



NSW Education Standards Authority

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Centre Number

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Student Number

2025 HIGHER SCHOOL CERTIFICATE EXAMINATION

Mathematics Advanced

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
- Write your Centre Number and Student Number at the top of this page

Total marks: 100

Section I – 10 marks (pages 2–8)

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

Section II – 90 marks (pages 9–40)

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

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.

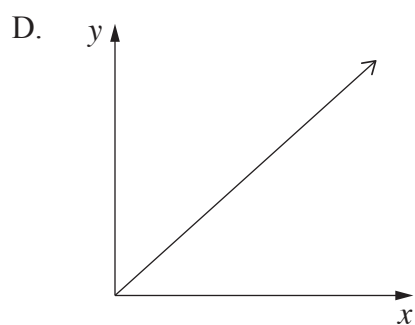
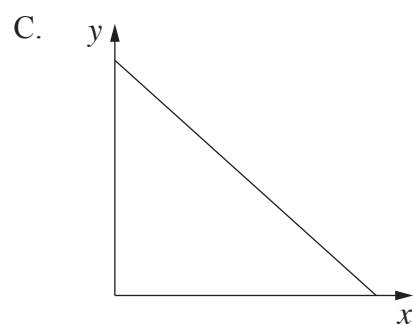
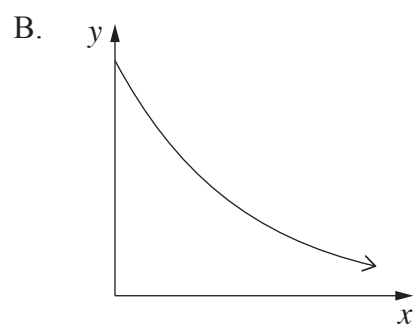
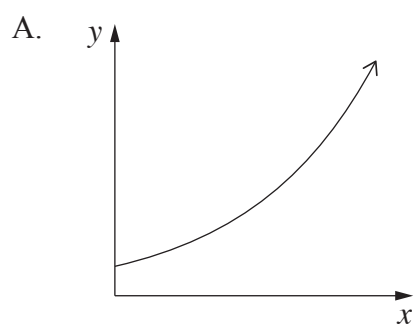
- 1** The probability distribution table for a discrete random variable X is shown.

x	$P(X = x)$
1	0.4
2	0.2
3	

What is the value of $P(X = 3)$?

- A. 0.2
- B. 0.4
- C. 1.2
- D. 2.0

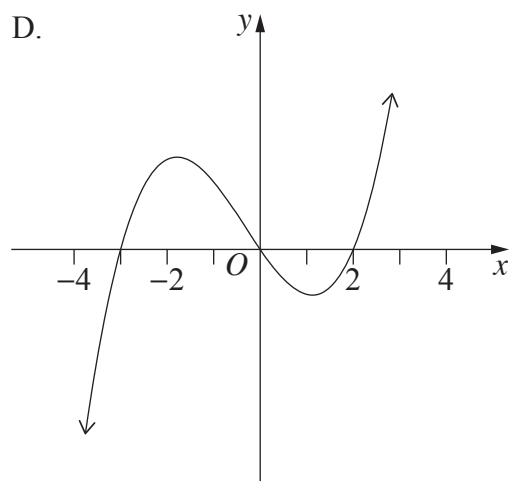
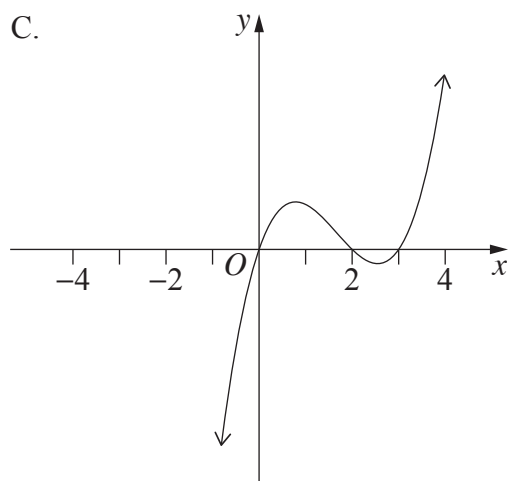
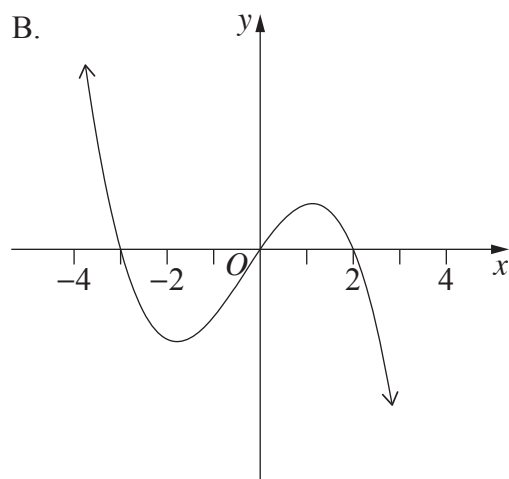
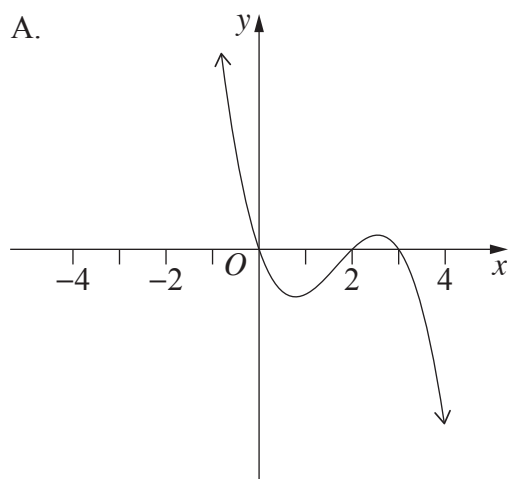
2 Which graph could represent $y = 4^x$?



3 What is the domain of the function $y = \sqrt{6 - x^2}$?

- A. $(0, \sqrt{6})$
- B. $[0, \sqrt{6}]$
- C. $(-\sqrt{6}, \sqrt{6})$
- D. $[-\sqrt{6}, \sqrt{6}]$

4 Which of the following best represents the graph of $y = -5x(x - 2)(3 - x)$?



5 What is $\int \frac{1}{\sqrt{x+5}} dx$?

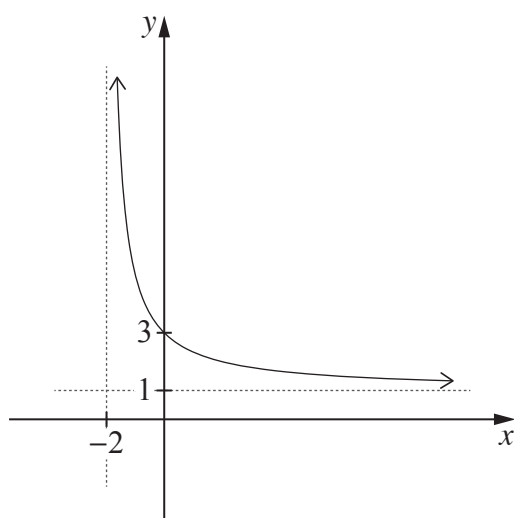
A. $\frac{1}{2}\sqrt{x+5} + C$

B. $2\sqrt{x+5} + C$

C. $-\frac{1}{2}\sqrt{x+5} + C$

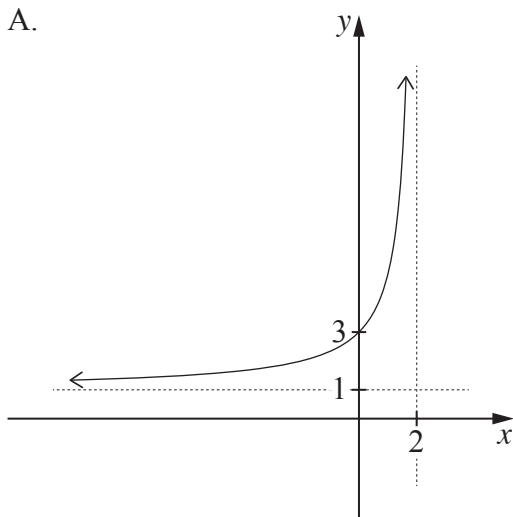
D. $-2\sqrt{x+5} + C$

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

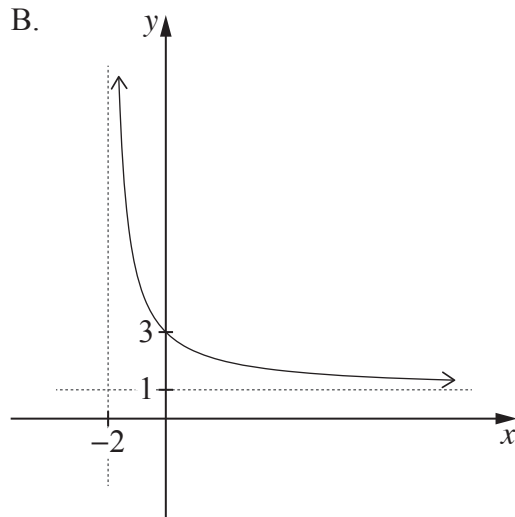


Which of the following is the graph of $y = -f(-x)$?

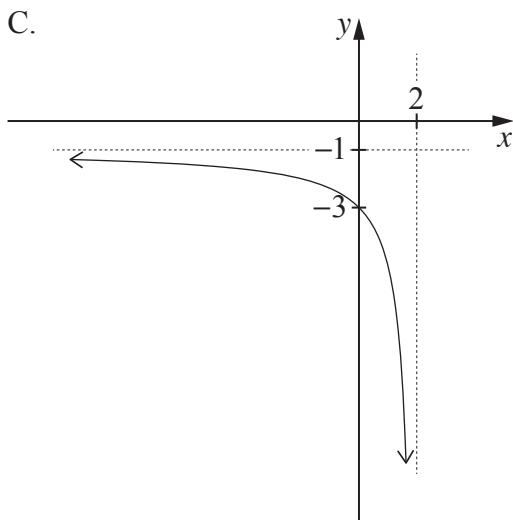
A.



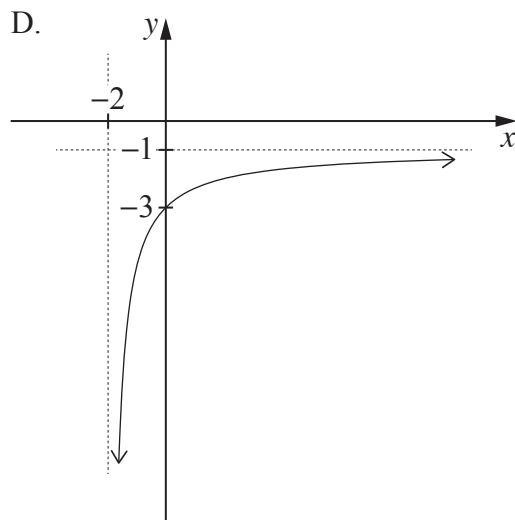
B.



C.



D.



- 7 A ten-sided die has faces numbered 1 to 10.

The die is constructed so that the probability of obtaining the number 1 is greater than the probability of obtaining any of the other numbers. The numbers 2 to 10 are equally likely to occur.

When the die is rolled 153 times, a 1 is obtained 72 times.

By using the relative frequency of rolling a 1, which of the following is the best estimate for the probability of rolling a 10?

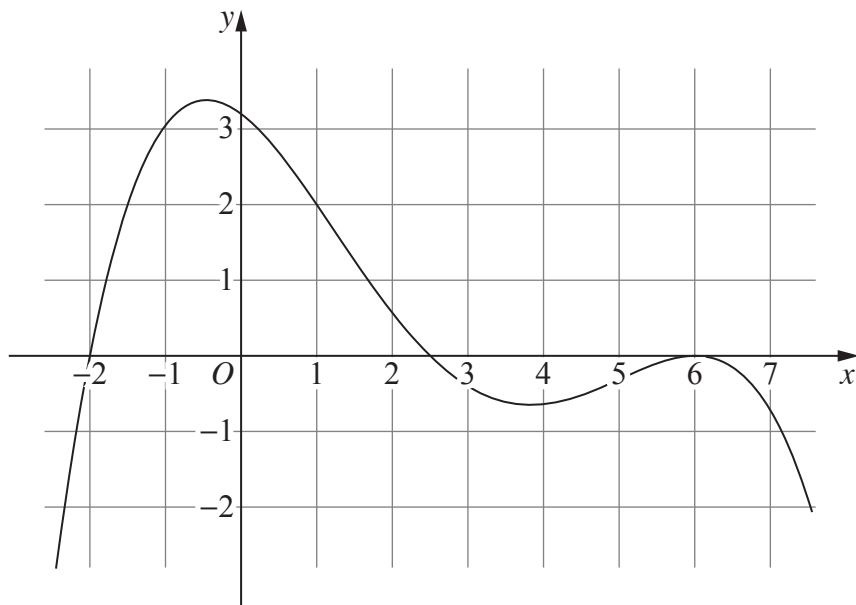
- A. $\frac{1}{17}$
- B. $\frac{1}{11}$
- C. $\frac{1}{10}$
- D. $\frac{1}{9}$

- 8 The minimum daily temperature, in degrees, of a town each year follows a normal distribution with its mean equal to its standard deviation. The minimum daily temperature was recorded over one year.

What percentage of the recorded minimum daily temperatures was above zero degrees?

- A. 16%
- B. 50%
- C. 68%
- D. 84%

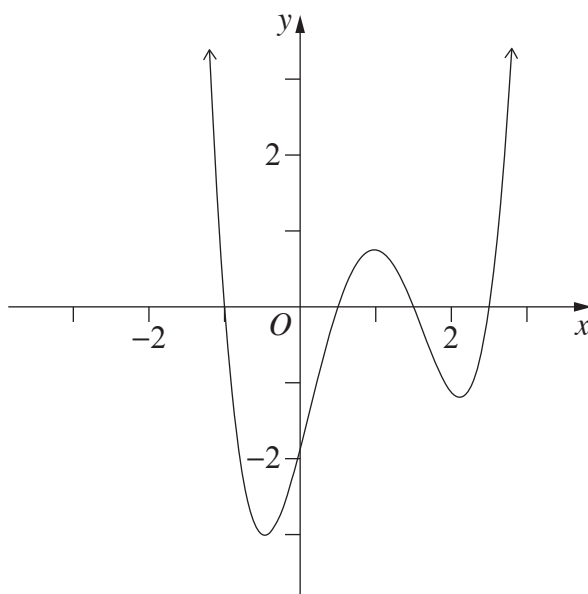
- 9 The diagram shows the graph of $y = f'(x)$.



Given $f(1) = 6$, which interval includes the best estimate for $f(1.1)$?

- A. $[6.2, 6.4)$
- B. $[6.0, 6.2)$
- C. $[5.8, 6.0)$
- D. $[5.6, 5.8)$

- 10 The graph of $y = f(x)$, with all its stationary points, is shown.



How many stationary points does the graph of $y = f(e^x)$ have?

- A. 0
- B. 1
- C. 2
- D. 3

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Centre Number

Mathematics Advanced

Section II Answer Booklet

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Student Number

90 marks

Attempt Questions 11–31

Allow about 2 hours and 45 minutes for this section

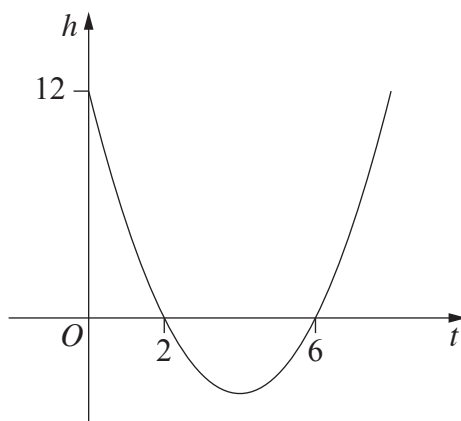
Instructions

- Write your Centre Number and Student Number at the top of this page
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response
- Your responses should include relevant mathematical reasoning and/or calculations
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering

Please turn over

Question 11 (3 marks)

The graph of a quadratic function represented by the equation $h = t^2 - 8t + 12$ is shown.



- (a) Find the values of t and h at the turning point of the graph.

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- (b) The graph shows $h = 12$ when $t = 0$.

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What is the other value of t for which $h = 12$?

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Question 12 (3 marks)

Find the equation of the tangent to $y = 5x^3 - \frac{2}{x^2} - 9$ at the point $(1, -6)$.

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Question 13 (2 marks)

The numbers, 75, p , q , 2025, form a geometric sequence.

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Find the values of p and q .

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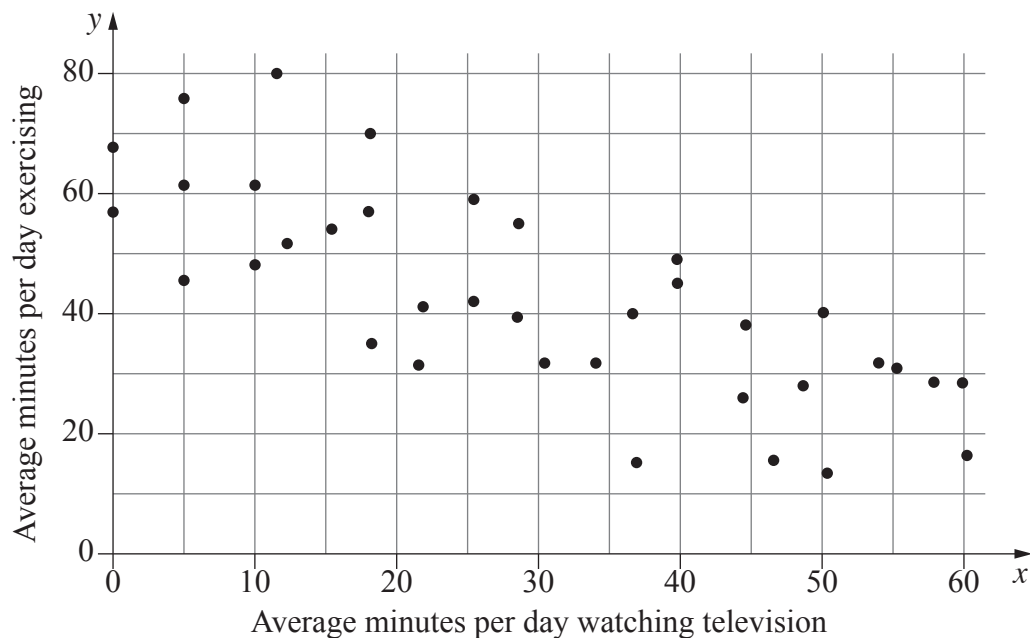
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Question 14 (6 marks)

In a research study, participants were asked to record the number of minutes they spent watching television and the number of minutes they spent exercising each day over a period of 3 months. The averages for each participant were recorded and graphed.



- (a) Describe the bivariate dataset in terms of its form and direction.

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Form:

Direction:

Question 14 continues on page 13

Question 14 (continued)

The equation of the least-squares regression line for this dataset is

$$y = 64.3 - 0.7x.$$

- (b) Interpret the values of the slope and y-intercept of the regression line in the context of this dataset. 2

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- (c) Jo spends an average of 42 minutes per day watching television. 1

Use the equation of the regression line to determine how many minutes on average Jo is expected to exercise each day.

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- (d) Explain why it is NOT appropriate to extrapolate the regression line to predict the average number of minutes of exercise per day for someone who watches an average of 2 hours of television per day. 1

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End of Question 14

Question 15 (6 marks)

A sound wave can be modelled using a function $P(t) = k \sin at$, where P is air pressure in Pascals, t is time in milliseconds (ms) and k and a are constants.

- (a) Write the equation for a sound wave $P_1(t)$ that has an amplitude of 2 Pascals and a period of 5 ms.

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Question 15 continues on page 15

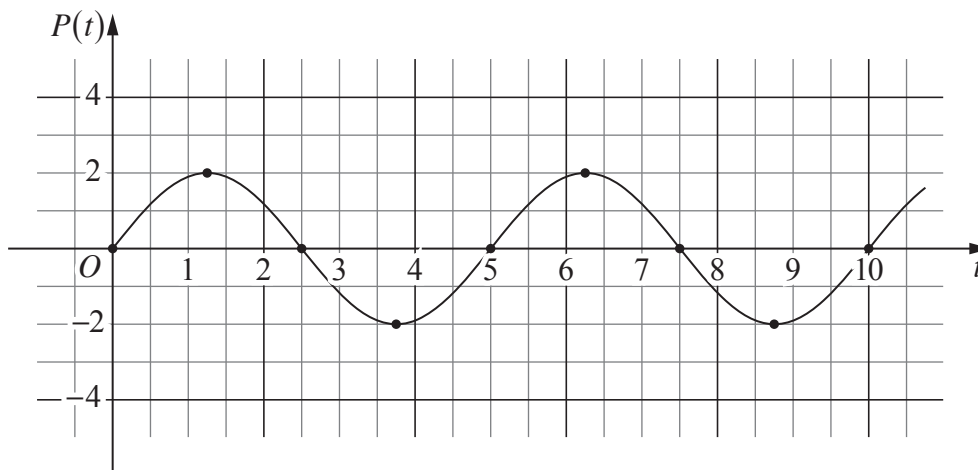
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Question 15 (continued)

- (b) The graph of $P_1(t)$ from part (a) is shown.

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On the diagram, sketch the graph of $P_2(t) = 4 \sin\left(\frac{\pi}{10}t\right)$ for $0 \leq t \leq 10$.



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- (c) Hence, find the values of t , where $0 < t < 10$, for which functions $P_1(t)$ and $P_2(t)$ are BOTH decreasing.

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End of Question 15

Question 16 (5 marks)

Consider the function $f(x) = \frac{x^2}{e^x}$.

- (a) Find the stationary points of the function and determine their nature.

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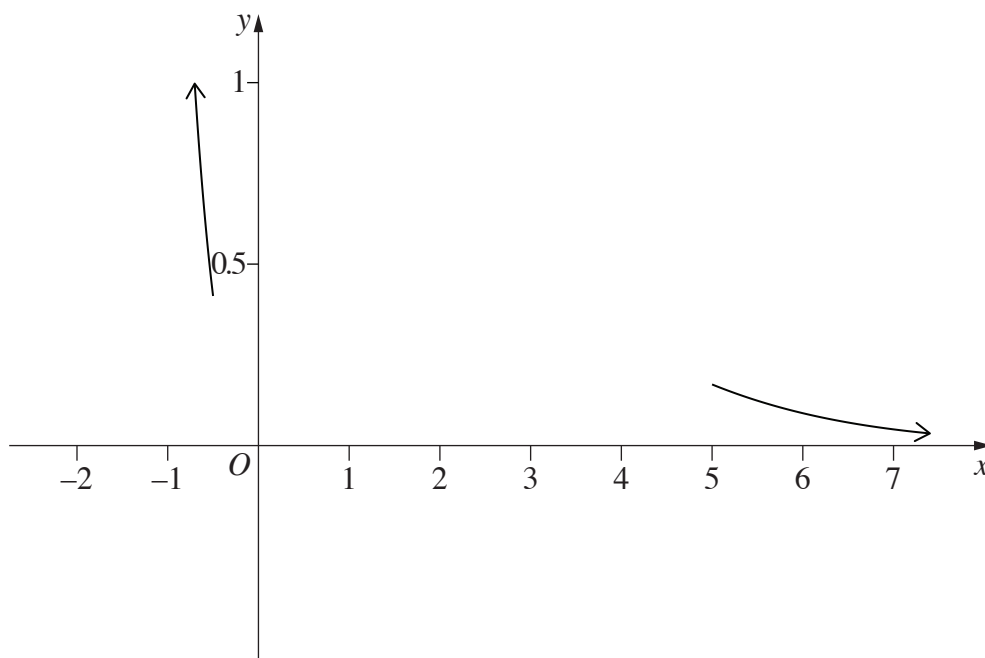
Question 16 continues on page 17

Question 16 (continued)

- (b) A partially completed graph of $f(x) = \frac{x^2}{e^x}$ is shown.

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Use your answer from part (a) to complete the graph.



End of Question 16

Please turn over

Question 17 (7 marks)

A borrower obtains a reducing-balance loan of \$800 000 to buy a house.

Interest is charged at 0.5% monthly, compounded monthly.

On the last day of each month, interest is added to the balance owing on the loan and then the monthly repayment of \$5740 is made.

Let $\$A_n$ be the balance owing on the loan at the end of n months.

- (a) Show that $A_2 = 800\,000(1.005)^2 - 5740(1.005) - 5740$.

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Question 17 continues on page 19

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Question 18 (2 marks)

Find the range of $g(f(x))$, given $f(x) = \frac{3}{x-1}$ and $g(x) = x + 5$.

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Question 19 (3 marks)

Three girls, Amara, Bala and Cassie, have nominated themselves for the local soccer team. Exactly one of the girls will be selected. The chances of their selection are in the ratio 1 : 2 : 3, respectively.

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The probability that the team wins when:

- Amara is selected is 0.5
- Bala is selected is 0.4
- Cassie is selected is 0.2.

Given that the team wins, find the probability that Amara was selected.

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Question 20 (3 marks)

The table shows future value interest factors for an annuity of \$1.

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<i>Rate (r)</i> <i>Period (n)</i>	<i>0.005</i>	<i>0.01</i>	<i>0.015</i>	<i>0.02</i>	<i>0.03</i>	<i>0.06</i>
7	7.10588	7.21354	7.32300	7.43428	7.66246	8.39384
28	29.97452	32.12910	34.48148	37.05121	42.93092	68.52811
56	64.44140	74.58098	86.79754	101.55826	141.15377	418.82235
84	104.07393	130.67227	166.17264	213.86661	365.88054	2209.41674

Lin invests a lump sum of \$21 000 for 7 years at an interest rate of 6% per annum, compounding monthly.

Yemi wants to achieve the same future value as Lin by using an annuity. Yemi plans to deposit a fixed amount into an investment account at the end of each month for 7 years. The investment account pays 6% per annum, compounding monthly.

Using the table provided, determine how much Yemi needs to deposit each month.

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Question 21 (5 marks)

A continuous random variable X has a probability density function given by

$$f(x) = \begin{cases} 0 & x < 1 \\ \frac{1}{x} & 1 \leq x \leq e \\ 0 & x > e \end{cases}$$

- (a) Find the mode of the given probability density function. Justify your answer. 2

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- (b) Calculate the value of the 25th percentile (Q_1) of this distribution. Give your answer correct to 3 decimal places. 3

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Question 22 (2 marks)

Prove that

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$$\frac{\sin^4 \theta + \cos^4 \theta}{\sin^2 \theta \cos^2 \theta} + 2 = \sec^2 \theta \operatorname{cosec}^2 \theta.$$

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Questions 11–22 are worth 47 marks in total

Question 23 (5 marks)

- (a) In a flock of 12 600 sheep, the ratio of males to females is 1 : 20.

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The weights of the male sheep are normally distributed with a mean of 76.2 kg and a standard deviation of 6.8 kg.

In the flock, 15 of the male sheep each weigh more than x kg.

Find the value of x .

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- (b) The weights of the female sheep are also normally distributed but have a smaller mean and smaller standard deviation than the weights of male sheep.

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Explain whether it could be expected that 300 of the females from the flock each weigh more than x kg, where x is the value found in part (a).

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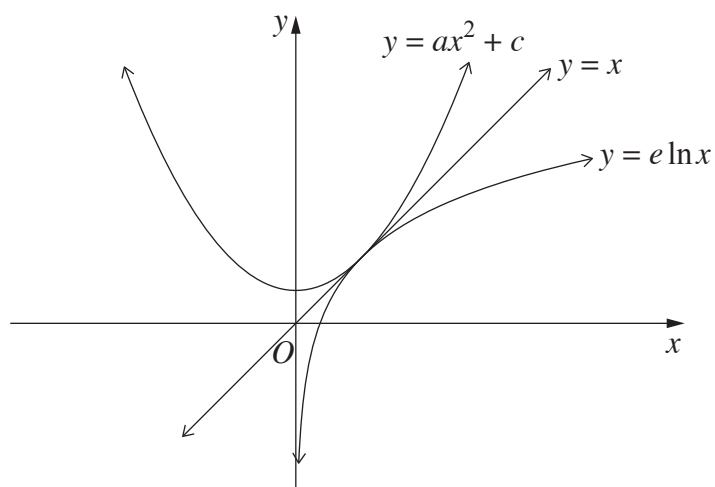
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Find the values of a and c .

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Question 25 (6 marks)

(a) Show that

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$$\frac{d}{dx}(\sin x - x \cos x) = x \sin x.$$

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(b) Hence, find the value of $\int_0^{2025\pi} x \sin x \, dx$.

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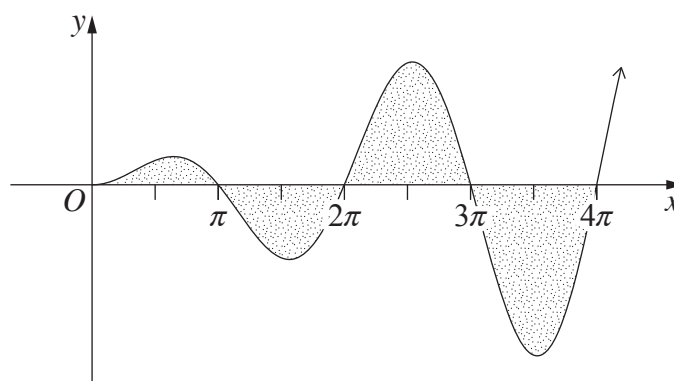
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Question 25 continues on page 27

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- 2



It can be shown that $|A_n| = (2n - 1)\pi$. (Do NOT prove this.)

Find the exact total area of the regions bounded by the curve $y = x \sin x$, and the x -axis between $x = 0$ and $x = 2025\pi$.

[illegible]

– 27 –

Question 26 (5 marks)

A piece of wire is 100 cm long. Some of the wire is to be used to make a circle of radius r cm. The remainder of the wire is used to make an equilateral triangle of side length x cm.

- (a) Show that the combined area of the circle and equilateral triangle is given by

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$$A(x) = \frac{1}{4} \left(\sqrt{3}x^2 + \frac{(100 - 3x)^2}{\pi} \right).$$

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Question 26 continues on page 29

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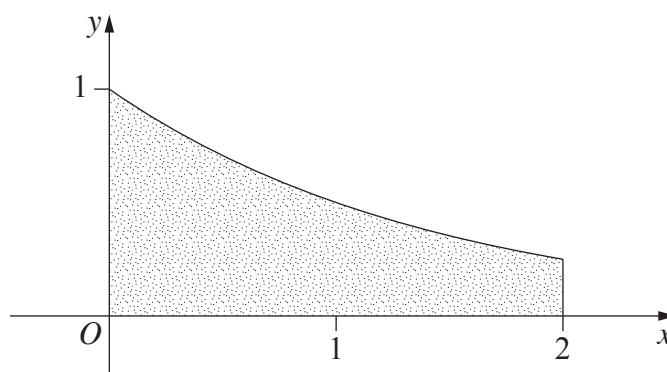
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[illegible]

– 29 –

Question 27 (6 marks)

The shaded region is bounded by the graph $y = \left(\frac{1}{2}\right)^x$, the coordinate axes and $x = 2$.



- (a) Use two applications of the trapezoidal rule to estimate the area of the shaded region. 2

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- (b) Show that the exact area of the shaded region is $\frac{3}{4 \ln 2}$. 2

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Question 27 continues on page 31

Question 27 (continued)

- (c) Using your answers from part (a) and part (b), deduce $e < 2\sqrt{2}$.

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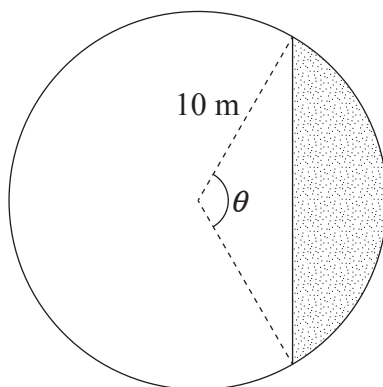
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End of Question 27

Please turn over

Question 28 (4 marks)

A farmer wants to use a straight fence to divide a circular paddock of radius 10 metres into two segments. The smaller segment is $\frac{1}{4}$ of the paddock and is shaded in the diagram. The fence subtends an angle of θ radians at the centre of the circle as shown.



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- (a) Show that $\theta = \sin \theta + \frac{\pi}{2}$.

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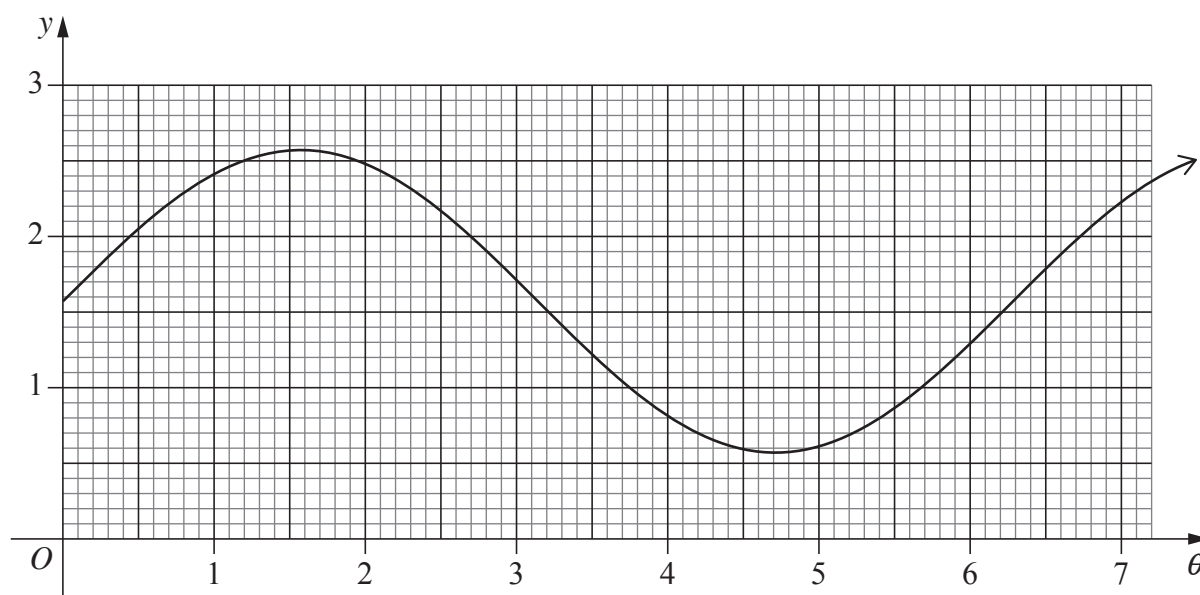
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Question 28 continues on page 33

Question 28 (continued)

(b) The graph of $y = \sin \theta + \frac{\pi}{2}$ is shown.

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Use the graph and the result in part (a) to estimate the arc length of the smaller segment to the nearest metre.

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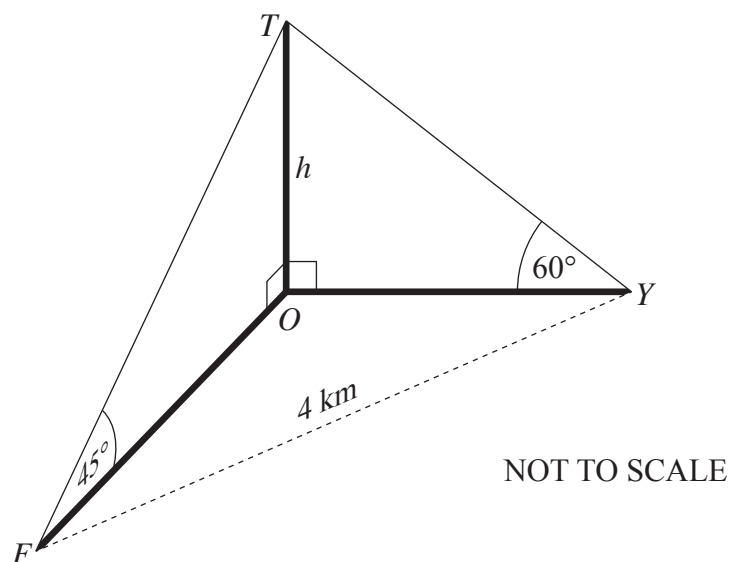
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End of Question 28

Question 29 (7 marks)

The point T is the peak of a mountain and the point O is directly below the mountain's peak. The point Y is due east of O and the angle of elevation of T from Y is 60° . The point F is 4 km south-west of Y . The points O , Y and F are on level ground. The angle of elevation of T from F is 45° .



- (a) Let the height of the mountain be h .

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Show that $OY = \frac{h}{\sqrt{3}}$.

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Question 29 continues on page 35



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[illegible]

– 35 –

Question 30 (3 marks)

The parabola with equation $y = (x - 1)(x - 5)$ is translated both horizontally to the right and vertically up by k units, where k is positive.

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The translated parabola passes through the point $(6, 11)$.

Find the value of k .

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Question 31 (3 marks)

The equation $\cos px = \frac{1}{2}$ has 2 solutions where $0 \leq x \leq 2\pi$ and $p > 0$.

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Find all possible values of p .

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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

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

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

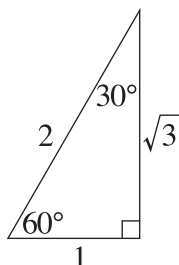
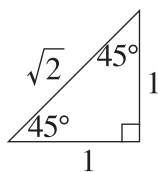
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

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

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

$$l = r\theta$$

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



Trigonometric identities

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

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

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

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

Compound angles

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

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

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

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

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

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

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

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

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

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

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

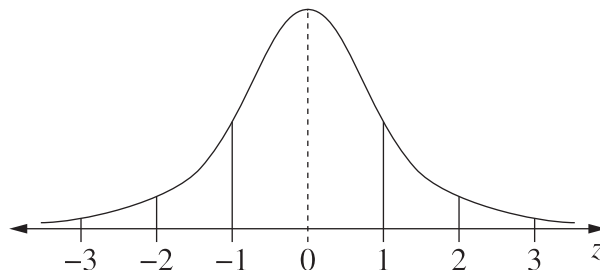
$$\cos^2 nx = \frac{1}{2} (1 + \cos 2nx)$$

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

$$E(X) = \mu$$

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

Probability

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

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

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

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

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

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

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

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

$$E(X) = np$$

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

Differential Calculus

Function

Derivative

$$y = f(x)^n$$

$$\frac{dy}{dx} = n f'(x) [f(x)]^{n-1}$$

$$y = uv$$

$$\frac{dy}{dx} = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$y = g(u) \text{ where } u = f(x)$$

$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$$

$$y = \frac{u}{v}$$

$$\frac{dy}{dx} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$$

$$y = \sin f(x)$$

$$\frac{dy}{dx} = f'(x) \cos f(x)$$

$$y = \cos f(x)$$

$$\frac{dy}{dx} = -f'(x) \sin f(x)$$

$$y = \tan f(x)$$

$$\frac{dy}{dx} = f'(x) \sec^2 f(x)$$

$$y = e^{f(x)}$$

$$\frac{dy}{dx} = f'(x) e^{f(x)}$$

$$y = \ln f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{f(x)}$$

$$y = a^{f(x)}$$

$$\frac{dy}{dx} = (\ln a) f'(x) a^{f(x)}$$

$$y = \log_a f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{(\ln a) f(x)}$$

$$y = \sin^{-1} f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{\sqrt{1 - [f(x)]^2}}$$

$$y = \cos^{-1} f(x)$$

$$\frac{dy}{dx} = -\frac{f'(x)}{\sqrt{1 - [f(x)]^2}}$$

$$y = \tan^{-1} f(x)$$

$$\frac{dy}{dx} = \frac{f'(x)}{1 + [f(x)]^2}$$

Integral Calculus

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

where $n \neq -1$

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

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

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

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

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

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

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

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

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

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

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

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

$$|\underline{u}| = |x\underline{i} + y\underline{j}| = \sqrt{x^2 + y^2}$$

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

$$\text{where } \underline{u} = x_1\underline{i} + y_1\underline{j}$$

$$\text{and } \underline{v} = x_2\underline{i} + y_2\underline{j}$$

$$\underline{r} = a + \lambda \underline{b}$$

Complex Numbers

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

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

Mechanics

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

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

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

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

2025 HSC Mathematics Advanced Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	B
2	A
3	D
4	C
5	B
6	C
7	A
8	D
9	B
10	C

Section II

Question 11 (a)

Criteria	Marks
• Provides correct answer	2
• Finds correct value of t , or equivalent merit	1

Sample answer:

$$\begin{aligned}t &= \frac{6+2}{2} \\&= 4\end{aligned}$$

$$\begin{aligned}h &= 4^2 - 8 \times 4 + 12 \\&= -4\end{aligned}$$

Question 11 (b)

Criteria	Marks
• Provides correct answer	1

Sample answer:

$$t = 4 + 4 = 8 \quad \text{using axis of symmetry}$$

$$\therefore t = 8$$

Question 12

Criteria	Marks
• Provides correct solution	3
• Finds the correct gradient of the tangent, or equivalent merit	2
• Attempts to find the gradient of the tangent, or equivalent merit	1

Sample answer:

$$y = 5x^3 - \frac{2}{x^2} - 9$$

$$y = 5x^3 - 2x^{-2} - 9$$

$$y' = 15x^2 + 4x^{-3}$$

$$y' = 15x^2 + \frac{4}{x^3}$$

$$y' = 15(1) + \frac{4}{(1)}$$

$$y' = 19$$

$$y - y_1 = m(x - x_1)$$

$$y + 6 = 19(x - 1)$$

$$y + 6 = 19x - 19$$

$$y = 19x - 25$$

Question 13

Criteria	Marks
• Provides correct solution	2
• Shows understanding that the sequence is geometric, or equivalent merit	1

Sample answer:

$$T_1 = 75, \quad T_2 = p, \quad T_3 = q, \quad T_4 = 2025$$

$$ar^3 = 2025$$

$$(75)r^3 = 2025$$

$$r^3 = 27$$

$$r = 3$$

$$T_2 = p = ar = 75 \times 3 = 225$$

$$T_3 = q = ar^2 = 75 \times 3^2 = 675$$

$$p = 225 \quad q = 675$$

Question 14 (a)

Criteria	Marks
• Provides correct form and direction	2
• Provides correct direction, or equivalent merit	1

Sample answer:

Form: Linear
 Direction: Negative

Question 14 (b)

Criteria	Marks
• Provides correct interpretation of both slope and y-intercept	2
• Provides correct interpretation of y-intercept, or equivalent merit	1

Sample answer:

Slope: For every 1 minute increase in time spent watching television per day the time spent exercising decreases by 0.7 minutes per day.

y-intercept: If someone doesn't watch television they are expected to exercise for 64.3 minutes per day.

Question 14 (c)

Criteria	Marks
• Provides correct answer	1

Sample answer:

$$y = 64.3 - 0.7x$$

$$y = 64.3 - 0.7 \times 42$$

$$= 34.9 \text{ minutes}$$

Question 14 (d)

Criteria	Marks
• Provides correct reason	1

Sample answer:

– 2 hours or 120 minutes of television suggests –19.7 minutes of exercise and can't do negative minutes of exercise.

Alternative answer:

– 2 hours or 120 minutes is outside the dataset so extrapolating is not reliable.

Question 15 (a)

Criteria	Marks
• Provides correct equation	2
• Finds k , or equivalent merit	1

Sample answer:

$$k = 2$$

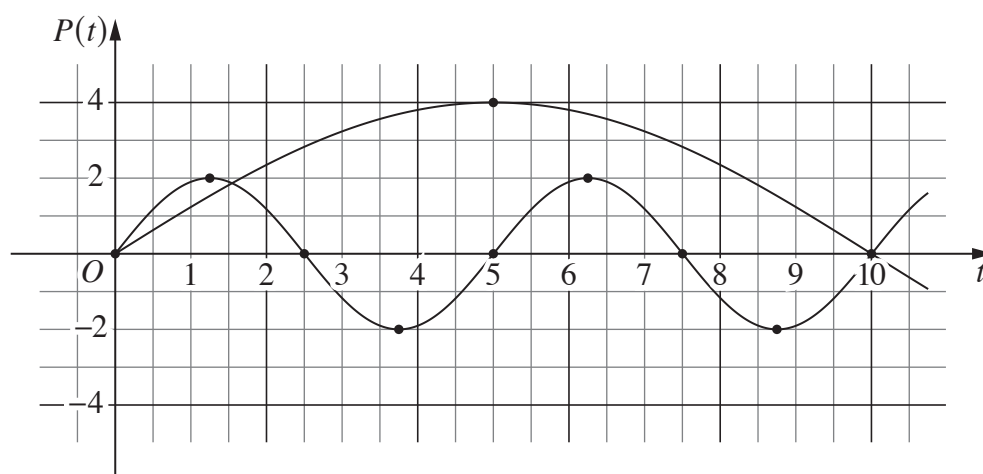
$$\text{Period} = \frac{2\pi}{a} = 5 \text{ ms} \quad \text{so} \quad a = \frac{2\pi}{5}$$

$$P_1(t) = 2 \sin \frac{2\pi}{5} t$$

Question 15 (b)

Criteria	Marks
• Provides correct graph	2
• Draws a sine wave with an amplitude of 4, or equivalent merit	1

Sample answer:



Question 15 (c)

Criteria	Marks
• Provides correct answer	2
• Finds one correct endpoint of interval, or equivalent merit	1

Sample answer:

$$6.25 < t < 8.75$$

Question 16 (a)

Criteria	Marks
• Provides correct solution	4
• Finds both stationary points	3
• Finds one of the stationary points, or equivalent merit	2
• Attempts to use quotient rule, or equivalent merit	1

Sample answer:

$$f(x) = \frac{x^2}{e^x}$$

$$f'(x) = \frac{2xe^x - x^2e^x}{e^{2x}} = \frac{xe^x(2-x)}{e^{2x}}$$

$$f'(x) = \frac{x(2-x)}{e^x}$$

$$x = 0, \quad 2 - x = 0$$

$$x = 0, \quad x = 2$$

$$y = 0, \quad y = \frac{4}{e^2} = 0.541 \dots$$

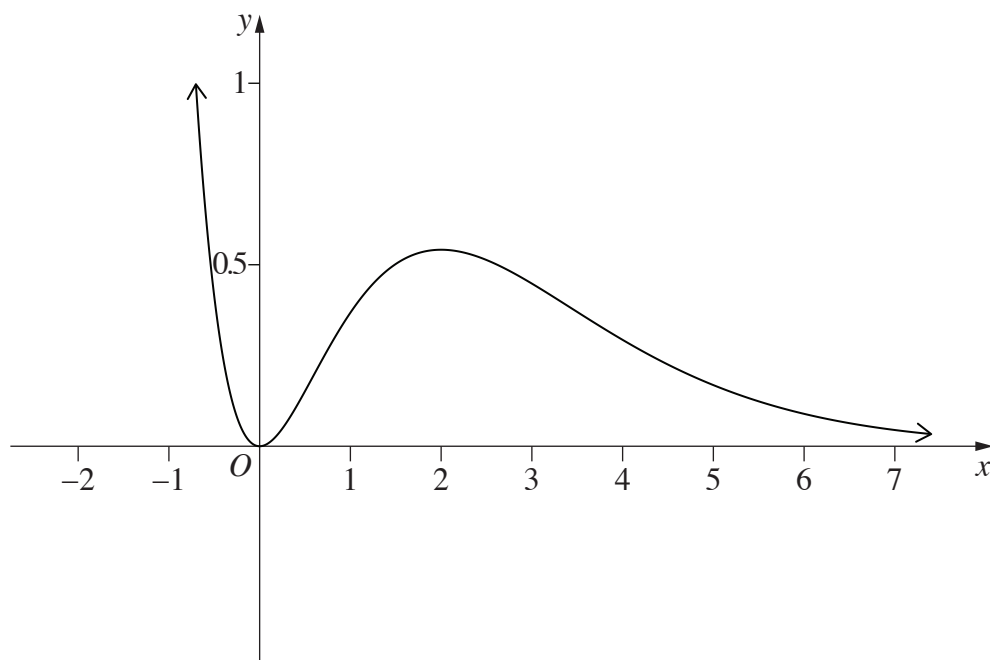
x	-1	0	1	2	3
$f'(x)$	Negative	0	Positive	0	Negative

$\therefore$ Minimum at $(0, 0)$ and maximum at $\left(2, \frac{4}{e^2}\right)$

Question 16 (b)

Criteria	Marks
• Provides correct graph	1

Sample answer:



Question 17 (a)

Criteria	Marks
• Provides correct solution	2
• Provides a correct A_1 , or equivalent merit	1

Sample answer:

$$A_0 = 800\,000$$

$$A_1 = 800\,000 \times (1.005) - 5740$$

$$\begin{aligned} A_2 &= A_1 \times (1.005) - 5740 \\ &= (800\,000 \times (1.005) - 5740) \times 1.005 - 5740 \\ &= 800\,000(1.005)^2 - 5740(1.005) - 5740 \end{aligned}$$

Question 17 (b)

Criteria	Marks
• Provides correct solution	3
• Uses the sum of a geometric sequence in A_n , or equivalent merit	2
• Provides an expression that shows evidence of the pattern, or equivalent merit	1

Sample answer:

$$\begin{aligned} A_3 &= A_2 \times (1.005) - 5740 \\ &= (800\,000 \times (1.005)^2 - 5740 \times (1.005) - 5740) \times 1.005 - 5740 \\ &= 800\,000(1.005)^3 - 5740(1.005)^2 - 5740(1.005) - 5740 \end{aligned}$$

So, using the pattern above

$$A_n = 800\,000(1.005)^n - 5740(1.005^{n-1} + 1.005^{n-2} + \dots + 1.005 + 1)$$

$$A_n = 800\,000(1.005)^n - \frac{5740(1.005^n - 1)}{1.005 - 1}$$

$$A_n = 800\,000(1.005)^n - \frac{5740(1.005^n - 1)}{0.005}$$

$$\begin{aligned} A_n &= 800\,000(1.005)^n - 1\,148\,000(1.005^n - 1) \\ &= 800\,000(1.005)^n - 1\,148\,000(1.005)^n + 1\,148\,000 \\ &= 1\,148\,000 - 348\,000(1.005)^n \end{aligned}$$

Question 17 (c)

Criteria	Marks
• Provides correct solution	2
• Attempts to use logarithms to find n , or equivalent merit	1

Sample answer:

$$400\,000 = 1\,148\,000 - 348\,000(1.005)^n$$

$$348\,000(1.005)^n = 748\,000$$

$$(1.005)^n = \frac{748}{348}$$

$$n \ln(1.005) = \ln \frac{748}{348}$$

$$n = \ln\left(\frac{748}{348}\right) \div \ln(1.005)$$

$$n = 153.4\dots$$

So the balance will be less than \$400 000 after 154 months.

Question 18

Criteria	Marks
• Provides correct solution	2
• Finds a composite function, or equivalent merit	1

Sample answer:

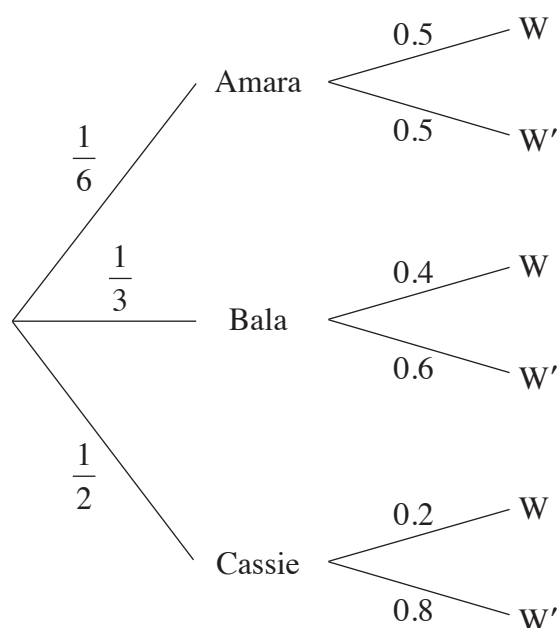
$$g(f(x)) = \frac{3}{x-1} + 5$$

Range: All real y , $y \neq 5$

Question 19

Criteria	Marks
• Provides correct solution	3
• Demonstrates some understanding of conditional probability in this context	2
• Shows evidence of correct interpretation of the ratio, or equivalent merit	1

Sample answer:



$$\begin{aligned}
 P(\text{Amara}|\text{wins}) &= \frac{\frac{1}{6} \times 0.5}{\frac{1}{6} \times 0.5 + \frac{1}{3} \times 0.4 + \frac{1}{2} \times 0.2} \\
 &= \frac{5}{19}
 \end{aligned}$$

Question 20

Criteria	Marks
• Provides correct solution	3
• Finds Lin's correct future value. or equivalent merit	2
• Finds the correct rate and number of periods, or equivalent merit	1

Sample answer:

$$n = 7 \times 12$$

$$= 84 \text{ periods}$$

$$r = \frac{6}{12}$$

$$21\,000 \left(1 + \frac{6}{12} \% \right)^{84}$$

$$= 31\,927.76$$

$$\therefore \text{Monthly deposit} = \$31\,927.76 \div 104.07393$$

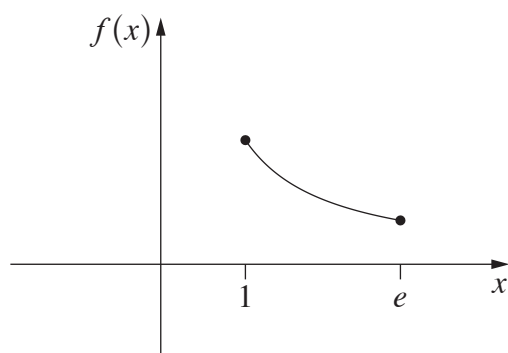
$$= \$306.78$$

Question 21 (a)

Criteria	Marks
• Provides correct solution	2
• Attempts to find maximum value of $f(x)$, or equivalent merit	1

Sample answer:

$$f(x) = \frac{1}{x} \quad 1 \leq x \leq e$$



So maximum of $f(x)$ on this interval is when $x = 1$.

Therefore, the mode is 1.

Question 21 (b)

Criteria	Marks
• Provides correct solution	3
• Finds the correct cumulative distribution function (cdf), or equivalent merit	2
• Writes a correct integral for the cumulative distribution function (cdf), or equivalent merit	1

Sample answer:

$$\int_1^{Q_1} \frac{1}{x} dx = 0.25$$

$$\int_1^{Q_1} \frac{1}{x} dx = \left[\ln x \right]_1^{Q_1} = \ln Q_1 - \ln 1$$

$$= \ln Q_1 = 0.25$$

$$Q_1 = e^{0.25} = 1.284$$

Question 22

Criteria	Marks
• Provides correct solution	2
• Factorises the numerator correctly, or equivalent merit	1

Sample answer:

$$\begin{aligned}
 \text{LHS} &= \frac{\sin^4\theta + \cos^4\theta}{\sin^2\theta \cos^2\theta} + 2 \\
 &= \frac{\sin^4\theta + \cos^4\theta + 2\sin^2\theta \cos^2\theta}{\sin^2\theta \cos^2\theta} \\
 &= \frac{(\sin^2\theta + \cos^2\theta)^2}{\sin^2\theta \cos^2\theta} \\
 &= \frac{(1)^2}{\sin^2\theta \cos^2\theta} \quad (\text{as } \sin^2\theta + \cos^2\theta = 1) \\
 &= \frac{1}{\cos^2\theta} \times \frac{1}{\sin^2\theta} \\
 &= \sec^2\theta \operatorname{cosec}^2\theta \\
 &= \text{RHS}
 \end{aligned}$$

Question 23 (a)

Criteria	Marks
• Provides correct solution	4
• Attempt to use a z -score in a calculation, or equivalent merit	3
• Calculates the percentage of males that weigh more than x kg	2
• Calculates the number of male sheep, or equivalent merit	1

Sample answer:

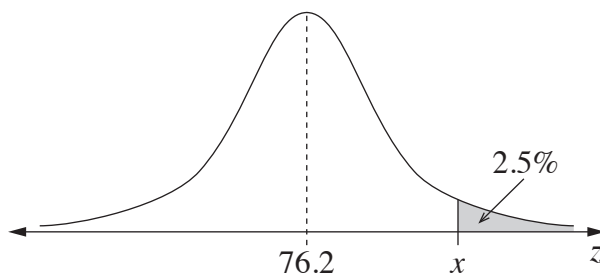
$$\text{Number of male sheep} = \frac{12\,600}{21} = 600$$

$$\text{Percentage of males weighing more than } x \text{ kg} = \frac{15}{600} \times 100 = 2.5\%$$

$$x = 76.2 + 2 \times 6.8$$

$$x = 76.2 + 13.6$$

$$x = 89.8 \text{ kg}$$



$\therefore z\text{-score} = 2$

Question 23 (b)

Criteria	Marks
• Provides correct reason	1

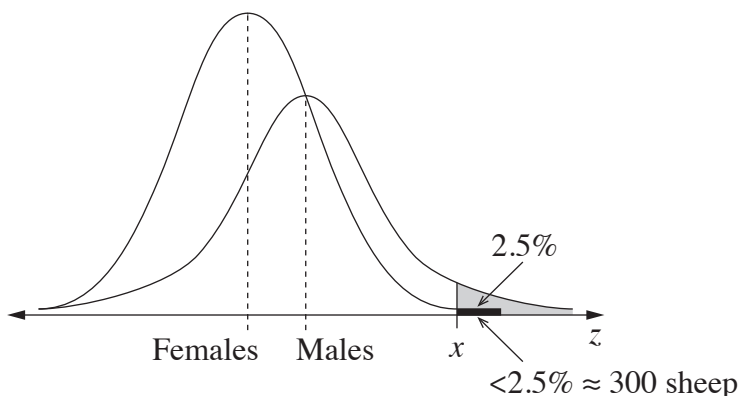
Sample answer:

$z = \frac{x - \mu}{\sigma}$ will be larger than 2 as the mean and standard deviation for females is smaller.

The percentage of female sheep with weight greater than x kg will be smaller than 2.5%.

So less than 300 females will weigh more than x kg.

Answer could include:



Question 24

Criteria	Marks
• Provides correct solution	4
• Finds value of a , or equivalent merit	3
• Sets one derivative equal to 1, or equivalent merit	2
• Provides a correct derivative, or equivalent merit	1

Sample answer:

The gradients of $y = e \ln x$ and $y = ax^2 + c$ at point of intersection are both equal to 1.

$$\therefore \frac{d}{dx}(e \ln x) = 1$$

$$\therefore \frac{e}{x} = 1$$

$$x = e \quad (\because y = e)$$

$\therefore y = ax^2 + c$ has gradient of 1 at point (e, e) .

$$\therefore \frac{d}{dx}[ax^2 + c] = 2ax$$

$$\therefore 2ax = 1 \text{ at } x = e$$

$$\therefore 2a \cdot e = 1$$

$$a = \frac{1}{2e} \quad \text{-----} \textcircled{1}$$

and $y = ax^2 + c = e$ at $x = e$

$$\therefore e = \frac{1}{2e} \cdot e^2 + c$$

$$e = \frac{e}{2} + c$$

$$\therefore c = \frac{e}{2} \quad \text{-----} \textcircled{2}$$

Question 25 (a)

Criteria	Marks
• Provides correct solution	2
• Attempts to use the product rule, or equivalent merit	1

Sample answer:

$$\begin{aligned}\frac{d}{dx}(\sin x - x \cos x) &= \cos x - [x \times (-\sin x) + \cos x] \\ &= \cos x + x \sin x - \cos x \\ &= x \sin x \quad \text{as required}\end{aligned}$$

Question 25 (b)

Criteria	Marks
• Provides correct solution	2
• Uses part (a) to rewrite the definite integral, or equivalent merit	1

Sample answer:

$$\begin{aligned}\int_0^{2025\pi} x \sin x \, dx &= [\sin x - x \cos x]_0^{2025\pi} \quad \text{from part (a)} \\ &= (\sin 2025\pi - 2025\pi \cos 2025\pi) - (0) \\ &= 0 - 2025\pi \times (-1) \\ &= 2025\pi\end{aligned}$$

Question 25 (c)

Criteria	Marks
• Provides correct solution	2
• Sums an arithmetic sequence, or equivalent merit	1

Sample answer:

$$\begin{aligned}\text{Exact area of regions} &= \pi + 3\pi + 5\pi + \dots + (2 \times 2025 - 1)\pi \\ &= \pi + 3\pi + 5\pi + \dots + 4049\pi\end{aligned}$$

This is an arithmetic series with $a = \pi$, $d = 2\pi$, $n = 2025$ and $l = 4049\pi$

$$\begin{aligned}S_n &= \frac{n}{2}(a + l) \\ S_n &= \frac{2025}{2}(\pi + 4049\pi) \\ &= 2025 \times 2025 \times \pi \\ &= (2025)^2 \pi \text{ units}^2\end{aligned}$$

Question 26 (a)

Criteria	Marks
• Provides correct solution	2
• Finds an expression for r in terms of x , or equivalent merit	1

Sample answer:

Circumference of circle and perimeter of triangle must add to 100 cm.

So $2\pi r + 3x = 100$

That is $r = \frac{100 - 3x}{2\pi}$

$A(x)$ = Area of circle + area of equilateral triangle

$$= \pi r^2 + \frac{1}{2}x^2 \sin 60^\circ$$

$$= \pi r^2 + \frac{\sqrt{3}}{4}x^2$$

$$= \pi \left(\frac{100 - 3x}{2\pi} \right)^2 + \frac{\sqrt{3}}{4}x^2$$

$$= \frac{1}{4} \left(\sqrt{3}x^2 + \frac{(100 - 3x)^2}{\pi} \right)$$

Question 26 (b)

Criteria	Marks
• Provides correct solution	3
• Finds the value of A at an endpoint, or equivalent merit	2
• Identifies that the quadratic will have a minimum turning point, or equivalent merit	1

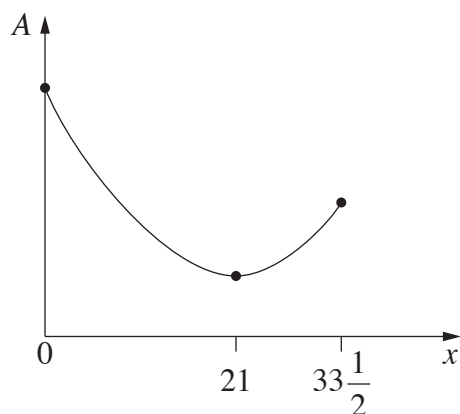
Sample answer:

$A(x)$ is a quadratic with positive coefficient of x^2 so A has a minimum stationary point.

The maximum will therefore occur on an endpoint of the domain.

$$\text{When } x = 0 \quad r = \frac{50}{\pi} \quad \text{Area} = \pi r^2 = \frac{50^2}{\pi} \approx 796$$

$$\text{When } r = 0 \quad x = 33\frac{1}{3} \quad \text{Area} = \frac{1}{2}x^2 \sin 60^\circ = \frac{\sqrt{3}}{4} \times 33.333^2 \approx 481$$



$\therefore$ The maximum value of $A(x)$ occurs when all wire is used for the circle.

Question 27 (a)

Criteria	Marks
• Provides correct solution	2
• Attempts to use trapezoidal rule, or equivalent merit	1

Sample answer:

$$\begin{aligned}
 \text{Area} &= \frac{b-a}{2n} \left\{ f(a) + f(b) + 2 \left[f(x_1) \right] \right\} \\
 &= \frac{2-0}{2 \times 2} \left\{ 1 + \frac{1}{4} + 2 \times \frac{1}{2} \right\} \\
 &= \frac{1}{2} \left(1 + \frac{1}{4} + 1 \right) \\
 &= \frac{9}{8} \text{ units}^2
 \end{aligned}$$

Question 27 (b)

Criteria	Marks
• Provides correct solution	2
• Provides the correct antiderivative of $\left(\frac{1}{2}\right)^x$, or equivalent merit	1

Sample answer:

$$\begin{aligned}
 &\int_0^2 \left(\frac{1}{2}\right)^x dx \\
 &= \left[\frac{\left(\frac{1}{2}\right)^x}{\ln \frac{1}{2}} \right]_0^2 \\
 &= \frac{\left(\frac{1}{2}\right)^2}{\ln \frac{1}{2}} - \frac{\left(\frac{1}{2}\right)^0}{\ln \frac{1}{2}} \\
 &= \frac{-\frac{3}{4}}{-\ln 2} \\
 &= \frac{3}{4 \ln 2}
 \end{aligned}$$

Question 27 (c)

Criteria	Marks
• Provides correct solution	2
• Provides correct initial inequality, or equivalent merit	1

Sample answer:

$$\frac{3}{4 \ln 2} < \frac{9}{8} \quad (\text{Function is concave up.} \\ \therefore \text{Exact value is less than trapezoidal approximation.})$$

$$24 < 36 \ln 2$$

$$2 < 3 \ln 2$$

$$2 < \ln 8$$

$$e^2 < 8$$

$$e < \sqrt{8} = 2\sqrt{2}$$

$$\therefore e < 2\sqrt{2}$$

Question 28 (a)

Criteria	Marks
• Provides correct solution	2
• Provides a correct expression relating the areas in the diagram, or equivalent merit	1

Sample answer:

Area of shaded segment = area of sector – area of triangle

area of sector – area of triangle = $\frac{1}{4} \times$ area of circle

$$\frac{1}{2} \times 10^2 \theta - \frac{1}{2} \times 10^2 \sin \theta = \frac{10^2 \pi}{4}$$

$$50\theta - 50 \sin \theta = 25\pi$$

$$50(\theta - \sin \theta) = 25\pi$$

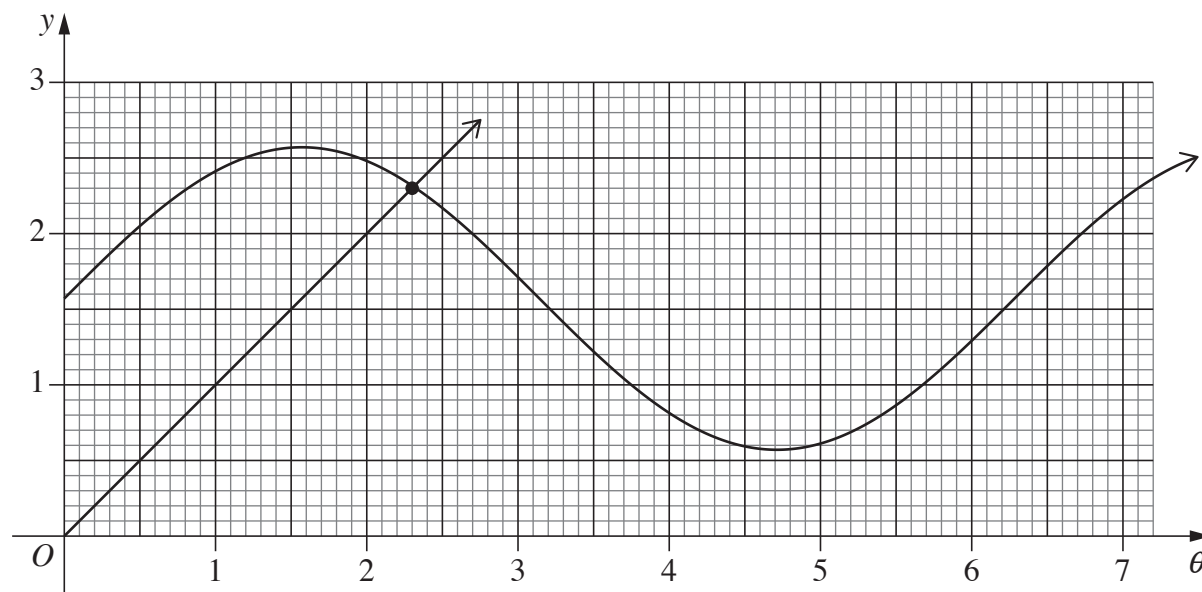
$$\theta - \sin \theta = \frac{\pi}{2}$$

$$\theta = \sin \theta + \frac{\pi}{2}$$

Question 28 (b)

Criteria	Marks
• Provides correct solution	2
• Finds the value of θ , or equivalent merit	1

Sample answer:



$$y = \sin \theta + \frac{\pi}{2}$$

$$\theta = \sin \theta + \frac{\pi}{2} \quad \text{from part (a)}$$

Looking for point of intersection of $y = \theta$ and $y = \sin \theta + \frac{\pi}{2}$

So, $\theta = 2.3$ radians

$$\text{Arc length} = r\theta$$

$$= 10 \text{ m} \times 2.3 = 23 \text{ metres}$$

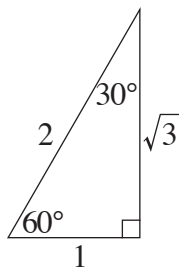
Question 29 (a)

Criteria	Marks
• Provides correct solution	1

Sample answer:

$$\tan 60^\circ = \frac{h}{OY} \text{ in } \triangle TYO$$

$$\begin{aligned}\therefore OY &= \frac{h}{\tan 60^\circ} \\ &= \frac{h}{\sqrt{3}}\end{aligned}$$



Question 29 (b)

Criteria	Marks
• Provides correct solution	3
• Finds a quadratic expression in h , or equivalent merit	2
• Attempts to use the cosine rule to find a value for h , or equivalent merit	1

Sample answer:

In $\triangle TFO$, $\angle TFO = 45^\circ$, $\angle TOF = 90^\circ$

$\therefore \angle OTF = 45^\circ$

$\therefore \triangle$ is isosceles and $OF = h$

In $\triangle FOY$, by cosine rule

$$h^2 = \left(\frac{h}{\sqrt{3}}\right)^2 + 4^2 - 2 \times 4 \times \frac{h}{\sqrt{3}} \cos 45^\circ$$

$$h^2 = \frac{h^2}{3} + 16 - \frac{8h}{\sqrt{6}}$$

$$\frac{2h^2}{3} + \frac{8h}{\sqrt{6}} - 16 = 0$$

$$h = \frac{-\frac{8}{\sqrt{6}} \pm \sqrt{\frac{64}{6} + 4 \times \frac{2}{3} \times 16}}{\frac{4}{3}}$$

$$= 3.03 \text{ since } h > 0$$

Question 29 (c)

Criteria	Marks
• Provides correct solution	3
• Attempts to find the bearing, or equivalent merit	2
• Finds angle OFY , or equivalent merit	1

Sample answer:

$$\frac{\sin \theta}{\frac{h}{\sqrt{3}}} = \frac{\sin 45^\circ}{h}$$

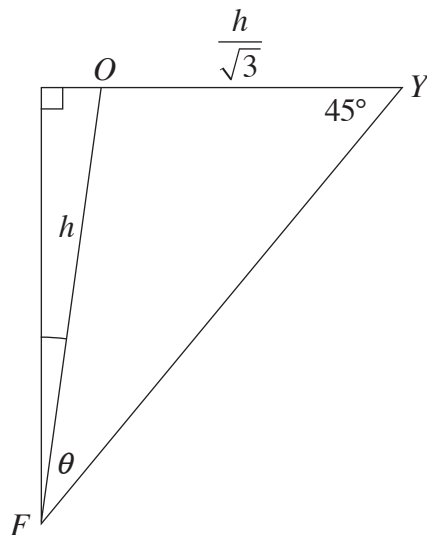
$$\sin \theta = \frac{1}{\sqrt{2} \sqrt{3}}$$

$$\theta = 24^\circ \dots$$

$$\approx 24^\circ$$

$$\text{Bearing} = 45^\circ - 24^\circ$$

$$\approx 021^\circ$$



Question 30

Criteria	Marks
• Provides correct solution	3
• Obtains a quadratic in k , or equivalent merit	2
• Substitutes $x - k$ and $y - k$ into equation, or equivalent merit	1

Sample answer:

$$x \rightarrow x - k \quad y \rightarrow y - k$$

$$y - k = (x - k - 1)(x - k - 5)$$

$$11 - k = (6 - k - 1)(6 - k - 5)$$

$$11 - k = (5 - k)(1 - k)$$

$$11 - k = 5 - 6k + k^2$$

$$k^2 - 5k - 6 = 0$$

$$(k - 6)(k + 1) = 0$$

So, $k = 6$ since k is positive

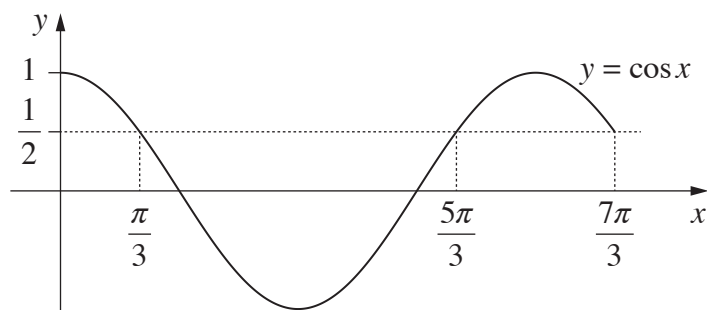
Question 31

Criteria	Marks
• Provides correct solution	3
• Finds $p = \frac{5}{6}$ or $p = \frac{7}{6}$, or equivalent merit	2
• Finds $x = \frac{\pi}{3}$ and $\frac{5\pi}{3}$, or equivalent merit	1

Sample answer:

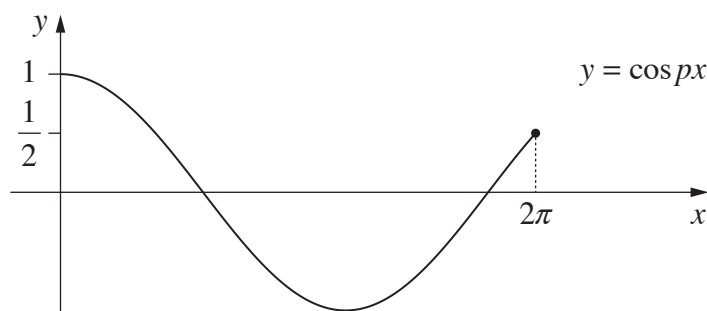
$$\cos x = \frac{1}{2}$$

$$x = \frac{\pi}{3}, \frac{5\pi}{3}, \frac{7\pi}{3}, \dots$$



$y = \cos px$ dilation horizontally by a factor of $\frac{1}{p}$

Lowest value of p to get 2 solutions

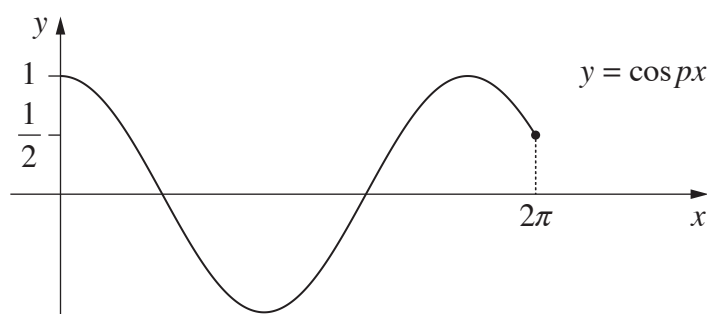


$$\therefore \frac{5\pi}{3} \times \frac{1}{p} = 2\pi$$

$$p = \frac{5\pi}{3 \times 2\pi}$$

$$= \frac{5}{6}$$

Highest value of p to get 2 solutions



$$\therefore \frac{7\pi}{3} \times \frac{1}{p} = 2\pi$$

$$p = \frac{7\pi}{3 \times 2\pi}$$

$$= \frac{7}{6}$$

$$\therefore \frac{5}{6} \leq p < \frac{7}{6}$$

2025 HSC Mathematics Advanced Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	MA-S1 Probability and Discrete Probability Distributions	MA11-7
2	1	MA-E1 Logarithms and Exponentials	MA11-9
3	1	MA-F1 Working with Functions	MA11-1
4	1	MA-F1 Working with Functions	MA11-1
5	1	MA-C4 Integral Calculus	MA12-7
6	1	MA-F1 Working with Functions	MA11-1
7	1	MA-S1 Probability and Discrete Probability Distributions	MA11-7
8	1	MA-S3 Random Variables	MA12-8
9	1	MA-C3 Applications of Differentiation	MA12-10
10	1	MA-C3 Applications of Differentiation	MA12-3

Section II

Question	Marks	Content	Syllabus outcomes
11 (a)	2	MA-F1 Working with Functions	MA11-2
11 (b)	1	MA-F1 Working with Functions	MA11-2
12	3	MA-C1 Introduction to Differentiation	MA11-5
13	2	MA-M1 Modelling Financial Situations	MA12-4
14 (a)	2	MA-S2 Descriptive Statistics and Bivariate Data Analysis	MA12-8
14 (b)	2	MA-S2 Descriptive Statistics and Bivariate Data Analysis	MA12-8
14 (c)	1	MA-S2 Descriptive Statistics and Bivariate Data Analysis	MA12-8
14 (d)	1	MA-S2 Descriptive Statistics and Bivariate Data Analysis	MA12-10
15 (a)	2	MA-T3 Trigonometric Functions and Graphs	MA12-5
15 (b)	2	MA-T3 Trigonometric Functions and Graphs	MA12-5
15 (c)	2	MA-T3 Trigonometric Functions and Graphs	MA12-5
16 (a)	4	MA-C3 Applications of Differentiation	MA12-6
16 (b)	1	MA-C3 Applications of Differentiation	MA12-6
17 (a)	2	MA-M1 Modelling Financial Situations	MA12-4
17 (b)	3	MA-M1 Modelling Financial Situations	MA12-4
17 (c)	2	MA-E1 Logarithms and Exponentials MA-M1 Modelling Financial Situations	MA11-6, MA12-2
18	2	MA-F1 Working with Functions	MA11-2
19	3	MA-S1 Probability and Discrete Probability Distributions	MA11-7
20	3	MA-M1 Modelling Financial Situations	MA12-2
21 (a)	2	MA-S3 Random Variables	MA12-8
21 (b)	3	MA-E1 Logarithms and Exponentials MA-S3 Random Variables	MA11-6, MA12-8

Question	Marks	Content	Syllabus outcomes
22	2	MA-T2 Trigonometric Functions and Identities	MA11-4
23 (a)	4	MA-S3 Random Variables	MA12-8
23 (b)	1	MA-S3 Random Variables	MA12-10
24	4	MA-C3 Applications of Differentiation	MA12-6
25 (a)	2	MA-C2 Differential Calculus	MA12-3
25 (b)	2	MA-C4 Integral Calculus	MA12-7
25 (c)	2	MA-M1 Modelling Financial Situations	MA12-4
26 (a)	2	MA-C3 Applications of Differentiation	MA12-3
26 (b)	3	MA-C3 Applications of Differentiation	MA12-3, MA12-10
27 (a)	2	MA-C4 Integral Calculus	MA12-7
27 (b)	2	MA-C4 Integral Calculus	MA12-7
27 (c)	2	MA-C3 Applications of Differentiation MA-C4 Integral Calculus MA-E1 Logarithms and Exponentials	MA12-10
28 (a)	2	MA-T1 Trigonometry and Measure of Angles	MA11-3
28 (b)	2	MA-T1 Trigonometry and Measure of Angles MA-T3 Trigonometric Functions and Graphs	MA11-3, MA12-9
29 (a)	1	MA-T1 Trigonometry and Measure of Angles	MA11-3
29 (b)	3	MA-T1 Trigonometry and Measure of Angles	MA11-3
29 (c)	3	MA-T1 Trigonometry and Measure of Angles	MA11-3
30	3	MA-F2 Graphing Techniques	MA12-1
31	3	MA-T3 Trigonometric Functions and Graphs	MA12-5, MA12-10