Name:…….....

Student Number:

Teacher's Name:…….....

Pymble Ladies' College

Mathematics Advanced
HSC Trial Examination
Term 3 2025

General Instructions

- Reading time – 10 minutes
- Working time – 3 hours
- Write using non-erasable 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 or calculations

Total marks 100

Section 1 – 10 marks (pages 1-4)

- Attempt Questions 1-10
- Allow about 15 minutes for this section

Section II – 90 marks (pages 7-31)

- Attempt Questions 11-31
- Allow about 2 hours and 45 minutes for this section

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Mathematics Advanced

HSC Trial Examination 2025

Name:…….....

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Section I – Multiple Choice Answer Sheet

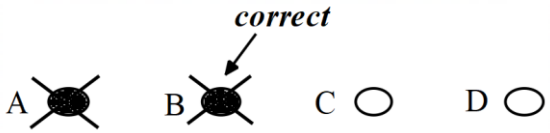
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

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.

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.



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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 ○

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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

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1 Which expression is equivalent to $\left(\frac{2x}{5}\right)^{-3}$?

(A) $\frac{8x^3}{125}$

(B) $\frac{125x^3}{8}$

(C) $\frac{125}{8x^3}$

(D) $\frac{8}{125x^3}$

2 A curve with equation $y = f(x)$ passes through the point $(3,7)$. Given $f'(3) = 0$, what is the equation of the normal to the curve at $(3,7)$?

(A) $y = \frac{7}{3}x$

(B) $y = 0$

(C) $x = 3$

(D) $x = 7$

3 A and B are mutually exclusive events. Which of the following statements must be correct?

(A) $P(A \cup B) = P(A) \times P(B)$

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

(C) $P(A \cap B) = 0$

(D) $P(A \cap B) = 1$

4 What is the domain of the function $f(x) = \dfrac{1}{\sqrt{x^3 - 1}}$?

(A) $x \in [-1, 1]$

(B) $x \in (-\infty, -1] \cup [1, \infty)$

(C) $x \in (-1, 1)$

(D) $x \in (1, \infty)$

5 In a group of 100 students, 35 play basketball, 38 play hockey and 30 do not play either basketball or hockey.
How many students play both basketball and hockey?

(A) 70

(B) 3

(C) 27

(D) 33

6 If $y = \sqrt{x^2 + 8}$ what is an expression for $\dfrac{dy}{dx}$?

(A) $\dfrac{dy}{dx} = \sqrt{2x}$

(B) $\dfrac{dy}{dx} = \dfrac{x}{2\sqrt{x^2 + 8}}$

(C) $\dfrac{dy}{dx} = \dfrac{2x}{\sqrt{x^2 + 8}}$

(D) $\dfrac{dy}{dx} = \dfrac{x}{\sqrt{x^2 + 8}}$

7 A and B are two independent events such that $P(\overline{A} \cap B) = 0.4$ and $P(B) = 0.5$.

What is the value of $P(A)$?

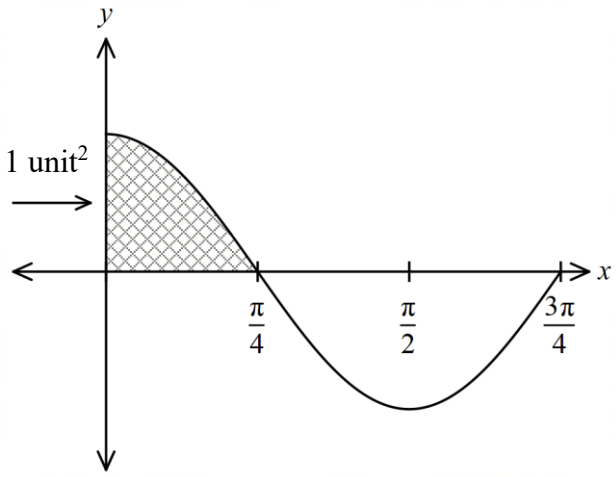
(A) 0.1

(B) 0.2

(C) 0.3

(D) 0.4

8 The diagram shows part of the graph $f(x) = a\cos bx$.



The area of the shaded region is equal to 1 unit^2. What is the value of $\int_0^{\frac{3\pi}{4}} f(x)\,dx$?

(A) −2

(B) −1

(C) 1

(D) 3

9 The graph of $y = \dfrac{5}{x+2}$ is translated 4 units to the right then dilated vertically by a factor of $\dfrac{1}{2}$.

Which of the following gives the equation of the new function?

(A) $\dfrac{y}{2} = \dfrac{5}{x-2}$

(B) $2y = \dfrac{5}{x-4}$

(C) $2y = \dfrac{5}{x-2}$

(D) $\dfrac{y}{2} = \dfrac{5}{x-4}$

10 Let $h(x) = f(g(x))$, with $f(4) = 1$, $f'(4) = 6$, $g(2) = 4$ and $g'(2) = 4$.

What is the equation of the tangent to the graph of $y = h(x)$ at $x = 2$?

(A) $y = x - 6$

(B) $y = 4x - 2$

(C) $y = 6x - 11$

(D) $y = 24x - 47$

End of Section I

Name……..……..

Student Number

Teacher's Name……..

Mathematics Advanced

Section II
Answer Booklet

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

Instructions

- Answer in the spaces provided. These spaces provide guidance for the expected length of the answer.
- Extra writing space is provided at the end of the paper. If you use the additional space, clearly indicate which question you are answering.
- Your responses should include relevant mathematical reasoning and/or calculations.

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Question 11 (5 marks)

Phoebe and Sophie's bakery sells bread rolls for \$0.80 each. The cost, C dollars, of making n bread rolls is given by $C = 300 + 0.2n$.

(a) How much does every 100 bread rolls made add to the cost of production? **1**

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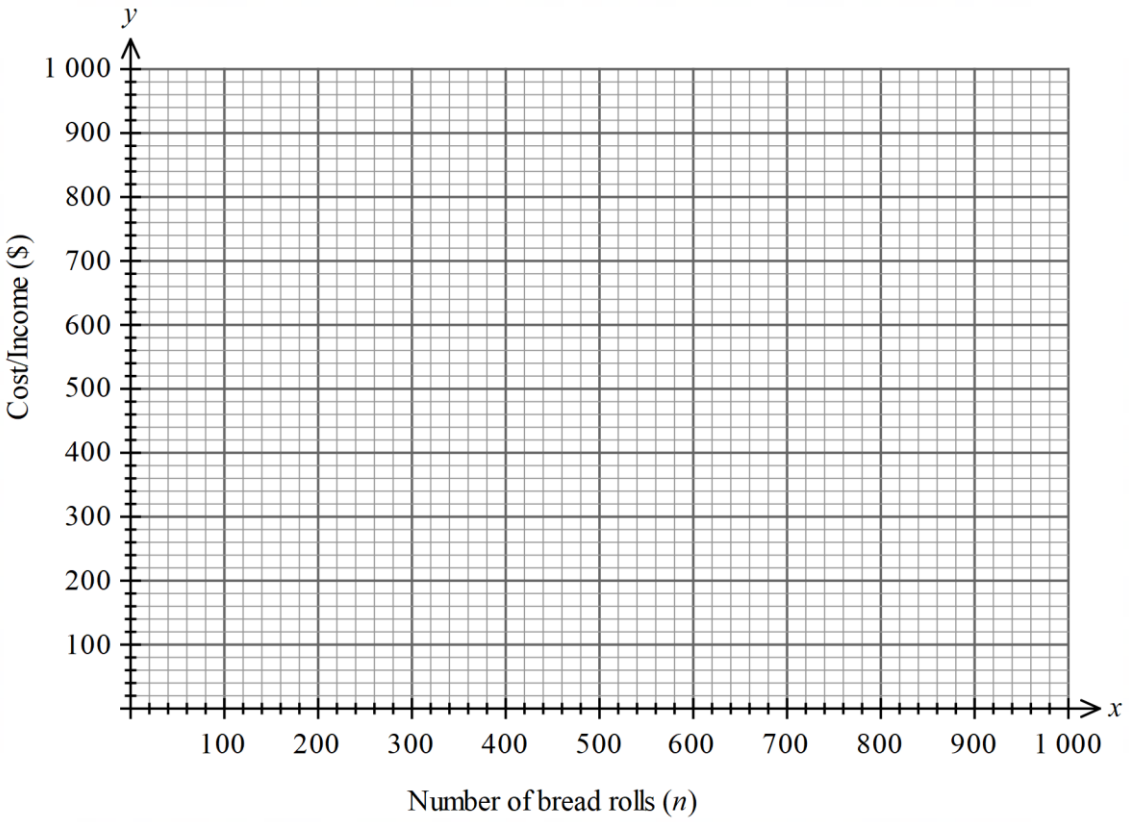
(b) On the grid below, draw the graphs of the cost, C, and the income, I. **2**



Hence, find the number of bread rolls that must be sold to break even.

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(c) How many bread rolls must be sold to make a profit of \$240? **2**

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Question 12 (3 marks)

Solve the equation **3**

$$2\log_{10} x = \log_{10} 4 + \log_{10}(x+8).$$

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Question 13 (3 marks)

The curve $y = x^2 - \frac{a}{x}$ has a stationary point at $(-3, b)$. **3**

Find the values of the constants a and b.

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Question 14 (3 marks)

Solve $\tan x + 2\sin x = 0,$ for $x \in [0, 2\pi]$. **3**

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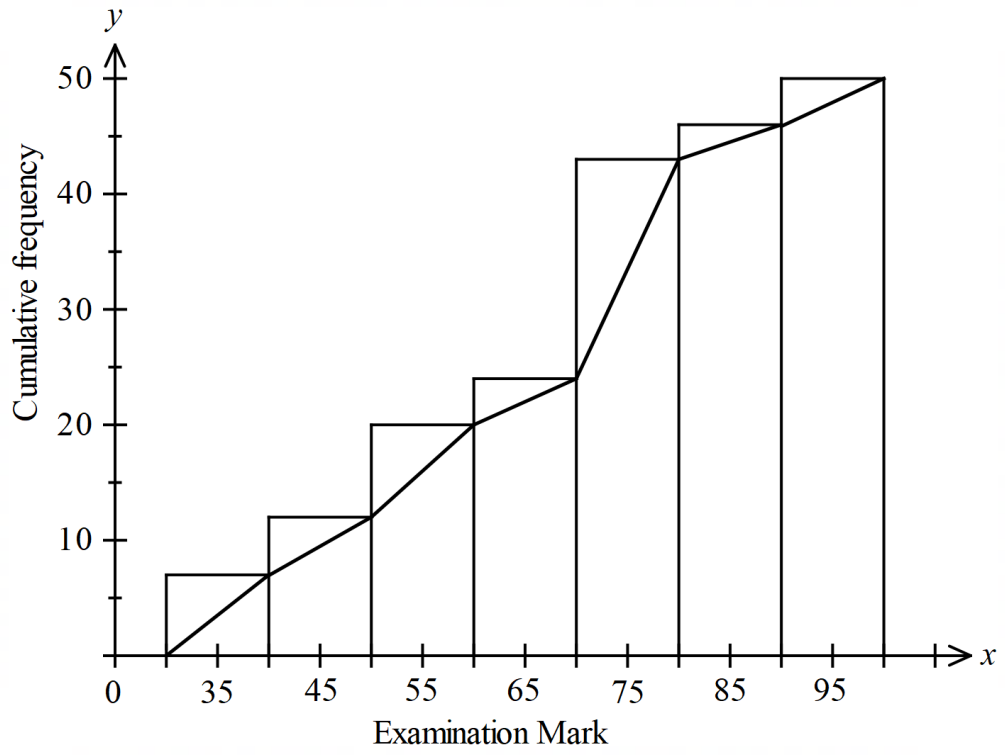
Question 15 (3 marks)

A set of examination results is displayed in a cumulative frequency histogram and polygon (ogive). The marks have been sorted into groups and the marks given on the diagram are class centres.



(a) Find the median examination mark. **1**

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(b) Estimate the percentage of students that achieved a mark below 45. **1**

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(c) A student knows that their mark is between the 6^{th} and 7^{th} decile. **1**
Give a possible examination mark for the student.

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Question 16 (4 marks)

(a) Given that $y = x\sqrt{x}$, find $\frac{dy}{dx}$. **1**

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(b) The line, L, has equation $6x - 2y + 5 = 0$. L is a tangent to the curve with equation $y = x\sqrt{x} + k$, where k is a constant. **3**

Find the value of k.

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Question 17 (4 marks)

Jessica has two types of coins in her money box. 20% of the coins are gold and 80% are silver. Jessica takes a coin from the money box, notes it's type and replaces it. She then takes a second coin and repeats the process.

(a) Find the probability that both coins are the same type. **2**

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(b) Find the probability that both coins are gold, given that at least one of the coins is gold. **2**

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Question 18 (6 marks)

A random sample of eight cars was selected from a large data set. The masses of these cars, in kilograms, were as follows:

950, 989, 1247, 1415, 1506, 1680, 1833, 2040

It is given that for the population of cars in the large data set, the lower quartile = 1167 kg, the median = 1393 kg and the upper quartile = 1570 kg.

(a) Are any of the cars from the sample of eight outliers? **2**
Justify your answer mathematically.

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The table shows the probability distribution of the number of previous owners, N, for a sample of cars taken from the large data set.

n	0	1	2	3	4	5	6 or more
$P(N = n)$	0.14	0.37	$0.9k$	0.25	$0.4k$	$1.7k$	0

(b) Find the value of k. **2**

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(c) Hence, find the value of $P(1 \leq N < 5)$. **2**

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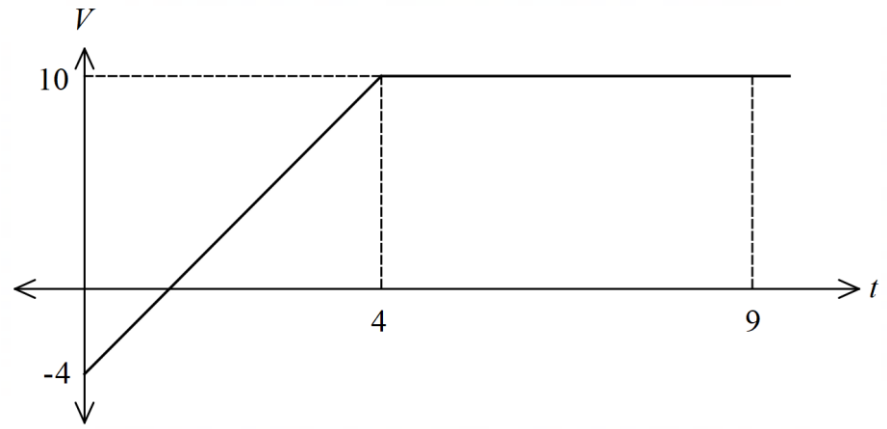
Question 19 (3 marks)

A particle is moving in a straight line such that it's velocity, V m/s, changes with respect to time, t seconds, as shown in the graph below.



(a) What is the acceleration of the particle over the first 4 seconds? **1**

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(b) The particle is initially at a fixed point P. What is the displacement of the particle from P when $t = 9$? **2**

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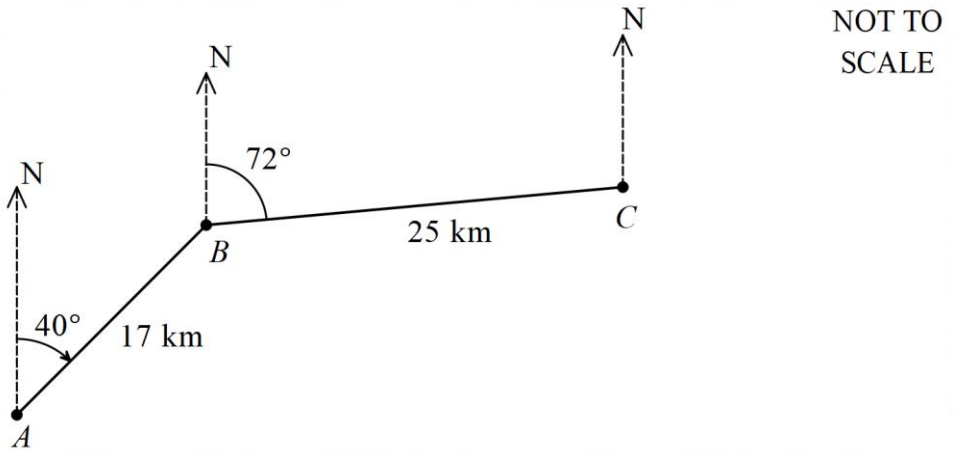
Question 20 (6 marks)

The positions of three towns *A, B* and *C* are shown below.



Town *A* and Town *B* are 17 km apart. Town *B* is on a bearing of $040°$ from Town *A*.
Town *B* and Town *C* are 25 km apart. Town *C* is on a bearing of $072°$ from Town *B*.

(a) Find the size of the obtuse angle *ABC*. **1**

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(b) What is the distance between Town *A* and Town *C*, correct to the nearest kilometre? **2**

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(c) What is the bearing of Town *A* from Town *C*? **3**

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Question 21 (6 marks)

Zarina buys a car for \$18 000 on 1st January 2023. The value of the car decreases exponentially. The car has a value of \$12 000 on 1st January 2025.

Zarina says "because the car has lost \$6000 after 2 years, after another 2 years, it will be worth \$6000".

Zarina's friend Sarah says "because the car has lost one-third of its value after 2 years, after another two years it will be worth \$8000".

(a) Explain whose statement is correct, using mathematical reasoning. **1**

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(b) The value of Zarina's car \$$V$, t years after 1st January 2023 may be modelled by by the equation **4**

$$V = Ae^{-kt}$$ where A and k are positive constants.

Find the value of t when the car has a value of \$10 000, giving your answer correct to 2 significant figures.

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Question 21 continues on page 17

Question 21 continued.

(c) Give a reason why the model will not be suitable to calculate the value of her car when $t = 30$. **1**

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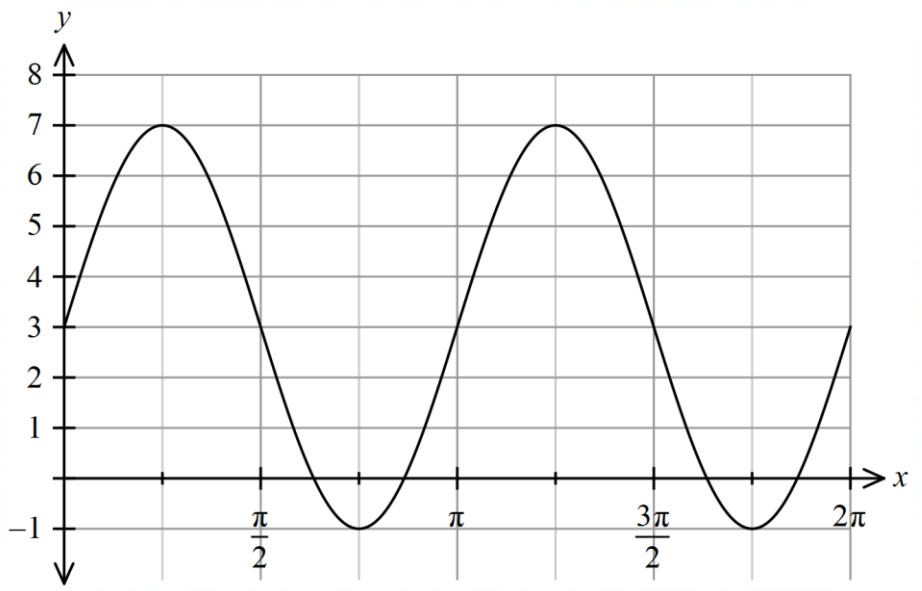
Question 22 (4 marks)



The diagram shows the curve with equation $y = a\sin(bx) + c$ for $0 \le x \le 2\pi$, where a, b and c are positive constants.

(a) State the values of a, b and c. **3**

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(b) For these values of a, b and c, determine the number of solutions in the interval $0 \le x \le 2\pi$ for $a\sin(bx) + c = 7 - x$. **1**

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Question 23 (4 marks)

The first term of an arithmetic series is -20 and the common difference is 5.

(a) Find the sum of the first 20 terms of the progession. **1**

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(b) It is given that the sum of the first $2k$ terms is ten times the sum of the first k terms. Find the value of k. **3**

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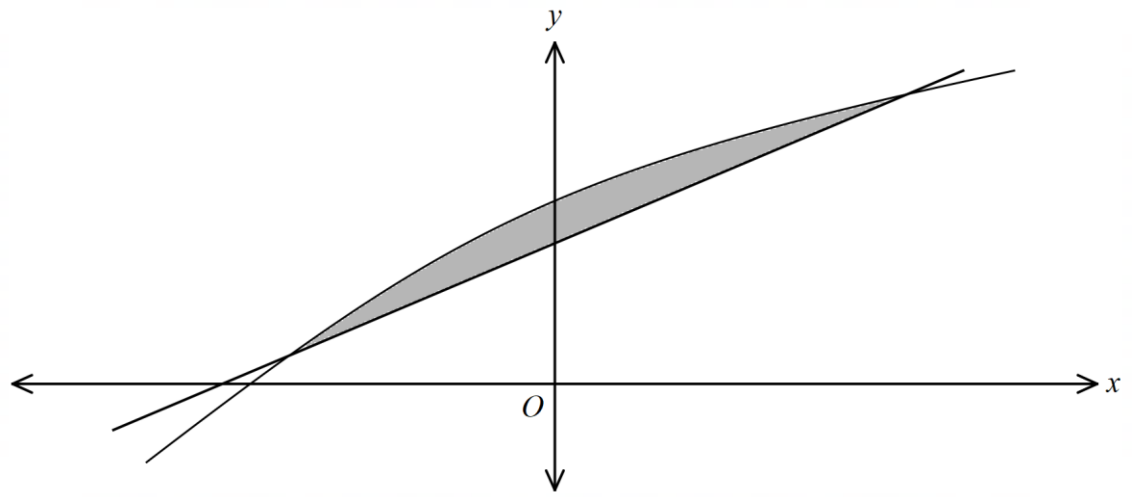
Question 24 (4 marks)



The diagram shows part of the curve with equation $y = -2x^2 + 8x + 11$ and the line with equation $y = 8x + 9$. **4**

Find the area of the shaded region.

Question 25 (3 marks)

The shoe size of women in a town is normally distributed with a mean size of 8 and a standard deviation of 1. **3**

A shoe shop in the town sells women's shoes ranging from size 5 to size 10.

Given that there are 4000 women in the town, how many would be expected to find shoes that fit them in this shop?

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Question 26 (5 marks)

A continouos random variable, x, has the following probability density function

$$f(x) = \begin{cases} \dfrac{A}{\sqrt{3x+1}} & 1 \le x \le 5 \ (\text{where } A > 0) \\ 0 & \text{otherwise} \end{cases}$$

(a) Show that the value of A is $\dfrac{3}{4}$. **3**

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Question 26 continues on page 23

Question 26 continued

(b) Given that $P(X < C) = 3P(X > C)$, find the value of C. **2**

Question 27 (7 marks)

Consider the curve $y=(x+2)^2(x-4)$.

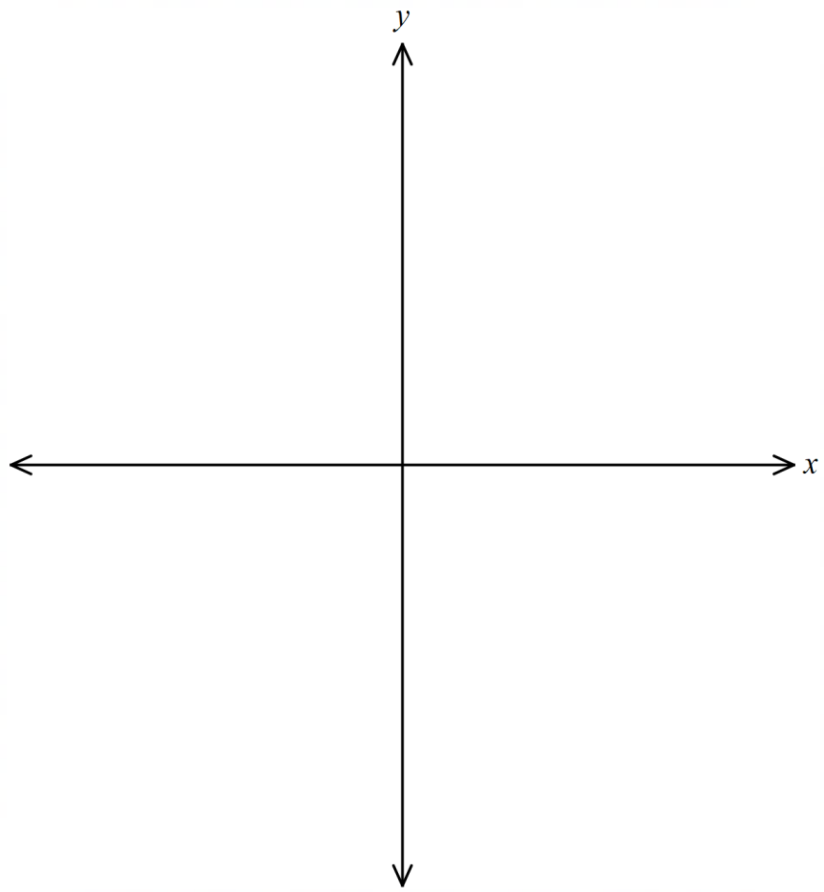
(a) Find the stationary points and determine their nature. **3**

(b) Show that $(0, -16)$ is a point of inflexion. **2**

Question 27 continues on page 25

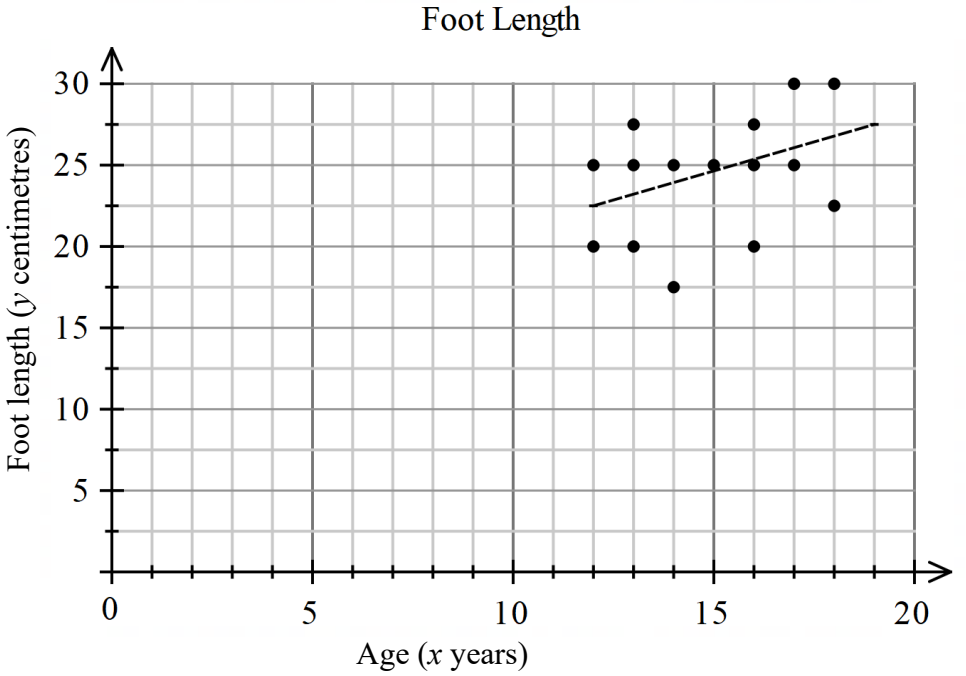
Question 27 continued.

(c) Sketch the curve showing all relevant features. **2**



Question 28 (4 marks)

For a sample of 15 high school students, their age in years, x, and the length of their right foot in centimetres, y, were recorded.



The graph shows the data as well as a regression line which passes through $(12, 22.5)$ and $(19, 27.5)$.

(a) Find the equation of the regression line in the form $y = mx + c$. **2**

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Question 28 continues on page 27

Question 28 continued

(b) Lisa has a five-year old brother whose right foot is 13 centimetres in length. **2**

She extends the line of best fit and notes that it predicts that a five-year old should have a foot length of approximately 17.5 centimetres.

Give two reasons why Lisa is incorrect to assume from the bivariate data that her brother has smaller than normal feet for a five-year old.

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Question 29 (2 marks)

Use two applications of the trapezoidal rule to find an approximate value of **2**

$$\int_1^2 \ln x \; dx \, .$$

Give your answer correct to 2 decimal places.

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Question 30 (6 marks)

(a) Show that $\int_1^a \left(6 - \frac{12}{\sqrt{x}}\right) dx = 6a - 24\sqrt{a} + 18.$ **2**

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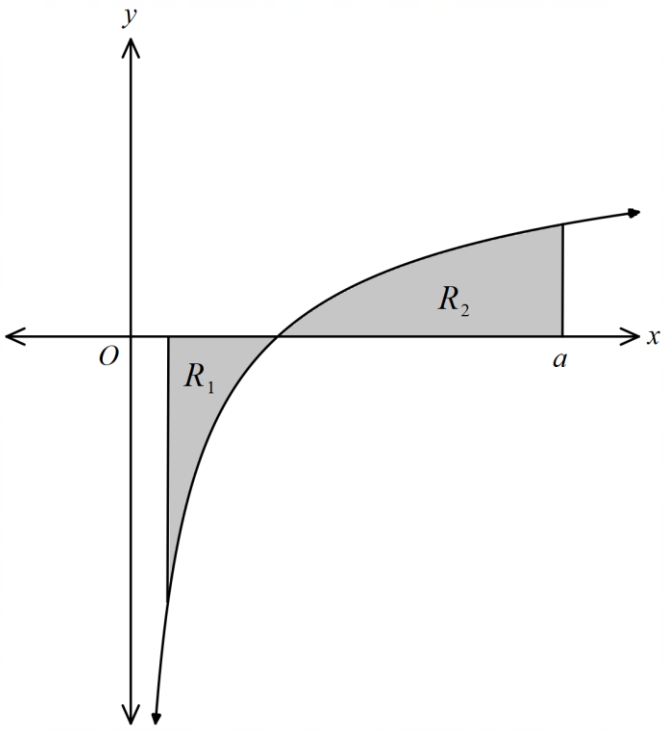
(b) The curve, $y = 6 - \frac{12}{\sqrt{x}}$, the line $x = 1$ and the line $x = a$ are shown on the diagram below. **4**

The shaded region R_1 is bounded by the curve, the line $x = 1$ and the x-axis.

The shaded region R_2 is bounded by the curve, the line $x = a$ and the x-axis.



Question 30 continues on page 29

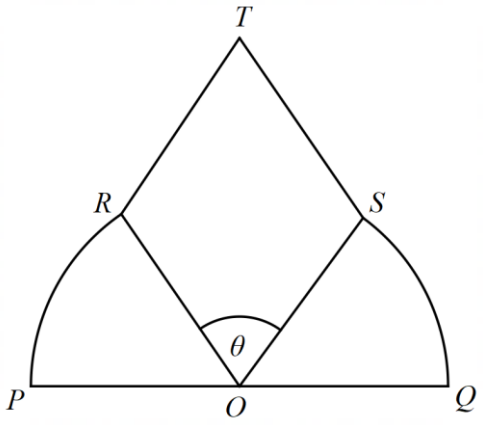
Question 30 continued.

Part (b)

It is given that the areas of R_1 and R_2 are equal.
Find the value of a. Justify your answer mathematically.

Question 31 (5 marks)

A new design for a company logo is to be made from two equal sectors of a circle, *ORP* and *OQS*, and a rhombus *OSTR*, as shown in the diagram below.



The points *P*, *O* and *Q* lie on a straight line and the angle *ROS* is θ radians.
A large copy of the logo, with $PQ = 5$ metres, is to be put on a wall.

(a) Show that the area of the logo, *A* square metres, is given by **2**

$$A = \frac{25}{8}(\pi - \theta + 2\sin\theta)$$

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Question 31 continued on page 31

Question 31 continued

(b) What value of θ will produce a maximum area for the logo. **3**
Fully justify your answer.

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NSW Education Standards Authority

HIGHER SCHOOL CERTIFICATE

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

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

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

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

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

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

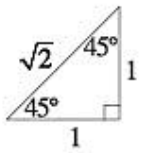
$$\log_a x = \frac{\log_b x}{\log_b a}$$

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

Trigonometric Functions

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

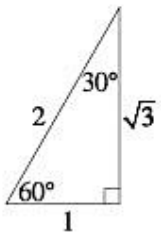
$$A = \frac{1}{2}ab\sin C$$



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

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

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



$$l = r\theta$$

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

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

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

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

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

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

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

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

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

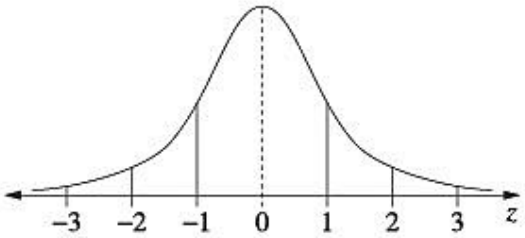
$$\cos^2 nx = \frac{1}{2}(1 + \cos 2nx)$$

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

$$E(X) = \mu$$

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

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

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

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

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

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

$$E(X) = np$$

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

Differential Calculus

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

Integral Calculus

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

where $n \neq -1$

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

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

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

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

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

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

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

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

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

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

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

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

Combinatorics

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

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

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

Vectors

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

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

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

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

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

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

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