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Mathematics: applications and interpretation

Higher level

Paper 1

14 May 2026

Zone A afternoon | Zone B afternoon | Zone C afternoon

Session number

2 hours

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Instructions to students

- 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 HL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[110 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: 5]

The population of Nova Antara can be modelled by the function $f(t) = a \times b^t$, where t is the number of years since the beginning of 2024.

At the beginning of 2024, the population was 104 000.

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

At the beginning of 2025, the population was 105 144.

- (b) Find the exact value of b . [2]

- (c) Use the model to estimate the population of Nova Antara at the beginning of 2034.
Give your answer correct to the nearest integer. [2]

(This question continues on the following page)



(Question 1 continued)

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28EP03

Turn over

2. [Maximum mark: 5]

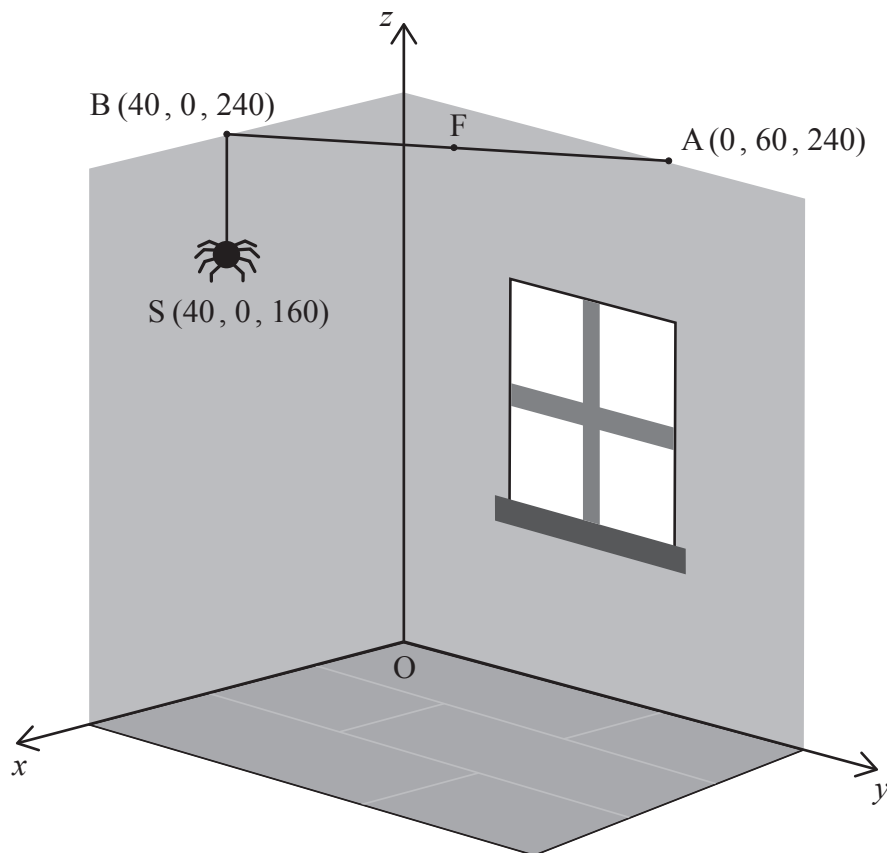
A spider's web lies across the corner of a room that can be modelled using the Cartesian coordinate system in three dimensions. The origin, O , is located where the two walls meet the floor. All measurements are in centimetres.

One thread of the web lies in a straight line from point $A(0, 60, 240)$ to point $B(40, 0, 240)$.

A fly is trapped on the thread at the midpoint, F , of AB . The spider is hanging vertically from point B on a second thread, and is at point $S(40, 0, 160)$.

This information is shown on the diagram.

diagram not to scale



(a) Find the coordinates of F . [2]

(b) Calculate the distance between the spider and the fly. [3]

(This question continues on the following page)



(Question 2 continued)

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28EP05

Turn over

3. [Maximum mark: 9]

Sae Yung works in a café. On a particular day, Sae Yung asks 180 people who visit the café their age and whether they prefer a hot drink or a cold drink.

The table shows the data she collects.

	Age, n years		
	$n < 30$	$30 \leq n \leq 50$	$n > 50$
Hot drink	21	18	19
Cold drink	62	26	34

One of the 180 people is chosen at random.

- (a) Write down the probability that this person is less than 30 years of age and prefers a cold drink. [1]
- (b) Given that this person is more than 50 years of age, find the probability that they prefer a hot drink. [2]

Sae Yung performs a χ^2 test at the 1 % significance level to determine if age and preferred type of drink are independent.

- (c) Write down the null hypothesis. [1]
- (d) Calculate
- (i) the χ^2 test statistic.
- (ii) the p -value. [3]

The critical value for this test is 9.210.

- (e) Write down the conclusion for the test, giving a reason for your answer. [2]

(This question continues on the following page)



(Question 3 continued)

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28EP07

Turn over

4. [Maximum mark: 4]

Peter’s monthly electricity bill is the sum of two parts:

- a fixed amount, c , called a “standing charge”
- an amount that is directly proportional to the number of “electrical units” used by Peter.

For a summer month when he used 3000 electrical units, his bill was \$ 117.90.

For a winter month when he used 4800 electrical units, his bill was \$ 179.10.

Find

- (i) the value of c , the standing charge.
- (ii) the price, u , of an electrical unit.

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5. [Maximum mark: 7]

The first term of an arithmetic sequence is 18 and its common difference is 7.

- (a) Find the 42nd term of the sequence. [2]

The sum of the first n terms of the sequence is 9475.

- (b) Find a quadratic equation in terms of n that represents this information.
Give your answer in the form $an^2 + bn + c = 0$. [3]

- (c) Find the value of n . [2]

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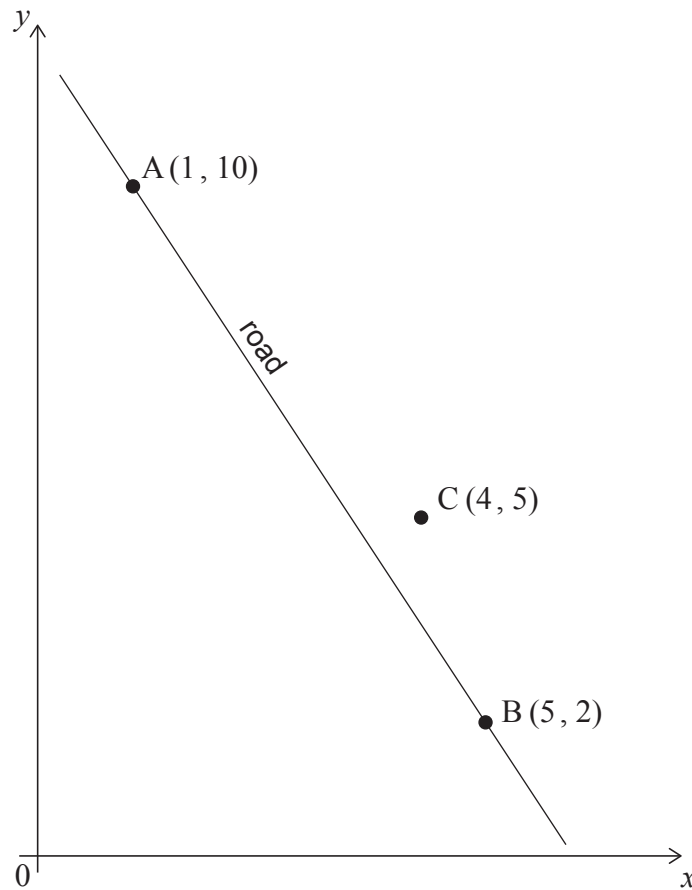


6. [Maximum mark: 7]

The diagram shows part of a road that passes through the points $A(1, 10)$ and $B(5, 2)$.

A new factory is built at the point $C(4, 5)$.

diagram not to scale



Otto owns a food truck. He wants to park it on the road as close as possible to the new factory.

Calculate the coordinates of the point, D , where Otto should park his food truck.

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(Question 6 continued)

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28EP11

Turn over

7. [Maximum mark: 4]

The solution curve to the differential equation

$$\frac{dy}{dx} = x + \ln(1+x)$$

passes through the point $(1, 4)$.

Use Euler's method with a step size of 0.1 to estimate the value of y when $x = 1.5$.
Give your answer correct to three decimal places.

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8. [Maximum mark: 7]

Grace takes out a loan of \$30 000 to renovate her home. She plans to repay the loan over 5 years at a nominal annual interest rate of 8.4%, compounded monthly. Her payments are made at the end of each month.

- (a) Find the amount of Grace's monthly payment, correct to two decimal places. [3]

After two years, Grace inherits \$5000 and uses all of this to reduce the outstanding balance on her loan. Then she continues to make monthly payments to pay off the loan over the next three years.

- (b) Find the amount of Grace's monthly payment for these final three years, correct to two decimal places. [4]

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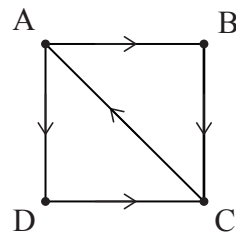
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9. [Maximum mark: 8]

The directed graph shown in the diagram has adjacency matrix M .



(a) Find

(i) M .

(ii) M^4 .

[3]

(b) Write down the vertices that can be reached by a walk of length 4 that starts at vertex A.

[1]

(c) Find

(i) M^7 .

(ii) M^{10} .

[2]

(d) Hence find an expression, in terms of n where $n \in \mathbb{Z}^+$, for the number of walks of length $3n - 2$ that start at D and end at C.

[2]

(This question continues on the following page)



(Question 9 continued)

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28EP15

Turn over

10. [Maximum mark: 8]

Charmaine believes that there is a positive correlation between the number of hours spent studying for a test and the percentage scored on it.

She takes a random sample of 8 students taking the test and records the number of hours spent studying and their percentage score on the test.

Studying time (hours)	15	20	15	11	13	18	14	25
Test score (%)	63	67	68	63	65	65	69	72

- (a) Calculate the product moment correlation coefficient for this data.

[2]

Charmaine performs a test at the 5% significance level to determine whether this sample provides evidence of a positive correlation between the number of hours spent studying and the test score. She assumes the data is taken from a bivariate normal distribution.

- (b) (i) Write down the null and alternative hypotheses of the test.
- (ii) Find the p -value.
- (iii) State the conclusion to the test, giving the reason for your answer.

[6]

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(Question 10 continued)

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11. [Maximum mark: 6]

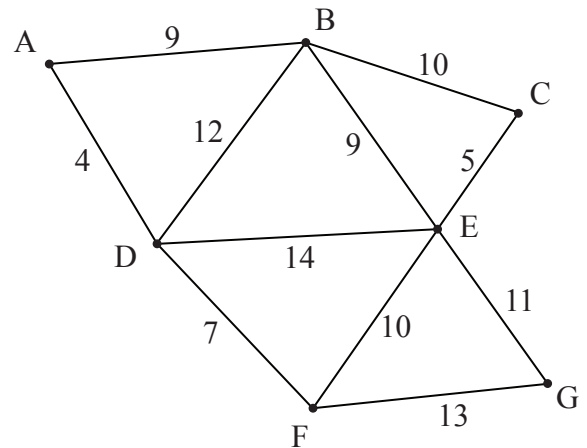
An offshore oil field has drilling rigs placed at points A, B, C, D, E, F and G.
The cost of building pipelines between these rigs, in millions of dollars, is shown in the graph.

diagram not to scale

Oil rig



Graph of rigs, A-G



- (a) Use Kruskal's algorithm to find the minimum spanning tree for the graph.
Include the order in which the edges are considered in your response. [4]
- (b) Sketch this minimum spanning tree. [1]
- (c) Write down the minimum cost of connecting the rigs. [1]

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(Question 11 continued)

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28EP19

Turn over

12. [Maximum mark: 9]

The random variable, X , has a probability distribution

$$P(X = x) = kx(16 - x^2), \text{ for } x = 1, 2, 3.$$

(a) Show that $k = \frac{1}{60}$. [3]

(b) (i) Find $P(X = 2)$.

(ii) Calculate $E(X)$. [3]

Let x_1 and x_2 be two independent observations of X .

(c) Calculate the probability that x_1 and x_2 are equal. [3]

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(Question 12 continued)

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28EP21

Turn over

13. [Maximum mark: 8]

An object moves in a straight line such that its velocity, v , in metres per second at time t seconds, is

$$v(t) = (3t^2 - t^3) e^{-t}, \text{ where } t \geq 0.$$

The object is at rest when $t = 0$.

- (a) Find the value of t the next time the object is at rest. [2]
- (b) Calculate the distance travelled by the object between these values of t . [2]
- (c) Find an expression, in terms of t , for the acceleration of the object. [2]
- (d) Find the value of t when the object reaches its maximum acceleration. [2]

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14. [Maximum mark: 8]

- (a) Write down z^* , the complex conjugate of $z = a + bi$, where $i = \sqrt{-1}$ and $a, b \in \mathbb{R}$. [1]
- (b) Show that the product zz^* is a real number. [3]
- (c) Given that $zz^* = 5$ and that $a, b \in \mathbb{Z}^+$, find the two possible values, z_1 and z_2 , of z . [2]
- (d) Find the value of $\arg(z_1) + \arg(z_2)$. [2]

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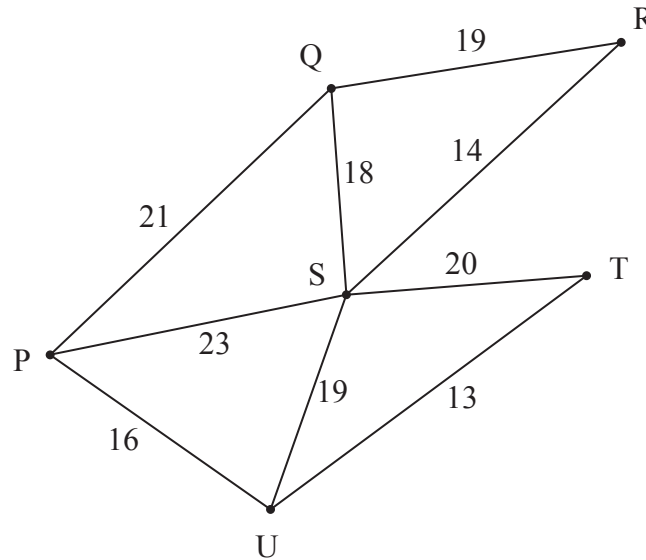
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15. [Maximum mark: 6]

Six villages connected by roads are represented by the following weighted graph. The villages are represented by the vertices P, Q, R, S, T and U. The distances, in kilometres, between villages are shown on the edges.

diagram not to scale



A road repair team must inspect each road before making a repair plan. The team's headquarters are situated at vertex T.

- (a) Write down the degree of T. [1]

The team plan to travel along each road exactly once, starting from and ending at T.

- (b) State a reason why this plan is not possible. [1]

The team plan to complete their inspection of all the roads by travelling the minimum distance, starting from and ending at T.

- (c) (i) State the edges that represent the roads that must be travelled along twice to minimize the distance travelled.
- (ii) Calculate the minimum distance the team must travel to complete their inspection. [4]

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(Question 15 continued)

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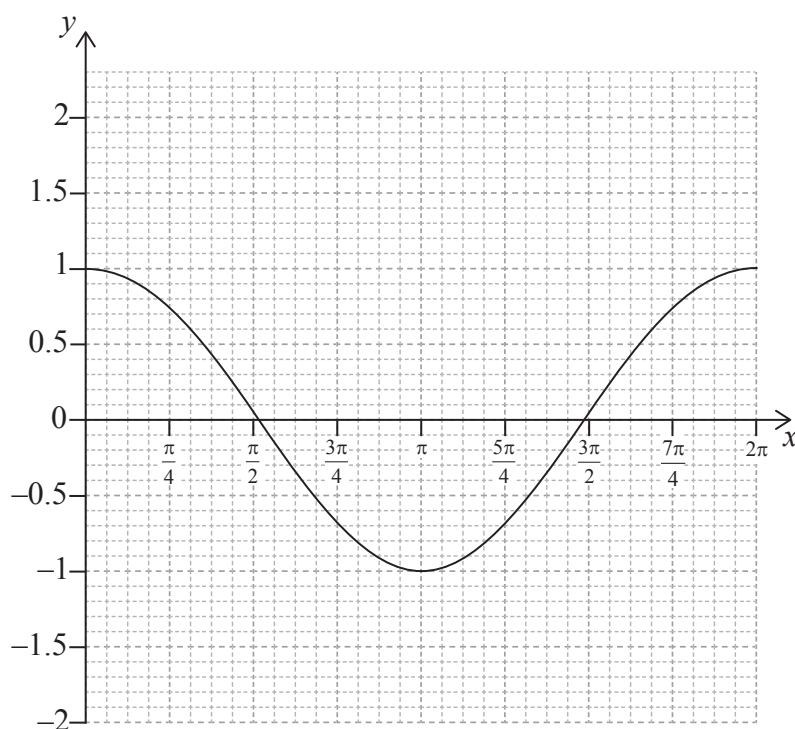


28EP25

Turn over

16. [Maximum mark: 9]

The graph shows part of the function $f(x) = \cos(x)$.



(a) On the axes, sketch the graph of

(i) $g(x) = 0.5 \cos(2x)$.

(ii) $h(x) = \cos^2(x)$.

[2]

(b) Given that the graphs of $h(x)$ and $g(x)$ are vertical translations of each other, write down $h(x)$ in terms of $g(x)$.

[1]

The area between the graph of $f(x)$ and the x -axis from $x = 0$ to $x = \frac{\pi}{2}$ is rotated through 2π radians about the x -axis to form a solid.

(c) (i) Write down the integral that represents this volume.

(ii) Hence, use the result from part (b) to show that the **exact** value of this volume is $\frac{\pi^2}{4}$.

[6]

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(Question 16 continued)

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References:

11. Flyingrussian, 2015. *Oil rig or platform flaring, offshore petroleum industry*. [photograph] Available at: <https://www.gettyimages.co.uk/detail/photo/oil-rig-or-platform-flaring-offshore-petroleum-royalty-free-image/493604082> [Accessed 19 May 2025].



28EP28