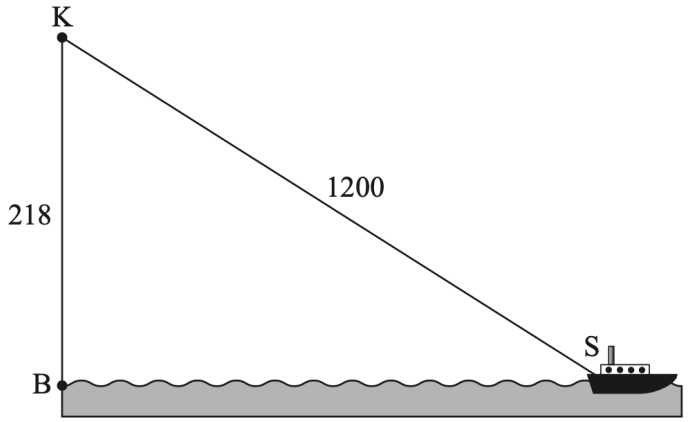
Answers must be written within the answer boxes provided. Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. Solutions found from a graphic display calculator should be supported by suitable working. For example, if graphs are used to find a solution, you should sketch these as part of your answer. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

Q1. [Maximum marks: 6]

Kacheena stands at point K, the top of a $218\,\mathrm{m}$ vertical cliff. The base of the cliff is located at point B. A ship is located at point S, $1200\,\mathrm{m}$ from Kacheena.

This information is shown in the following diagram.

diagram not to scale



(a) Find the angle of elevation from the ship to Kacheena. [2]

(b) Find the horizontal distance from the base of the cliff to the ship. [2]

(c) Write down your answer to part (b) in the form $a \times 10^k$ where $1 \leq a < 10$ and $k \in \mathbb{Z}$. [2]

……
……
……

Q2. [Maximum marks: 7]

In the first month of a reforestation program, the town of Neerim plants 85 trees. Each subsequent month the number of trees planted will increase by an additional 30 trees.

The number of trees to be planted in each of the first three months are shown in the following table.

Month	Trees planted
1	85
2	115
3	145

(a) Find the number of trees to be planted in the 15th month. [3]

(b) Find the total number of trees to be planted in the first 15 months. [2]

(c) Find the mean number of trees planted per month during the first 15 months. [2]

Q3.[Maximum marks: 7]

On January the 1st 2017 Ji Sun had savings of $7,380.

He decided to keep his money in a bank account that pays an annual interest rate of 4.7% per year which is compounded monthly.

(a) Ji Sun left the money in the bank account until January the 1st 2025.

Calculate the value of his investment on this day, giving your answer to 2 decimal places. [2]

After 2 complete years of earning interest in the bank account, Ji Sun decided to move his money into a savings account which paid a higher rate of yearly interest, compounded monthly.

(b) On January the 1st 2025 he is projected to have $11,747.40.

Determine the annual interest rate of the savings account. [4]

Q4.[Maximum marks: 7]

Taizo plays a game where he throws one ball at two bottles that are sitting on a table.
The probability of knocking over bottles, in any given game, is shown in the following table.

Number of bottles knocked over	0	1	2
Probability	0.5	0.4	0.1

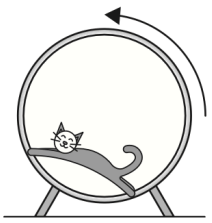
(a) Taizo plays two games that are independent of each other. Find the probability that Taizo knocks over a **total** of two bottles. [4]

In any given game, Taizo will win k points if he knocks over two bottles, win 4 points if he knocks over one bottle and lose 8 points if no bottles are knocked over.

(b) Find the value of k such that the game is fair. [3]

Q5.[Maximum marks: 6]

A cat runs inside a circular exercise wheel, making the wheel spin at a constant rate in an anticlockwise direction. The height, h cm, of a fixed point, P, on the wheel can be modelled by $h(t) = a\sin(bt) + c$ where t is the time in seconds and a, b, $c \in \mathbb{R}^+$.



When $t = 0$, point P is at a height of 78 cm.

(a) Write down the value of c. [1]

When $t = 4$, point P first reaches its maximum height of 143 cm.

(b) Find the value of

(i) a.

(ii) b. [3]

(c) Write down the minimum height of point P. [1]

Later, the cat is tired, and it takes twice as long for point P to complete one revolution at a new constant rate.

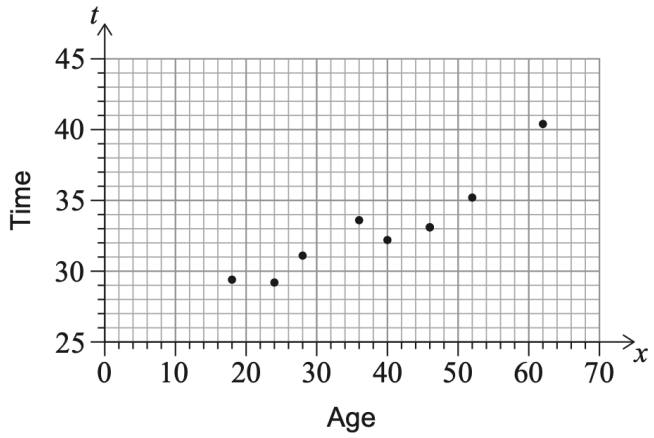
(d) Write down the new value of b. [1]

Q6.[Maximum marks: 6]

Eduardo believes that there is a linear relationship between the age of a male runner and the time it takes them to run 5000 metres.

To test this, he recorded the age, x years, and the time, t minutes, for eight males in a single $5000\,\text{m}$ race. His results are presented in the following table and scatter diagram.

***x*, years**	18	24	28	36	40	46	52	62
***t*, minutes**	29.4	29.2	31.1	33.6	32.2	33.1	35.2	40.4



(a) For this data, find the value of the Pearson's product-moment correlation coefficient, r. [2]

Eduardo looked in a sports science text book. He found that the following information about r was appropriate for athletic performance.

Value of $\lvert r \rvert$	**Description of the correlation**
$0 \leq \lvert r \rvert < 0.4$	weak
$0.4 \leq \lvert r \rvert < 0.8$	moderate
$0.8 \leq \lvert r \rvert \leq 1$	strong

(b) Comment on your answer to part (a), using the information that Eduardo found. [1]

(c) Write down the equation of the regression line of t on x, in the form $t = ax + b$. [1]

A 57-year-old male also ran in the $5000\,\text{m}$ race.

(d) Use the equation of the regression line to estimate the time he took to complete the $5000\,\text{m}$ race. [2]

……
……
……

Q7. [Maximum marks: 7]

Let the function $h(x)$ represent the height in centimetres of a cylindrical tin can with diameter x cm.

$$h(x) = \frac{640}{x^2} + 0.5 \text{ for } 4 \leq x \leq 14.$$

(a) Find the range of h. [3]

The function h^{-1} is the inverse function of h.

(b) (i) Find $h^{-1}(10)$.

(ii) In the context of the question, interpret your answer to part (b)(i).

(iii) Write down the range of h^{-1}. [4]

Q8. [Maximum marks: 5]

Inspectors are investigating the carbon dioxide emissions of a power plant. Let R be the rate, in tonnes per hour, at which carbon dioxide is being emitted and t be the time in hours since the inspection began.

When R is plotted against t, the total amount of carbon dioxide produced is represented by the area between the graph and the horizontal t-axis.

The rate, R, is measured over the course of two hours. The results are shown in the following table.

t	0	0.4	0.8	1.2	1.6	2
R	30	50	60	40	20	50

(a) Use the trapezoidal rule with an interval width of 0.4 to estimate the total amount of carbon dioxide emitted during these two hours. [3]

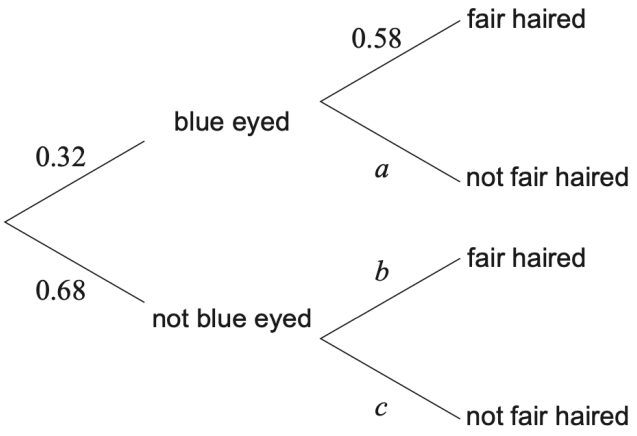
The real amount of carbon dioxide emitted during these two hours was 72 tonnes.

(b) Find the percentage error of the estimate found in part (a). [2]

……
……
……

Q9. [Maximum marks: 5]

In a city, 32% of people have blue eyes. If someone has blue eyes, the probability that they also have fair hair is 58%. This information is represented in the following tree diagram.



(a) Write down the value of a. [1]

(b) Find an expression, in terms of b, for the probability of a person not having blue eyes **and** having fair hair. [1]

It is known that 41% of people in this city have fair hair.

(c) Calculate the value of

(i) b.

(ii) c. [3]

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

Q10. [Maximum marks: 6]

The surface area of an open box with a volume of $32\,\text{cm}^3$ and a square base with sides of length $x\,\text{cm}$ is given by $S(x) = x^2 + \frac{128}{x}$ where $x > 0$.

(a) Find $S'(x)$. [3]

(b) (i) Solve $S'(x) = 0$.

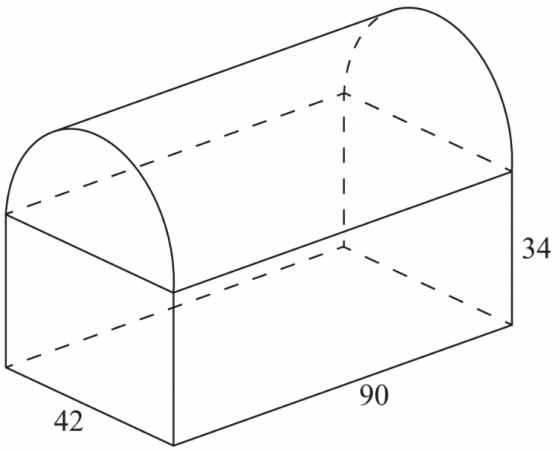
(ii) Interpret your answer to (b)(i) in context. [3]

Q11. [Maximum marks: 5]

A storage container consists of a box of length $90\,\text{cm}$, width $42\,\text{cm}$ and height $34\,\text{cm}$, and a lid in the shape of a half-cylinder, as shown in the diagram. The lid fits the top of the box exactly. The total exterior surface of the storage container is to be painted.

Find the area to be painted.

diagram not to scale



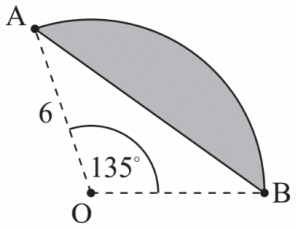
……
……
……
……
……
……
……
……
……
……
……
……
……
……

Q12. [Maximum marks: 7]

A garden includes a small lawn. The lawn is enclosed by an arc AB of a circle with centre O and radius 6 m, such that $A\hat{O}B = 135^\circ$. The straight border of the lawn is defined by chord [AB].

The lawn is shown as the shaded region in the following diagram.

diagram not to scale



(a) A footpath is to be laid around the curved side of the lawn. Find the length of the footpath. [3]

(b) Find the area of the lawn. [4]