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# Mathematics: applications and interpretation

## Standard level

### Paper 1

1 May 2024

Zone A afternoon | Zone B afternoon | Zone C afternoon

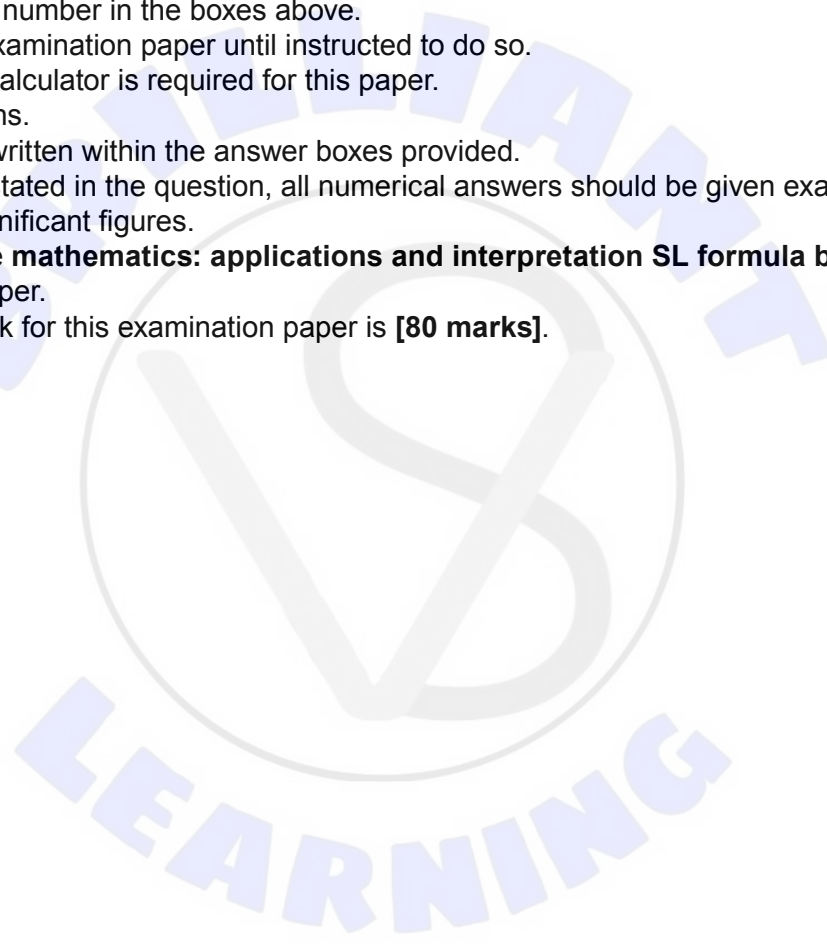
Candidate session number

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]**.





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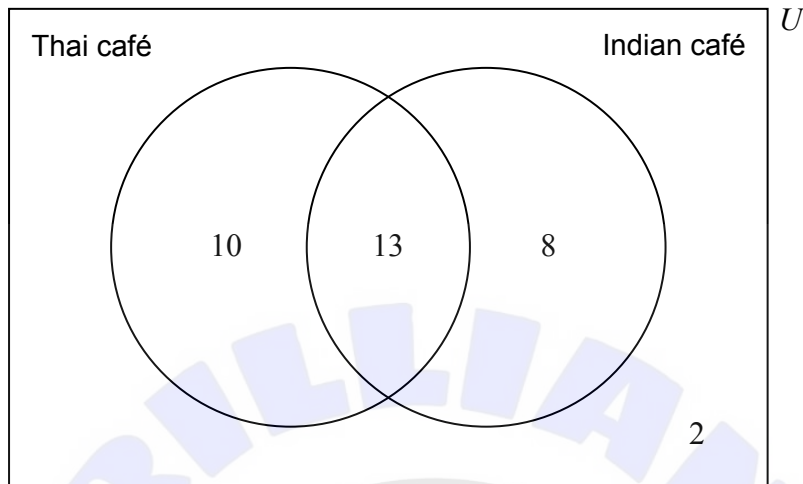
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will not be marked.





2. [Maximum mark: 6]

A teacher surveys their students to find out if they have eaten at the local Thai and Indian cafés. The results of the survey are shown in the following Venn diagram.



(a) Write down the number of students surveyed. [1]

(b) Write down the number of students who have not eaten at the Indian café. [1]

A student is chosen at random from those surveyed.

(c) Find the probability this student has eaten at both the Thai café and the Indian café. [1]

Let  $T$  be the event: a student has eaten at the Thai café.  
Let  $I$  be the event: a student has eaten at the Indian café.

(d) Find  $P(T \cup I)$ . [1]

(e) State whether the events  $T$  and  $I$  are mutually exclusive. Justify your answer. [2]

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4. [Maximum mark: 7]

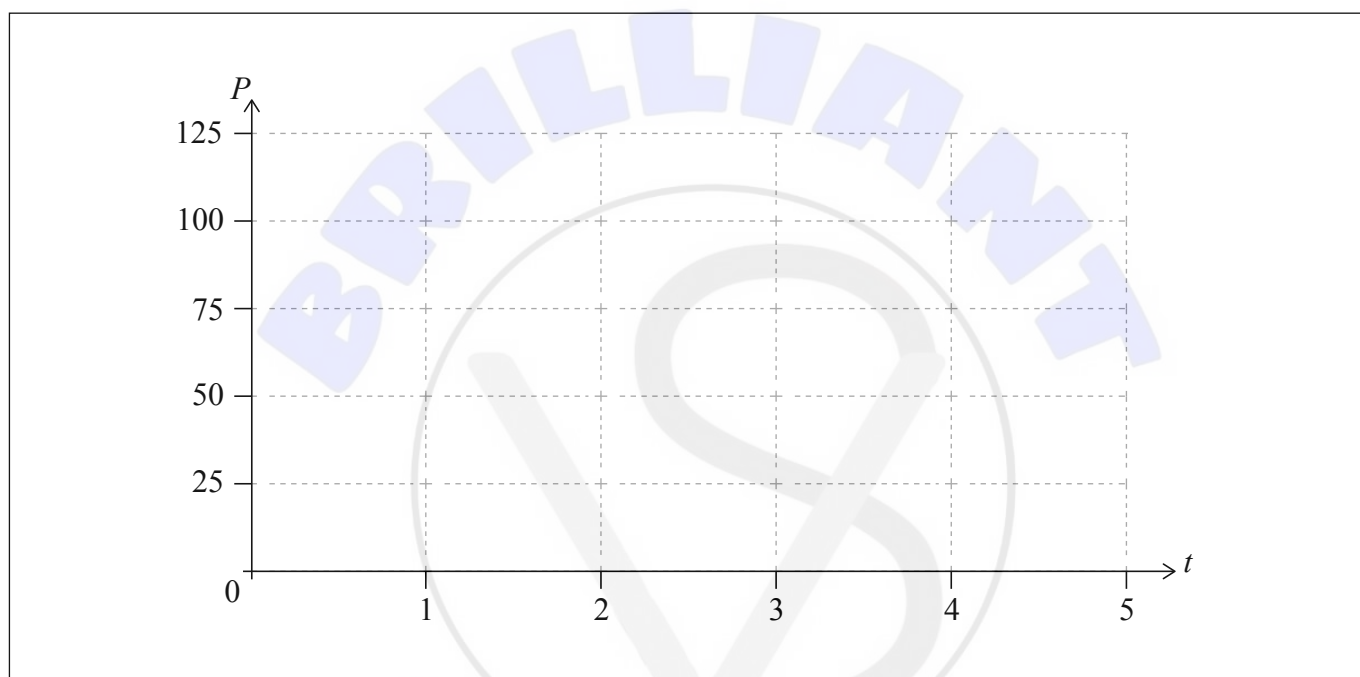
A cell phone starts charging at 07:00. While being charged, the percentage of power,  $P$ , in the phone is modelled by the function  $P=100-60 \times a^{-t}$ , where  $t$  is the number of hours after 07:00.

(a) Find the percentage of power in the phone at 07:00. [2]

The percentage of power in the phone reaches 75% at 08:00.

(b) Find the value of  $a$ . [2]

(c) Draw the graph of  $P=100-60 \times a^{-t}$  on the following set of axes. [2]



(d) State a mathematical reason why the model predicts the percentage of power in the phone will never reach 100%. [1]

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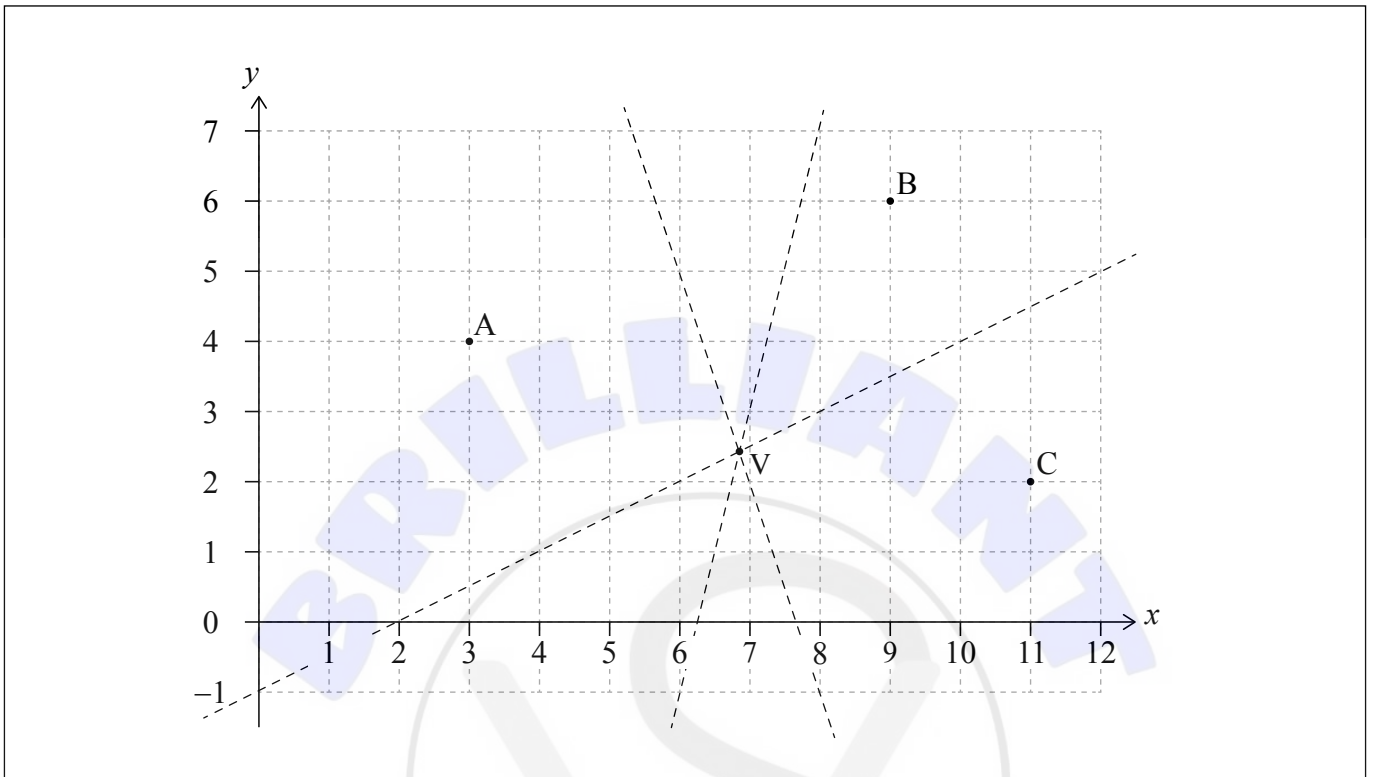
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6. [Maximum mark: 6]

Points A(3, 4), B(9, 6) and C(11, 2) are shown on the following diagram, along with the perpendicular bisectors of [AB], [AC] and [BC].



The perpendicular bisector of [BC] intercepts the axes at coordinates (0, -1) and (2, 0).

(a) Write down the equation of the perpendicular bisector of [BC]. [2]

The equation of the perpendicular bisector of [AB] is  $y = -3x + 23$ .

(b) Find the coordinates of point V where the perpendicular bisectors meet. Give your answer to four significant figures. [2]

A Voronoi diagram is constructed with points A, B and C as the three sites.

(c) Draw, clearly, the edges of the Voronoi diagram on the given diagram. [2]

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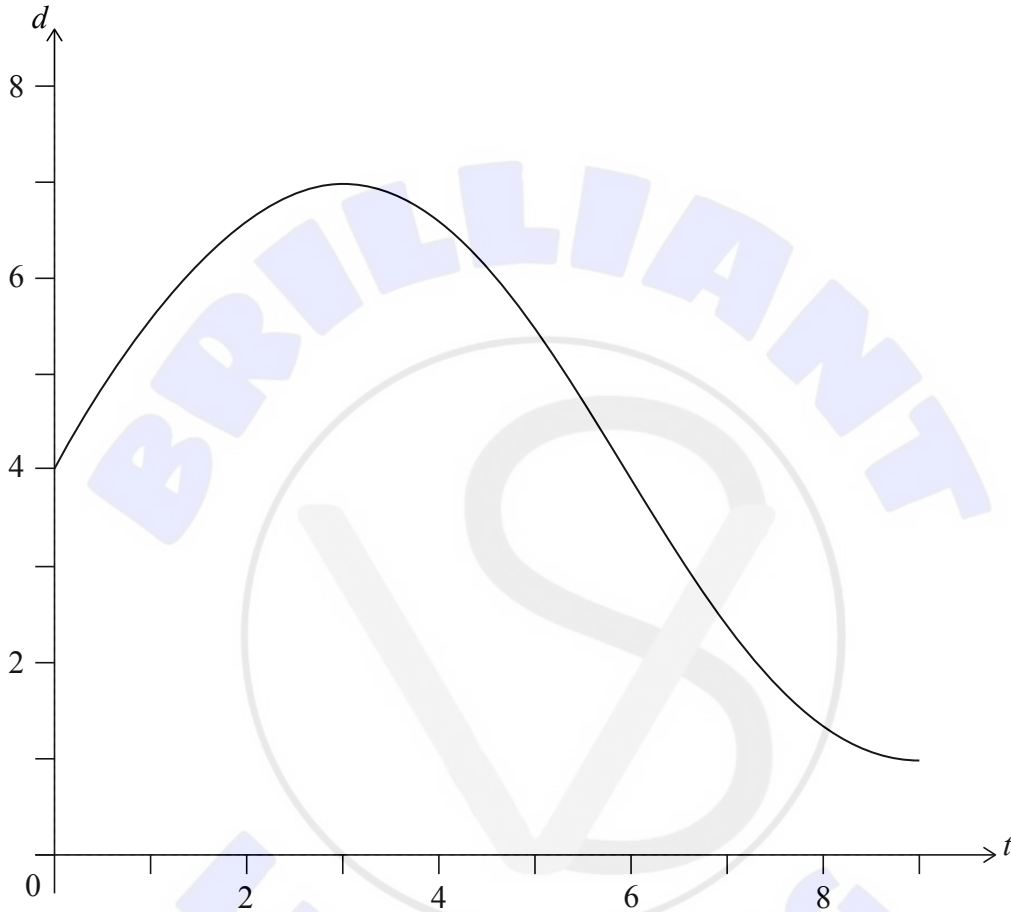


7. [Maximum mark: 6]

The following graph shows the depth of water,  $d$  metres, in a river at  $t$  hours after 12:00.

At 15:00, the depth of water reaches 7 m, its highest level. At 21:00, the depth of water drops to 1 m, its lowest level.

The depth can be modelled by the function  $d(t) = a \sin(bt) + 4$ .



- (a) Find the value of  $a$ . [1]
- (b) Find the value of  $b$ . [2]
- (c) Find the first time after 12:00 when the depth is equal to 3 m. Give your answer to the nearest minute. [3]

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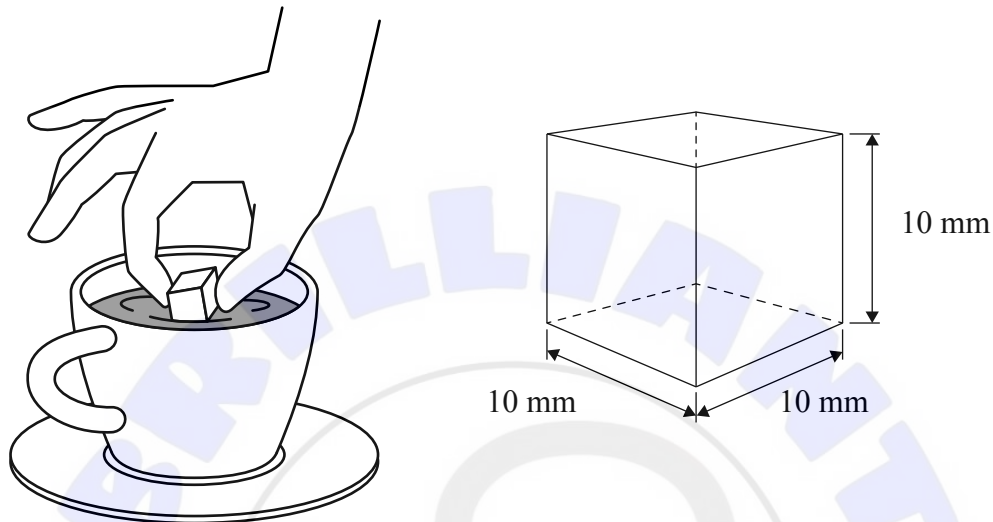




9. [Maximum mark: 8]

Kyungyoon investigates the rate at which a cubical block of sugar dissolves in hot coffee. Initially, the cube has side lengths of 10 mm. This information is illustrated in the following diagrams.

diagram not to scale



Kyungyoon predicts that, as the block of sugar dissolves, each side length will decrease at a constant rate of 0.2 mm per second.

- (a) According to this model, find
- (i) the length of one side of a block of sugar, 20 seconds after it is placed in hot coffee.
  - (ii) the volume of a block of sugar, 20 seconds after it is placed in hot coffee. [3]

Let the function  $V(t)$  represent the volume of the block of sugar,  $\text{mm}^3$ ,  $t$  seconds after it is placed in hot coffee.  $V(t)$  is given by

$$V(t) = 1000 - 60t + 1.2t^2 - 0.008t^3, \text{ for } 0 \leq t \leq 50.$$

- (b) Find  $V'(t)$ . [2]
- (c) Find the rate of change of the volume of the block of sugar at  $t = 20$ . [2]
- (d) State one reason why the side length of the cube may not always decrease at a constant rate. [1]

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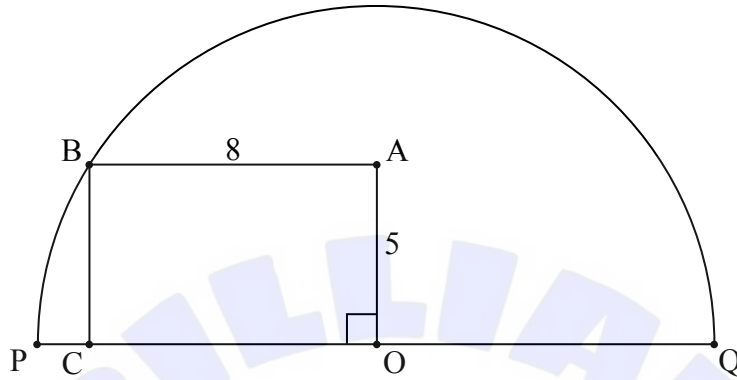




11. [Maximum mark: 5]

The following diagram shows a semicircle with centre  $O$  and diameter  $PQ$ . A rectangle  $OABC$  is also shown, such that  $AB = 8$  and  $OA = 5$ .

diagram not to scale



Find the length of the arc  $BQ$ .

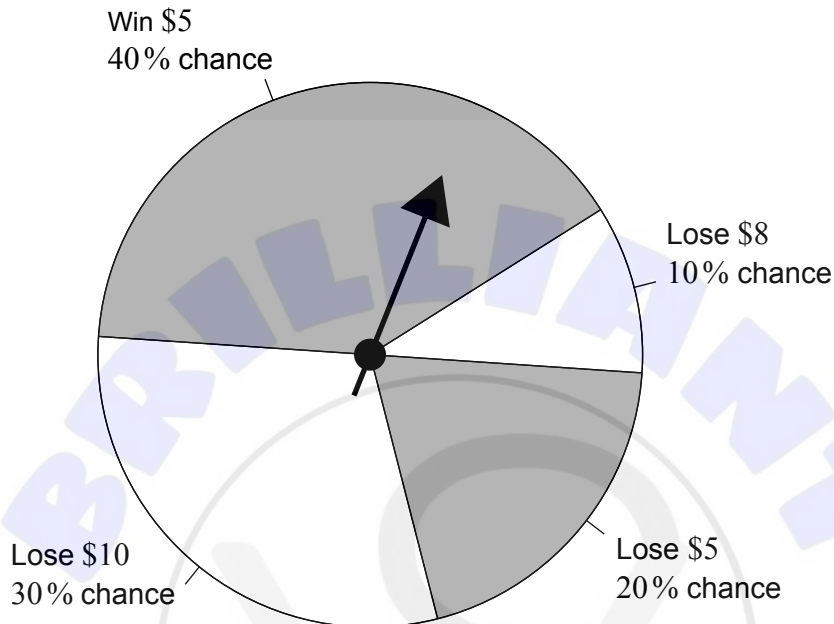
Area for student response with horizontal dotted lines.



12. [Maximum mark: 8]

Zac raises funds for a library by running a game where players spin a needle. The final position of the needle results in an outcome where a player wins or loses money. The outcomes, with associated probabilities, are shown in the following diagram.

diagram not to scale



Let  $X$  represent the amount that a player of this game wins.

- (a) (i) Find the expected value of  $X$ .
- (ii) Interpret your answer to part (a)(i).

[3]

To encourage a person to keep playing this game, Zac increases the winning prize for the second game they play from \$5 to \$6. For each successive game they play, the winning prize continues to increase by \$1.

Emily plays  $k$  games. The  $k$ th game is fair.

- (b) (i) Find the value of  $k$ .
- (ii) Explain why Zac expects to raise money from the games Emily plays.

[5]

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**References:**

10. Saddako, n.d. *Cheetah (Acinonyx jubatus) Running - stock photo*. [image online] Available at: <https://www.gettyimages.co.uk/detail/photo/cheetah-running-royalty-free-image/523244194?phrase=cheetah+speed&adppopup=true> [Accessed 2 May 2023]. Source adapted.

GlobalP, n.d. *Lion, Panthera leo, 8 years old, standing - stock photo*. [image online] Available at: <https://www.gettyimages.co.uk/detail/photo/lion-panthera-leo-8-years-old-standing-royalty-free-image/134976936?phrase=Lion+standing&adppopup=true> [Accessed 2 May 2023]. Source adapted.

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