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

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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Mathematics and Statistics 2023

91028 Investigate relationships between tables, equations and graphs

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Investigate relationships between tables, equations and graphs.	Investigate relationships between tables, equations and graphs, using relational thinking.	Investigate relationships between tables, equations and graphs, using extended abstract thinking.

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.

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 2–24 in the correct order and that none of these pages is blank.

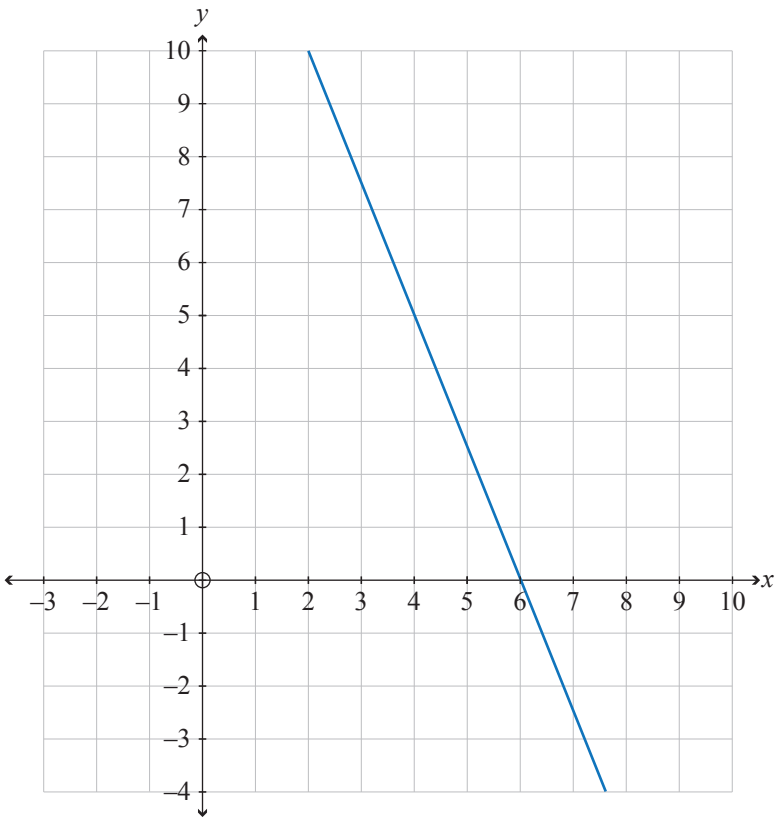
Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

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

This page has been deliberately left blank.
The assessment starts on the following page.

QUESTION ONE

(a) (i) Give the equation of the graph shown below.



Equation is: _____

(ii) Find the equation of the new line if the graph shown above is reflected in the y-axis, and also shifted 10 units vertically upwards.

(b) A city council plans to create a fenced grassed area in Fantail Reserve.

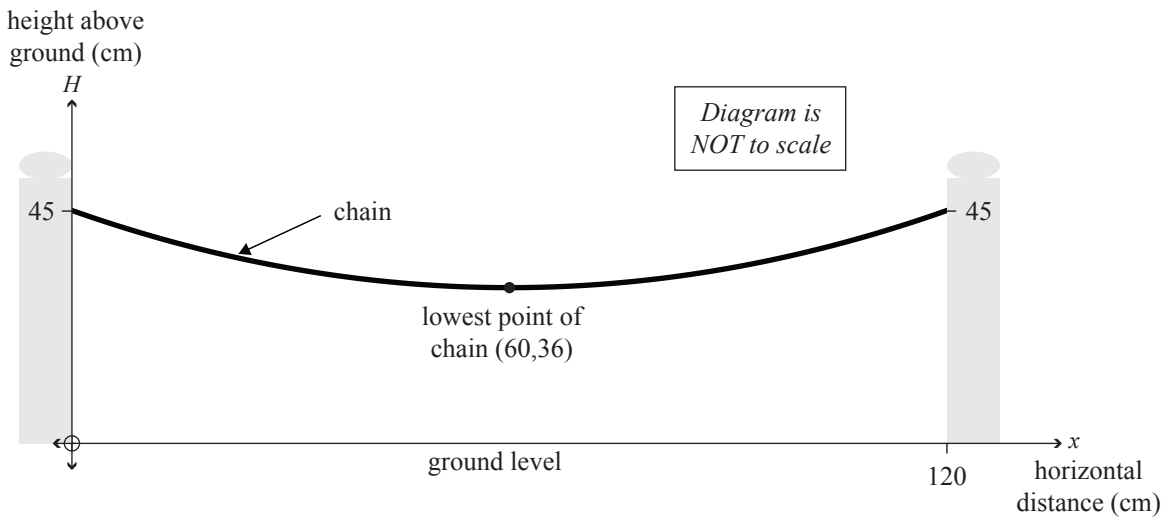
They decide to install some posts with a chain fence between them, as shown right.

The distance between the inside of each of the two posts is 120 cm.

The chain is attached to each post 45 cm above the horizontal ground, and hangs symmetrically.

The lowest point on the fence is 36 cm above the ground.

One section of the fencing is shown in the diagram below.



(i) Find an equation that would model the height of the chain between the two posts, as shown in the diagram above, where x is the horizontal distance from the inside of the left-hand post and H is the vertical height of the chain above the ground.

The x-axis will be at ground level, and the H-axis will be in line with the inside of the left-hand post.

Justify your answer with full and clear working.

(ii) After reviewing the design, the council decides that the lowest point of the chain should actually be lower than the design shown. The posts cannot be moved or changed, as they have already been installed, but where the chain fixes onto the post could be changed if required.

Suggest at least one way in which the original equation of the chain fence design could be altered to make the chain hang lower, but with the chain being in the same shape as the original chain.

Describe how your suggested change would affect the shape of the chain fence AND provide the equation of your alternative design.

(c) One side of the reserve has trees along it, and this side will not be fenced.

The council has a budget to purchase only 240 metres of material for the total of the other three sides of the rectangular grassed area, as shown in the diagram below.

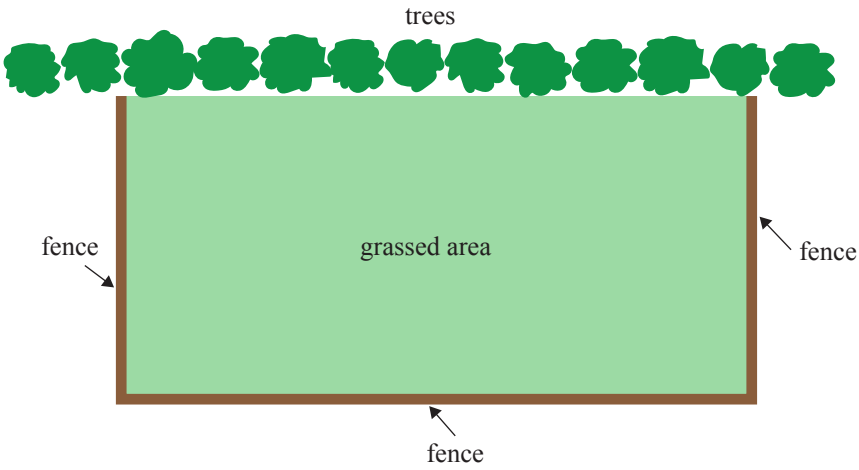
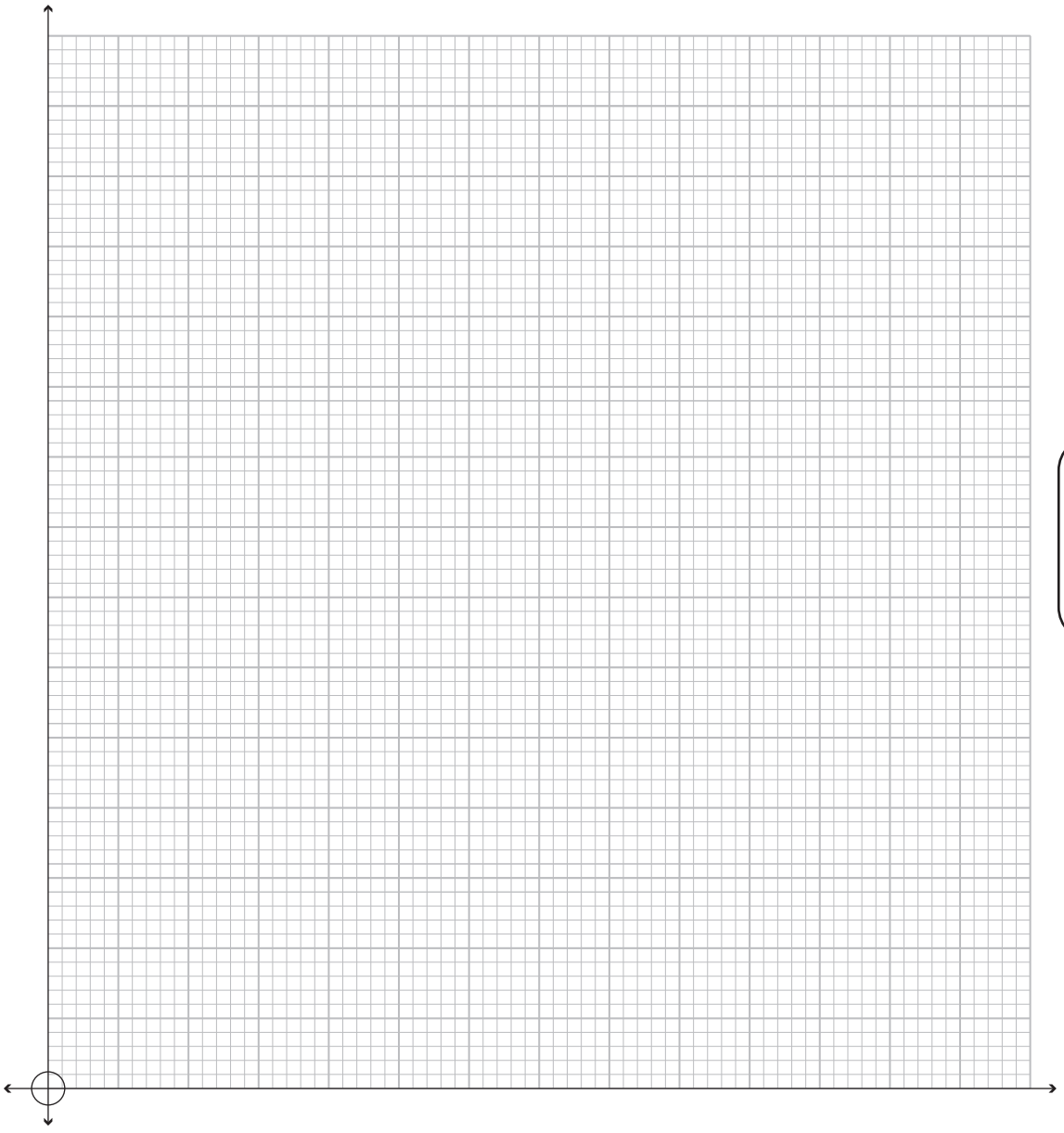


Diagram is NOT to scale

Use tables, equations, AND graphs to investigate the relationship between the length and the width of the grassed reserve and the area enclosed by the fences.

Provide at least THREE different comments that follow from your investigation.

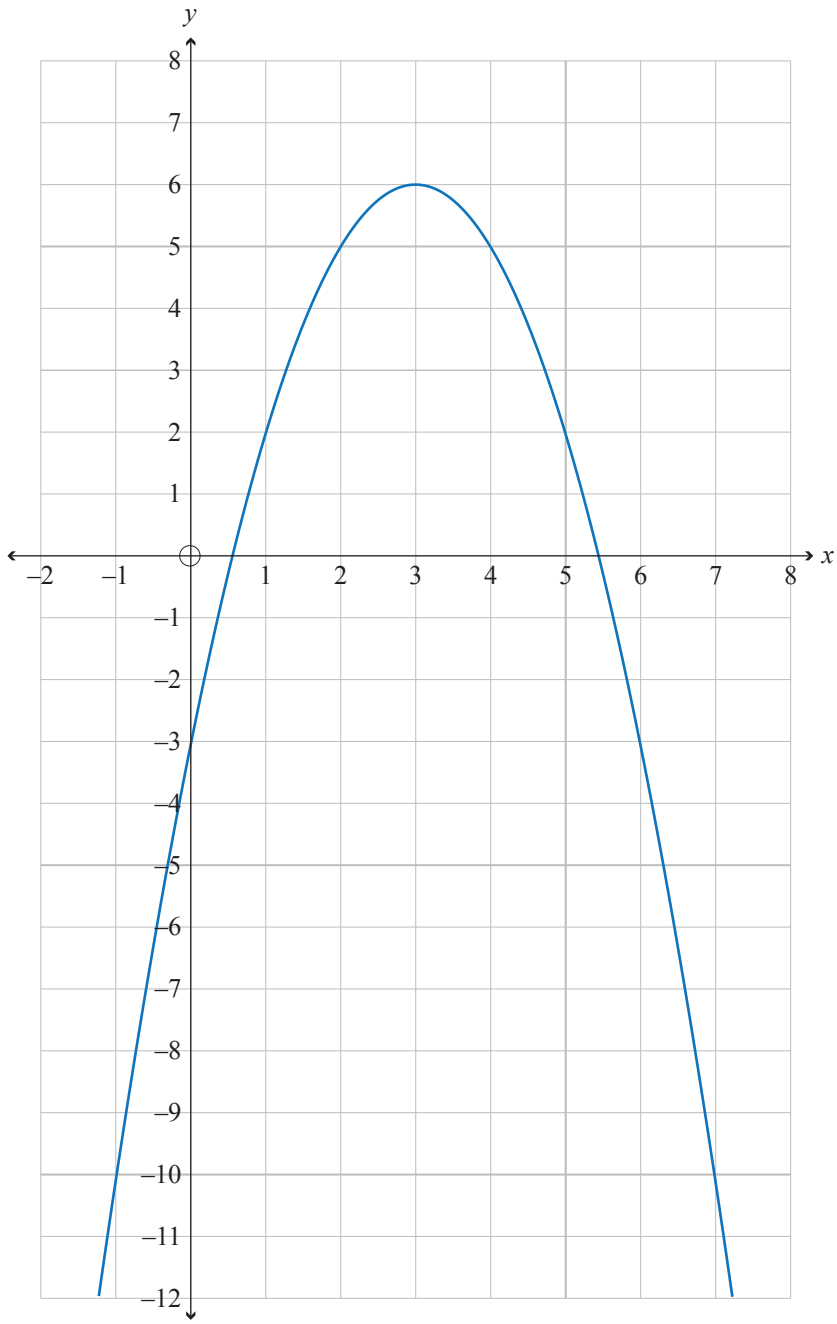
Justify your comments with full details.



If you need to redraw your graphs, use the grid on page 17.

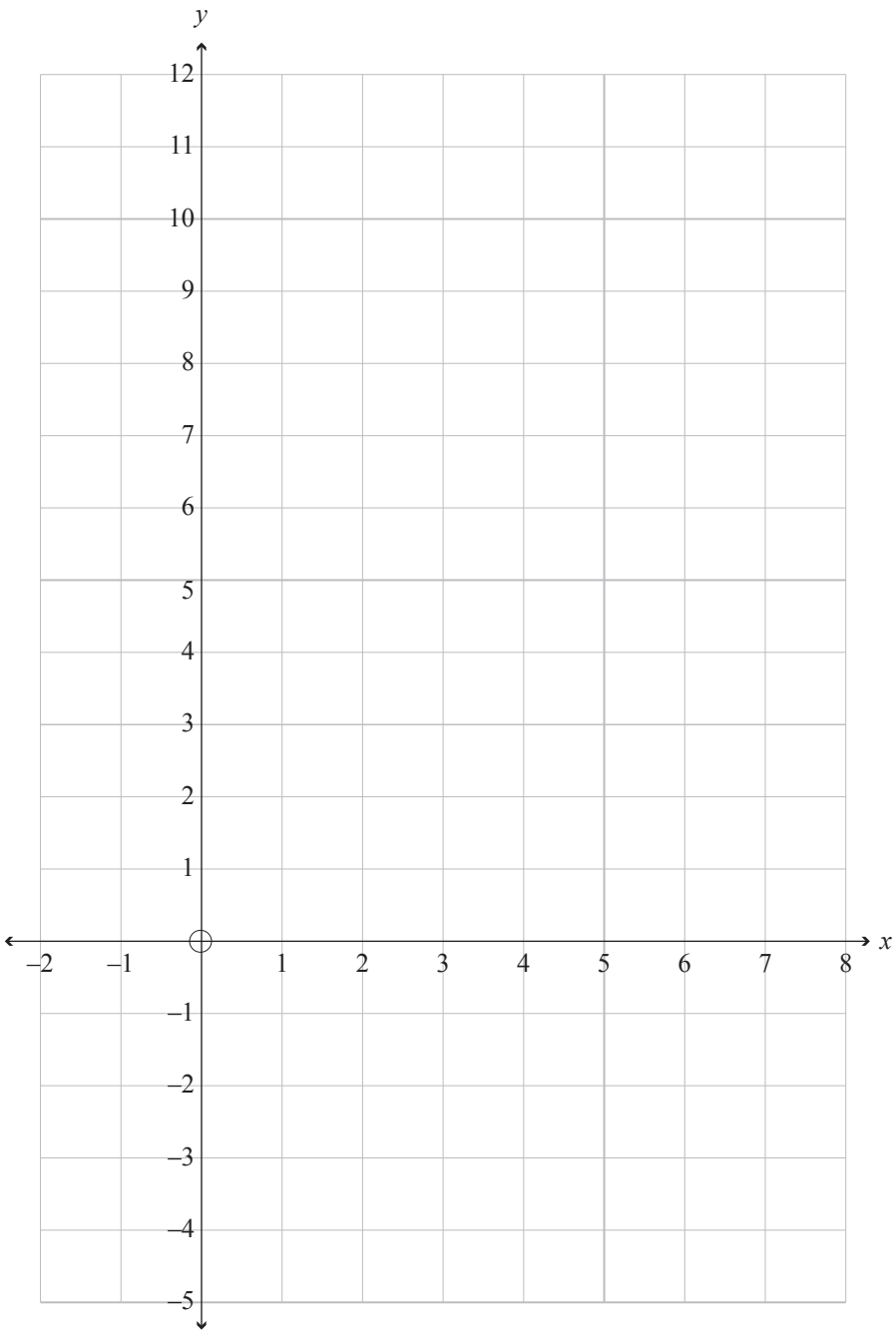
QUESTION TWO

(a) Give the equation of the graph shown below.



Equation is: _____

(b) Using the set of axes provided below, draw the two graphs $y = 2^{x-3}$ and $y = 2x - 3$.
Using your graphs, solve the equation $2^{x-3} = 2x - 3$.



If you need to redraw your graph, use the grid on page 18.

(c) Adam is looking at the number of flowers on a particular tree in his garden.

He counts the number of flowers on each level of branch on the tree. Branch level 1 is the branch closest to the ground, branch level 2 is the next one up, and so on.

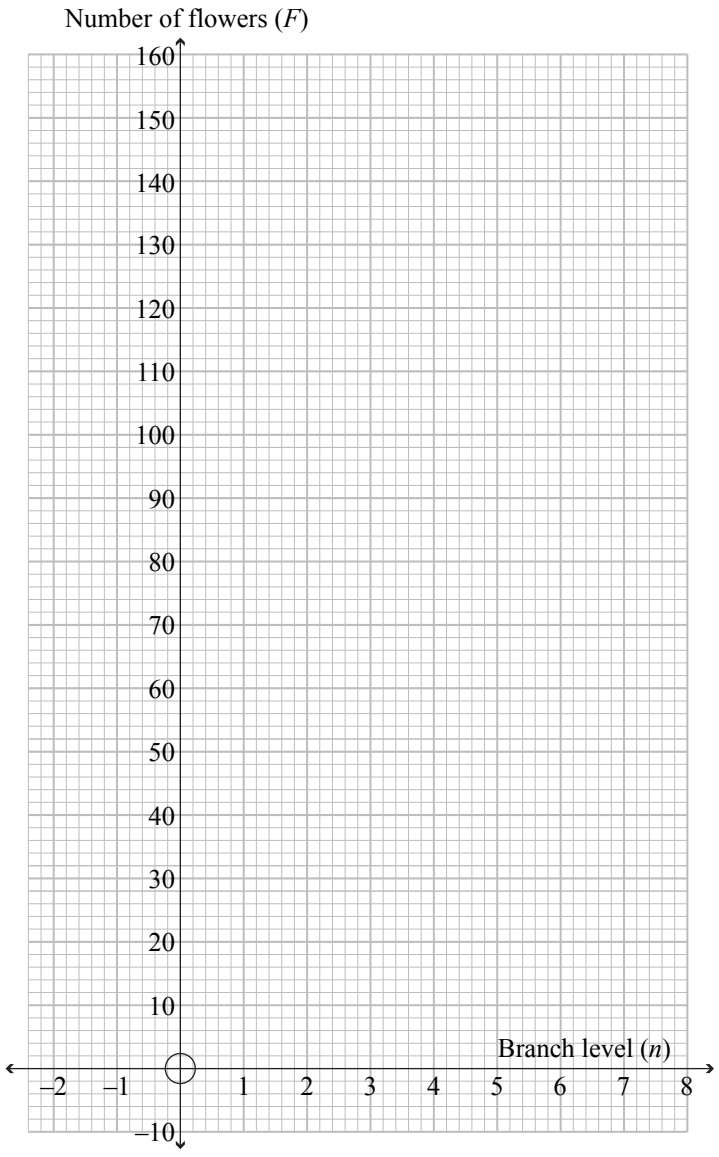
The table below lists the results from his research.

Branch level (n)	Number of flowers on that branch (F)
1	6
2	16
3	30
4	48
5	70
6	
7	
8	

https://www.southernliving.com/garden/trees/cherry-blossom-tree

(i) Using the axes below, draw the graph that best represents the relationship between "Branch level" (n) and "Number of flowers on that branch" (F).

Show the results as far as $n = 8$.



If you need to redraw your graph, use the grid on page 19.

(ii) Find an equation that represents the "Number of flowers" on any given branch.

Justify your answer with clear working, **including an appropriate domain**.

(iii) Adam counts the number of flowers on each level of branch on a different tree.

The table below lists the results from his research on this second tree.

Branch level (n)	**Number of flowers on that branch (F)**
1	1
2	4
3	16
4	64
5	256
6	
7	
8	

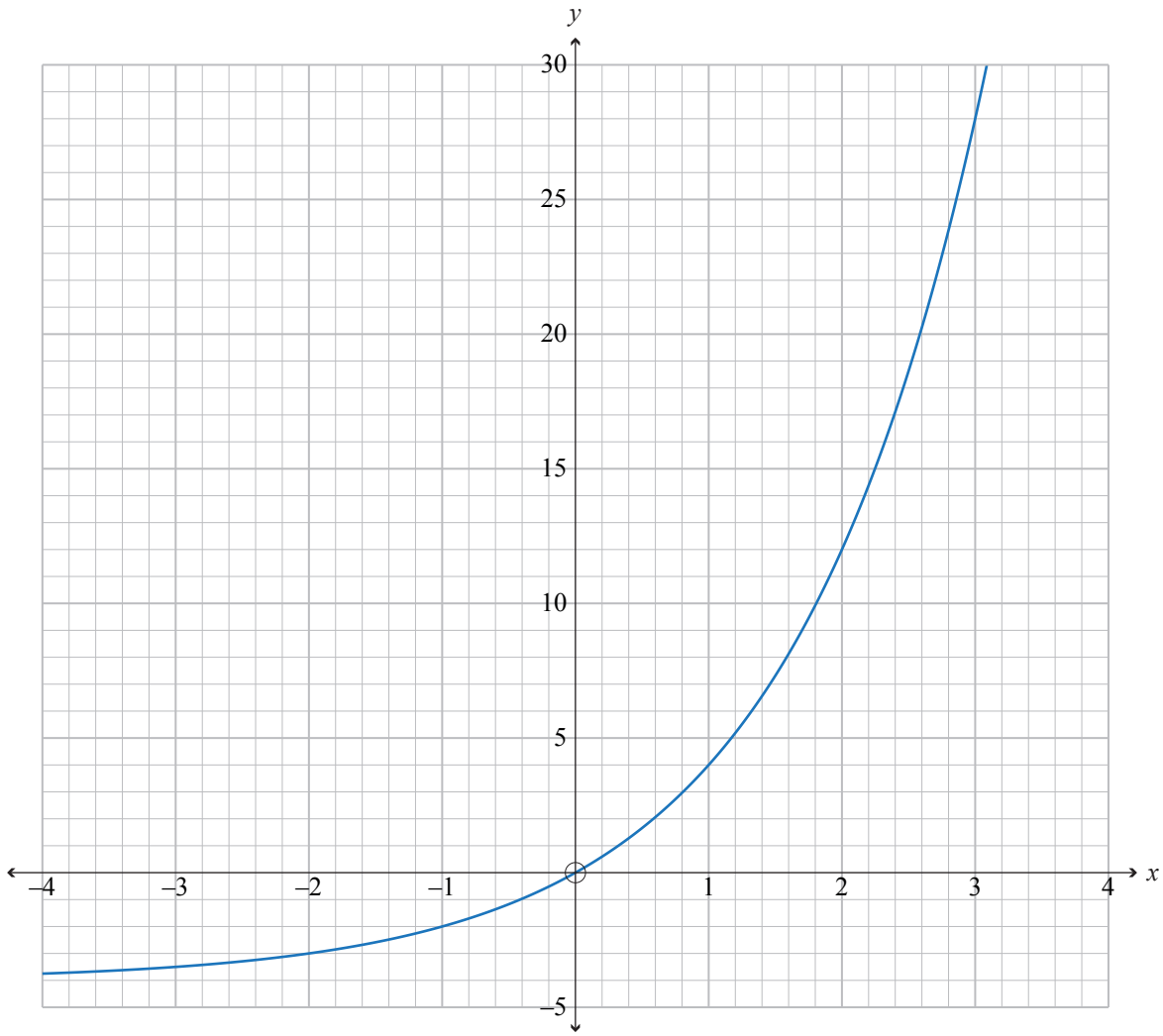
Find an equation that represents the "Number of flowers" on any given branch on this second tree. Justify your answer.

(iv) Adam claims that this formula will help him predict the number of flowers on trees in New Zealand.

Comment on this claim giving at least TWO different statements to support your reasoning.

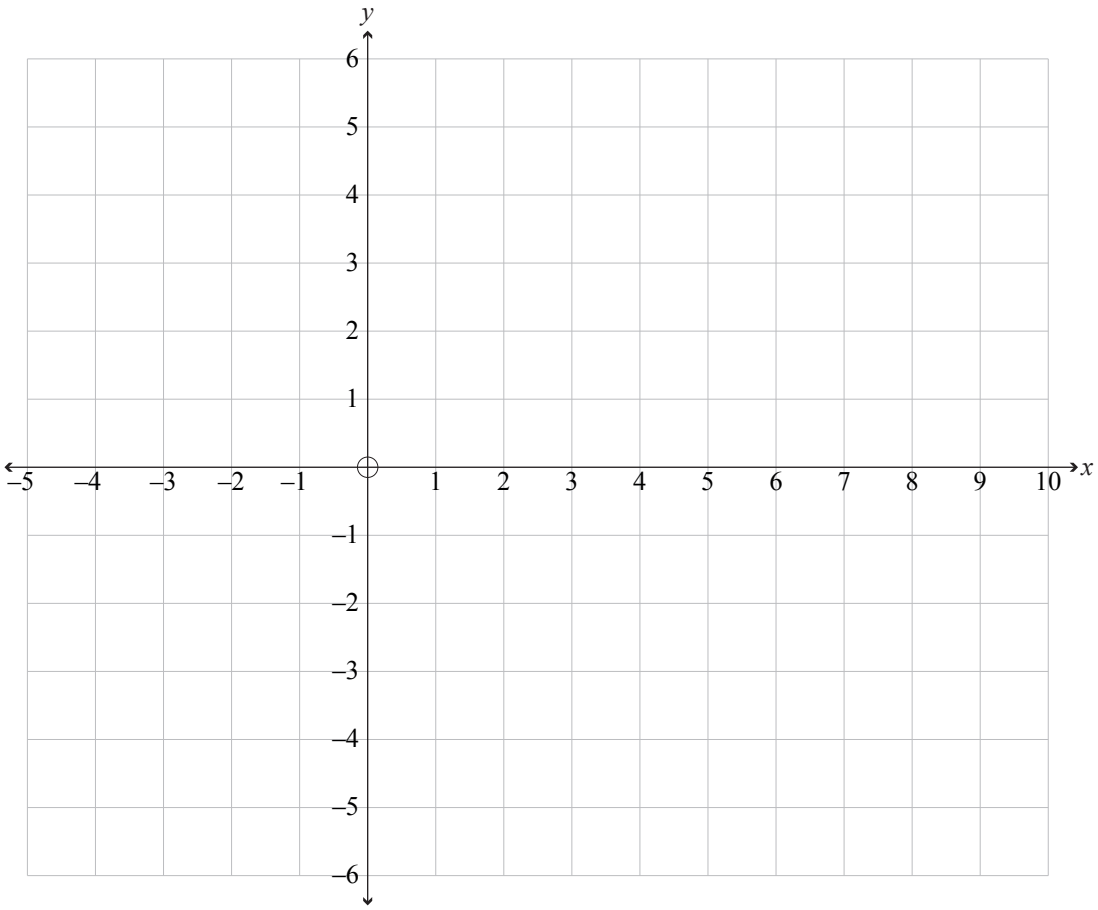
QUESTION THREE

(a) (i) Give the equation of the graph shown below.



Equation is: _____

(ii) On the axes below, draw the graph of $3y - 2x + 6 = 0$.



If you need to redraw your graph, use the grid on page 20.

(b) Bronwyn plans to invest **$1000** using her bank. The bank offers three different types of savings plans, and she needs to decide which one to choose.

She wants to compare how her savings will increase over the next 6 years.

The details of each savings plan are listed below.

Bronwyn does not plan to take out any money during the 6 years.

Note: All graphs in this question can be considered to be continuous.

Savings Plan A: Invest $1000 at the start, and then receive the same regular payment of **$250** at the end of each year.

Savings Plan B: The equation for Savings Plan B is modelled by the formula

$$S = 60t^2 + 10t + 1000$$

where t represents the number of years since Bronwyn started her savings plan,
and S represents the total amount ($) in Bronwyn's account.

Savings Plan C: The details of Savings Plan C are shown in the table below, which can be modelled by an exponential equation of the form $S = p \times q^t$.

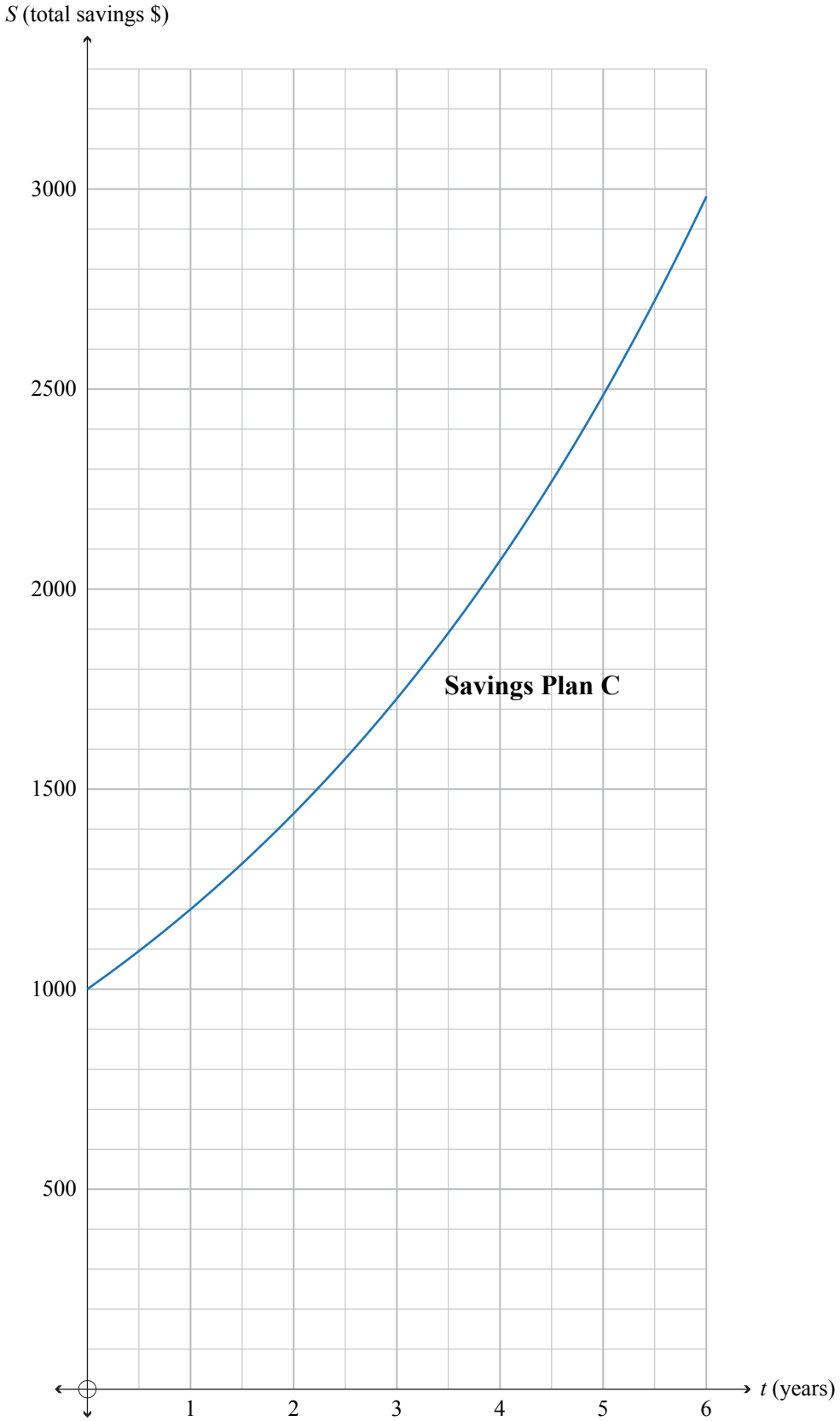
where p and q are numbers to be found,
t represents the number of years since Bronwyn started her savings plan,
and S represents the total amount ($) in Bronwyn's account.

Note: The graph of Savings Plan C has already been drawn for you on page 15.

End of year (t)	**Total savings amount (S) ($)**
0 (at the start of saving)	1000.00
1	1200.00
2	1440.00
3	1728.00
4	2073.60
5	2488.32
6	2985.98

(i) Write the equation of **Savings Plan C**.

(ii) Draw the graphs that model **Savings Plan A** and **Savings Plan B** below.
(The graph of **Savings Plan C** has been drawn for you.)



If you need to redraw your graphs, use the grid on page 21.

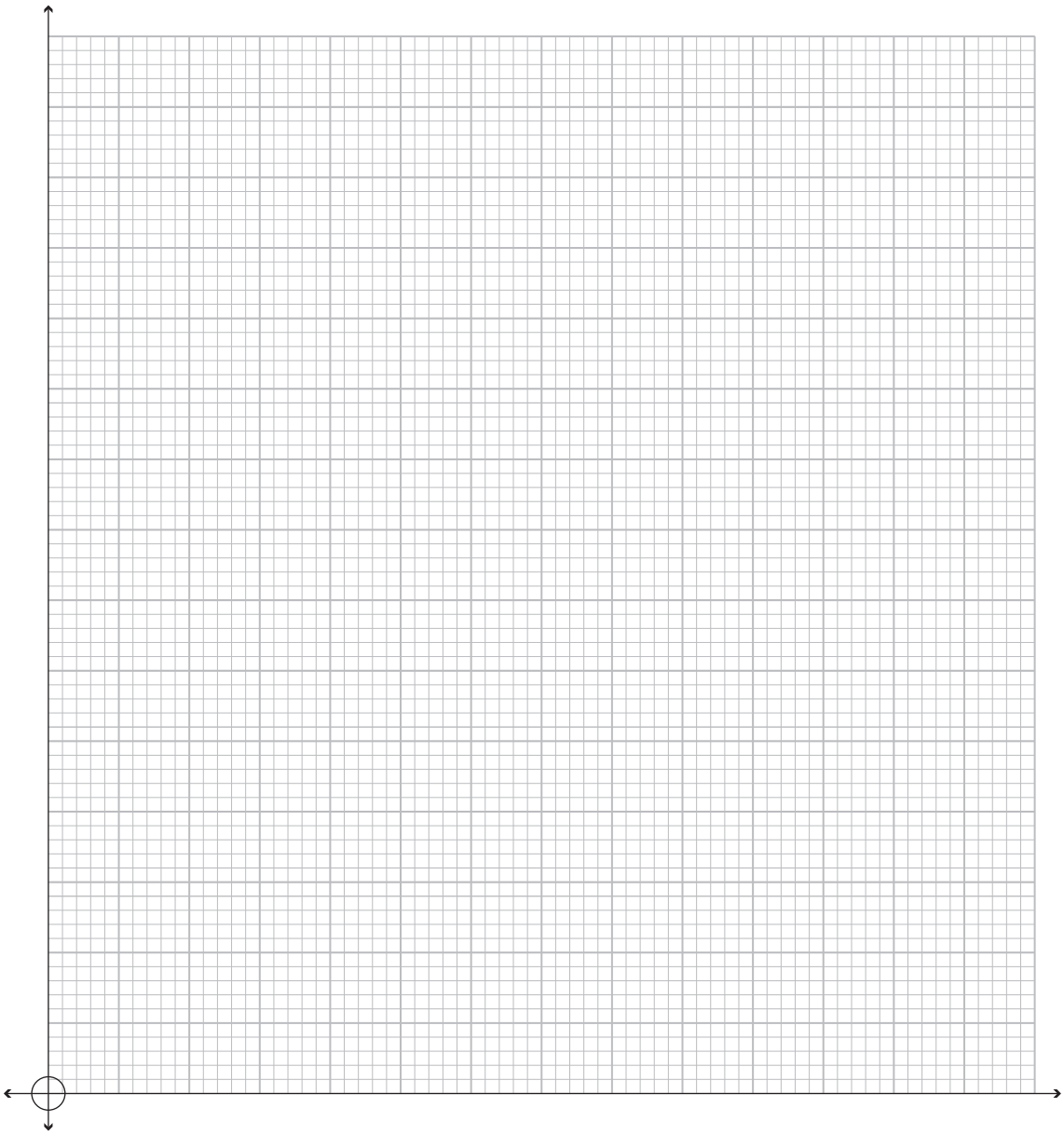
(iii) Using tables and the graphs in part (ii) on page 15, give a detailed comparison between the three savings plans at various stages during the first six years.

Provide at least THREE comments that follow from your comparison.

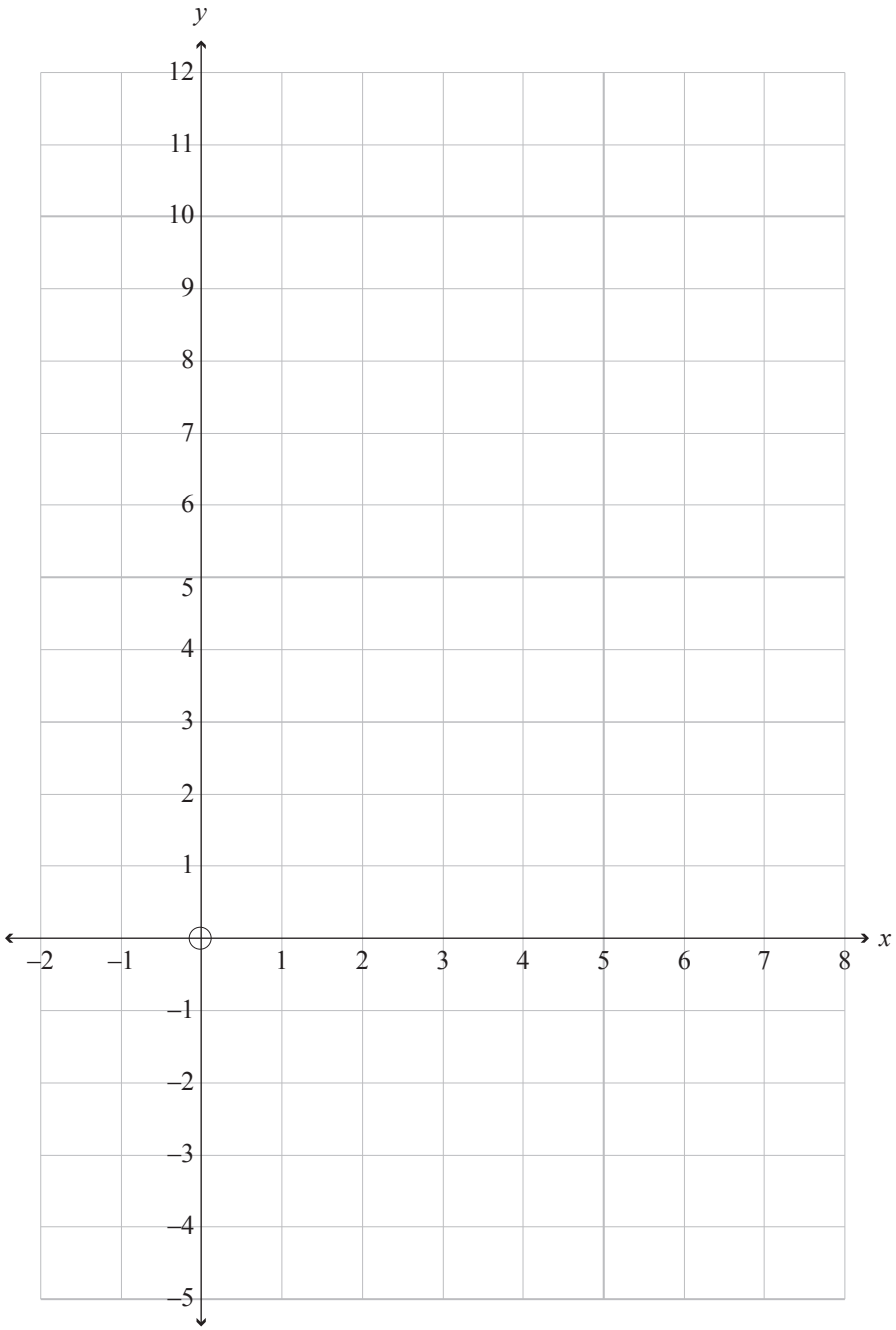
End of Year (t)	Total savings Savings Plan A	Total savings Savings Plan B	Total savings Savings Plan C	
0			1000.00	
1			1200.00	
2			1440.00	
3			1728.00	
4			2073.60	
5			2488.32	
6			2985.98	

SPARE DIAGRAMS

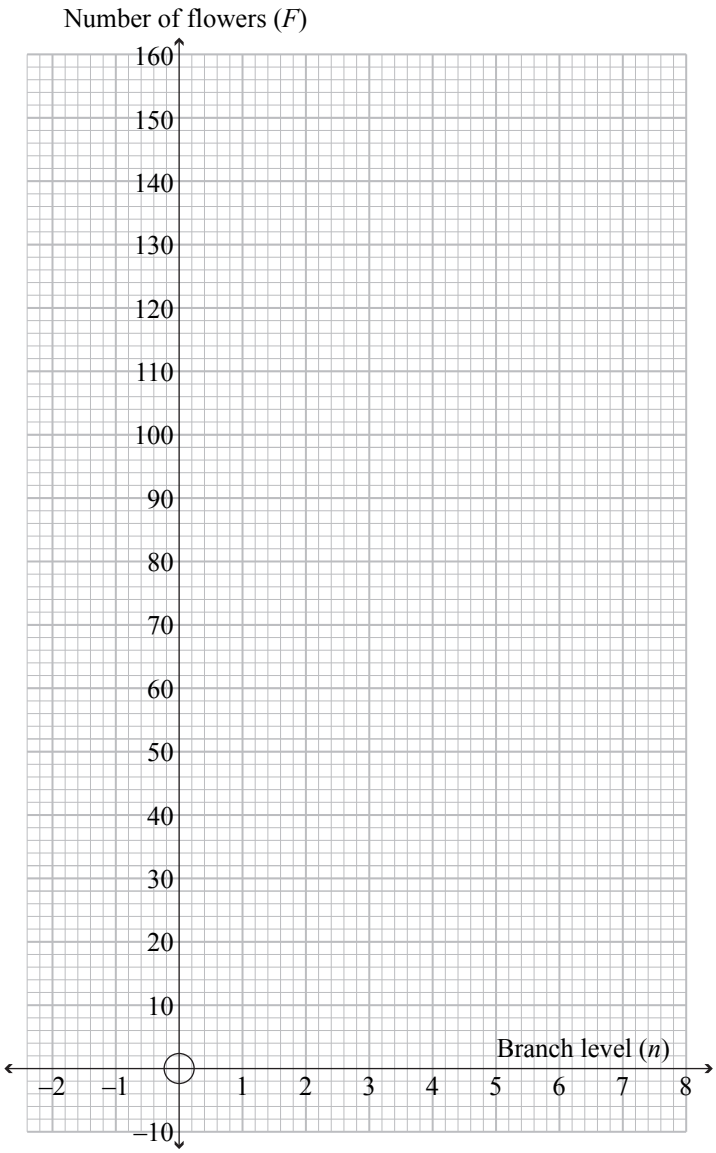
If you need to redraw your graphs for Question One (c), use the grid below. Make sure it is clear which answer you want marked.



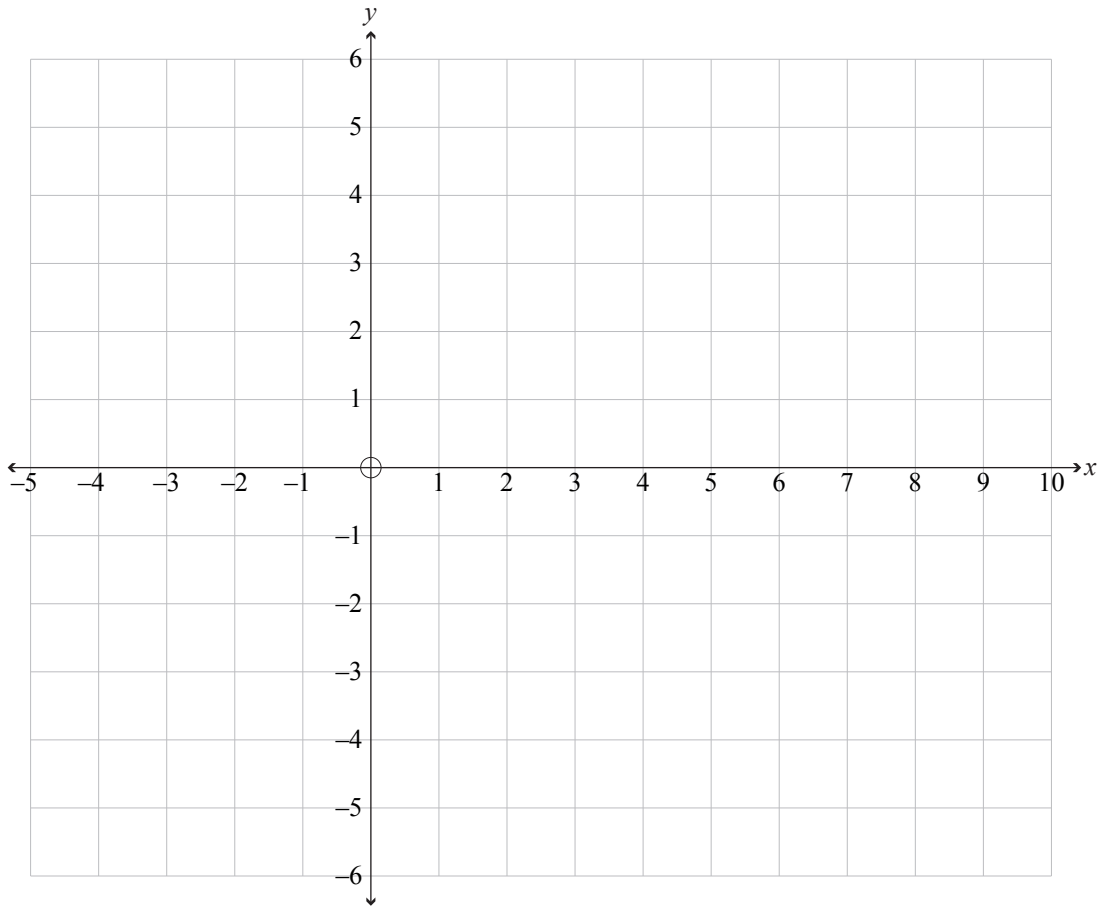
If you need to redraw your response to Question Two (b), use the diagram below. Make sure it is clear which answer you want marked.



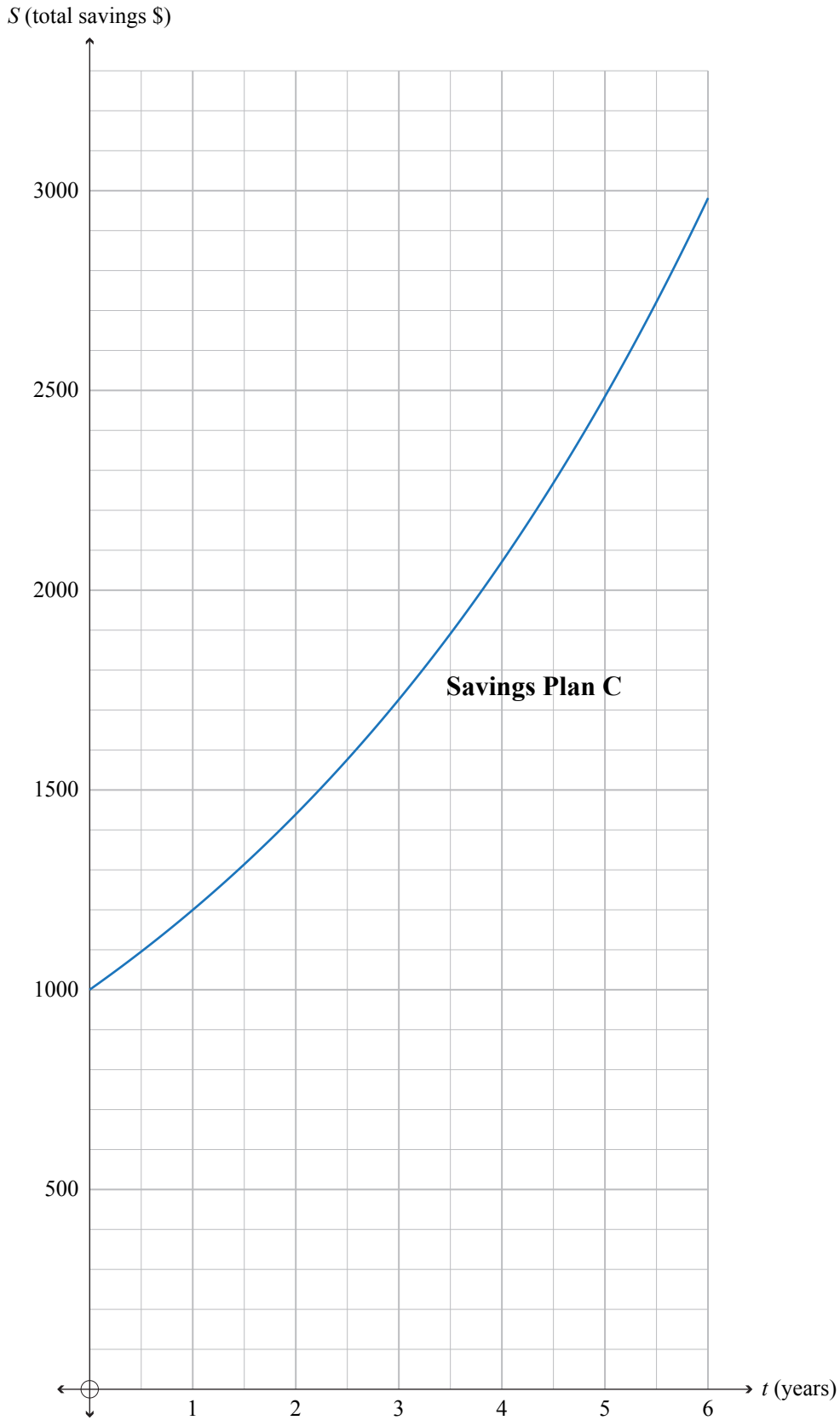
If you need to redraw your response to Question Two (c)(i), use the diagram below. Make sure it is clear which answer you want marked.



If you need to redraw your response to Question Three (a)(ii), use the diagram below. Make sure it is clear which answer you want marked.



If you need to redraw your response to Question Three (b)(ii), use the diagram below. Make sure it is clear which answer you want marked.



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

QUESTION NUMBER

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QUESTION NUMBER