

91262



Draw a cross through the box (☒)
if you have NOT written in this booklet

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Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Mathematics and Statistics 2025

91262 Apply calculus methods in solving problems

Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Apply calculus methods in solving problems.	Apply calculus methods, using relational thinking, in solving problems.	Apply calculus methods, using extended abstract thinking, in solving problems.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

Show ALL working.

Make sure that you have the Formulae Sheet L2–MATHF.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in the margins (✂/✂/✂). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE

- (a) A function f is given by $f(x) = 2x^3 - 3x^2 + \frac{x}{2} + 7$.

Use calculus to find the gradient of the function at the point where $x = -\frac{1}{2}$.

- (b) For the cubic function $f(x) = -\frac{x^3}{3} + 2x^2 - 3x + 6$, find the equation of the tangent to the curve at $x = 2$.

- (c) The gradient function $f'(x)$ is given by $f'(x) = 2x^2 + 2x - 24$.

Find the equation of the original function, $f(x)$, if the y -value of the local minimum is equal to -46 .

- (d) A cruise ship, the *Helena*, moves at a constant speed of 5 m s^{-1} .

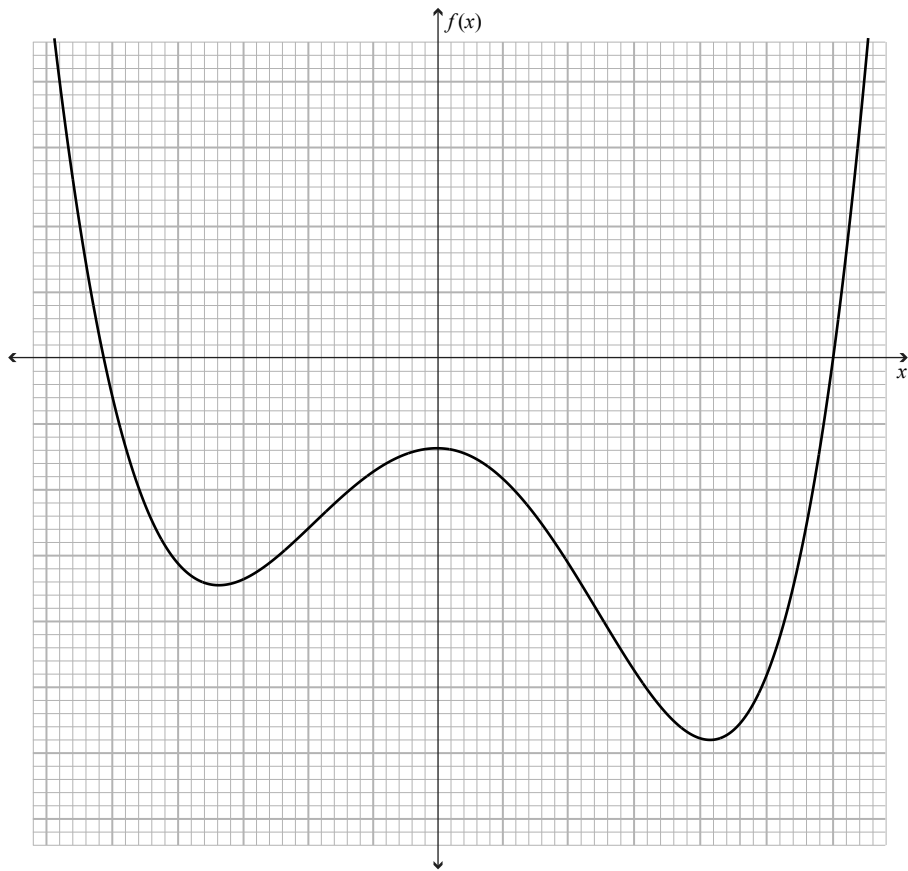
A passenger who missed the ship gets onto a smaller boat. The smaller boat accelerates at 0.5 m s^{-2} to catch up to the *Helena*.

When the smaller boat leaves the dock, the *Helena* is already 200 m away from the dock.

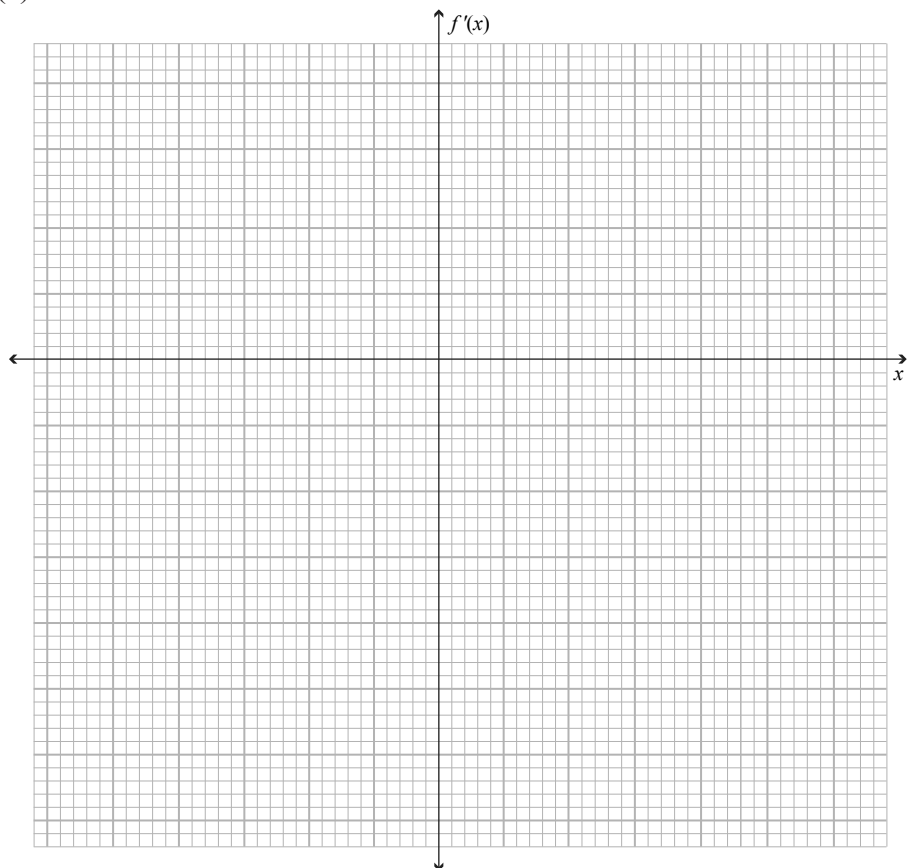
Find the distance from the dock at which the smaller boat catches up to the *Helena*.

QUESTION TWO

- (a) Given the graph of $f(x)$ below



sketch $f'(x)$ here:



If you need to redraw your graph, use the grid on page 12.

- (b) For the function f :

$$f'(x) = 2x^3 - 6x^2 + 2x + 4$$

The graph of $f(x)$ passes through $(2,5)$.

Find the equation of the function f .

- (c) Hemi is part of a student research project on how caffeine enters the bloodstream. A new device measures caffeine levels in his blood.

He is monitored for 180 minutes (3 hours) and, at some point, he is given a cup of coffee to drink.

His caffeine levels can be modelled using this equation:

$$C(t) = \frac{t^3}{150} - 1.4t^2 + 80t + 240 \quad \{0 \leq t \leq 180\}$$

where C is the concentration ($\mu\text{g/L}$), and t is time (minutes).

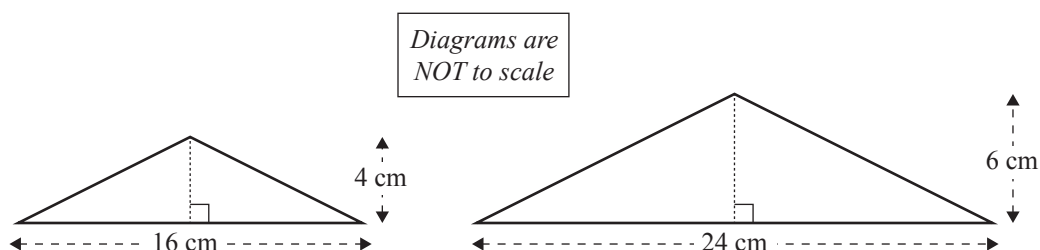
- (i) Show that the rate of change of concentration is $-16 \mu\text{g/L/min}$ after he has been there for 60 minutes.

QUESTION THREE

- (a) A function $f(x)$ is given by $f(x) = 2x^2 - 7x - 20$.

Find the coordinate of the point on the curve where the gradient of $f(x)$ is equal to 3.

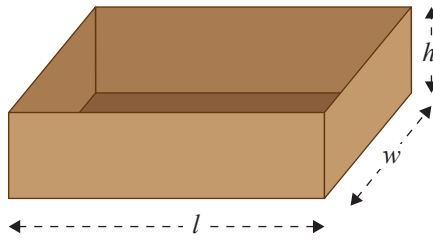
- (b) A triangle's area is expanding, such that its base is always 4 times greater than its perpendicular height, as shown in the diagrams below.



Find the rate of change of the area of the triangle, with respect to its vertical height, when the area of the triangle is equal to 98 cm^2 .

Question
Three
continues on
the following
page.

- (c) Evie is designing a lidless, rectangular cuboid container for her fishing trip, such as the one below.



The container is to be made of a maximum of 4.32 m^2 of material. She wants the box's width to be twice its height, and aims to maximise its volume.

Use calculus to:

- find the maximum volume of the box, given the limitations above
- prove that the volume is a maximum using calculus.

- (d) A function $f(x)$ is defined as:

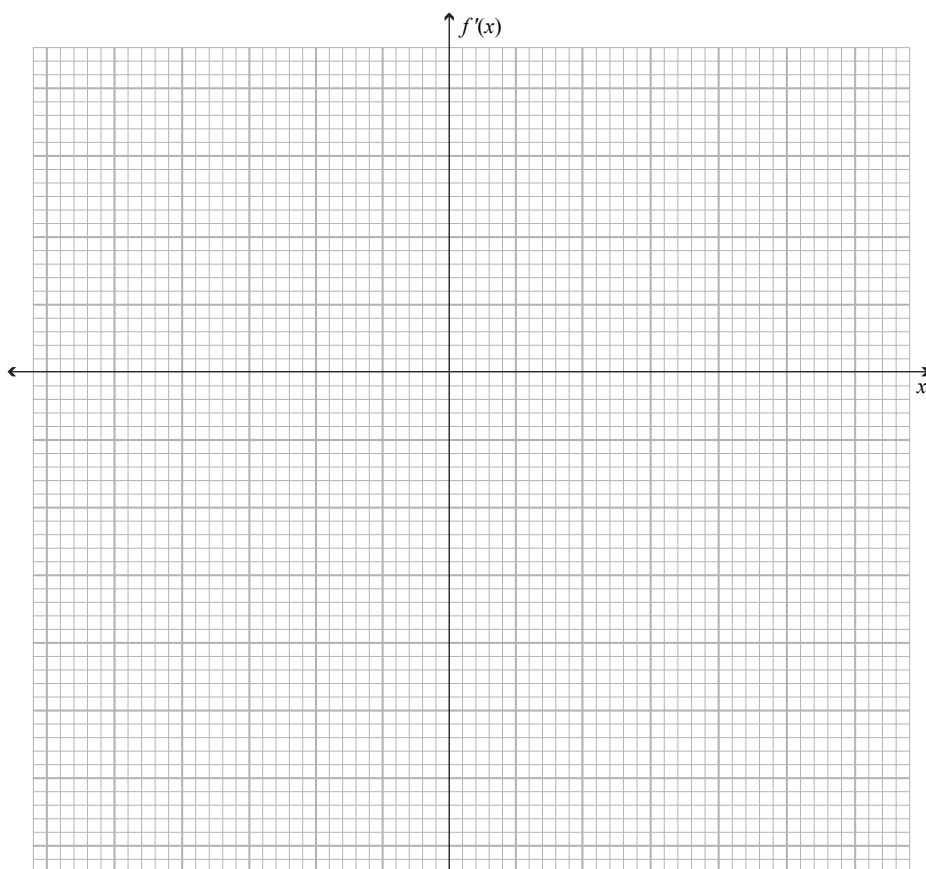
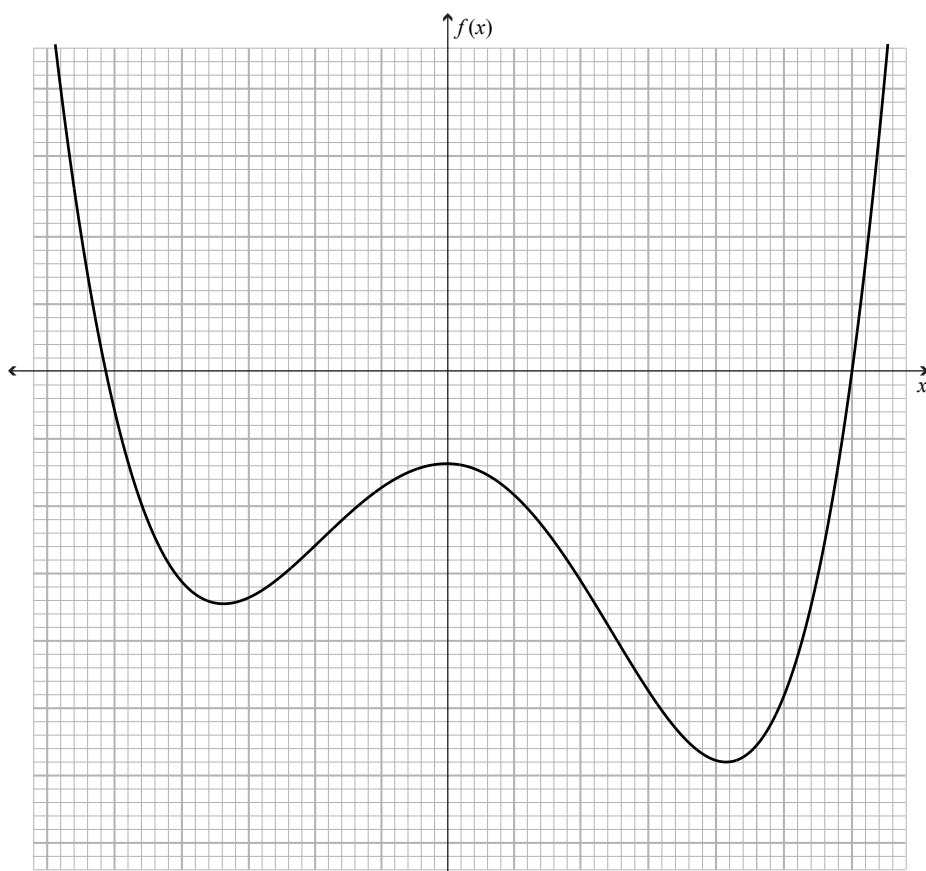
$$f(x) = \frac{x^4}{4} + \frac{(k-3)x^3}{3} - \frac{3kx^2}{2} + k$$

where k is a positive constant.

Using calculus, determine the regions where the function $f(x)$ is decreasing.

SPARE DIAGRAMS

If you need to redraw your response to Question Two (a), use the lower grid. Make sure it is clear which answer you want marked.



Extra space if required.
Write the question number(s) if applicable.

QUESTION
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