Hurlstone Agricultural High School

STUDENT NAME

TEACHER NAME

2025 **YEAR 11 YEARLY EXAMINATION**

Mathematics Extension 1

General Instructions

- **SE**: PB, DP, GH, BH, MS
- Reading time – 10 minutes
- Working time – 90 minutes
- Write using black or blue 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
- Write your name and your teachers name at top of this page, Multiple Choice Answer Sheet and on all the Writing Booklets

Total marks: 64

Section I – 10 marks (pages 2–4)

- Attempt Questions 1–10
- Allow about 10 minutes for this section

Section II – 54 marks (pages 5–7)

- Attempt Questions 11–15
- Allow about 80 minutes for this section

Section I

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

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

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1 Consider the parametric equations:

$$x = 3t$$
$$y = -3t^2$$

The point $(-6, m)$ lies on the curve. Which of the following gives the value of m?

A. $m = -12$

B. $m = -2$

C. $m = 2$

D. $m = 12$

2 For what values of x is $|2x - 3| > 1$?

A. $1 < x < 2$

B. $x < -2$ and $x > 1$

C. $x < -1$ and $x > 2$

D. $x < 1$ and $x > 2$

3 The function $f(x) = x^2 - 3$ has an inverse function, $f^{-1}(x)$, in the domain $x \leq 0$.
What is the value of $f^{-1}(f(b))$, where b is a real number NOT in the domain $x \leq 0$?

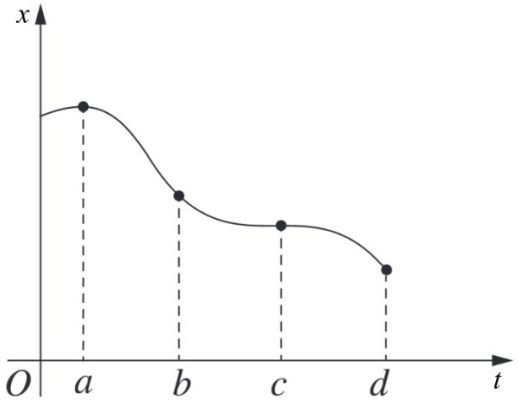
A. b

B. $-b$

C. $3 - b^2$

D. $b^2 - 3$

4 The diagram below shows the displacement of a particle over time, t.



When is the particle furthest from the origin?

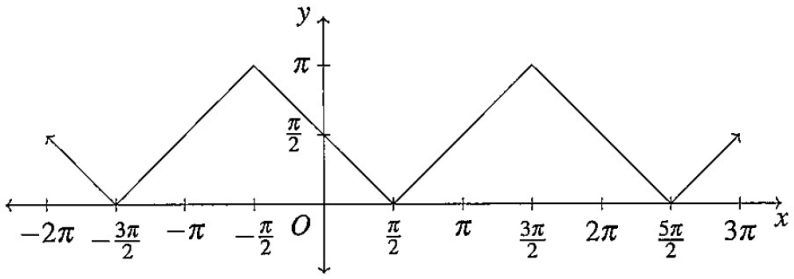
A. a

B. b

C. c

D. d

5 A function is graphed below:



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

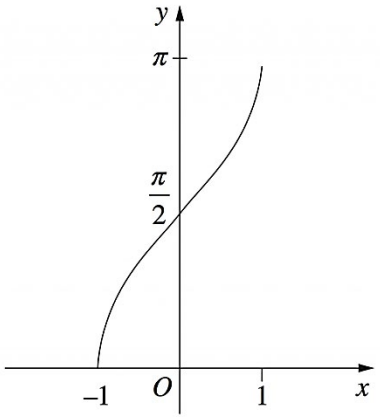
A. $y = \cos^{-1}(\sin x)$

B. $y = \cos(\sin^{-1} x)$

C. $y = \sin(\cos^{-1} x)$

D. $y = \sin^{-1}(\cos x)$

6 The diagram shows the graph of a function.



Which function does the graph represent?

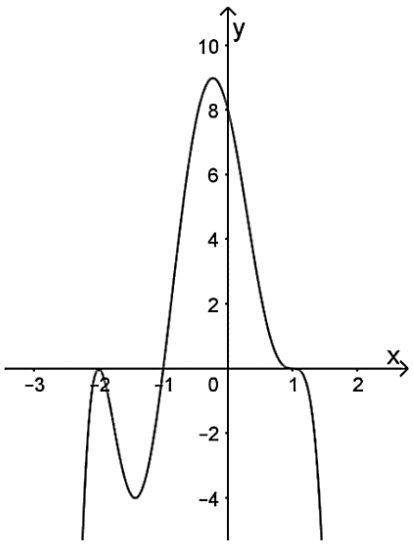
A. $y = \cos^{-1} x$

B. $y = \frac{\pi}{2} + \sin^{-1} x$

C. $y = -\cos^{-1} x$

D. $y = -\frac{\pi}{2} - \sin^{-1} x$

7 The diagram below shows the graph of $y = a(x+b)(x+c)^2(x+d)^3$.
What are the possible values of a, b, c and d?



A. $a = -2,\ b = 1,\ c = 2,\ d = -1$

B. $a = -2,\ b = -1,\ c = -2,\ d = 1$

C. $a = 8,\ b = 1,\ c = 2,\ d = -1$

D. $a = 8,\ b = -1,\ c = -2,\ d = 1$

8 What is the degree and leading coefficient of $f(x) = -x + 5x^2 - 6x^3 + 10$?

A. degree 1 with a leading coefficient of -1

B. degree 3 with a leading coefficient of 6

C. degree 3 with a leading coefficient of -6

D. degree 6 with a leading coefficient of -1

9 From a collection of 8 different books, how many possible arrangements are there for selecting and placing 5 of them on a shelf?

A. 8

B. 120

C. 6720

D. 40320

10 Aaron has a drawer containing 30 socks: 10 red, 10 blue, and 10 black. All socks are loose and indistinguishable by feel in the dark. What is the minimum number of socks Aaron must pull out to guarantee that at least four socks of the same colour are selected?

A. 9

B. 10

C. 11

D. 12

End of Section I

Section II

54 marks
Attempt Questions 11–15
Allow about 80 minutes for this section

Answer each question in the appropriate writing booklet. Extra writing paper is available.

For questions in Section II, your responses should include relevant mathematical reasoning and/or calculations.

Question 11 (10 marks) Use the Question 11 Writing Booklet

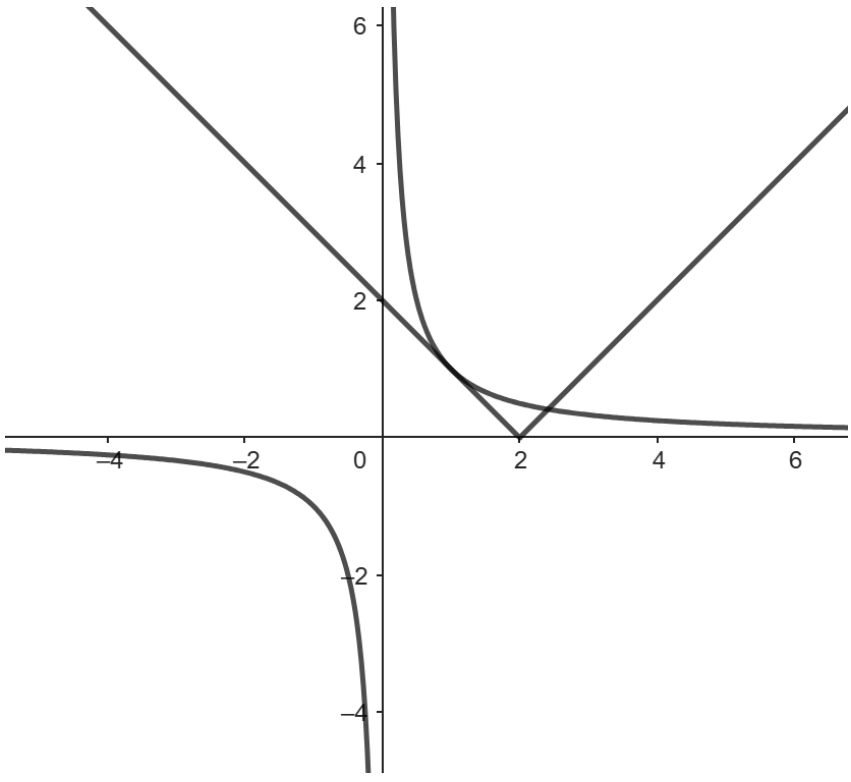
(a) Find the Cartesian equation of the following curve with the parametric equations:

$$x = \cos\theta \text{ and } y = 3\sin\theta.$$ **1**

(b) Solve the inequality $\dfrac{x}{x+3} \geq -2$. **3**

(c) The graph below shows $y = |x-2|$ and $y = \dfrac{1}{x}$, intersecting at two points.

Solve $|x-2| > \dfrac{1}{x}$. **2**

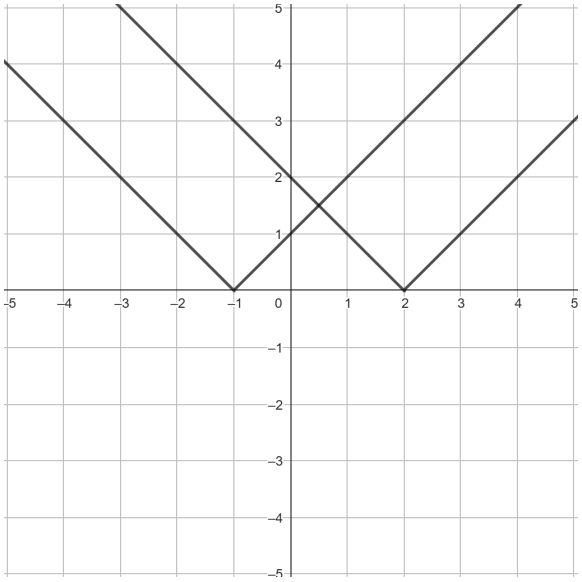


Question 11 continued on next page …

Question 11 continued …

(d) The graph below shows $y = |x-2|$ and $y = |x+1|$

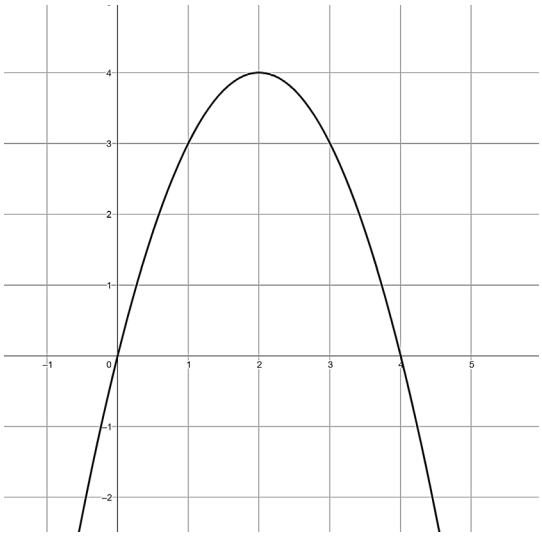
On the number plane **provided in the answer booklet**, sketch $y = |x-2| - |x+1|$. **2**



(e) The graph shown is $y = 4x - x^2$.

On the number plane **provided in the answer booklet**,

sketch the graph of $y^2 = 4x - x^2$. **2**



End of Question 11

Question 12 (10 marks) Use the Question 12 Writing Booklet

(a) A particle is moving in a straight line. At time t seconds its position x metres is given by $x = \dfrac{1}{1+t}$.

i) Find the velocity at time $t = 2$. **2**

ii) What is the range of the particle's displacement? **1**

(b) A particle is moving in a straight line so that at time t seconds, the distance from a fixed point is given by $x = t^4 - 2t^2 + 1$ for $t \geq 0$.
When is the acceleration 8 units per second squared? **3**

(c) With the aid of a diagram, explain why $y = x^2$ with a domain $0 \leq x \leq 4$ has an inverse. **2**

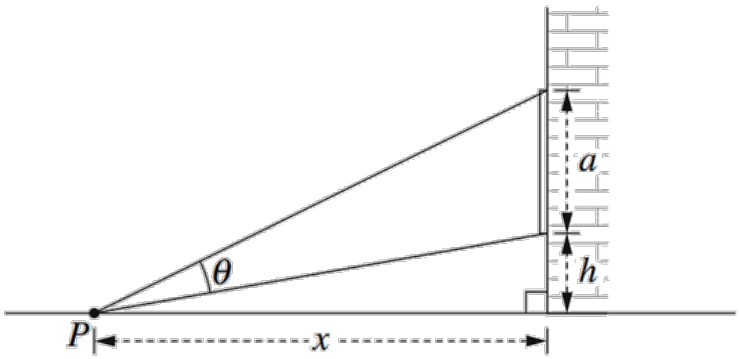
(d) Let $f(x) = e^{x^2}$.
Find a formula for $f^{-1}(x)$ if the domain of $f(x)$ is restricted to $x \geq 0$. **2**

End of Question 12

Question 13 (10 marks) Use the Question 13 Writing Booklet

(a) State the domain of $y = \cos^{-1}(3x)$. **1**

(b) A billboard of height a metres is mounted on the side of a building, with its bottom edge h metres above street level. The billboard subtends an angle θ at the point P, x metres from the building, as shown in the diagram below.

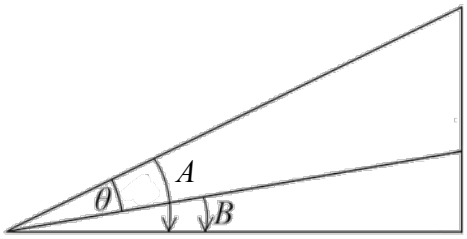


Angelita knows the following:

- the height of the billboard is 3 metres
- the height from the ground to the bottom of the billboard is 2 meters
- the horizontal distance from building to point P is 4 metres

(i) Angelita draws the following diagram to help her in finding the angle θ.

Find the values of $\tan A$ and $\tan B$. **2**



(ii) Hence, or otherwise show that $\theta = \tan^{-1}\left(\frac{6}{13}\right)$ **2**

Question 13 continued on next page …

Question 13 continued …

(c) **On the grid provided in the answer booklet,** sketch the graph of $y = 4\tan^{-1} x$, clearly indicating the range. **2**

(d) **On the grid provided in the answer booklet** sketch the graph of $y = 2\sin^{-1}(x+1)$, clearly indicating the endpoints of the curve**.** **3**

End of Question 13

Question 14 (12 marks) Use the Question 14 Writing Booklet

(a) When $P(x) = 2ax^3 + (a+1)x - 6$ is divided by $x+2$ the remainder is 2.
What is the value of a? **2**

(b) By using the method of long division, divide the polynomial $P(x) = x^4 + 11x^2 - 1$ by $(x+3)$.
Write your answer in the form $P(x) = Q(x)A(x) + R(x)$. **4**

(c) The polynomial $P(x) = x^3 - x^2 - 8x + 12$ has a root of multiplicity 2.

(i) Find the root of multiplicity 2 of $P(x) = 0$, show working out to support your answer. **2**

(ii) Hence or otherwise solve $P(x) = 0$. **2**

(d) The roots of the polynomial $P(x) = x^2 - 7x + 4$ are α and β.
Find the value of $\alpha^2 + \beta^2$. **2**

End of Question 14

Question 15 (12 marks) Use the Question 15 Writing Booklet

(a) How many different words can be formed from the letters of the word "PEPPER":

(i) if there are no restrictions **2**

(ii) if the Ps cannot be together **2**

(b) A manufacturing company performs a quality control analysis on the ceramic tiles it produces. It produces the tiles in batches of 24 tiles. In the quality control analysis, the company tests 3 tiles per batch.

Suppose a batch of 24 tiles has 4 defective tiles.

(i) In how many ways can the company select 3 tiles from the batch of 24 for testing? **1**

(ii) What is the probability that exactly 1 of the 3 tiles tested is defective? **2**

(iii) If at least one of the tiles in the batch is defective, the company will not ship the batch.

What is the probability the batch is not shipped? **2**

(c) How many 3-digit even numbers can be made using the digits 0, 1, 2, 3, 4, 6, and 7 if no digit is repeated? **3**

End of Question 15

END OF EXAMINATION

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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

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

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

Financial Mathematics

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

Sequences and series

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

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

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

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

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

Functions

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

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

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

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

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

Relations

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

Logarithmic and Exponential Functions

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

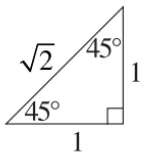
$$\log_a x = \frac{\log_b x}{\log_b a}$$

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

Trigonometric Functions

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

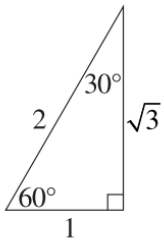
$$A = \frac{1}{2}ab\sin C$$



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

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

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



$$l = r\theta$$

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

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

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

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

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

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

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

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

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

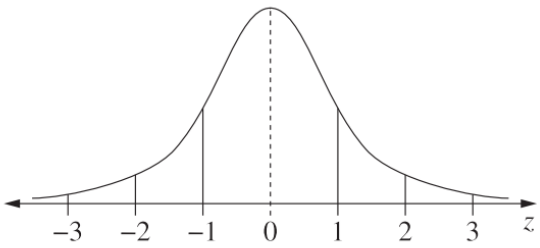
$$\cos^2 nx = \frac{1}{2}(1 + \cos 2nx)$$

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

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

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

Binomial distribution

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

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

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

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

$$E(X) = np$$

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

Differential Calculus

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

Integral Calculus

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

where $n \neq -1$

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

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

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

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

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

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

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

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

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

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

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

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

Combinatorics

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

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

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

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

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

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

Mechanics

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

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

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

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

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2025 YEAR 11 YEARLY EXAMINATION

Mathematics Extension 1

Section I – Multiple Choice Answer Sheet

Allow about 10 minutes for this section

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

A ⊗ B ⊗ (correct) C ○ D ○

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 ○