Student Name: ______________________________

Teacher Name: ______________________________

2025

Hurlstone Agricultural High School
Year 12
HSC Assessment Task 2

Mathematics Advanced

General Instructions	• **Senior Examiner:** Mrs M. Sabah • Reading time – 5 minutes • Working time – 90 minutes • Write using black or blue pen • NESA approved calculators may be used • A Mathematics reference sheet is provided at the back of this paper • For all Questions in Section II - IV, show relevant mathematical reasoning and/or calculations
Total Marks: 60	**Section I – 10 marks** • Attempt Questions 1 – 10 • Allow about 15 minutes for this section **Section II – IV - 50 marks** • Attempt Questions 11 – 22 in the booklets provided • Allow about 75 minutes for these sections

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.

1. For which values of x is the curve $f(x) = 2x^3 + x^2$ concave down?

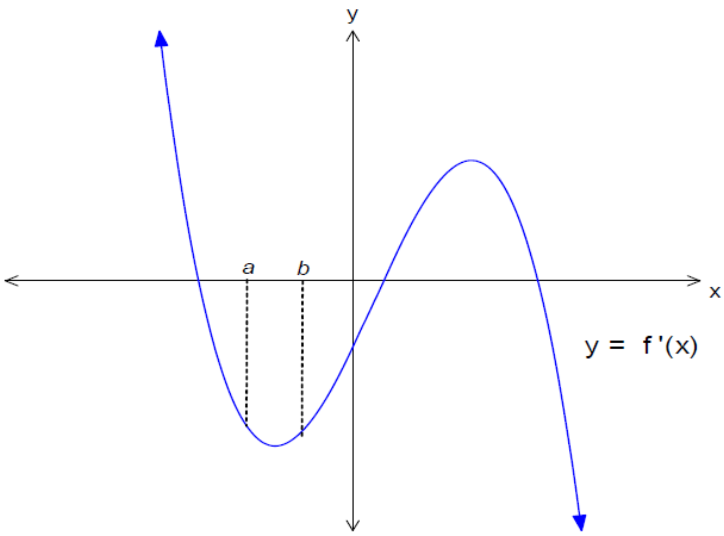
A. $x < -\frac{1}{6}$

B. $x > -\frac{1}{6}$

C. $x < 6$

D. $x > 6$

2. The graph of the function $y = f'(x)$ is shown below.



Which of the following characteristics will the function $f(x)$ have between $x = a$ and $x = b$?

A. Negative gradient

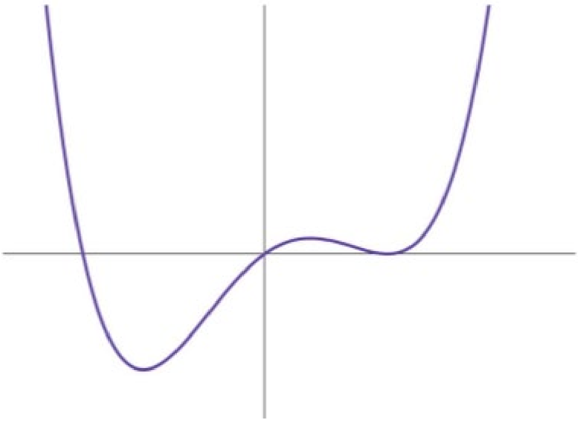
B. Positive gradient

C. Local minimum value

D. Local maximum value

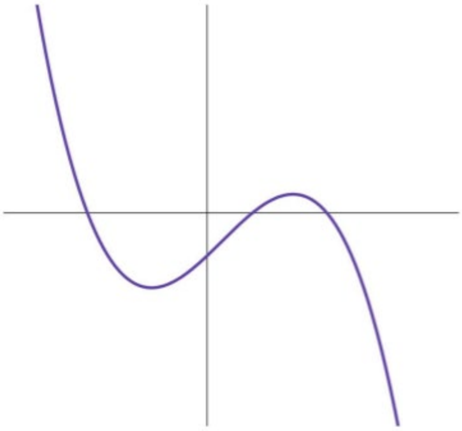
Section I continues on next page ...

3. The graph of a function $y = f(x)$ is shown below.

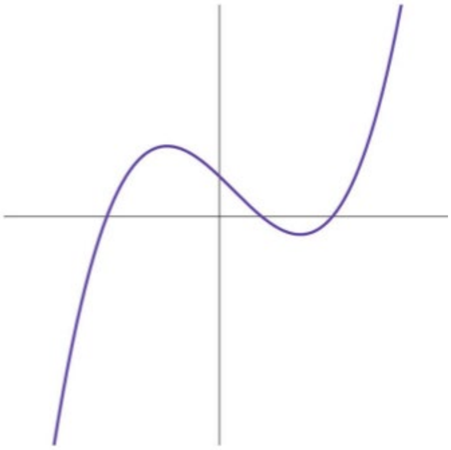


Which of the following is the graph of $y = f'(x)$?

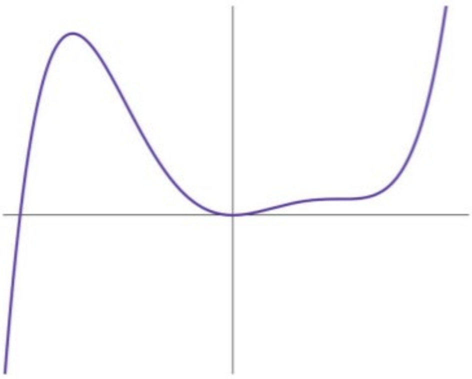
A.



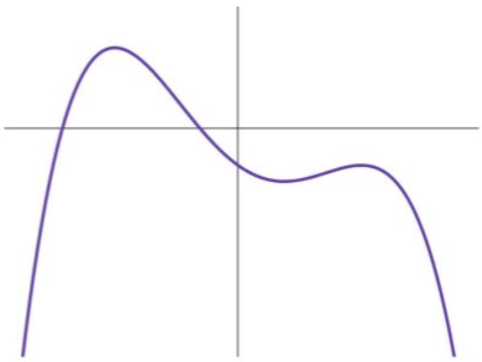
B.



C.



D.



Section I continues on next page ...

4. It is given that $y = 4x^4 + 2x$.

Which of the following is the simplified value of $\frac{d^2y}{dx^2} - 6\frac{dy}{dx}$?

A. $4x^2 + 8x - 1$

B. $-12\left(8x^3 - 4x^2 + 1\right)$

C. $-12\left(8x^3 + 4x^2 + 1\right)$

D. $-12\left(4x^2 - 8x^3 - 1\right)$

---

5. What is the solution to the inequality $x^2 > 3x$?

A. $x > 3$

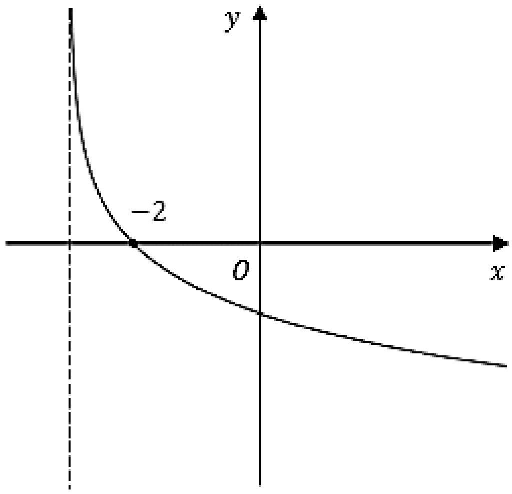
B. $x < 0, x > 3$

C. $0 < x < 3$

D. $x < 3$

Section I continues on next page ...

6. The graph of $y = f(x)$ is shown.



Which of the following could be the equation of this graph?

A. $f(x) = -\ln(x+2)$

B. $f(x) = -\ln(2-x)-1$

C. $f(x) = -\ln(x+2)-1$

D. $f(x) = -\ln(x+3)$

---

7. The graph of $f(x)$ is obtained by transforming $g(x) = \sqrt{2x-5}$ by a reflection in the x-axis followed by a horizontal dilation from the y-axis by a factor of $\frac{1}{2}$. What is the correct equation for $f(x)$?

A. $f(x) = -\sqrt{x-5}$

B. $f(x) = -\sqrt{4x-5}$

C. $f(x) = -\frac{1}{2}\sqrt{4x-5}$

D. $f(x) = -2\sqrt{4x-5}$

Section I continues on next page ...

8. Rithwik gets cast in a major motion picture and needs to gain weight for the role.

Every day he sets a goal to eat three times as many cookies as he did the day before.

By the 14th day he has eaten a grand total of 2 391 484 cookies.

How many cookies must Rithwik have eaten on the second day?

A. 1

B. ≈ 1.5

C. 3

D. ≈ 4.5

---

9. Which of the following is the exact value of $\int_0^1 \sqrt{x^3}\ dx$?

A. $\frac{2}{5}$

B. $\frac{5}{2}$

C. $\frac{2}{7}$

D. $\frac{3}{7}$

---

10. If $\int_1^4 f(x)\ dx = 2$ which of the following is the value of $\int_1^4 (2f(x)+3)\ dx$?

A. 2

B. 7

C. 10

D. 13

~ End of Section I ~

NSW Education Standards Authority

2020 HIGHER SCHOOL CERTIFICATE EXAMINATION

Mathematics Advanced
Mathematics Extension 1
Mathematics Extension 2

REFERENCE SHEET

Measurement

Length

$$l = \frac{\theta}{360} \times 2\pi r$$

Area

$$A = \frac{\theta}{360} \times \pi r^2$$

$$A = \frac{h}{2}(a + b)$$

Surface area

$$A = 2\pi r^2 + 2\pi rh$$

$$A = 4\pi r^2$$

Volume

$$V = \frac{1}{3}Ah$$

$$V = \frac{4}{3}\pi r^3$$

Functions

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

For $ax^3 + bx^2 + cx + d = 0$:

$$\alpha + \beta + \gamma = -\frac{b}{a}$$

$$\alpha\beta + \alpha\gamma + \beta\gamma = \frac{c}{a}$$

and $\alpha\beta\gamma = -\frac{d}{a}$

Relations

$$(x - h)^2 + (y - k)^2 = r^2$$

Financial Mathematics

$$A = P(1 + r)^n$$

Sequences and series

$$T_n = a + (n - 1)d$$

$$S_n = \frac{n}{2}[2a + (n - 1)d] = \frac{n}{2}(a + l)$$

$$T_n = ar^{n-1}$$

$$S_n = \frac{a(1 - r^n)}{1 - r} = \frac{a(r^n - 1)}{r - 1}, \; r \neq 1$$

$$S = \frac{a}{1 - r}, \; |r| < 1$$

Logarithmic and Exponential Functions

$$\log_a a^x = x = a^{\log_a x}$$

$$\log_a x = \frac{\log_b x}{\log_b a}$$

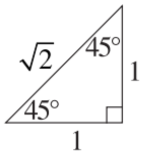
$$a^x = e^{x \ln a}$$

Trigonometric Functions

$$\sin A = \frac{\text{opp}}{\text{hyp}}, \quad \cos A = \frac{\text{adj}}{\text{hyp}}, \quad \tan A = \frac{\text{opp}}{\text{adj}}$$

$$A = \frac{1}{2}ab\sin C$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

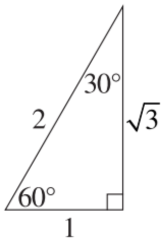


$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$$

$$l = r\theta$$

$$A = \frac{1}{2}r^2\theta$$



Trigonometric identities

$$\sec A = \frac{1}{\cos A}, \ \cos A \neq 0$$

$$\operatorname{cosec} A = \frac{1}{\sin A}, \ \sin A \neq 0$$

$$\cot A = \frac{\cos A}{\sin A}, \ \sin A \neq 0$$

$$\cos^2 x + \sin^2 x = 1$$

Compound angles

$$\sin(A + B) = \sin A\cos B + \cos A\sin B$$

$$\cos(A + B) = \cos A\cos B - \sin A\sin B$$

$$\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A\tan B}$$

If $t = \tan\frac{A}{2}$ then $\sin A = \frac{2t}{1+t^2}$

$$\cos A = \frac{1-t^2}{1+t^2}$$

$$\tan A = \frac{2t}{1-t^2}$$

$$\cos A\cos B = \frac{1}{2}\left[\cos(A - B) + \cos(A + B)\right]$$

$$\sin A\sin B = \frac{1}{2}\left[\cos(A - B) - \cos(A + B)\right]$$

$$\sin A\cos B = \frac{1}{2}\left[\sin(A + B) + \sin(A - B)\right]$$

$$\cos A\sin B = \frac{1}{2}\left[\sin(A + B) - \sin(A - B)\right]$$

$$\sin^2 nx = \frac{1}{2}(1 - \cos 2nx)$$

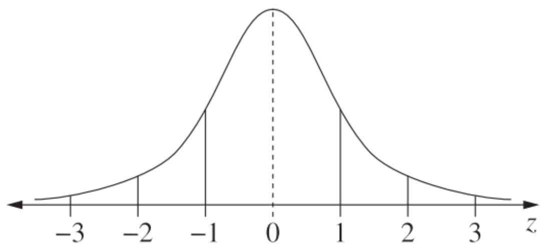
$$\cos^2 nx = \frac{1}{2}(1 + \cos 2nx)$$

Statistical Analysis

$$z = \frac{x - \mu}{\sigma}$$

An outlier is a score
less than $Q_1 - 1.5 \times IQR$
or
more than $Q_3 + 1.5 \times IQR$

Normal distribution



- approximately 68% of scores have z-scores between –1 and 1
- approximately 95% of scores have z-scores between –2 and 2
- approximately 99.7% of scores have z-scores between –3 and 3

$$E(X) = \mu$$

$$\operatorname{Var}(X) = E\left[(X - \mu)^2\right] = E\left(X^2\right) - \mu^2$$

Probability

$$P(A \cap B) = P(A)P(B)$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}, \ P(B) \neq 0$$

Continuous random variables

$$P(X \le r) = \int_a^r f(x)\,dx$$

$$P(a < X < b) = \int_a^b f(x)\,dx$$

Binomial distribution

$$P(X = r) = {}^nC_r p^r(1 - p)^{n-r}$$

$$X \sim \operatorname{Bin}(n, p)$$

$$\Rightarrow \ P(X = x)$$

$$= \binom{n}{x}p^x(1 - p)^{n-x}, \ x = 0, 1, \ldots, n$$

$$E(X) = np$$

$$\operatorname{Var}(X) = np(1 - p)$$

Differential Calculus

Function	Derivative
$y = f(x)^n$	$\frac{dy}{dx} = nf'(x)\left[f(x)\right]^{n-1}$
$y = uv$	$\frac{dy}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$
$y = g(u)$ where $u = f(x)$	$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$
$y = \frac{u}{v}$	$\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$
$y = \sin f(x)$	$\frac{dy}{dx} = f'(x)\cos f(x)$
$y = \cos f(x)$	$\frac{dy}{dx} = -f'(x)\sin f(x)$
$y = \tan f(x)$	$\frac{dy}{dx} = f'(x)\sec^2 f(x)$
$y = e^{f(x)}$	$\frac{dy}{dx} = f'(x)e^{f(x)}$
$y = \ln f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{f(x)}$
$y = a^{f(x)}$	$\frac{dy}{dx} = (\ln a)f'(x)a^{f(x)}$
$y = \log_a f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{(\ln a)f(x)}$
$y = \sin^{-1} f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{\sqrt{1-\left[f(x)\right]^2}}$
$y = \cos^{-1} f(x)$	$\frac{dy}{dx} = -\frac{f'(x)}{\sqrt{1-\left[f(x)\right]^2}}$
$y = \tan^{-1} f(x)$	$\frac{dy}{dx} = \frac{f'(x)}{1+\left[f(x)\right]^2}$

Integral Calculus

$$\int f'(x)\left[f(x)\right]^n dx = \frac{1}{n+1}\left[f(x)\right]^{n+1} + c$$

where $n \neq -1$

$$\int f'(x)\sin f(x)\,dx = -\cos f(x) + c$$

$$\int f'(x)\cos f(x)\,dx = \sin f(x) + c$$

$$\int f'(x)\sec^2 f(x)\,dx = \tan f(x) + c$$

$$\int f'(x)e^{f(x)}\,dx = e^{f(x)} + c$$

$$\int \frac{f'(x)}{f(x)}\,dx = \ln\left|f(x)\right| + c$$

$$\int f'(x)a^{f(x)}\,dx = \frac{a^{f(x)}}{\ln a} + c$$

$$\int \frac{f'(x)}{\sqrt{a^2 - \left[f(x)\right]^2}}\,dx = \sin^{-1}\frac{f(x)}{a} + c$$

$$\int \frac{f'(x)}{a^2 + \left[f(x)\right]^2}\,dx = \frac{1}{a}\tan^{-1}\frac{f(x)}{a} + c$$

$$\int u\frac{dv}{dx}\,dx = uv - \int v\frac{du}{dx}\,dx$$

$$\int_a^b f(x)\,dx$$

$$\approx \frac{b-a}{2n}\left\{f(a) + f(b) + 2\left[f(x_1) + \cdots + f(x_{n-1})\right]\right\}$$

where $a = x_0$ and $b = x_n$

Combinatorics

$$^{n}P_{r} = \frac{n!}{(n-r)!}$$

$$\binom{n}{r} = {}^{n}C_{r} = \frac{n!}{r!\,(n-r)!}$$

$$(x+a)^n = x^n + \binom{n}{1}x^{n-1}a + \cdots + \binom{n}{r}x^{n-r}a^r + \cdots + a^n$$

Vectors

$$\left|\underset{\sim}{u}\right| = \left|x\underset{\sim}{i} + y\underset{\sim}{j}\right| = \sqrt{x^2 + y^2}$$

$$\underset{\sim}{u} \cdot \underset{\sim}{v} = \left|\underset{\sim}{u}\right|\left|\underset{\sim}{v}\right|\cos\theta = x_1x_2 + y_1y_2\,,$$

where $\underset{\sim}{u} = x_1\underset{\sim}{i} + y_1\underset{\sim}{j}$

and $\underset{\sim}{v} = x_2\underset{\sim}{i} + y_2\underset{\sim}{j}$

$$\underset{\sim}{r} = \underset{\sim}{a} + \lambda\underset{\sim}{b}$$

Complex Numbers

$$\begin{aligned} z = a + ib &= r(\cos\theta + i\sin\theta) \\ &= re^{i\theta} \end{aligned}$$

$$\begin{aligned} \left[r(\cos\theta + i\sin\theta)\right]^n &= r^n(\cos n\theta + i\sin n\theta) \\ &= r^n e^{in\theta} \end{aligned}$$

Mechanics

$$\frac{d^2x}{dt^2} = \frac{dv}{dt} = v\frac{dv}{dx} = \frac{d}{dx}\left(\frac{1}{2}v^2\right)$$

$$x = a\cos(nt + \alpha) + c$$

$$x = a\sin(nt + \alpha) + c$$

$$\ddot{x} = -n^2(x - c)$$

BLANK PAGE

Students Name: ____________________________

Teachers Name: ____________________________

2025

Hurlstone Agricultural High School
Year 12
HSC Assessment Task 2

Mathematics Advanced

Multiple-Choice Answer Sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ● B ○ C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word correct and drawing an arrow as follows.

correct

A ⊗ B ⊗ C ○ D ○

Question

1.	**A** ○	**B** ○	**C** ○	**D** ○
2.	**A** ○	**B** ○	**C** ○	**D** ○
3.	**A** ○	**B** ○	**C** ○	**D** ○
4.	**A** ○	**B** ○	**C** ○	**D** ○
5.	**A** ○	**B** ○	**C** ○	**D** ○
6.	**A** ○	**B** ○	**C** ○	**D** ○
7.	**A** ○	**B** ○	**C** ○	**D** ○
8.	**A** ○	**B** ○	**C** ○	**D** ○
9.	**A** ○	**B** ○	**C** ○	**D** ○
10.	**A** ○	**B** ○	**C** ○	**D** ○

Students Name: ______________________________

Teachers Name: ______________________________

2025 Hurlstone Agricultural High School
Year 12
HSC Assessment Task 2

YEAR 12
Mathematics Advanced

Section II
(18 Marks)

Applications of Differentiation

- Answer each question in the space provided.
- Your responses should include relevant mathematical reasoning and/or calculations.

Question 11

(a) If $y = \dfrac{x^2}{x+1}$, find $\dfrac{dy}{dx}$ in simplest form. **2**

Question 11 continued on next page ....

(b) Find the set of values of x for which the function $y = \dfrac{x^2}{x+1}$, is increasing. **2**

Question 12

Consider the curve given by $y = -x^3 + 6x^2 - 1$ for $-2 \le x \le 6$.

(a) Find the coordinates of the stationary points and determine their nature. **3**

Question 12 continued on next page ....

(b) Find the point/s of inflection. **2**

Question 12 continued on next page ....

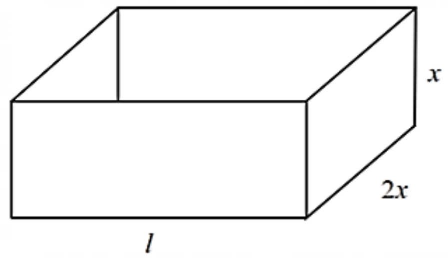
Question 12 continued ...

(c) Sketch the curve $y=-x^3+6x^2-1$ for $-2 \le x \le 6$ showing all important features. **3**

(x-intercepts not required)

Question 13

A factory produces boxes in the shape of an **open** rectangular prism.



NOT TO SCALE

The length, height and width of the box are l cm, x cm and $2x$ cm respectively.

The factory uses k cm^2 of sheet metal to make the box, where k is a constant.

(a) Show that $l = \dfrac{k - 4x^2}{4x}$. **2**

Question 13 continued on next page ....

Question 13 continued ...

(b) Hence, find the maximum volume of the box that can be produced from a sheet of metal with an area of 1 200 cm^2. **4**

Question 13b continued on next page ....

Question 13b extra writing space ...

~ End of Section II ~

Section II Extra Writing Space **Please label the questions clearly.**

Question No. | | **Part** | |

Students Name: ______________________________

Teachers Name: ______________________________

2025 Hurlstone Agricultural High School
Year 12
HSC Assessment Task 2

YEAR 12
Mathematics Advanced

Section III
(15 Marks)

Series and Sequences and Graphing Techniques

- Answer each question in the space provided.
- Your responses should include relevant mathematical reasoning and/or calculations.

Question 14

The zoom function in a software package multiplies the dimensions of an image by 1.2.
In an image, the height of a building is 50 mm.
After the zoom function is applied once, the height of the building in the image is 60 mm.
After the second application, it is 72 mm.

(a) Calculate the height of the building in the image after the zoom function has been applied eight times. Give your answer to the nearest mm. **2**

(b) The building's height in an image must be greater than 400 mm. Starting from the original image, what is the minimum number of times the zoom function needs to be applied? **3**

Question 15

Consider the function $f\left(x\right)=\left(x+1\right)^{2}$.

Christian wants to **successively** apply the following transformations to the graph of $y=f(x)$ in the order shown below.

Transformation 1: Horizontal translation to the right by 2 units.

Transformation 2: Horizontal dilation by a factor of 2

Transformation 3: Vertical translation down by 4 units

Transformation 4: Reflection about the x-axis

(a) Write the equation of the function after the: **4**

first transformation: ....

....

....

....

second transformation: ....

....

....

....

third transformation: ....

....

....

....

final transformation: ....

....

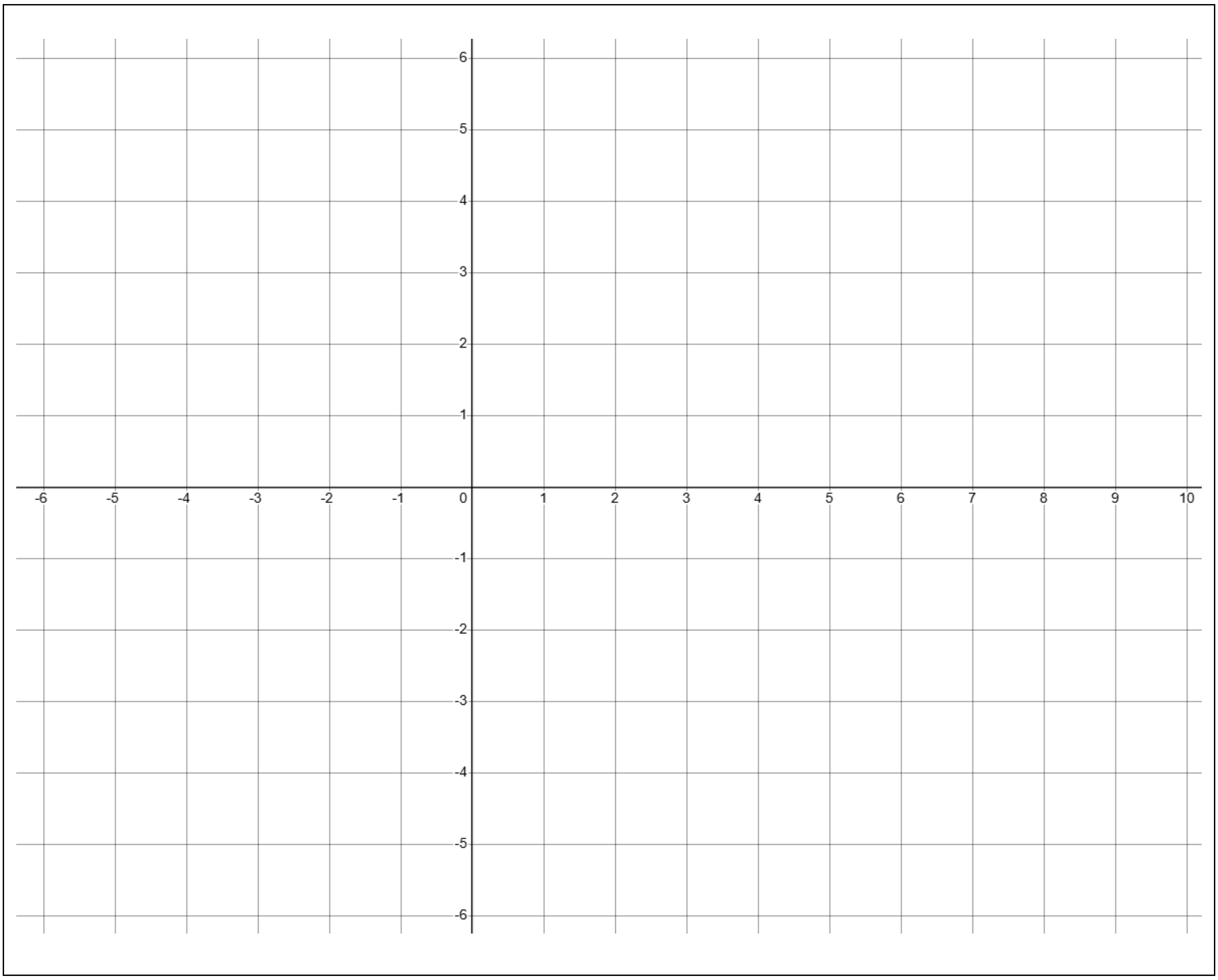
....

....

Question 15 continued on next page ....

Question 15 continued ...

(b) Sketch the graph of the function, after the final transformation, showing the location of the vertex and the intercepts. **2**



Question 16

It is given that $f(x)=|4x-3|$

(a) Sketch the graph of $f(x)$. **1**

(b) By using the graph or otherwise, determine all values of m such that $|4x-3|=mx$ has exactly 1 solution. **3**

~ End of Section III ~

Section III Extra Writing Space **Please label the questions clearly.**

Question No. | **Part**

Students Name: ______________________________

Teachers Name: ______________________________

Hurlstone Agricultural High School
Year 12
HSC Assessment Task 2

2025

YEAR 12
Mathematics Advanced

Section IV
(17 Marks)

Series and Sequences and Integral Calculus

- Answer each question in the space provided.
- Your responses should include relevant mathematical reasoning and/or calculations.

Question 17

Evaluate the integral of $f(x) = 6x^2 + 2x + 5$ between the function values $x = 0$ and $x = 3$. **2**

Question 18

Find $\int x\left(x^2+5\right)^9\ dx$. **3**

Question 19

Given that $f''(x) = 6x - 2$ and that there is a stationary point at $(1, 2)$ find $f(x)$. **4**

Question 20

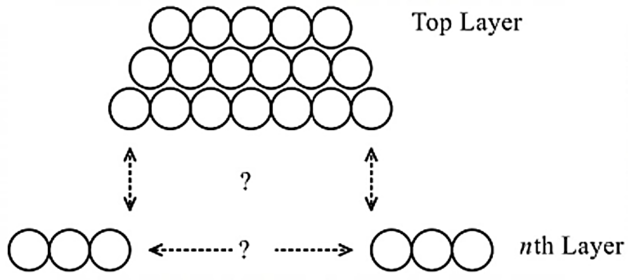
Given that P is a constant and $\int_1^5 (2Px+7)\,dx = 4P^2$, show that there are two possible values for P and find these values. **2**

Question 21

Find $\int (2x)^2 + \frac{\sqrt{x}+5}{x^2}\, dx$ **3**

Question 22

Shreyan works in a Moolworths store and he is making a stack of oranges against a sloping display panel.
The oranges are stacked in layers, as shown, where each later contains one orange less than the layer below it.



When Shreyan finishes, there are five oranges in the top layer, six in the next and so on.
There are n layers altogether.

(a) Show that there are $\frac{1}{2}n(n+9)$ oranges in the stack. **1**

(b) If Shreyan has 300 oranges to create the display, how many full rows can he create, if the top row still contains five oranges? **2**

~ End of Section IV ~

Section IV Extra Writing Page. **Please label the question clearly.**

Question No. | | **Part** | |

2025 Year 12 Assessment Tasks Extra Writing Page. **<u>Please label the questions clearly.</u>**

Question No.		**Part**	

2025 Year 12 Assessment Tasks Extra Writing Page. **<u>Please label the questions clearly.</u>**

Question No.		**Part**	

Year 12	HSC Mathematics Advanced	Assessment Task 2 2025

Section I Solutions and Answers

MC1

Concave down means $f''(x) < 0$

$$f'(x) = 6x^2 + 2x$$
$$f''(x) = 12x + 2$$
$$12x + 2 < 0$$
$$\therefore x < -\frac{1}{6}$$

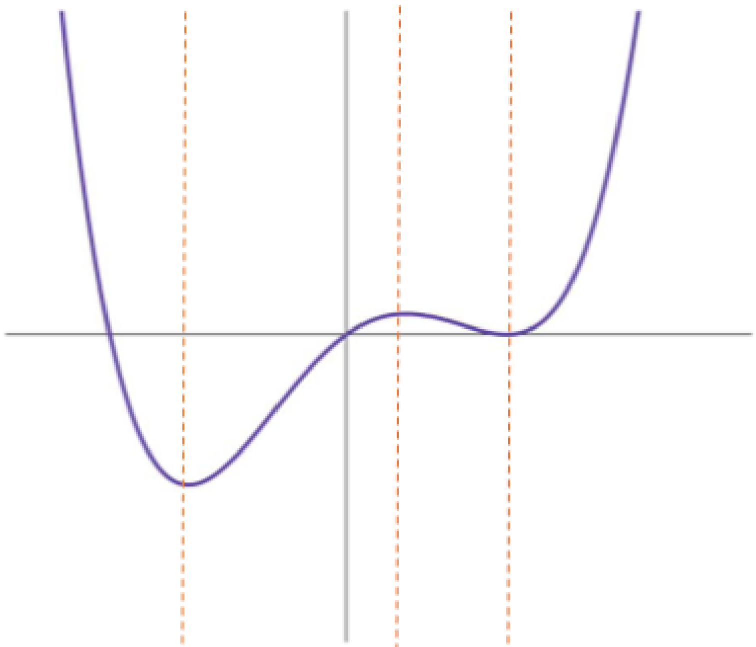
Answer: **(A)**

MC2

The graph shown is drawn below the x - axis between the marked interval $[a, b]$, hence $f(x)$ will have negative gradient.

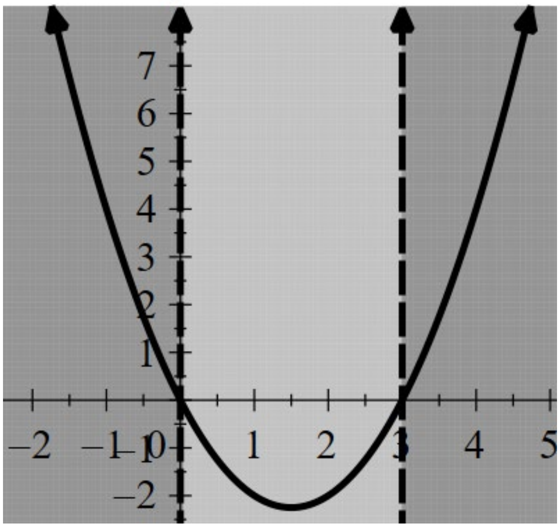
Answer: **(A)**

MC3



For $f(x)$:	negative gradient	positive gradient	negative gradient	positive gradient
For $f'(x)$:	below x axis	above x axis	below x axis	above x axis

Answer: **(B)**

MC4	$y = 4x^4 + 2x$ $\frac{dy}{dx} = 16x^3 + 2$ $\frac{d^2y}{dx^2} = 48x^2$ $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} = 48x^2 - 6\left(16x^3 + 2\right)$ $= 48x^2 - 96x^3 - 12$ $= 12\left(4x^2 - 8x^3 - 1\right)$ $= -12\left(-4x^2 + 8x^3 + 1\right)$ $= -12\left(8x^3 - 4x^2 + 1\right)$ Answer: **(B)**
MC5	$x^2 > 3x$ $x^2 - 3x > 0$ $x(x-3) > 0$ Drawing a diagram of $y = x(x-3)$,  We can see that $y > 0$ when $x < 0$ and $x > 3$ as indicated by the shading of the regions in the diagram above. Answer: **(B)**
MC6	The graph has an asymptote at $x < -2$. Hence it cannot be A or C, as its asymptote is at $x = -2$. It cannot be B, as its asymptote is at $x = 2$. Hence it can only be D, which has an asymptote at $x = -3$. Answer: **(D)**

MC7	$f(x) = -g(2x)$ $= -\sqrt{2(2x)-5}$ $= -\sqrt{4x-5}$ Answer: (**B**)
MC8	Let a be the number of cookies Rithwik eats on the first day $r = 3$ $S_{14} = 2\ 391\ 484$ Since it is a geometric progression, the sum of the n terms of a series is given by $S_n = \dfrac{a\left(r^n - 1\right)}{r-1}$ $2391484 = \dfrac{a\left(3^{14}-1\right)}{3-1}$ $a = \dfrac{2391484 \times 2}{3^{14}-1} = 1$ $\therefore$ on second day Rithwik could have eaten $1 \times 3 = 3$ cookies Answer: (**C**)
MC9	$\int_0^1 \sqrt{x^3}\ dx = \int_0^1 x^{\frac{3}{2}}\ dx$ $= \left.\dfrac{2}{5} x^{\frac{5}{2}}\right\|_0^1$ $= \dfrac{2}{5}$ Answer: (**A**)
MC10	$\int_1^4 f(x)\ dx = 2$ $\int_1^4 (2f(x)+3)\ dx = \int_1^4 2f(x)\ dx + \int_1^4 3\ dx$ $= 2\int_1^4 f(x)\ dx + \int_1^4 3\ dx$ $= 2\ (2) + 3(4-1)$ $= 4 + 9$ $= 13$ Answer: (**D**)

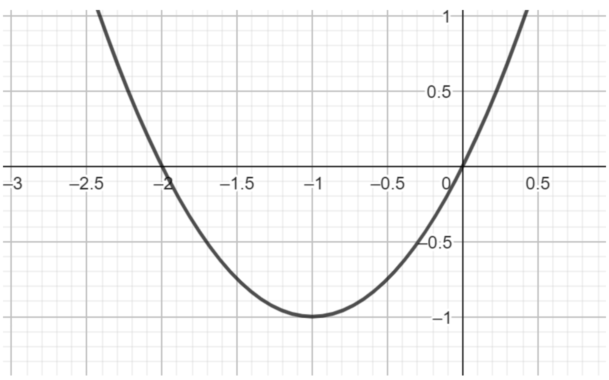
Year 12	HSC Mathematics Advanced	Task 2 2025

Section II Solutions and Marking Guidelines

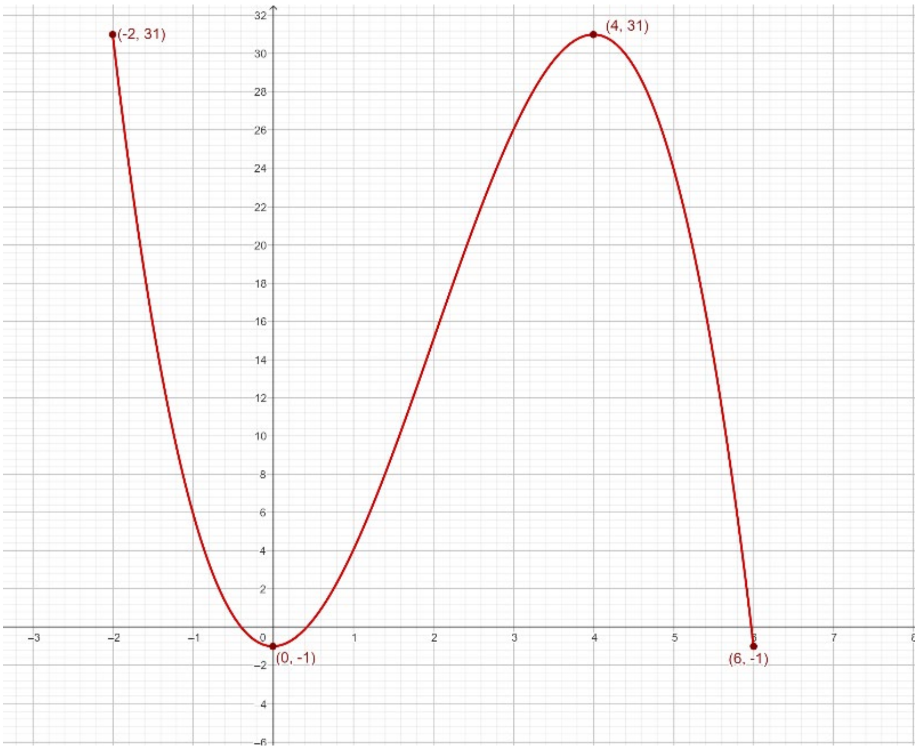
Outcomes Addressed in this Question:

MA12-3 applies calculus techniques to model and solve problems

MA12-6 applies appropriate differentiation methods to solve problems

Part	Solutions	Marking Guidelines
Q11 (a)	$y=\dfrac{x^2}{x+1}$ $\dfrac{dy}{dx}=\dfrac{2x(x+1)-(1)x^2}{(x+1)^2}$ $=\dfrac{2x^2+2x-x^2}{(x+1)^2}$ $=\dfrac{x^2+2x}{(x+1)^2}$ $=\dfrac{x(x+2)}{(x+1)^2}$	**2 marks –** correctly applies the quotient or the product rule and simplifies the expression without any errors **1 mark –** Substantially correct solution
Q11(b)	For $y=\dfrac{x^2}{x+1}$ to be increasing $\dfrac{dy}{dx}>0$ $\dfrac{x(x+2)}{(x+1)^2}>0$ $\because (x+1)^2$ is positive for all $x,$ the inequlaity sign doesnot get affected. $\therefore x(x+2)>0$  $\therefore x<-2$ or $x>0$	**2 marks –** correctly sets up the quadratic inequality and solves the inequality showing all necessary working out without any errors **1 mark –** Substantially correct solution.

Q12 (a)	$y=-x^3+6x^2-1$ $\frac{dy}{dx}=-3x^2+12x$ For stationary points $\frac{dy}{dx}=0$ $-3x^2+12x=0$ $-3x(x-4)=0$ $x=0$ or $x=4$ When $x=0, y=-1$ and when $x=4, y=-4^3+6(4)^2-1=31$ $\frac{d^2y}{dx^2}=-6x+12$ when $x=0$, $\frac{d^2y}{dx^2}=-6(0)+12=12>0 \Rightarrow$ curve concave up $\therefore (0,-1)$ is a local minimum stationary point. when $x=4$, $\frac{d^2y}{dx^2}=-6(4)+12=-12<0 \Rightarrow$ curve concave down $\therefore (4,31)$ is a local maximum stationary point.	**3 marks** – Correctly solves for the stationary points, identifies, justifies the nature of the stationary points and concludes by showing the coordinates of the stationary points without any errors **2 marks** – Substantially correct solution. **1 mark** – some correct working towards correct solution
Q12 (b)	Possible points of inflection where $\frac{d^2y}{dx^2}=0$ $-6x+12=0$ $-6x=-12$ $x=2$ When $x=2$, $y=-2^3+6(2)^2-1=15$ <table><tr><td>x</td><td>1</td><td>2</td><td>3</td></tr><tr><td>$\frac{d^2y}{dx^2}$</td><td>6</td><td>0</td><td>-6</td></tr></table> Changes concavity at $x=2$ $\therefore (2,15)$ is the point of inflection.	**2 marks** – correctly finding the point of inflection and justifying by showing concavity change around the point of inflection without any errors. Also, must include both coordinates of the point of infection. **1 mark** – Substantially correct solution

12(c)		**3 marks –** Correctly sketching and showing all turning points, end points including the correct shape and positioning of the point of inflection on their graph. **2 marks –** Substantially correct solution. **1 mark –** some correct working towards correct solution
Q13(a)	$k = 2lx + 2lx + 2(2x^2)$ $k = 4lx + 4x^2$ $4lx = k - 4x^2$ $l = \dfrac{k - 4x^2}{4x}$	**2 marks –** correctly writing out the formula of surface area k and showing working out to make l the subject of the equation without any errors **1 mark –** Substantially correct solution

Q13(b)	$V=2x^2l \qquad k=1200$ $=2x^2\left(\dfrac{1200-4x^2}{4x}\right)$ $=600x-2x^3$ $\dfrac{dV}{dx}=600-6x^2$ $\dfrac{d^2V}{dx^2}=-12x$ Possible maximum/minimum at $\dfrac{dV}{dx}=0$ $\therefore\ 600-6x^2=0$ $\therefore\ x=10\ (x>0 \because x$ represents a length) Test $x=10,\ \dfrac{d^2V}{dx^2}=-12\times10=-120<0$ $\therefore$ Maximum volume when $x=10$. and $\therefore$ Maximum volume $=2\times10^2\times\dfrac{1200-4(10)^2}{40}=4000\text{ cm}^3$	**4 marks** – Correctly writing the expression for volume in terms of x, differentiating to find the x coordinate of the possible maximum, justifying why it gives a maximum and finding the maximum volume without any errors in the solution. **3 marks** – Correct solution with only minor errors **2 marks** – Substantially correct solution. **1 mark** – some correct working towards correct solution

<table>
<tr><td>Year 12</td><td>Mathematics Advanced</td><td>Task 2 2025</td></tr>
<tr><td>Section III</td><td colspan="2">Solutions and Marking Guidelines</td></tr>
<tr><td colspan="3">Outcomes Addressed in this Question</td></tr>
<tr><td colspan="3">MA12-1: uses detailed algebraic and graphical techniques to critically construct, model and evaluate arguments in a range of familiar and unfamiliar contexts
MA12-4: applies the concepts and techniques of arithmetic and geometric sequences and series in the solution of problems</td></tr>
<tr><th>Outcome</th><th>Solutions</th><th>Marking Guidelines</th></tr>
<tr><td>MA12-4</td><td>Question 14a

Multiplication of dimensions – Geometric sequence

$r=1.2$

$T_1=a=50$
$T_2=ar=60$
$T_3=ar^2=72\ldots$

Hence, when zoom has been applied 8 times,
$T_9=ar^8=50(1.2)^8$

$=215$ (nearest mm)</td><td>2 marks
Substitutes correct values of a and r into the correct formula to obtain the correct answer

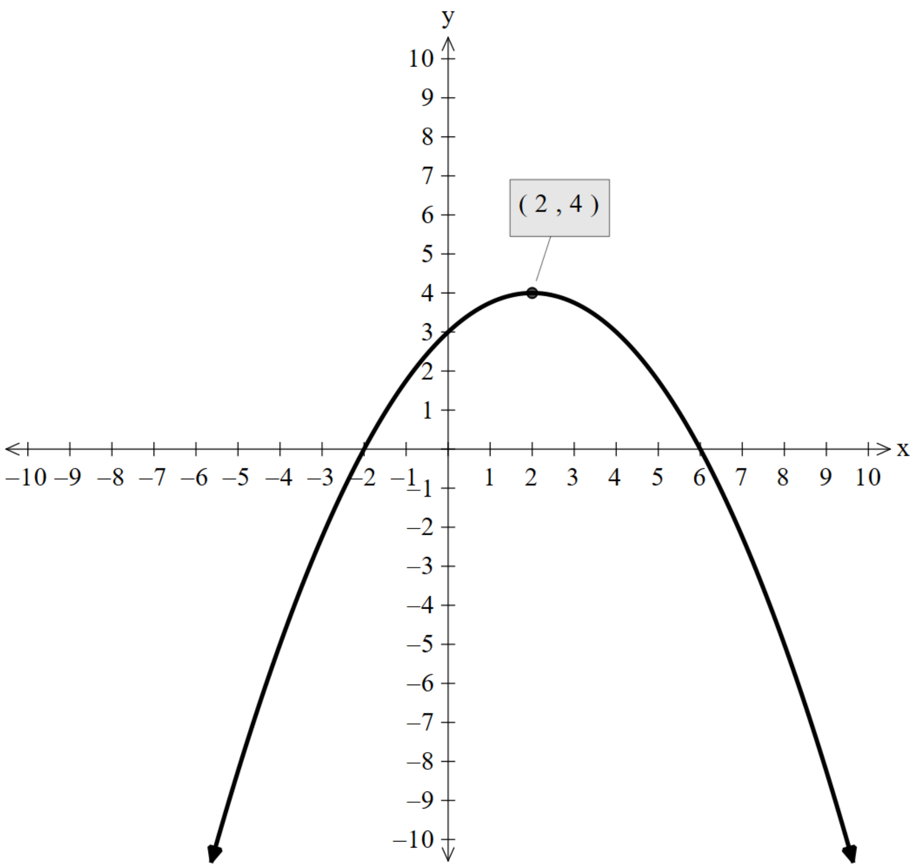
1 mark
Attempts to correctly use the term formula for a geometric progression</td></tr>
<tr><td>MA12-4</td><td>Question 14b
$T_n>400$
$ar^{n-1}>400$
$50(1.2)^{n-1}>400$
$\ln(1.2)^{n-1}>\ln 8$
$(n-1)\ln 1.2>\ln 8$
$n>\frac{\ln(8)}{\ln(1.2)}+1$
$n>12.405\ldots$
Hence the smallest integer of n that $T_n>400$ is $n=13$

This means 12 applications of zoom is required.</td><td>3 marks
Applies all logarithm laws correctly and correctly identifies the number of applications required or equivalent

2 marks
Applies logarithm laws correctly to determine all possible values of n or equivalent

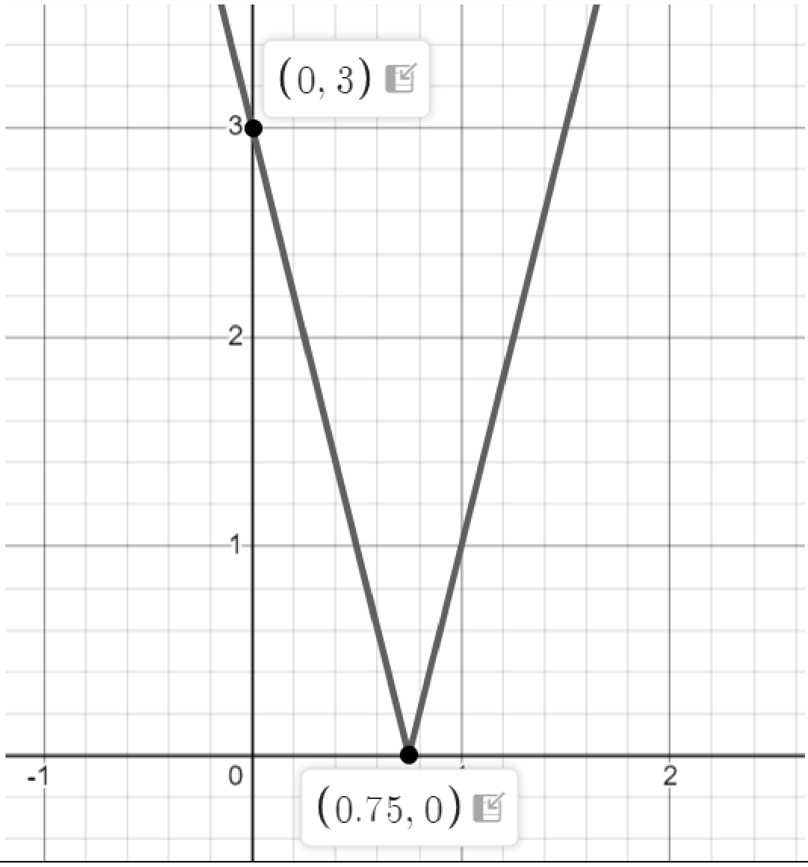
1 mark
Identifies that $50(1.2)^{n-1}>400$ or equivalent</td></tr>
</table>

MA12-1	**Question 15a** First transformation: $g(x) = f(x-2)$ $= ((x-2)+1)^2$ $= (x-1)^2$ Second transformation: $h(x) = g\left(\frac{x}{2}\right)$ $= \left(\frac{x}{2}-1\right)^2$ Third transformation: $i(x) = h(x) - 4$ $= \left(\frac{x}{2}-1\right)^2 - 4$ Fourth transformation: $j(x) = -i(x)$ $= -\left(\left(\frac{x}{2}-1\right)^2 - 4\right)$ $= -\left(\frac{x}{2}-1\right)^2 + 4$ or $4 - \left(\frac{x}{2}-1\right)^2$ Note: To attain full marks there is no need to have different names of each function as the subject, but it is done in the sample solutions to distinguish between the difference of each function after each successive transformation. Whilst the working out does not need to be shown to attain full marks, it is good practice in general to be using function notation to demonstrate each of the transformations.	**4 marks** Produces the correct equation for all 4 transformations **3 marks** Produces the correct equation for 3 transformations **2 marks** Produces the correct equation for 2 transformations **1 mark** Produces the correct equation for 1 transformation

<table>
<tr>
<td>MA12-1</td>
<td>Question 15b


</td>
<td>2 marks
Draws the correct graph after the final transformation stated in Question 15a

1 mark
Draws the correct graph after the final transformation stated in Question 15a with one error

Note that incorrect answers to Question 15a required labelling of non-integer intercepts to receive marks. Integer intercepts did not need to be labelled.</td>
</tr>
<tr>
<td>MA12-1</td>
<td>Question 16a


</td>
<td>1 mark
Correct graph with x-intercept labelled as $\frac{3}{4}$ and y-intercept labelled as 3</td>
</tr>
</table>

MA12-1	**Question 16b** $y = mx$ is a line passing through the origin (0, 0). For the line to touch the graph exactly once, there are three scenarios: • $m = 0$, as it cuts the point (3/4, 0) • $m < -4$, as at $m = -4$ it will be parallel to the left branch i.e. it doesn't cut it, but once $m < -4$ the line will get steeper and cut the left branch exactly once. • $m \geq 4$, as at $m = 4$ it is parallel to the right branch, so it'll cut at the left branch once, but when $0 < m < 4$ it cuts both branches. Once $m > 4$ the line will get steeper and cut the left branch exactly once. Note that there is no way to cut the right branch without the line passing through the graph twice. Hence the three solutions are: • $m = 0$ • $m < -4$ • $m \geq 4$	**3 marks** Correctly identifies all 3 solutions **2 marks** Correctly identifies 2 solutions **1 mark** Correctly identifies 1 solution

Year 12	HSC Mathematics Advanced	Assessment Task 2 2025

Section IV Solutions and Marking Guidelines

Outcomes Addressed in this Question

MA12-7: applies the concepts and techniques of indefinite and definite integrals in the solution of problems
MA12-10: constructs arguments to prove and justify results and provides reasoning to support conclusions which are appropriate to the context

Part	Solutions	Marking Guidelines
Q17	$\int_0^3 f(x)\ dx = \int_0^3 6x^2+2x+5\ dx$ $= \frac{6x^3}{3}+\frac{2x^2}{2}+5x\Big\|_0^3$ $= 2x^3+x^2+5x\Big\|_0^3$ $= 2(3)^3+(3)^2+5(3)-\left(2(0)^3+(0)^2+5(0)\right)$ $= 78$ **Marker's notes:** Students wrote the integral boundaries in wrong order i.e. $\int_3^0 f(x)\ dx$. Some substituted the boundaries in the wrong order after integration. Other arithmetic errors were also quite common.	**2 marks** – correct solution without any errors **1 mark** –Substantially correct solution.
Q18	$\int x\left(x^2+5\right)^9\ dx$ $\frac{d}{dx}\left(x^2+5\right)^{10} = 20x\left(x^2+5\right)^9$ Hence $\int 20x\left(x^2+5\right)^9 = \left(x^2+5\right)^{10} + c$ $\therefore\ \int x\left(x^2+5\right)^9\ dx\ = \frac{1}{20}\int 20x\left(x^2+5\right)^9\ dx$ $= \frac{1}{20}\left(x^2+5\right)^{10}+c$ **Marker's Notes:** Substitution method was also used. Overall done quite well. Some students expanded the function!!!!!	**3 marks** – Correct solution without any errors **2 marks** – Substantially correct solution. **1 mark** – some correct working towards correct solution
Q19	$f''(x)=6x-2$ $f'(x)=\int f''(x)\ dx$ $=\int 6x-2\ dx$ $f'(x)=3x^2-2x+c$	**4 marks** – Correct solution without any errors **3 marks** – Correct solution with only minor errors

	Stationary point at $(1,\ 2)$ means $f'(1)=0$ $f'(1)=3(1)^2-2(1)+c=0$ so $3-2+c=0$ $c=-1$ $\therefore\ f'(x)=3x^2-2x-1$ $f(x)=\int f'(x)\,dx$ $=\int 3x^2-2x-1\,dx$ $f(x)=x^3-x^2-x+b$ Stationary point $(1,\ 2)$ lies on the curve so $f(1)=2$ $f(1)=(1)^3-(1)^2-(1)+b=2$ $-1+b=2$ $b=3$ $\therefore\ f(x)=x^3-x^2-x+3$ **Marker's Notes:** Students forgot to add the + c after each integration and so then could not find the value of the constant of integration. Wrongly substituting the point (1,2) into $f'(x)$ to find the constant. Not realizing that first derivative is gradient and so at x = 1, y = 0 for the $f'(x)$ function. Integrating twice to get to $f''(x)$ without first finding the constant for $f'(x)$ first. Using the same constant variable for both	**2 marks** – Substantially correct solution. **1 mark** – some correct working towards correct solution
Q20	$\int_1^5 (2Px+7)\,dx = Px^2+7x\Big\|_1^5$ $=P(5)^2+7(5)-\left[P(1)^2+7(1)\right]$ $=25P+35-P-7$ $=24P+28$ $24P+28=4P^2$ $4P^2-24P-28=0$ $4\left(P^2-6P-7\right)=0$ $(P+1)(P-7)=0$ $P=-1$ or $P=7$ **Marker's Notes:** Arithmetic errors or incorrect integration due to not realizing that P is also a constant. incorrect substitution of the boundaries. Simple arithmetic mistakes.	**2 marks** – correct solution without any errors **1 mark** – Substantially correct solution

Q21	$\int (2x)^2 + \frac{\sqrt{x}+5}{x^2}\, dx$ $= \int 4x^2 + \frac{x^{\frac{1}{2}}}{x^2} + \frac{5}{x^2}\, dx$ $= \int 4x^2 + x^{-\frac{3}{2}} + 5x^{-2}\, dx$ $= \frac{4}{3}x^3 + \frac{x^{-\frac{1}{2}}}{-\frac{1}{2}} - 5x^{-1} + c$ $= \frac{4}{3}x^3 - 2x^{-\frac{1}{2}} - 5x^{-1} + c$ $= \frac{4}{3}x^3 - \frac{2}{\sqrt{x}} - \frac{5}{x} + c$ **Marker's Notes:** Not realising that the second term could be split into two easy to deal with fractions, which then could be simplified into index form for easy integration. Could not convert between surds to index form to make the term easier to integrate, incorrect arithmetic when simplifying powers or during integration process of adding +1 to power. Forgetting +c.	**3 marks** – Correct solution without any errors **2 marks** – Substantially correct solution. **1 mark** – some correct working towards correct solution

Q22 a)	$a = 5, d = 1$ $S_n = \frac{n}{2}\left(2(5)+(n-1)(1)\right)$ $= \frac{n}{2}(10+n-1)$ $= \frac{1}{2}n(n+9)$ as required **Marker's Notes:** Not showing all substitution or steps	**1 mark** – correct solution without any errors
Q22(b)	$S_n = \frac{1}{2}n(n+9)$ $300 = \frac{1}{2}n(n+9)$ $600 = n^2+9n$ $n^2+9n-600=0$ Using quadratic formula $n = 20.4 \quad or \quad n = -29.4$ $(\text{cannot be a solution})$ $\therefore \; n = 20.4$ Therefore Shreyan can create only 20 full rows. **Marker's Notes:** Making an inequality instead of equation. Simple arithmetic error. Not able to solve the quadratic equation to get 2 solutions or not showing the second solution or no justification of why only one solution was chosen. Not being able to interpret that 20.4 means only 20 full rows can be completed and not 21.	**2 marks** – correct solution without any errors **1 mark** – Substantially correct solution