Diploma Programme
Programme du diplôme
Programa del Diploma

Mathematics: analysis and approaches
Standard level
Paper 2

16 May 2025

Zone A morning | **Zone B** morning | **Zone C** morning

Candidate session number

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.
- Section A: answer all questions. Answers must be written within the answer boxes provided.
- Section B: answer all questions in the answer booklet provided. Fill in your session number on the front of the answer booklet, and attach it to this examination paper and your cover sheet using the tag 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: analysis and approaches SL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.

2225 – 7115

11 pages

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.

Section A

Answer **all** questions. Answers must be written within the answer boxes provided. Working may be continued below the lines, if necessary.

1. [Maximum mark: 4]

The following table shows the number of hours of play time, x, and sleep time, y, for a group of six children, over the period of one week.

Play time (x)	11	13	14	17	22	24
Sleep time (y)	62	65	68	75	84	87

The regression line of y on x for this data can be written in the form $y = ax + b$.

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

(b) Use the equation of the regression line to estimate the sleep time of a child whose weekly play time is 20 hours. [2]

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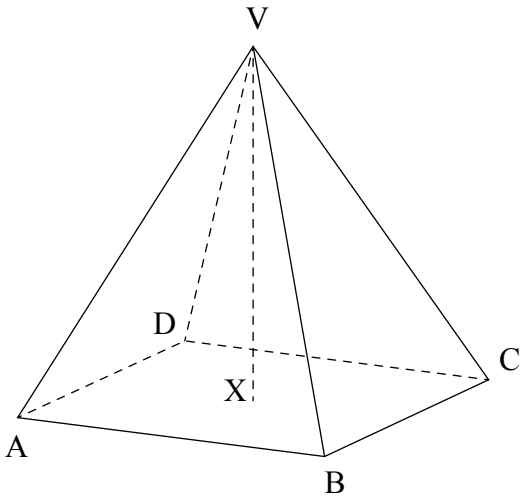
2. [Maximum mark: 6]

The following diagram shows a square-based right-pyramid with vertex $V(1, 7, 0)$.

Point $X(-3, 4, 2)$ is the centre of the base $ABCD$.

diagram not to scale



(a) Find VX. [2]

The square base has side length $5\,\text{cm}$.

(b) Find AC. [2]

(c) Find the size of the angle between the edge $[VC]$ and the base of the pyramid. [2]

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3. [Maximum mark: 6]

The derivative of a function f is given by $f'(x) = 4 + 2x - 3e^x$, where $x \in \mathbb{R}$.

(a) Find the values of x for which f is decreasing. [3]

(b) Find the values of x for which the graph of f is concave-up. [3]

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4. [Maximum mark: 5]

Consider the expansion of $(2x + k)^{10}$, where $k \in \mathbb{Z}$.

Given that the coefficient of x^6 is 8.4×10^6, find the possible values of k.

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5. [Maximum mark: 7]

A particle P moves in a straight line. The velocity $v\,\mathrm{m\,s^{-1}}$ of P, at time t seconds is given by $v(t) = \mathrm{e}^{-\sin t}\cos(2t)$, for $0 \le t \le 5$.

(a) Find the maximum speed of P. [2]

(b) Find the total distance travelled by P. [2]

(c) Find the acceleration when P changes direction for the **second** time. [3]

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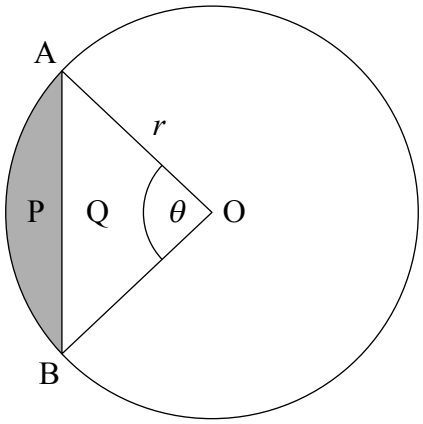
6. [Maximum mark: 6]

The following diagram shows a circle with centre O and radius $r\,\mathrm{cm}$. Points A and B lie on the circle and $\mathrm{A\hat{O}B} = \theta$ radians.

Sector OAB is divided into two regions, a shaded segment P and a triangle Q.



The area of the shaded segment P is $12.8\,\mathrm{cm}^2$.

The areas of P and Q are in the ratio $3:5$.

Find the value of r.

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Do **not** write solutions on this page.

Section B

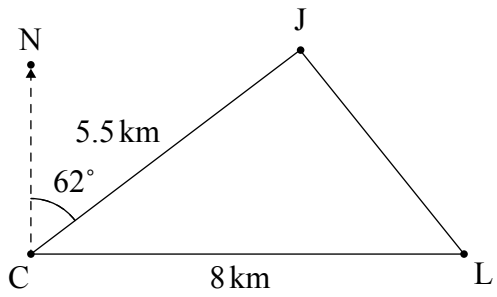
Answer **all** questions in the answer booklet provided. Please start each question on a new page.

7. [Maximum mark: 15]

A lighthouse, L, is located 8 kilometres due East of a coastguard station, C, on a straight stretch of coastline.

The coastguard station sees a Jet Ski, J, on a bearing of $062°$ and at a distance of 5.5 kilometres. This is shown on the following diagram.

diagram not to scale



(a) Find JL. [4]

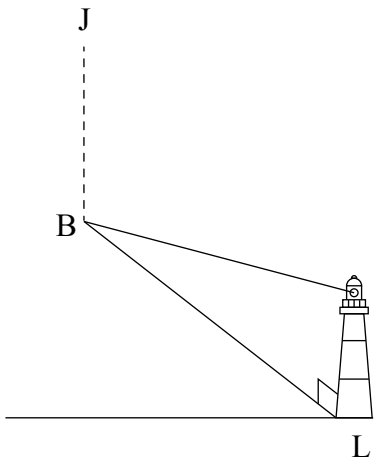
(This question continues on the following page)

Do **not** write solutions on this page.

(Question 7 continued)

While travelling due South, the Jet Ski breaks down at point B, before it reaches the coastline. The position of the Jet Ski at B and the lighthouse are shown in the following diagram.

diagram not to scale



From the top of the 60-metre-tall lighthouse, the angle of depression to the Jet Ski at B, is measured to be $0.94°$.

(b) Find BL. [3]

The bearing from the Jet Ski at B to the lighthouse is $121°$.

(c) Find the bearing from L to B. [2]

The jet-skier sets off a distress flare which is seen at the lighthouse and the coastguard station at the same time.

The lighthouse has a small rescue boat which travels at a speed of $48\,\mathrm{kmh}^{-1}$.

(d) Find the time, in minutes, for the lighthouse rescue boat to reach the Jet Ski at B. [2]

The coastguard rescue boat travels at a speed of $55\,\mathrm{kmh}^{-1}$ and sets out at the same time as the lighthouse rescue boat.

(e) Determine which rescue boat reaches the Jet Ski first. Justify your answer. [4]

Do **not** write solutions on this page.

8. [Maximum mark: 17]

At Adam's Apple Orchard the weights of apples, W, in grams, are normally distributed with a mean 175 grams and standard deviation 8 grams.

(a) Find the probability that a randomly chosen apple weighs less than 170 grams. [2]

(b) It is found that 20% of the apples weigh more than w grams. Find w, correct to four significant figures. [2]

All orchards classify an apple as premium when its weight is between 170 and 185 grams.

(c) Find the percentage of apples that are classified as premium at Adam's Apple Orchard. [2]

After orders are completed, there are many apples left over. Boxes are filled with randomly chosen left-over apples. Each box contains 40 apples.

(d) Find the probability that a randomly chosen box contains at least 30 premium apples. [3]

(e) If 10 of these boxes are randomly selected, find the probability that exactly 4 boxes have at least 30 premium apples. [2]

At a neighbouring orchard the weights of apples, M, in grams, are normally distributed with mean μ and standard deviation σ. It is known that:

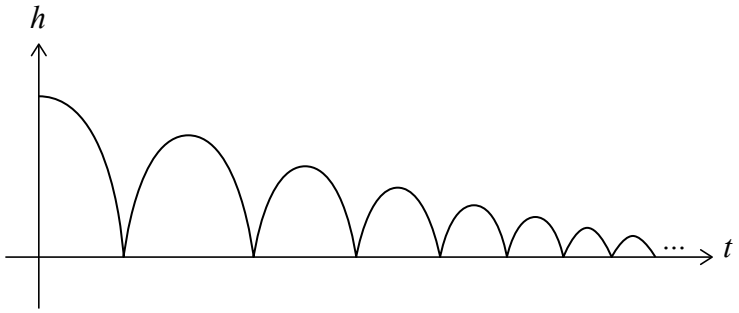
- 82% of their apples are classified as premium
- the percentage of apples that weigh less than 170 grams is twice the percentage of apples that weigh more than 185 grams.

(f) Find the value of μ. [6]

Do **not** write solutions on this page.

9. [Maximum mark: 14]

A tennis ball is dropped from a height. After each bounce the maximum height reached by the ball is $\frac{2}{3}$ of its previous maximum height. This can be seen in the diagram below where h, in metres, is the height of a ball after t seconds.



A box contains tennis balls. Each ball satisfies the condition of rebounding to $\frac{2}{3}$ of their previous maximum height. The tennis balls are numbered Ball 1, 2, 3, ...

Ball 1 is dropped from a height of 10 metres.

(a) Find the maximum height of Ball 1 after the 5th bounce. [3]

(b) Find the total distance travelled by Ball 1 immediately before the 5th bounce. [3]

Let δ be the total distance travelled by any of these balls.

(c) A ball is dropped from a height of x metres. Show that $\delta = 5x$ metres. [3]

Let δ_1 be the total distance travelled by Ball 1.

(d) Write down the value of δ_1. [1]

Ball 2 is dropped from a height of 9.56 metres.

Let δ_2 be the total distance travelled by Ball 2, and so on for each ball in the box.

It is given that δ_1, δ_2 δ_3, ... form an arithmetic sequence.

(e) Determine which tennis ball is the first ball to travel less than 25 metres. [4]

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Answers written on this page
will not be marked.