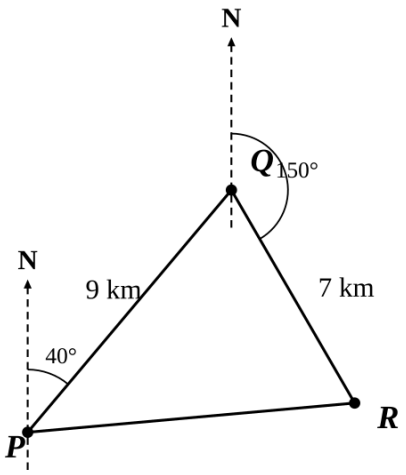



DIAGRAM PROVIDED IN THE EXAM

**(a)** Show that $\angle PQR = 70^\circ$. **(1 mark)**

**(b)** Find the distance $PR$, correct to two decimal places. **(2 marks)**

**(c)** Find the bearing of $R$ from $P$, correct to the nearest degree. **(2 marks)**

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**Question 26** *(4 marks)*

A teacher records the number of hours, $x$, that each student in a class spent revising, and their test score, $y$. The hours revised range from 1 to 8. The least-squares regression line is

$$\hat{y} = 4.2x + 38, \qquad r = 0.87.$$

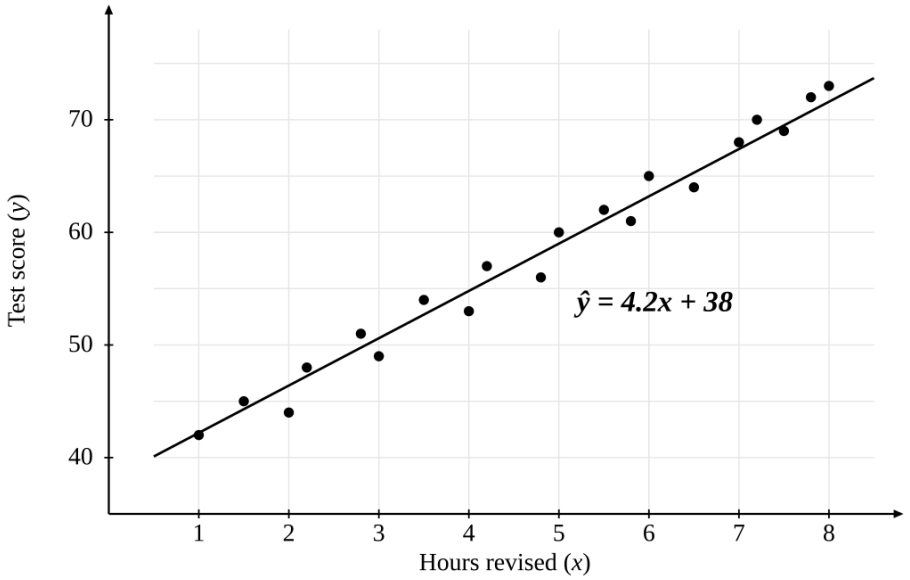



DIAGRAM PROVIDED IN THE EXAM

**(a)** Interpret the gradient of the regression line in the context of the data. **(1 mark)**

**(b)** Predict the test score of a student who revised for 6 hours. **(1 mark)**

**(c)** Explain why this regression line should not be used to predict the score of a student who revised for 20 hours. Support your answer with a calculation. **(1 mark)**

**(d)** A student claims that the gradient of 4.2 shows that the correlation is strong. Explain the error in this claim. **(1 mark)**

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**Question 27** *(6 marks)*

A continuous random variable $X$ has probability density function

$$f(x) = \begin{cases} k(4 - x), & 0 \le x \le 4 \\ 0, & \text{otherwise,} \end{cases}$$

where $k$ is a constant.

**(a)** Show that $k = \dfrac{1}{8}$. **(1 mark)**

**(b)** Show that the cumulative distribution function of $X$ is $F(x) = \dfrac{8x - x^2}{16}$ for $0 \le x \le 4$. **(1 mark)**

**(c)** Find the exact value of the median of $X$. **(2 marks)**

**(d)** Write down the mode of $X$, justifying your answer. **(1 mark)**

**(e)** Find $P(X > 2)$. **(1 mark)**

**Question 28** *(6 marks)*

Let $f(x) = xe^{-x}$.

**(a)** Show that $f'(x) = (1 - x)e^{-x}$. **(1 mark)**

**(b)** Find the coordinates of the stationary point of the graph of $y = f(x)$ and determine its nature. **(2 marks)**

**(c)** Show that $f''(x) = (x - 2)e^{-x}$, and hence show that the graph of $y = f(x)$ has a point of inflection at $x = 2$, justifying your answer. **(2 marks)**

**(d)** Sketch the graph of $y = f(x)$, showing the intercept, the stationary point, the point of inflection and the behaviour of the graph as $x \to \infty$. **(1 mark)**

**Question 29** *(6 marks)*

The depth of water in a harbour is modelled by

$$D(t) = A + B\cos\left(\frac{\pi t}{6}\right),$$

where $D$ is the depth in metres and $t$ is the time in hours after midnight. High tide, of depth $9$ m, occurs at midnight, and low tide, of depth $3$ m, occurs at $6$ am.

**(a)** Show that $A = 6$ and $B = 3$. **(2 marks)**

**(b)** Sketch the graph of $D(t)$ for $0 \le t \le 12$. **(2 marks)**

**(c)** A ship needs a depth of at least $7.5$ m to enter the harbour. For how many hours during each $12$-hour tidal cycle can the ship enter? **(2 marks)**

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**Question 30** *(7 marks)*

Priya borrows $\$400\,000$ to buy an apartment. Interest is charged at $0.5\%$ per month on the balance owing. At the end of each month, immediately after the interest has been charged, Priya makes a repayment of $\$M$. Let $A_n$ be the balance owing after the $n$th repayment.

**(a)** Show that $A_2 = 400\,000(1.005)^2 - M(1 + 1.005)$. **(1 mark)**

**(b)** Show that $A_n = 400\,000(1.005)^n - 200M\left((1.005)^n - 1\right)$. **(2 marks)**

**(c)** Find the value of $M$, correct to the nearest cent, for which the loan is repaid after exactly $300$ monthly repayments. **(2 marks)**

**(d)** Suppose instead Priya repays $\$3000$ each month. Show that $A_n = 600\,000 - 200\,000(1.005)^n$, and find the number of months needed for the balance owing to first fall below $\$200\,000$. **(2 marks)**

**Question 31** *(6 marks)*

A company manufactures closed rectangular boxes with a square base of side $x$ cm and height $h$ cm. Each box must have a volume of $432$ cm$^3$. The material for the base and the top costs $2$ cents per cm$^2$, and the material for the four sides costs $1$ cent per cm$^2$.

**(a)** Show that the total cost of the material for one box, in cents, is

$$C = 4x^2 + \frac{1728}{x}.$$

**(2 marks)**

**(b)** Find the value of $x$ that minimises the cost, verifying that it gives a minimum. **(3 marks)**

**(c)** Find the minimum cost of the material for one box, in dollars. **(1 mark)**

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