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Mathematics: applications and interpretation
Standard level
Paper 1

24 October 2024

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

Candidate session number

1 hour 30 minutes

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Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- Answer all questions.
- Answers must be written within the answer boxes 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]**.

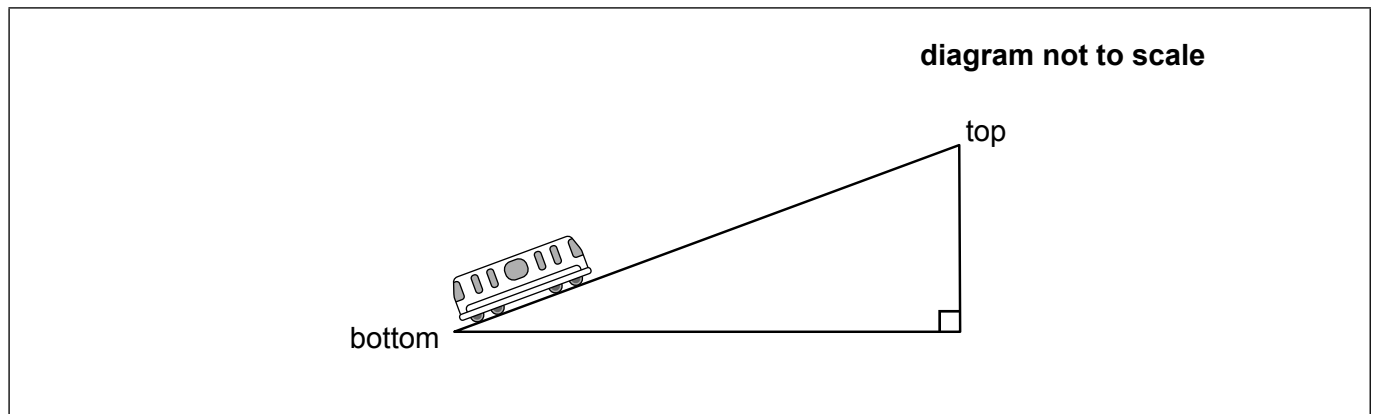


Answers must be written within the answer boxes provided. Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. Solutions found from a graphic display calculator should be supported by suitable working. For example, if graphs 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.

1. [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]

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2. [Maximum mark: 7]

The scores on a test, out of 7 points, for 240 students are shown in the following table.

Score	1	2	3	4	5	6	7
Frequency	11	29	31	34	65	47	23

- (a) Find the mean **and** standard deviation of these test scores. Give your answers correct to four significant figures. [3]
- (b) The scores are multiplied by ten. Write down the new mean and standard deviation. [2]
- (c) After the scores have been multiplied by ten, 30 points are added to each of them. Write down the new mean and standard deviation. [2]

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3. [Maximum mark: 5]

Tickets to enter a museum are priced at a dollars for adults and c dollars for children.

A school group of 7 adults and 60 children paid a total of \$832.

A family of 3 adults and 5 children paid a total of \$108.

(a) Write down **two** equations that represent this information. [2]

(b) Hence, find the price of

(i) an adult ticket

(ii) a child ticket. [2]

Rounded to the **nearest thousand**, there were 203 000 visitors at the museum last year.

(c) Write down the lower bound for the number of visitors last year. [1]

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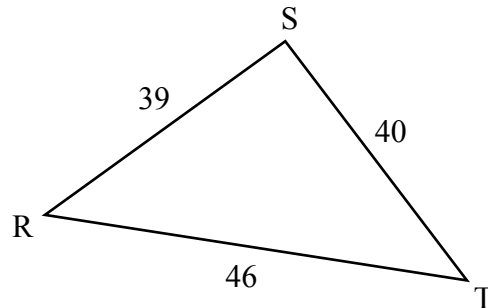
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4. [Maximum mark: 5]

Consider the following triangle, RST, such that $RS = 39\text{ cm}$, $ST = 40\text{ cm}$, and $TR = 46\text{ cm}$.

diagram not to scale



(a) Find the value of \hat{TRS} . [3]

(b) Find the area of the triangle RST. [2]

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5. [Maximum mark: 7]

The total cost, $C(d)$, in Canadian dollars (CAD), to hire a bicycle for d days from *Pedal Paradise* is given by the function

$$C(d) = 60d + 10, d \geq 3, d \in \mathbb{Z}.$$

The total cost includes a fixed charge to hire both a helmet and a repair kit.

(a) State, in context, what the values 60 and 10 represent. [2]

(b) Calculate the cost of hiring a bicycle for 5 days. [2]

Hema hires a bicycle from *Pedal Paradise*.

(c) Write down the minimum number of days she can hire the bicycle. [1]

(d) Given that $C^{-1}(1270) = k$, find the value of k . [2]

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6. [Maximum mark: 6]

Radioactive carbon is a material that decays over time.

The mass, $m(t)$ (in nanograms), of radioactive carbon in a fossil of a plant, after t years, can be modelled by the function

$$m(t) = 120e^{-0.000121t}$$

where t is the time since the plant died.

- (a) Write down the initial mass of the radioactive carbon. [1]
- (b) Find the mass of the radioactive carbon after 20 000 years. [2]
- (c) Calculate the smallest number of complete years it takes for more than half the sample to decay. [3]

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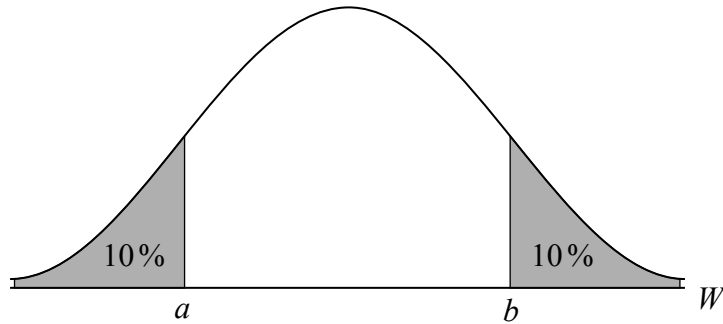


7. [Maximum mark: 7]

The mass, W , of Scottish Terriers (a breed of dog) is normally distributed with a mean of 8.9 kg and a standard deviation of 1.2 kg.

- (a) A Scottish Terrier is selected at random. Calculate the probability this dog's mass is more than 7.2 kg. [2]

The following curve represents this distribution. It is known that $P(W < a) = 0.1$ and $P(W > b) = 0.1$.



- (b) Find the value of

(i) a

(ii) b . [3]

- (c) Two Scottish Terriers are selected at random from a large population. Find the probability that both dogs have a mass less than 7.2 kg. [2]

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8. [Maximum mark: 5]

On 1 January in a particular year, Anton invests \$18 000 in a new bank account. The account earns 4% simple interest, on the original \$18 000, at the start of each subsequent year.

The amounts in the account at the start of each year form an arithmetic sequence.

- (a) Find the common difference of this sequence. [2]

After k complete years, the amount in Anton's account will be greater than \$32 000 for the first time.

- (b) Find the value of k . [3]

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9. [Maximum mark: 7]

The records at a driving school show that 60% of students pass their driving test on the first attempt.

A group of 30 students take their driving test for the first time.

As part of its quality control, the driving school uses the model $X \sim B(30, 0.60)$, where X is the number of students who pass the driving test.

(a) Calculate the

(i) mean of X

(ii) variance of X .

[2]

(b) Find the probability that

(i) exactly 21 students pass the test

(ii) fewer than 12 students pass the test.

[4]

(c) State one assumption that the driving school makes in using this model.

[1]

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10. [Maximum mark: 6]

When Humberto retires, he invests \$300 000 in an annuity fund that earns interest at a nominal rate of 3.8% per year, compounded monthly.

Humberto then withdraws \$2800 at the end of every month to pay for his living expenses.

(a) Find how much is in the annuity fund after 8 years. [3]

(b) Calculate how many times Humberto is able to make these withdrawals. [3]

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11. [Maximum mark: 7]

A fair game is played where points are scored as follows:

- A win scores w points.
- A draw scores 0 points.
- A loss scores -7 points.

Let X be the number of points scored during a game. The probability distribution is shown.

x	w	0	-7
$P(X = x)$	0.35	0.4	p

- (a) Find the value of p . [2]

The game is played 60 times.

- (b) Find the expected number of losses. [2]

- (c) Calculate the value of w , given that the game is fair. [3]

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12. [Maximum mark: 7]

Consider the curve $y = 5x^2 - \frac{3}{x^3}$.

- (a) Find $\frac{dy}{dx}$. [3]
- (b) Write down the gradient of the curve at $x = 1$. [1]
- (c) Hence, find the equation of the normal to the curve at $x = 1$. [3]

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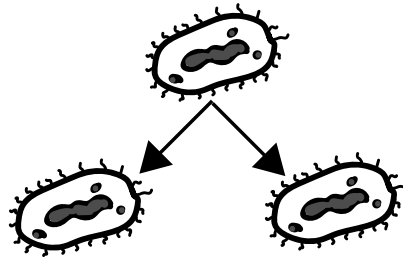
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13. [Maximum mark: 7]

A type of bacteria reproduces by **dividing in two** every 10 minutes.



There were 1250 bacteria in a colony 10 minutes after the start of an experiment.

The following table is used to estimate the number of bacteria, u_n , for this colony.

The values of u_n form the terms of a sequence.

n	1	2	3		9		k
Time in minutes	10	20	30		90		$10k$
Number of bacteria, u_n	1250	2500	5000	

(a) Complete the table by adding the two missing values.

[3]

As the number of bacteria increases from 1250 to 2500, the total number of **bacterial divisions** is 1250.

(b) (i) Find the value of n when the number of bacteria is 1.28×10^6 .

(ii) Hence or otherwise, find the total number of bacterial divisions as the number of bacteria increases from 1250 to 1.28×10^6 . Give your answer correct to the nearest thousand bacterial divisions.

[4]

(This question continues on the following page)



(Question 13 continued)

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Please **do not** write on this page.

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will not be marked.



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