PAPER 1 QUESTIONS (SHORT QUESTIONS)

Q1. $[Maximum\ mark: 4]$

Katya approximates π, correct to four decimal places, by using the following expression.

$$3 + \frac{1}{6 + \frac{13}{16}}$$

(a) Calculate Katya's approximation of π, correct to four decimal places. [2]

(b) Calculate the percentage error in using Katya's four decimal place approximation of π, compared to the exact value of π in your calculator. [2]

Q2. $[Maximum\ mark: 5]$

The amount, in milligrams, of a medicinal drug in the body t hours after it was injected is given by $D(t) = 23\ (0.85)^t, t \geq 0$. Before this injection, the amount of the drug in the body was zero.

(a) Write down

(i) the initial dose of the drug.

(ii) the percentage of the drug that leaves the body each hour. [3]

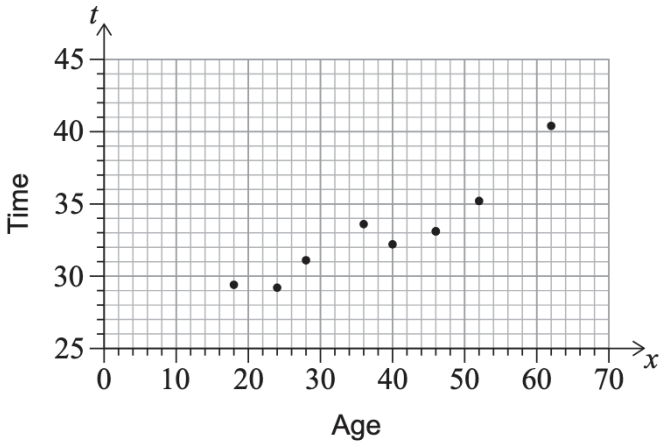
(b) Calculate the amount of the drug remaining in the body 10 hours after the injection. [2]

Q3. $[Maximum\ mark: 6]$

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 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]

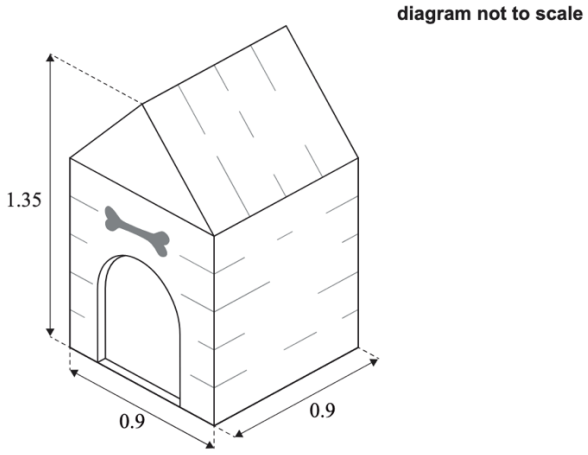
(c) Write down the equation of the regression line of t on x , in the form $t = ax + b$. [1]

A 57-year-old male also ran in the 5000 m race.

(d) Use the equation of the regression line to estimate the time he took to complete the 5000 m race. [2]

Q4. [$Maximum\ mark$: 5]

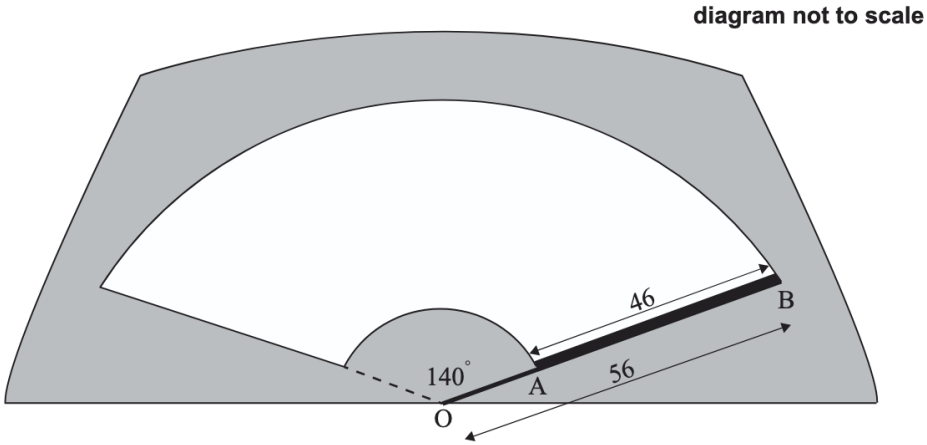
The front view of a doghouse is made up of a square with an isosceles triangle on top. The doghouse is 1.35 m high and 0.9 m wide, and sits on a square base.



The top of the rectangular surfaces of the roof of the doghouse are to be painted.
Find the area to be painted.

Q5. $[Maximum\ mark: 5]$

The straight metal arm of a windscreen wiper on a car rotates in a circular motion from a pivot point, O, through an angle of 140°. The windscreen is cleared by a rubber blade of length 46 cm that is attached to the metal arm between points A and B. The total length of the metal arm, OB, is 56 cm.
The part of the windscreen cleared by the rubber blade is shown unshaded in the following diagram.

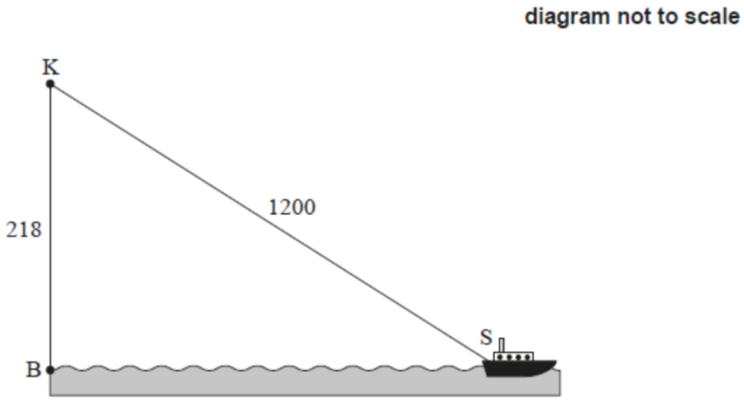


(a) Calculate the length of the arc made by B, the end of the rubber blade. [2]
(b) Determine the area of the windscreen that is cleared by the rubber blade. [3]

Q6. $[Maximum\ mark: 6]$

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

This information is shown in the following diagram.



(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]

Q7. $[Maximum\ mark: 6]$

The decathlon is a competition where athletes compete in ten events. Two of those events are long jump and high jump. In both events, a greater distance means a better ranking. The table shows results for these two events at the World Championships.

	Event		Rank	
Athlete's Country	**Long Jump (m)**	**High Jump (m)**	**Long Jump Rank**	**High Jump Rank**
Germany	7.64	2.11	1	
France	7.52	2.08	2	
Estonia	7.49	1.84	3	
Canada	7.44	2.02	4	
Netherlands	7.33	2.05	5	
Ukraine	7.28	2.02	6	
Algeria	7.22	1.90	7	
Austria	7.11	1.87	8	
Grenada	6.98	1.99	9	
Japan	6.64	1.96	10	

The Spearman's rank correlation coefficient is used to determine if there is a linear correlation between an athlete's ranking in long jump and their ranking in high jump.

(a) Complete the table to show the athletes' rankings in high jump. [2]

(b) Find the value of the Spearman's rank correlation coefficient r_s. [2]

The following guide is used by the coach to determine the strength of the correlation between the ranks for long jump and high jump.

$\lvert r_s \rvert$	**Strength**
0.000 to 0.199	Very weak
0.200 to 0.399	Weak
0.400 to 0.599	Moderate
0.600 to 0.799	Strong
0.800 to 1.000	Very strong

(c) State the strength of the correlation between the rankings as indicated by the table and interpret this in the context of the question. [2]

Q8. $[Maximum\ mark: 6]$

Zaha is designing a bridge to cross a river. She believes that the weight of the steel needed for this bridge is approximately 53 632 000 kg.

The exact weight of the steel needed for the bridge is 55 625 000 kg.

(a) Find the percentage error in Zaha's approximation. [2]

Zaha's design is used to build five identical bridges.

(b) (i) Find the weight of the steel needed for these five bridges, to three significant figures.

(ii) Write down your answer to part (b) in the form $a \times 10^k$ where $1 \leq a < 10$ and $k \in \mathbb{Z}$. [3]

Q9. $[Maximum\ mark: 7]$

Billy is a keen walker who keeps a record of his performance. The following table shows the time, in minutes, it takes him to walk one kilometre up hills with different gradients. The gradient of each hill is constant.

Gradient G (%)	0	4	10	15	20
Time T (min.)	6.85	8.42	11.20	14.49	17.88

(a) (i) Find the equation of the regression line of T on G .

(ii) Describe the correlation between T and G with reference to the value of r, the Pearson's product-moment correlation coefficient. [4]

On Sunday, Billy intends to walk up a hill with a gradient of 13 %.

(b) Estimate the time it will take Billy to walk one kilometre up the hill. [2]

This morning, Billy walked one kilometre up a hill, and it took 22 minutes.

(c) Explain why it would be inappropriate to use the equation found in part (a) to estimate the gradient of this hill. [1]

Q10. $[Maximum\ mark: 7]$

The following data show the heights, in metres, of six players in a basketball team.

1.67	1.60	1.68	2.31	2.31	2.19

(a) For these six players, find

(a.i) the mean height. [2]

(a.ii) the median height [1]

(a.iii) the modal height. [1]

(a.iv) the range of the heights. [2]

A new player, Gheorghe, joins the team. Their height is measured as metres to the nearest centimetre.

(b) Write down the shortest possible height of Gheorghe. [1]

Q11. $[Maximum\ mark: 7]$

The prices, in dollars, of 10 different garden chairs are:

79 139 255 99 50 209 229 193 69 49

(a) Find the range of the prices of the 10 chairs. [2]

(b) Use your graphic display calculator to find

(b.i) the mean price of the chairs. [2]

(b.ii) the standard deviation of the price of the chairs. [1]

In a sale, the price of each of the 10 garden chairs is reduced by $20.

(c) Write down

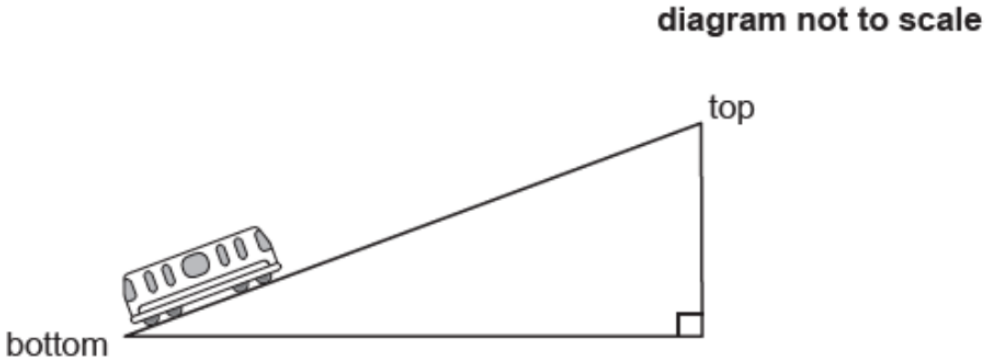
(c.i) the new mean. [1]

(c.ii) the new standard deviation. [1]

Q12. $[Maximum\ mark: 4]$

One of the steepest train tracks in the world is in Tennessee, USA.

This track is 1.52 km long, and the angle of elevation from the bottom of the track to the top is 36.1°.



(a) Label the diagram with the given values for the track length and the angle of elevation. [2]

(b) Find the vertical change in height from the bottom of the track to the top. [2]

PAPER 2 QUESTIONS (LONG QUESTIONS)

Q13. $[Maximum\ mark: 19]$

A medical centre is testing patients for a certain disease. This disease occurs in 5 % of the population.

They test every patient who comes to the centre on a particular day.

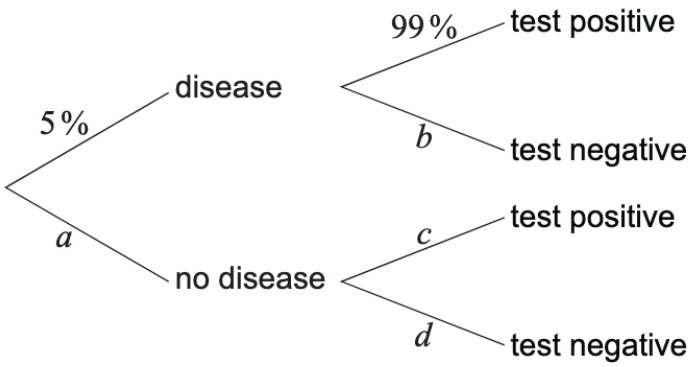
(a) State the sampling method being used. [1]

It is intended that if a patient has the disease, they test "positive", and if a patient does not have the disease, they test "negative".

However, the tests are not perfect, and only 99 % of people who have the disease test positive.

Also, 2% of people who do not have the disease test positive.

The tree diagram shows some of this information.



(b) Write down the value of

(i) a .

(ii) b .

(iii) c .

(iv) d . [4]

(c) Use the tree diagram to find the probability that a patient selected at random

(i) will not have the disease and will test positive.

(ii) will test negative.

(iii) has the disease given that they tested negative. [8]

(d) The medical centre finds the actual number of positive results in their sample is different than predicted by the tree diagram. Explain why this might be the case. [1]

The staff at the medical centre looked at the care received by all visiting patients on a randomly chosen day. All the patients received at least one of these services: they had medical tests (M), were seen by a nurse (N), or were seen by a doctor (D). It was found that:

- 78 had medical tests,
- 45 were seen by a nurse;
- 30 were seen by a doctor;
- 9 had medical tests and were seen by a doctor and a nurse;
- 18 had medical tests and were seen by a doctor but were not seen by a nurse;
- 11 patients were seen by a nurse and had medical tests but were not seen by a doctor;
- 2 patients were seen by a doctor without being seen by nurse and without having medical tests.

(e) Draw a Venn diagram to illustrate this information, placing all relevant information on the diagram. [3]

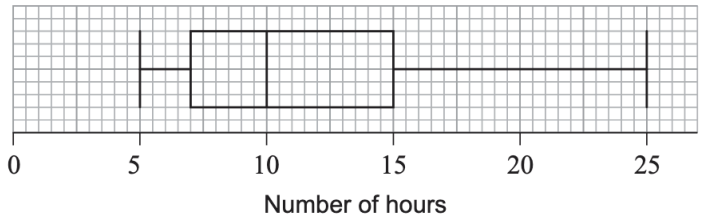
(f) Find the total number of patients who visited the centre during this day. [2]

Q14. [$Maximum\ mark$: 18]

As part of his mathematics exploration about classic books, Jason investigated the time taken by students in his school to read the book The Old Man and the Sea. He collected his data by stopping and asking students in the school corridor, until he reached his target of 10 students from each of the literature classes in his school.

(a) State which of the two sampling methods, systematic or quota, Jason has used. [1]

Jason constructed the following box and whisker diagram to show the number of hours students in the sample took to read this book.



(b) Write down the median time to read the book. [1]

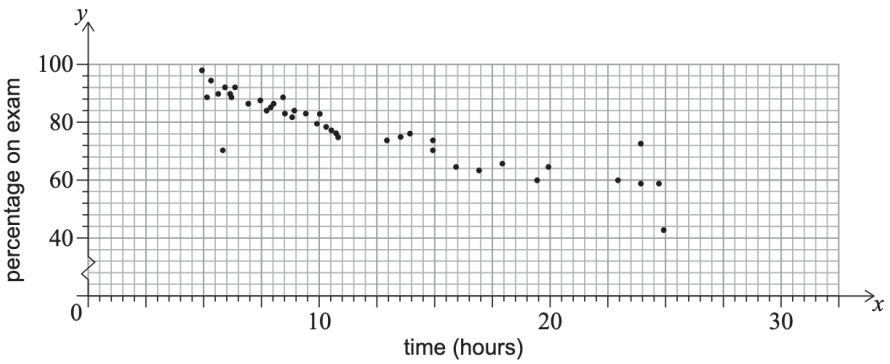
(c) Calculate the interquartile range. [2]

Mackenzie, a member of the sample, took 25 hours to read the novel. Jason believes Mackenzie's time is not an outlier.

(d) Determine whether Jason is correct. Support your reasoning. [4]

For each student interviewed, Jason recorded the time taken to read The Old Man and the Sea (x), measured in hours, and paired this with their percentage score on the final exam (y).

These data are represented on the scatter diagram.



e) Describe the correlation. [1]

Jason correctly calculates the equation of the regression line y on x for these students to be $y = -1.54x + 98.8$.

He uses the equation to estimate the percentage score on the final exam for a student who read the book in 1.5 hours.

(f) Find the percentage score calculated by Jason. [2]

(g) State whether it is valid to use the regression line y on x for Jason's estimate. Give a reason for your answer. [2]

Jason found a website that rated the 'top 50' classic books. He randomly chose eight of these

classic books and recorded the number of pages. For example, Book H is rated 44th and has 281 pages. These data are shown in the table.

Book	A	B	C	D	E	F	G	H
Number of pages (n)	4215	863	585	1225	366	209	624	281
Top 50 rating (t)	1	2	5	7	13	22	40	44

Jason intends to analyse the data using Spearman's rank correlation coefficient, rs .

(h) Copy and complete the information in the following table. [2]

Book	A	B	C	D	E	F	G	H
Rank – Number of pages	1							
Rank – Top 50 Rating	1							

(i) (i) Calculate the value of r_s.

(ii) Interpret your result. [3]

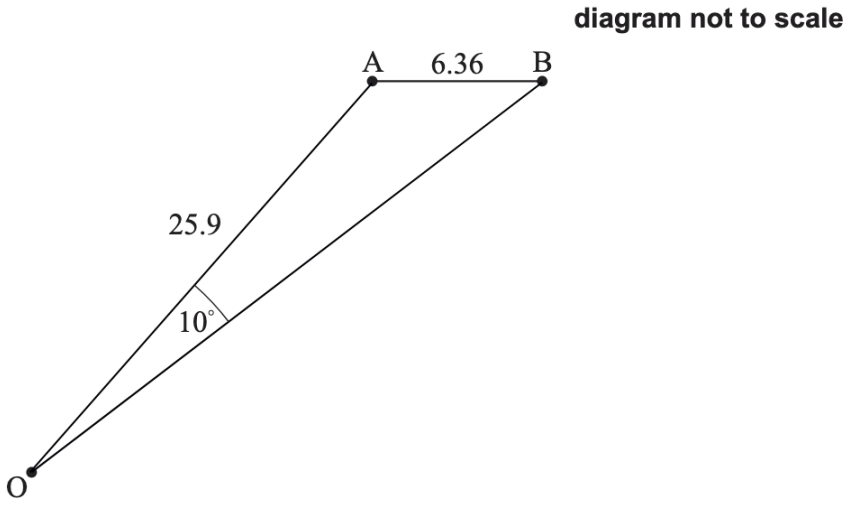
Q15. $[Maximum\ mark: 17]$

The diagram shows points in a park viewed from above, at a specific moment in time.

The distance between two trees, at points A and B, is 6.36 m.

Odette is playing football in the park and is standing at point O, such that $A\hat{O}B$ = 10 ,

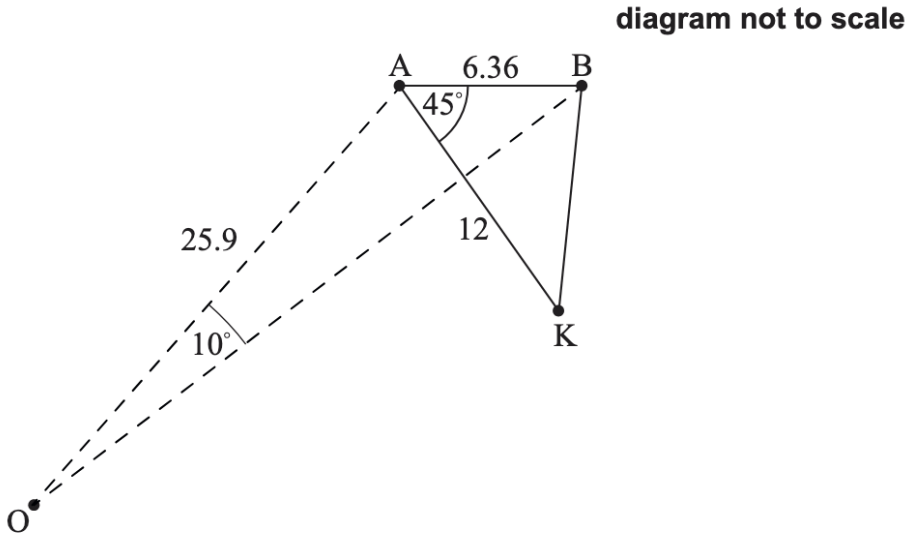
OA = 25.9 m and $O\hat{A}B$is obtuse.



(a) Calculate the size of $A\hat{B}O$. [3]

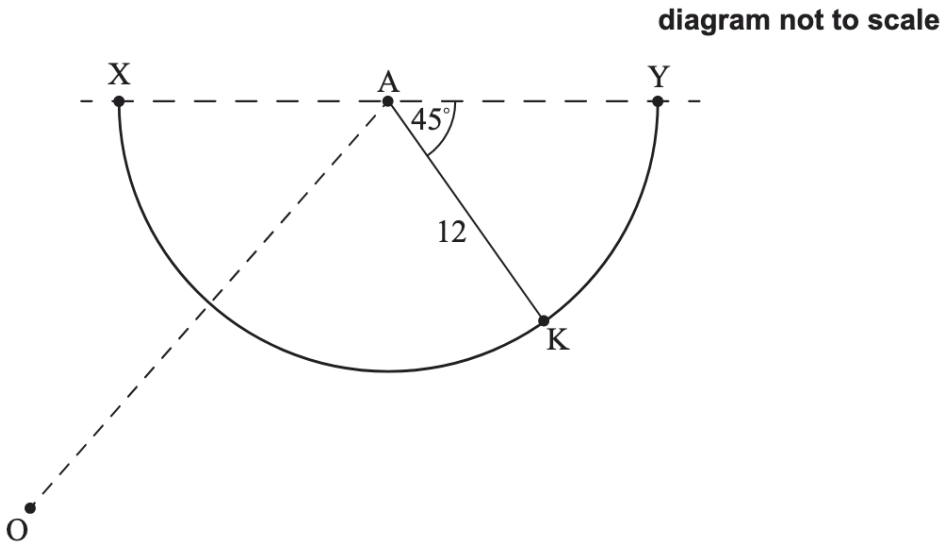
(b) Calculate the area of triangle AOB. [4]

Odette's friend, Khemil, is standing at point K such that he is 12 m from A and $K\hat{A}B = 45°$



(c) Calculate Khemil's distance from B. [3]

XY is a semicircular path in the park with centre A, such that. $K\hat{A}Y = 45°$ Khemil is standing on the path and Odette's football is at point X. This is shown in the diagram below.



The length KX = 22.2 m , $K\hat{O}X = 53.8°$ and $O\hat{K}X = 51.1°$.

(d) Find whether Odette or Khemil is closer to the football. [4]

Khemil runs along the semicircular path to pick up the football.

(e) Calculate the distance that Khemil runs. [3]

Q16. $[Maximum\ mark: 17]$

Elsie, a librarian, wants to investigate the length of time, T minutes, that people spent in her library on a particular day.

(a) State whether the variable T is discrete or continuous. [1]

Elsie's data for 160 people who visited the library on that particular day is shown in the following table.

T (minutes)	$0 \leq T < 20$	$20 \leq T < 40$	$40 \leq T < 60$	$60 \leq T < 80$	$80 \leq T < 100$
Frequency	50	62	k	14	8

(b) Find the value of k . [2]

(c) (i) Write down the modal class.

(ii) Write down the mid-interval value for this class. [2]

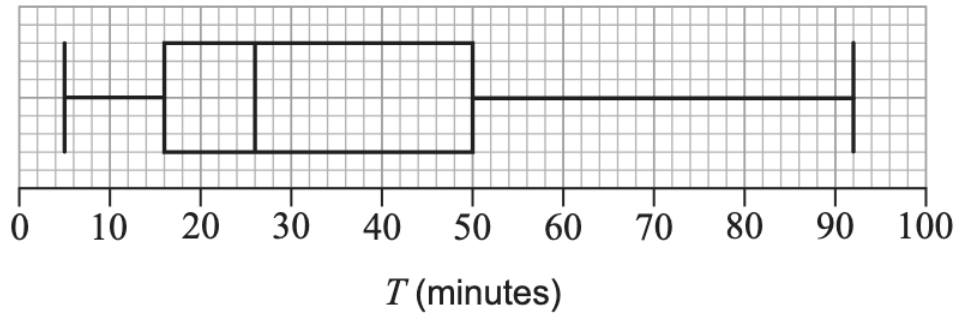
(d) Use Elsie's data to calculate an estimate of the mean time that people spent in the library. [2]

(e) Using the table, write down the maximum possible number of people who spent 35 minutes or less in the library on that day. [1]

Elsie assumes her data to be representative of future visitors to the library.

(f) Find the probability a visitor spends at least 60 minutes in the library. [2]

The following box and whisker diagram shows the times, in minutes, that the 160 visitors spent in the library.



(g) Write down the median time spent in the library. [1]

(h) Find the interquartile range. [2]

(i) Hence show that the longest time that a person spent in the library is not an outlier. [3]

Elsie believes the box and whisker diagram indicates that the times spent in the library are not normally distributed.

(j) Identify one feature of the box and whisker diagram which might support Elsie's belief. [1]

Q17. $[Maximum\ mark: 19]$

Give your answers in parts (a), (d)(i), (e) and (f) to the nearest dollar.

Daisy invested 37 000 Australian dollars (AUD) in a fixed deposit account with an annual interest rate of 6.4 % compounded **quarterly**.

(a) Calculate the value of Daisy's investment after 2 years. [3]

After m months, the amount of money in the fixed deposit account has appreciated to more than 50 000 AUD.

(b) Find the minimum value of m , where $m \in \mathbb{N}$. [4]

Daisy is saving to purchase a new apartment. The price of the apartment is 200 000 AUD. Daisy makes an initial payment of 25 % and takes out a loan to pay the rest.

(c) Write down the amount of the loan. [1]

The loan is for 10 years, compounded monthly, with equal monthly payments of 1700 AUD made by Daisy at the end of each month.

(d) For this loan, find

(i) the amount of interest paid by Daisy.

(ii) the annual interest rate of the loan. [5]

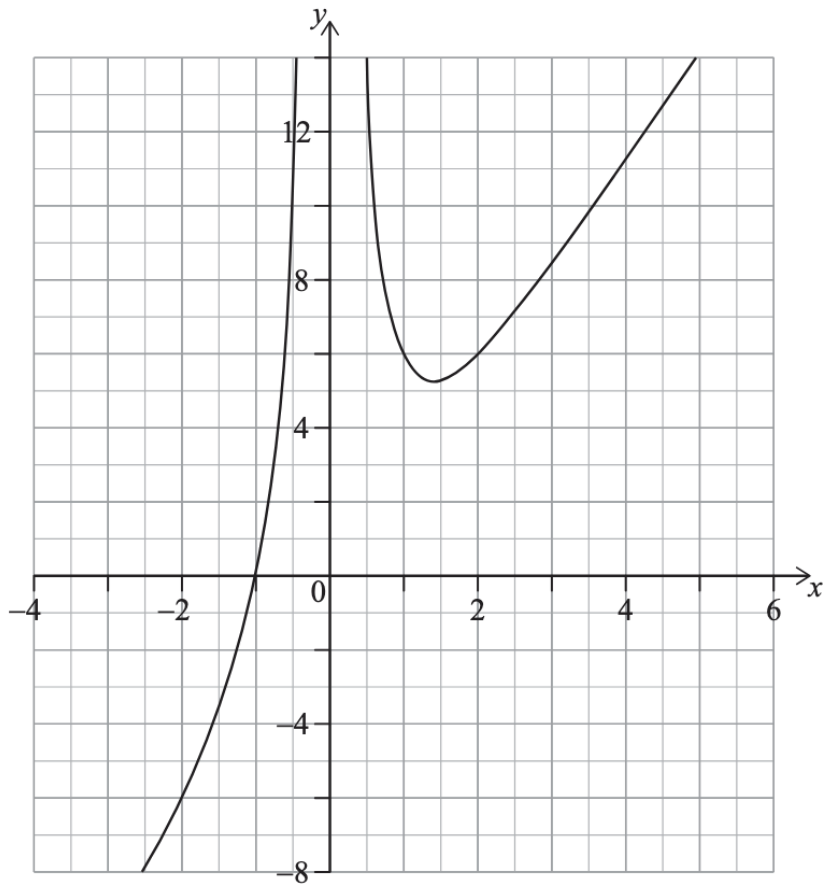
After 5 years of paying off this loan, Daisy decides to pay the remainder in one final payment.

(e) Find the amount of Daisy's final payment. [3]

(f) Find how much money Daisy saved by making one final payment after 5 years. [3]

Q18. [$Maximum\ mark$: 16]

Consider the function $f(x) = 3x - 1 + 4x^{-2}$. Part of the graph of $y = f(x)$ is shown below.



The function is defined for all values of x except for $x = a$.

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

(b) Use your graphic display calculator to find the coordinates of the local minimum. [2]

The equation $f(x) =$, where $w \in \mathbb{R}$, has three solutions.

(c) Identify one possible value for w. [1]

The line $y = mx - \frac{1}{4}$ is tangent to $f(x)$ when $x = -4$.

(d) Write down whether the value of m is positive or negative. Justify your answer. [2]

A second function is given by $g(x) = kp^x - 9$, where $p > 0$. The graph of $y = g(x)$ intersects the y −axis at point A (0, -5) and passes through point B (3, 4.5) .

(e) Find the value of

(i) k ;

(ii) p . [4]

(f) Write down the equation of the horizontal asymptote of $y = g(x)$. [2]

(g) Find the solution of $f(x) = g(x)$ when $x > 0$. [2]

Consider a third function, h , where $h(x) = f(x) + g(x)$. The point $C(-1, q)$ lies on the graph of $g(x)$.

(h) State whether C also lies on the graph of $h(x)$. Justify your answer. [2]

Q18. $[Maximum\ mark: 13]$

Scott purchases food for his dog in large bags and feeds the dog the same amount of dog food each day. The amount of dog food left in the bag at the end of each day can be modelled by an arithmetic sequence.

On a particular day, Scott opened a new bag of dog food and fed his dog. By the end of the third day there were 115.5 cups of dog food remaining in the bag and at the end of the eighth day there were 108 cups of dog food remaining in the bag.

(a) Find the number of cups of dog food

(i) fed to the dog per day;

(ii) remaining in the bag at the end of the first day. [4]

(b) Calculate the number of days that Scott can feed his dog with one bag of food. [2]

In 2021, Scott spent $625 on dog food. Scott expects that the amount he spends on dog food will increase at an annual rate of 6.4 %.

(c) Determine the amount that Scott expects to spend on dog food in 2025. Round your answer to the nearest dollar. [3]

(d) (i) Calculate the value of $\sum_{n=1}^{10}(625 \times 1.064^{(n-1)})$.

(ii) Describe what the value in part (d)(i) represents in this context. [3]

(e) Comment on the appropriateness of modelling this scenario with a geometric sequence. [1]