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Mathematics: applications and interpretation
Standard level
Paper 1

Monday 31 October 2022 (afternoon)

Candidate session number

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1 hour 30 minutes

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 formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.



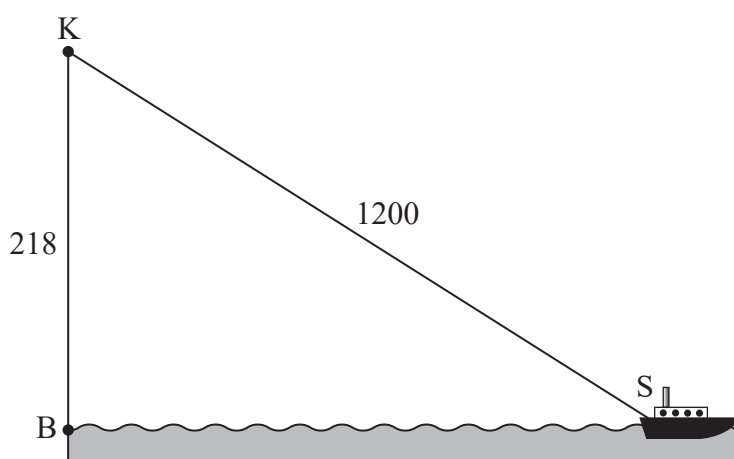
Answers must be written within the answer boxes provided. Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. Solutions found from a graphic display calculator should be supported by suitable working. For example, if graphs 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: 6]

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

This information is shown in the following diagram.

diagram not to scale



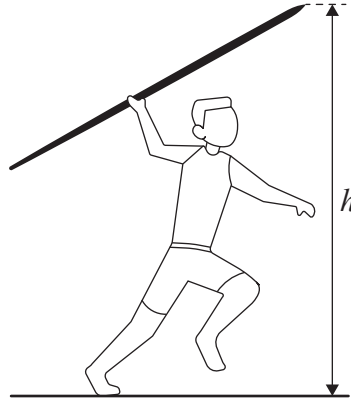
- (a) Find the angle of elevation from the ship to Kacheena. [2]
- (b) Find the horizontal distance from the base of the cliff to the ship. [2]
- (c) Write down your answer to part (b) in the form $a \times 10^k$ where $1 \leq a < 10$ and $k \in \mathbb{Z}$. [2]

(This question continues on the following page)



3. [Maximum mark: 5]

DeVaughn throws a javelin in a school track and field competition.



The height, h , of the front tip of the javelin above the ground, in metres, is modelled by the following quadratic function,

$$h(t) = -3.6t^2 + 10.8t + 1.8, \quad t \geq 0$$

where t is the time in seconds after the javelin is thrown.

- (a) Write down the height of the front tip of the javelin at the time it is thrown. [1]
- (b) Find the value of t when the front tip of the javelin reaches its maximum height. [2]
- (c) Find the value of t when the front tip of the javelin strikes the ground. [2]

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7. [Maximum mark: 7]

On 1 December 2022, Laviola invests 800 euros (EUR) into a savings account which pays a nominal annual interest rate of 7.5% compounded monthly. At the end of each month, Laviola deposits an additional EUR 500 into the savings account.

At the end of k months, Laviola will have saved enough money to withdraw EUR 10 000.

(a) Find the smallest possible value of k , for $k \in \mathbb{Z}^+$. [4]

(b) For this value of k , find the interest earned in the savings account.
Express your answer correct to the nearest EUR. [3]

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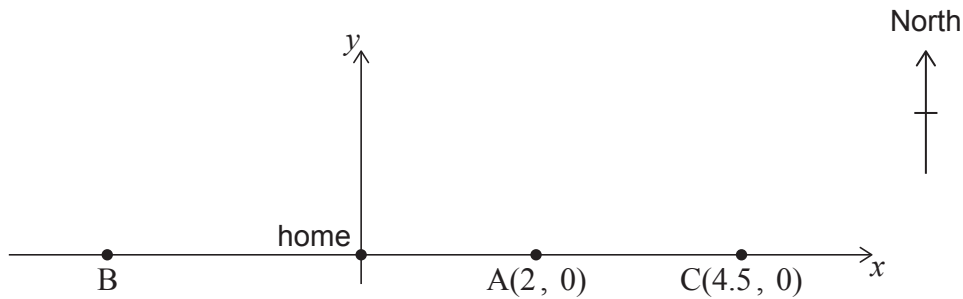
11. [Maximum mark: 7]

Kristi's house is located on a long straight road which traverses east-west. The road can be modelled by the equation $y = 0$, and her home is located at the origin $(0, 0)$.

She is training for a marathon by running from her home to a point on the road and then returning to her home by bus.

- The first day Kristi runs 2 kilometres east to point $A(2, 0)$.
- The second day Kristi runs west to point B.
- The third day Kristi runs 4.5 kilometres east to point $C(4.5, 0)$.

This information is represented in the following diagram.



Each day Kristi increases the distance she runs. The point she reaches each day can be represented by an x -coordinate. These x -coordinates form a geometric sequence.

- (a) Show that the common ratio, r , is -1.5 . [2]

On the 6th day, Kristi runs to point F.

- (b) Find the location of point F. [2]

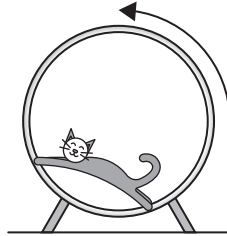
- (c) Find the total distance Kristi runs during the first 7 days of training. [3]

(This question continues on the following page)



12. [Maximum mark: 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]

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13. [Maximum mark: 8]

Giles charges a customer per hour to hire his boat. It is known that

$$\frac{dP}{dt} = 20 - \frac{980}{t^2}, \quad 0 < t \leq 12$$

where P is the cost per hour, in Norwegian krone (NOK), that the customer is charged and t is the time, in hours, spent on the boat.

The cost per hour has a local minimum when the boat is hired for h hours.

(a) Find the value of h . [2]

Sandra hired Giles' boat for 5 hours and was charged NOK 328 per hour. Yvonne hires Giles' boat for 7 hours.

(b) Show that the cost per hour for Yvonne is NOK 312. [6]

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References:

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