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Mathematics: applications and interpretation

Standard level

Paper 2

11 November 2025

Zone A morning | Zone B morning | Zone C morning

1 hour 30 minutes

Instructions to candidates

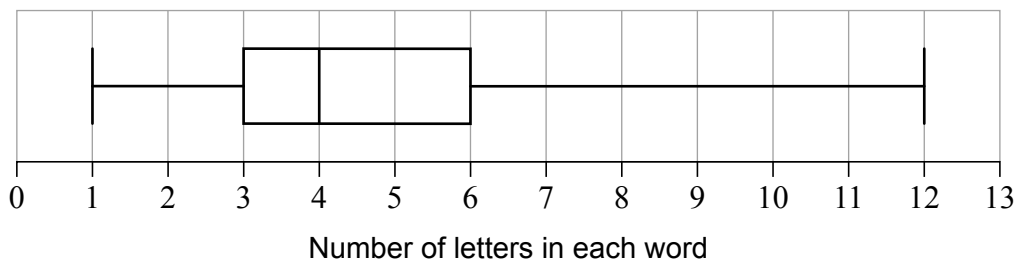
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- Answer all the questions in the answer booklet provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- A clean copy of the **mathematics: applications and interpretation SL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.

Answer **all** questions in the answer booklet provided. Please start each question on a new page. 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.

1. [Maximum mark: 15]

Dr Petrillo wrote a short scientific essay. He analysed the readability of his essay by counting the number of letters in each word.

Dr Petrillo constructs a box and whisker diagram for his data.



(a) Write down

- (i) the median;
- (ii) the upper quartile, Q_3 ;
- (iii) the interquartile range, IQR.

[3]

Dr Petrillo now wants to modify his diagram to show any outliers. He considers the longer words in his data and uses the following formula:

$$\text{outliers} > (1.5 \times \text{IQR}) + Q_3.$$

Words with at least k letters are considered outliers.

(b) Find the value of k .

[2]

(This question continues on the following page)

(Question 1 continued)

Dr Petrillo further considers the outliers and sees no reason to exclude them from his analysis.

The length of each word in the essay, n , and its associated frequency are given in the following table.

n	$1 \leq n \leq 2$	$3 \leq n \leq 4$	$5 \leq n \leq 6$	$7 \leq n \leq 8$	$9 \leq n \leq 10$	$11 \leq n \leq 12$	$n \geq 13$
Frequency	289	480	220	136	90	45	0

- (c) Use the mid-interval values to calculate an estimate of the mean number of letters in each word. [3]

Dr Petrillo conducts a χ^2 goodness of fit test at the 1% significance level, to test the following null hypothesis:

H_0 : The frequency of the number of letters in each word in his essay is consistent with the English language.

- (d) Write down the alternative hypothesis for this test. [1]

The observed and expected frequencies of the number of letters in each word in his essay are listed in the following table.

n	$1 \leq n \leq 2$	$3 \leq n \leq 4$	$5 \leq n \leq 6$	$7 \leq n \leq 8$	$9 \leq n \leq 10$	$11 \leq n \leq 12$	$n \geq 13$
Observed frequency	289	480	220	136	90	45	0
Expected frequency	252.0	491.4	239.4	151.2	88.2	31.8	6.0

- (e) (i) Write down the number of degrees of freedom.
 (ii) Find the χ^2 statistic for this test.
 (iii) Find the p -value for this test. [4]

The critical value for this test, at the 1% significance level, is 16.812.

- (f) State whether Dr Petrillo should reject the null hypothesis. Justify your answer. [2]

2. [Maximum mark: 16]

The height of a plant, h cm, depends on the time, t days, after it is planted.

For the first 15 days, the rate of change of the height of the plant is modelled as

$$\frac{dh}{dt} = 1.2 - 0.1t, \text{ where } 0 \leq t \leq 15.$$

- (a) (i) Find the value of $\frac{dh}{dt}$ at $t = 3$.
- (ii) Interpret the meaning of your answer to part (a)(i) in context. [2]
- (b) Use $\frac{dh}{dt}$ to find the value of t when the plant reaches its maximum height. [2]

Two days after it is planted, the height of the plant is 6.5 cm.

- (c) Find an expression for h in terms of t , for $0 \leq t \leq 15$. [5]
- (d) Hence, find the maximum height of the plant. [2]

A second plant was planted at the same time as the first plant. Its height, H cm, is modelled by $H = 2(1.2)^t$, where $0 \leq t \leq 15$.

- (e) Write down the initial height of the second plant. [1]

Each day, the height of the second plant increases by $p\%$.

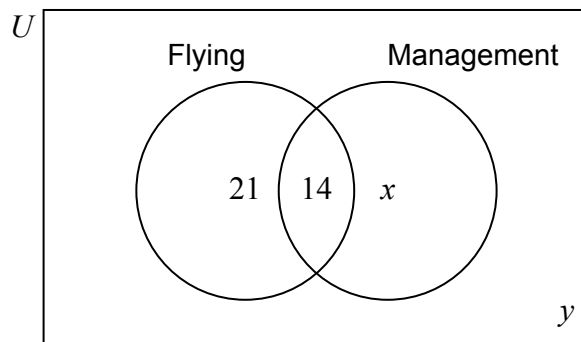
- (f) Find the value of p . [2]
- (g) Find the value of t when the two plants have the same height. [2]

3. [Maximum mark: 15]

Hawksburn Aviation School offers three courses, flying, management and engineering. The following information was collected about the 50 students enrolled in courses at the school.

- 21 students are enrolled in the flying course only.
- 14 students are enrolled in both the flying course and the management course.
- Students enrolled in the engineering course are not enrolled in any other courses.

The information about all 50 students is presented in the following Venn diagram.



A student is selected randomly from this group.

- (a) Find the probability that
- (i) the student is enrolled in the flying course;
 - (ii) the student is enrolled in the management course, given that they are enrolled in the flying course.
- [4]

Let F be the event that the student selected is enrolled in the flying course and M be the event that the student is enrolled in the management course.

- (b) State whether F and M are mutually exclusive. Justify your answer. [2]

It is known that $P(F|M) = 0.7$.

- (c) (i) Find the value of x .
- (ii) Find the value of y .
- (iii) Write down the number of students enrolled in only one course. [6]

Three students are randomly selected from the group of 50 to give a presentation.

- (d) Find the probability that all three students are enrolled in the flying course. [3]

4. [Maximum mark: 16]

Jenny designs a flexible suspension bridge, spanning 10 metres over the Swinburne Creek.

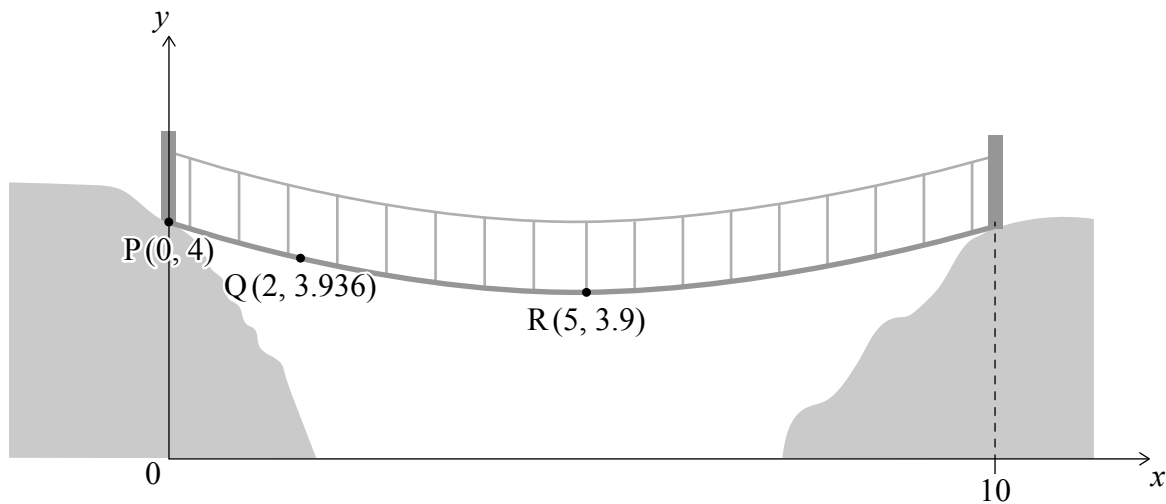
Jenny believes that when no people are on the bridge, the height, y , of the walkway on the bridge above the creek can be modelled by

$$y = ax^2 + bx + c \text{ for } 0 \leq x \leq 10.$$

She uses a coordinate system where the origin is directly below one side of the bridge, as shown in the following diagram. All distances are measured in metres.

According to this model, the points $P(0, 4)$, $Q(2, 3.936)$ and $R(5, 3.9)$ will be located on the walkway of the bridge. Point R is the lowest point of the bridge.

diagram not to scale



(a) Write down the value of c , the y -intercept of the model. [1]

Using point Q, Jenny finds the equation $-0.064 = 4a + 2b$.

(b) (i) Find another equation in terms of a and b .
 (ii) Hence or otherwise, find the value of a and the value of b . [4]

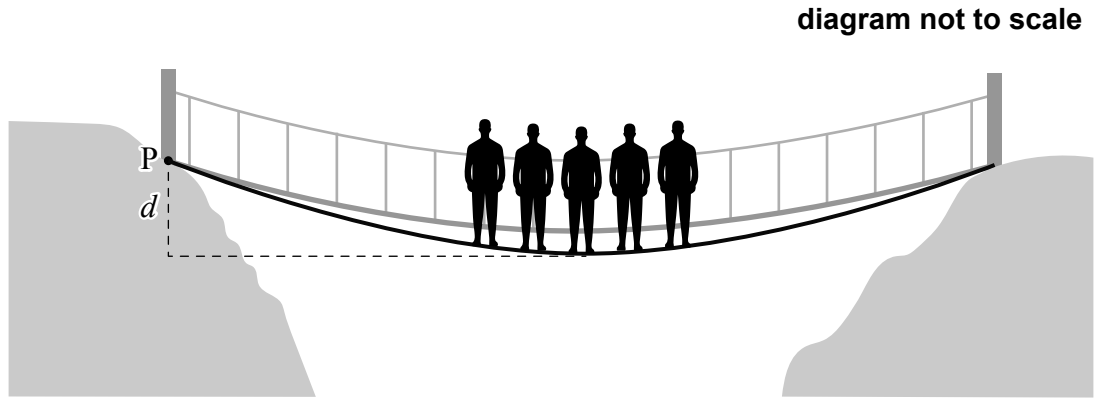
(c) For Jenny's model find
 (i) $\frac{dy}{dx}$;
 (ii) the steepest gradient of the walkway of bridge. [4]

(This question continues on the following page)

(Question 4 continued)

The deflection of the bridge, d , is the vertical distance of the walkway below P at the midpoint of the walkway.

After the bridge is built, Jenny explores the relationship between the number of people standing on the bridge and its deflection.



Jenny collected data on the number of people, n , on the bridge and the deflection, d metres, as shown in the following table.

Number of people, n	1	2	3	4	5	6
Deflection, d (m)	0.215	0.233	0.250	0.269	0.297	0.305

- (d) For this data,
- (i) find the value of Pearson’s product-moment correlation coefficient, r ;
 - (ii) comment on the strength of the correlation. [3]

The equation of the regression line for this data is $d = 0.01889n + 0.1954$ correct to four significant figures.

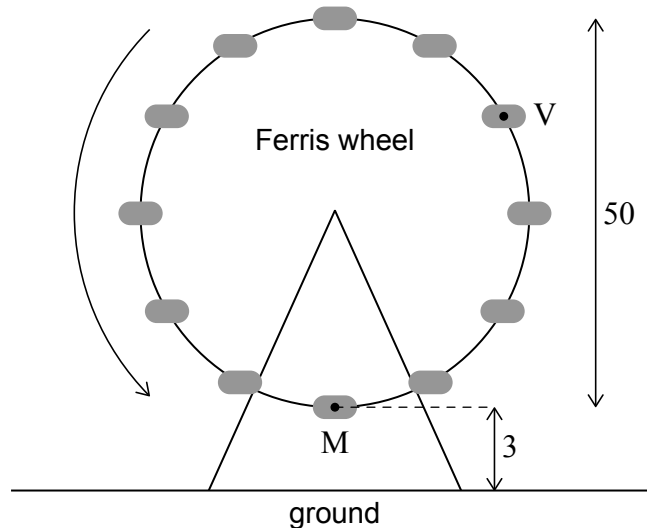
- (e) Interpret, in context, the meaning of 0.01889 in the equation of the regression line. [1]
- (f) Determine whether Jenny’s **model** for the height of the walkway or the equation of the regression line gives the smaller estimate of the deflection. Justify your answer. [3]

5. [Maximum mark: 18]

The following diagram represents a Ferris wheel with 50-metre diameter and lowest point 3 metres above the ground. There are twelve evenly spaced chairs on the Ferris wheel. The Ferris wheel rotates in an anticlockwise (counterclockwise) direction.

Martz is seated in the chair labelled M, which **initially** is located at the lowest point of the Ferris wheel when it starts rotating. At the same time, Victoria is seated in the chair labelled V.

diagram not to scale



Let t be the length of time, in minutes, after the Ferris wheel started rotating.

- (a) Find the height of V above the ground when $t = 0$. [3]

The wheel completes one revolution every 12 minutes.

- (b) Find the height of M above the ground when $t = 9$. [2]

- (c) Write down the values of t when M and V have the same height above the ground, for $0 \leq t \leq 12$. You may assume that Victoria stays on the ride during this interval. [3]

The height of M above the ground is given by the function

$$h(t) = -25 \cos bt + d, \text{ for } t \geq 0.$$

- (d) Write down the amplitude of h . [1]

- (e) Find the value of

- (i) b , given that $b > 0$;

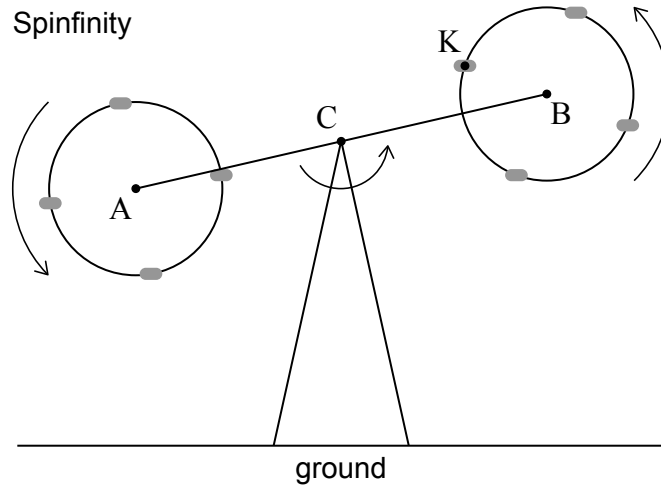
- (ii) d . [3]

(This question continues on the following page)

(Question 5 continued)

Kofi rides “Spinfinity”, a modified Ferris wheel. The beam AB rotates in an anticlockwise (counterclockwise) direction about its midpoint C . The beam supports two circular wheels with centres A and B , each rotating in an anticlockwise (counterclockwise) direction. Kofi is in a chair labelled K . This information is illustrated in the following diagram.

diagram not to scale



The height in metres of B above the ground, T seconds after “Spinfinity” starts moving, is modelled by the function $b(T) = 20 \sin(36T) + 40$.

The height in metres, of K above B , after T seconds, is modelled by the function $k(T) = 10 \cos(72T)$.

- (f) Find the furthest distance from Kofi to point C . [2]
 - (g) Find Kofi’s height above the ground after 18 seconds. [4]
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