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Examination Number:

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2024

YEAR 12
TRIAL EXAMINATION

Mathematics Advanced

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
- For questions in Section II, show relevant mathematical reasoning and/ or calculations

Total marks:
100

Section I – 10 marks

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

Section II – 90 marks

- Attempt Questions 11 – 30
- Allow about 2 hours and 45 minutes for this section

Note: Any time you have remaining should be spent reviewing your answers.

DO NOT REMOVE THIS PAPER FROM THE EXAMINATION ROOM

Section I

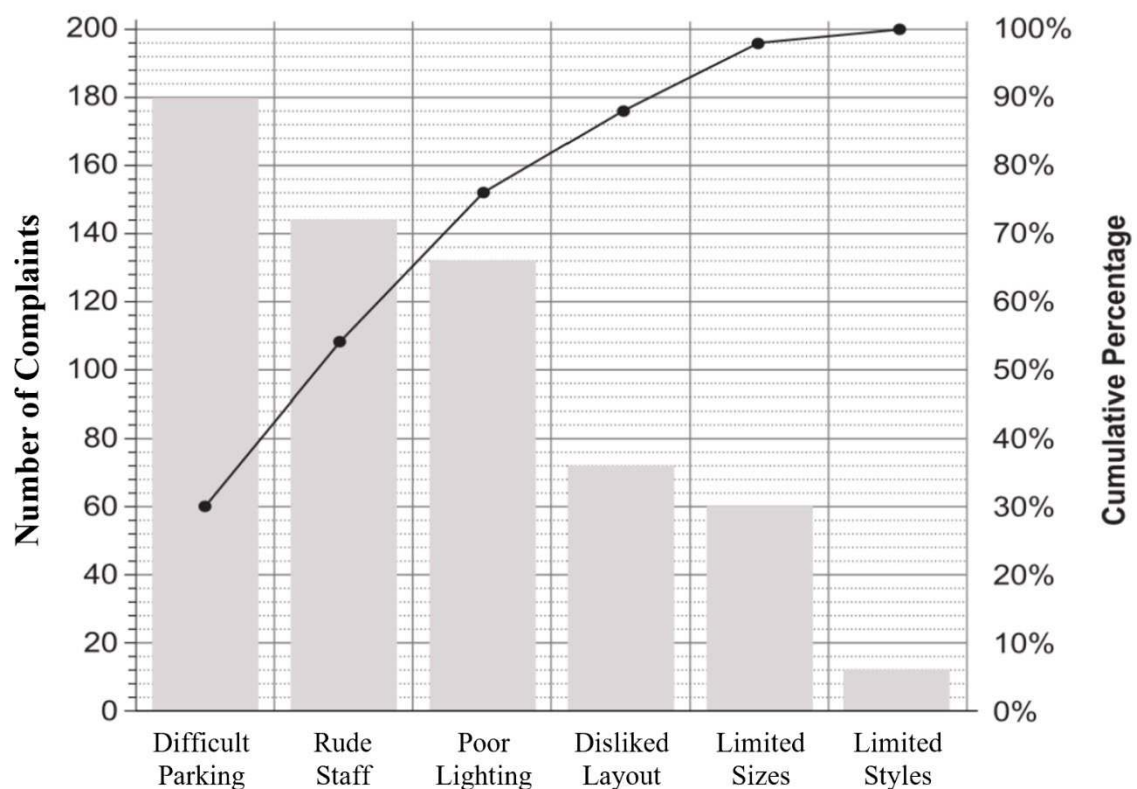
10 marks

Attempt Questions 1 – 10

Allow about 15 minutes for this section

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

- 1 A retail store owner collected a random sample of customer complaints. The pareto chart below shows the data collected.



The store owner will address 80% of the complaints. Which categories of complaints should be *completely* resolved?

- A. Difficult Parking only.
- B. Difficult Parking and Rude Staff only.
- C. Difficult Parking, Rude Staff and Poor Lighting only.
- D. Difficult Parking, Rude Staff, Poor Lighting and Disliked Layout only.

2 Consider the following three functional relations.

- $f(x) = f(-x)$
- $-f(x) = f(-x)$
- $f(x) = -f(x)$

How many of these does the function $f(x) = |3x|$ satisfy?

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

3 The table shows the future value of an annuity of \$1.

Periods (n)	Future Value of an Annuity of \$1				
	Interest Rate				
	2%	3%	4%	5%	6%
2	2.020	2.030	2.040	2.050	2.060
4	4.122	4.184	4.247	4.310	4.375
6	6.308	6.468	6.633	6.802	6.975
8	8.583	8.892	9.214	9.549	9.898
10	10.950	11.464	12.006	12.578	13.181

Angus wants to open an annuity account in order to save \$25 000 in 4 years' time.

He wants to make equal contributions at the end of each half year at an interest rate of 4% p.a. compounding half-yearly. What is his half-yearly contribution?

- A. \$2713.26
- B. \$2912.73
- C. \$5886.51
- D. \$6065.02

- 4 The length of human pregnancies from conception to birth approximates a normal distribution with a mean of 266 days and a standard deviation of 16 days. What proportion of all pregnancies will last between 250 and 298 days?
- A. 50%
 - B. 64%
 - C. 81.5%
 - D. 95%
- 5 Will decides to invest \$600 at the end of each month into an annuity. The interest rate quoted is 7.5% per annum, compounded monthly.
Let A_n represent the future value of the annuity after n months.
Which recurrence relation models this financial situation?
- A. $A_n = A_{n-1} \times 1.00625 + 600, A_0 = 0$
 - B. $A_n = A_{n-1} \times 1.00625, A_0 = 600$
 - C. $A_n = A_{n-1} \times 1.075 + 600, A_0 = 0$.
 - D. $A_n = A_{n-1} \times 1.075, A_0 = 600$
- 6 The graph $y = f(x)$ passes through the point $(-2, 7)$. If $h(x) = f\left(\frac{x}{2}\right) + 5$, then what is the transformed point that $h(x)$ passes through?
- A. $(-1, 2)$
 - B. $(-1, 12)$
 - C. $(-4, 2)$
 - D. $(-4, 12)$

7 Which of the following functions is differentiable for all real values of x ?

A. $f(x) = \begin{cases} x & x < 0 \\ -x & x \geq 0 \end{cases}$

B. $f(x) = \begin{cases} x & x < 0 \\ -x & x > 0 \end{cases}$

C. $f(x) = \begin{cases} 8x+4 & x < 0 \\ (2x+1)^2 & x \geq 0 \end{cases}$

D. $f(x) = \begin{cases} 4x+1 & x < 0 \\ (2x+1)^2 & x \geq 0 \end{cases}$

8 If $\int_0^a f(x) \, dx = k$, what is the value of $\int_0^a (5f(x) + 3) \, dx$?

A. $5k + 3a$

B. $5k + 3$

C. $5k$

D. $5k + a$

9 Let $f(x) = \sin(2x)$. If $f'(a) = \sqrt{3}$ and $f''(a) = 2$, what is the value of a for $0 < a < \pi$?

A. $\frac{\pi}{12}$

B. $\frac{5\pi}{12}$

C. $\frac{7\pi}{12}$

D. $\frac{11\pi}{12}$

10 Let A and B be two independent events from a sample space. If $P(A) = p$ and $P(B) = p^2$, what is $P(A' \cup B)$ equal to?

A. $1 - p - p^2$

B. $p^2 - p^3$

C. $p - p^3$

D. $1 - p + p^3$

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2024

YEAR 12 TRIAL EXAMINATION

Examination Number:

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Mathematics Advanced

Section II Answer Booklet

A

Section II

90 marks**Attempt Questions 11–30****Allow about 2 hours and 45 minutes for this section****Booklet A — Attempt Questions 11 – 15 (17 marks)****Booklet B — Attempt Questions 16 – 19 (18 marks)****Booklet C — Attempt Questions 20 – 23 (19 marks)****Booklet D — Attempt Questions 24 – 27 (19 marks)****Booklet E — Attempt Questions 28 – 30 (17 marks)**

Instructions

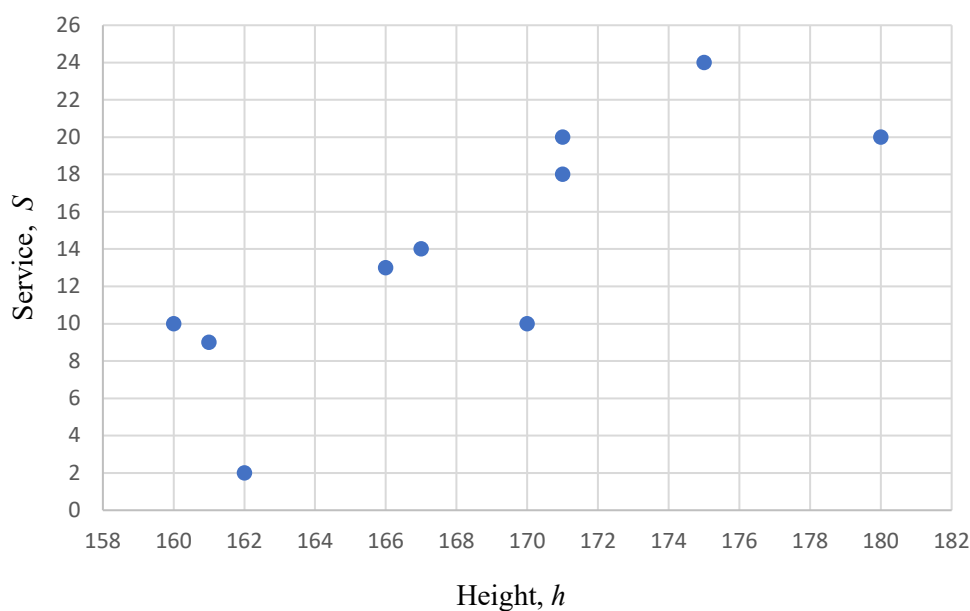
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Question 11 (5 marks)

The amount of community service in hours a student has completed at Shmoore has been recorded as well as the student's height. The results are below.

Height, h	160	161	162	166	167	170	171	171	175	180
Service, S	10	9	2	13	14	10	18	20	24	20



- (a) Using your calculator, find the correlation coefficient for this data correct to two decimal places and describe the relationship.

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- (b) Find the equation of the least-squares regression line for this data.

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- (c) Use the equation in part (b) to estimate the amount of community service hours a student that is 178 cm tall would complete. Answer to 1 decimal place.

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Question 11 continues on page 11.

- (d) Can your equation from part (b) be used to make reliable estimates for a student who is 188 cm tall? Justify your response. **1**

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Question 12 (2 marks)

- Differentiate $y = \frac{\sin x}{e^{2x}}$ with respect to x . **2**

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Question 13 (4 marks)

In the construction of a 5 km tunnel a truck delivers materials from a base at the entrance. After depositing each load, the truck returns to the base to collect the next load. The first load is deposited 200 m from the base and each subsequent load is deposited 150 m from the previous one. The last load is deposited 5 km from the base.

- (a) How many loads are deposited along the total length of the 5 km tunnel? **2**

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- (b) How many kilometres in total has the truck travelled in order to make all the deposits and return to base? **2**

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Question 14 (3 marks)

Solve $\sqrt{3} \tan 2x = 3$, in the interval $0 \leq x \leq \pi$.

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Question 15 (3 marks)

The following graph indicates z scores of ‘height-for-age’ for girls aged 5-19 years.



- (a) Mary is 165 cm tall. She is taller than 84% of girls her age. How old is she?

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- (b) Is Mary’s height in the interquartile range for her age group? Provide reasons.

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End of Booklet A.

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2024

YEAR 12 TRIAL EXAMINATION

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Mathematics Advanced

Section II Answer Booklet

B

Section II

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Please turn over

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Question 16 (3 marks)

The table show the probability distribution of a discrete random variable.

x	0	1	2	3	4
$P(X = x)$	$\frac{1}{81}$	$\frac{8}{81}$	$\frac{24}{81}$	$\frac{32}{81}$	$\frac{16}{81}$

Show that the standard deviation is equal to $\frac{2\sqrt{2}}{3}$.

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Question 17 (5 marks)

Two particles A and B are moving in a straight line.

The positions of the particles, with respect to the origin, are given by $x_A = \frac{1}{2}t^2 - t + 3$

and $x_B = -\frac{1}{4}t^2 + t + 1$ at time $t \geq 0$.

(a) Show that A and B do not intersect.

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(b) Find the time when particle A is stationary and the time when particle B is stationary.

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Question 17 continues on page 21.

(c) State when the particles are moving in opposite directions.

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Question 18 (6 marks)

A function is defined as $y = x[\ln(x)]^2$, $x > 0$.

- (a) Find the co-ordinates of the two stationary points and determine their nature, in exact form. 4

[illegible]

Question 18 continues on page 23.

(b) Find the point of inflection of $y = f(x)$.

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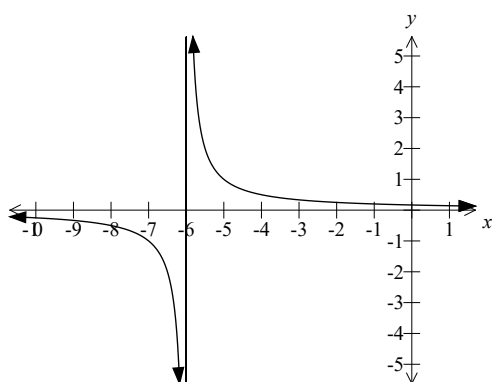
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Question 19 (4 marks)

The graph of the function $y = \frac{1}{x+6}$, is shown.



- (a) The graph of $y = f(x)$ is dilated horizontally by a factor of $\frac{1}{3}$ and then translated 2 units to the right. What is the equation of the transformed function $y = g(x)$? 2

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- (b) Is the graph of $y = g(x)$ odd, even or neither? Show mathematical reasoning. 2

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End of Booklet B.

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2024

YEAR 12 TRIAL EXAMINATION

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Mathematics Advanced

Section II Answer Booklet

C

Section II

90 marks**Attempt Questions 11–30****Allow about 2 hours and 45 minutes for this section****Booklet A — Attempt Questions 11 – 15 (17 marks)****Booklet B — Attempt Questions 16 – 19 (18 marks)****Booklet C — Attempt Questions 20 – 23 (19 marks)****Booklet D — Attempt Questions 24 – 27 (19 marks)****Booklet E — Attempt Questions 28 – 30 (17 marks)**

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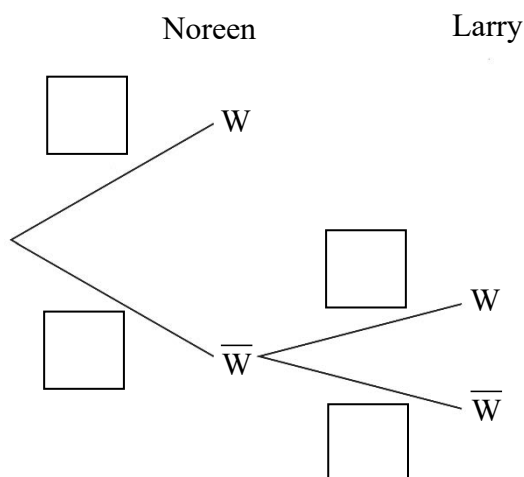
Question 20 (5 marks)

Noreen and Larry are playing a game. They take turns throwing two dice. The game is won by the first player to throw a double six or double one. Noreen starts the game.

- (a) Find the probability that Noreen wins on her first throw. **1**

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- (b) Complete the tree diagram. **1**



- (c) Calculate the probability that Noreen wins the game on her first or her second throw. **1**

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Question 20 continues on page 31.

(d) Find the probability that Noreen wins eventually.

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Question 21 (5 marks)

A continuous random variable has the following probability density function.

$$g(x) = \begin{cases} k(1+x) & 0 \leq x \leq 4 \\ 0 & \text{otherwise} \end{cases}$$

(a) Show that $k = \frac{1}{12}$.

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Question 21 continues on page 33.

(b) Find the value of a such that $P(X \leq a) = \frac{5}{8}$.

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(c) Hence, or otherwise, find $P\left[X \leq \frac{1}{3}a \mid X \leq a\right]$.

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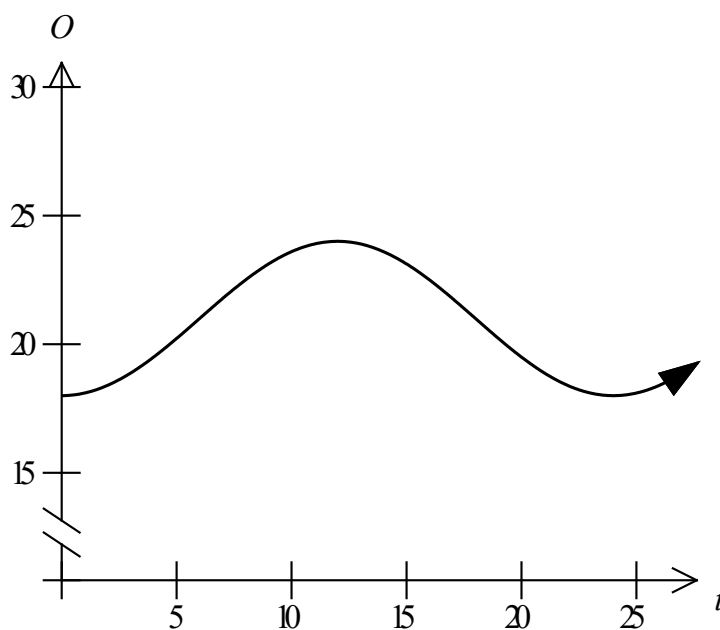
Question 22 (5 marks)

The temperature inside a house, (I), can be modelled by the function,

$$I(t) = a \cos(bt) + c,$$

where t is the time in hours and $0 \leq t \leq 24$.

The temperature reaches a maximum of 24° when $t = 12$ and a minimum of 18° when $t = 24$. The graph of $I(t)$ is shown.



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

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The temperature outside the house, (O), can be modelled by the function,

$$O(t) = 22 - 5 \cos\left(\frac{\pi t}{12}\right).$$

(b) Graph $O(t)$ on the same axis above for $0 \leq t \leq 24$.

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Question 22 continues on page 35.

(c) Find the times when the inside temperature is cooler than the outside temperature. **2**

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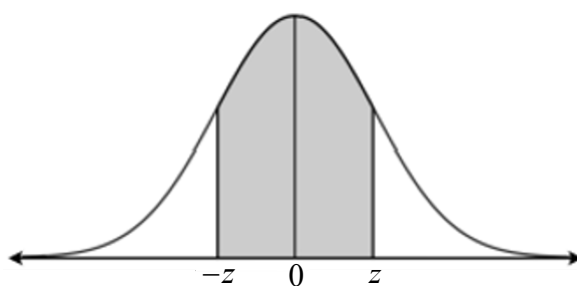
Question 23 (4 marks)

A random variable is normally distributed with mean 0 and standard deviation 1.

The table gives the probability that this random variable lies between $-z$ and z for different values of z .

z	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00
$P(-z \leq X \leq z)$	0.0000	0.1974	0.3829	0.5467	0.6827	0.7887	0.8664	0.9119	0.9545

The probability values given in the table for different values of z are represented by the shaded area in the diagram below.



- (a) Using the table, determine the probability that this random variable will lie between $z = -0.75$ and $z = 1.5$. **2**

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Question 23 continues on page 37.

- (b) The arm span (in metres) for a group of 2500 residents of a town are normally distributed with a mean of 1.63 metres and a standard deviation of 0.26 metres. How many of the residents will have an arm span greater than 1.5 metres? 2

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End of Booklet C.

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2024**YEAR 12 TRIAL EXAMINATION**

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Mathematics Advanced

Section II Answer Booklet

D

Section II

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Please turn over

Question 24 (7 marks)

A rectangular pool of volume 60 m^3 is to be made with length $3x$ metres, width x metres and height h metres. The cost of material to build the four sides of the pool is \$25 per square metre and the cost of material to build the base is \$20 per square metre.

- (a) Show that the total cost $\$C$ of making the pool is given by $C = 60x^2 + \frac{4000}{x}$.

3

[illegible]

Question 24 continues on page 43.

- (b) Hence, find the dimensions of a pool that will minimise the total cost, to the nearest metre.

[illegible]

Question 25 (5 marks)

The rate that water fills an empty vessel is given by $\frac{dV}{dt} = 0.25e^{0.25t}$ in litres per hour, $0 \leq t \leq 8 \ln(6)$, where t is time in hours. The vessel is full when $t = 8 \ln(6)$.

- (a) Determine the volume of water, to the nearest litre, the vessel can hold when it is full. **3**

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The table shows the approximate rate the water flows into the vessel at certain times.

t	0	1	2	3
$\frac{dV}{dt}$	0.25	0.32	0.41	0.53

- (b) Use the trapezoidal rule to determine the approximate volume of water in the vessel after three hours. **2**

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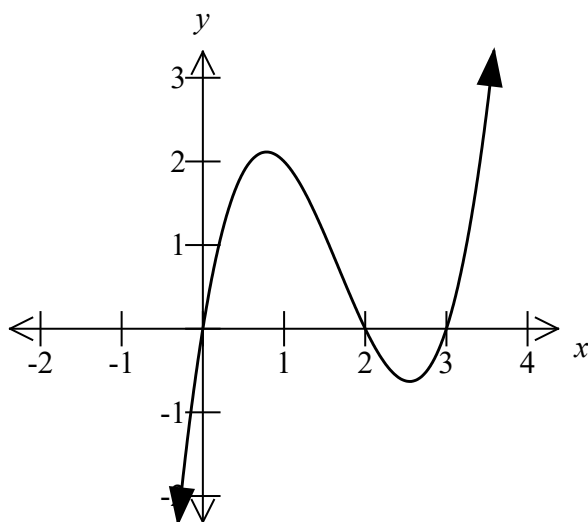
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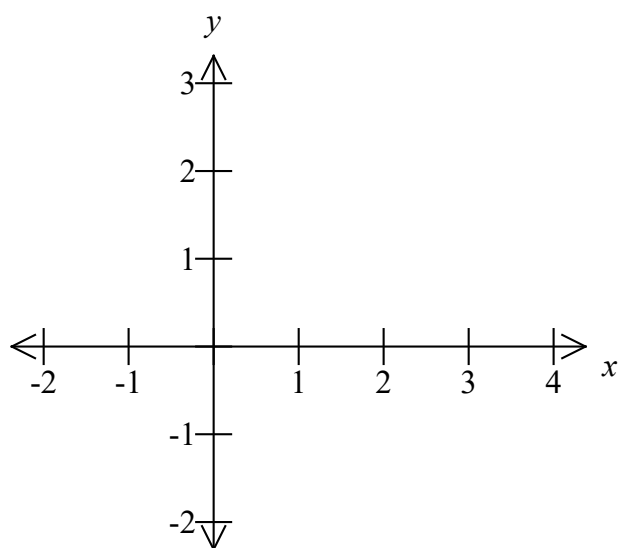
Question 26 (2 marks)

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



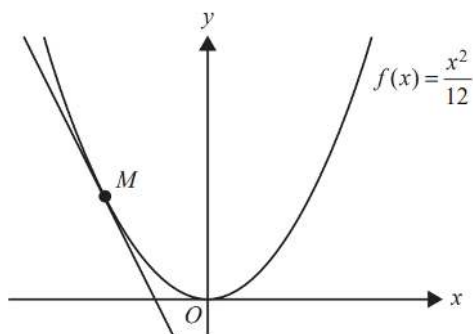
Sketch the graph of $y = 1 - f(x)$.

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Question 27 (5 marks)

The diagram below shows part of the graph of $y = f(x)$, where $f(x) = \frac{x^2}{12}$.



The tangent to $f(x)$ at point M has a gradient of -2 .

- (a) Show that the equation of the normal to the tangent at M is $y = \frac{x}{2} + 18$.

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Question 27 continues on page 47.

- (b) Calculate the area between the normal of the curve through point M and the curve $y = f(x)$. 3

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End of Booklet D.

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for letter height. The entire page is otherwise blank, with no margins, text, or other markings.

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Mathematics Advanced

Section II Answer Booklet

E

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Question 28 (4 marks)

- (a) Show that $\frac{\cos^3 x}{1 + \sin x} + \sin x \cos x = \cos x$.

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- (b) Hence, or otherwise, find the exact value of

$$\int_{\frac{\pi}{4}}^{\frac{\pi}{3}} \frac{\cos^3(x + \pi)}{1 + \sin(x + \pi)} + \sin(x + \pi) \cos(x + \pi) \, dx \quad .$$

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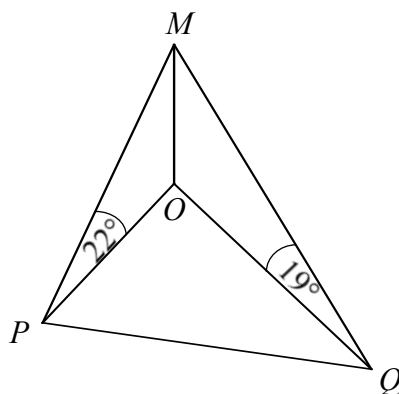
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Question 29 (5 marks)

Two observers P and Q , who are 2000 metres apart, take the bearing and elevation of a mountain M at the same instant. The observer P finds the bearing to be 018°T and the angle of elevation to be 22° , while the observer Q finds the bearing to be 345°T and the angle of elevation to be 19° .



- (a) Let h be the height of the mountain. Create an expression for OQ in terms of h . 1

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- (b) Show that $\angle POQ = 33^\circ$. 1

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Question 29 continues on page 53.

Question 30 (8 marks)

A fund is established to provide prizes for a basketball team's annual Awards night. \$10 000 is placed in the fund one year before the first Awards night. It is decided that \$450 will be withdrawn from the fund each year to purchase the annual prizes. The money in the fund is invested at 3% p.a. compounded annually with the interest paid into the fund before each annual Awards night.

- (a) If A_n is the amount in dollars remaining in the fund after the n^{th} Awards night, prove that $A_n = 5000(3 - 1.03^n)$. 3

[illegible]

Question 30 continues on page 55.

- (b) Find the maximum number of Awards nights that can be financed using this fund. **2**

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For the fund described, the club decides to increase the money withdrawn for each Awards night by 2% each year.

- (c) Find the amount remaining in the fund after the 25th Awards night with this new condition. **3**

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End of Booklet E.

Section II extra writing space

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