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Instructions

There are **two** sections in this examination paper.

| | | | |
|-----------|---------------------------|-----------|-------------|
| Section A | Concepts and Skills | 150 marks | 6 questions |
| Section B | Contexts and Applications | 150 marks | 4 questions |

Answer questions as follows:

- any **five** questions from Section A – Concepts and Skills
- any **three** questions from Section B – Contexts and Applications.

Write your Name and Individual Details in the grid on the front cover.

Write your answers in blue or black pen. You may use pencil in graphs and diagrams only.

This examination booklet will be scanned and your work will be presented to an examiner on screen. Anything that you write outside of the answer areas may not be seen by the examiner.

Write all answers into this booklet. There is space for extra work at the back of the booklet. If you need to use it, label any extra work clearly with the question number and part.

The superintendent will give you a copy of the *Formulae and Tables* booklet. You must return it at the end of the examination. You are not allowed to bring your own copy into the examination.

You will lose marks if your solutions do not include relevant supporting work.

You may lose marks if the appropriate units of measurement are not included, where relevant.

You may lose marks if your answers are not given in simplest form, where relevant.

Write the make and model of your calculator(s) here:



Answer **any five questions** from this section.

Question 1

(30 marks)

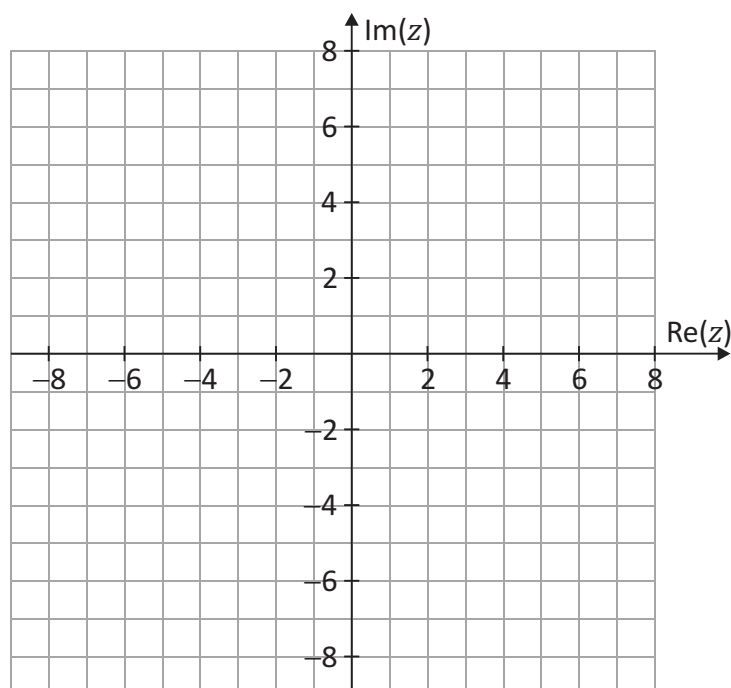
(a) $z_1 = 2 + 3i$ and $z_2 = 3 - 2i$ are complex numbers, where $i^2 = -1$.

(i) $z_3 = 3z_1 - iz_2$.

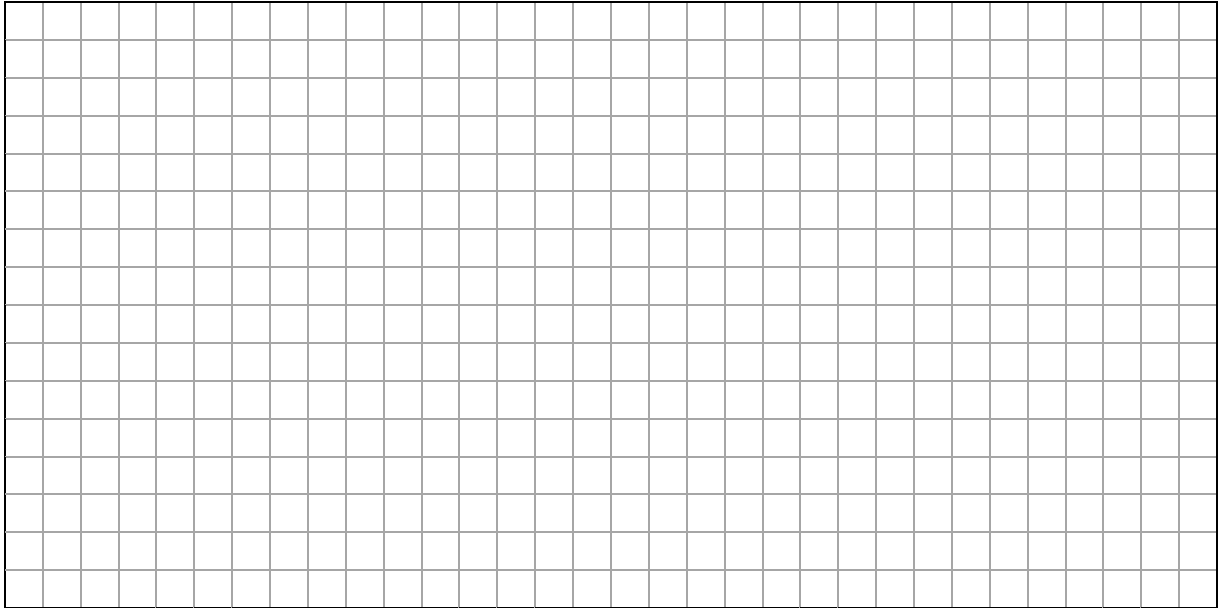
Write z_3 in the form $a + bi$, where $a, b \in \mathbb{Z}$.

[illegible]

(ii) Plot and label z_1 , z_2 and z_3 on the Argand Diagram.

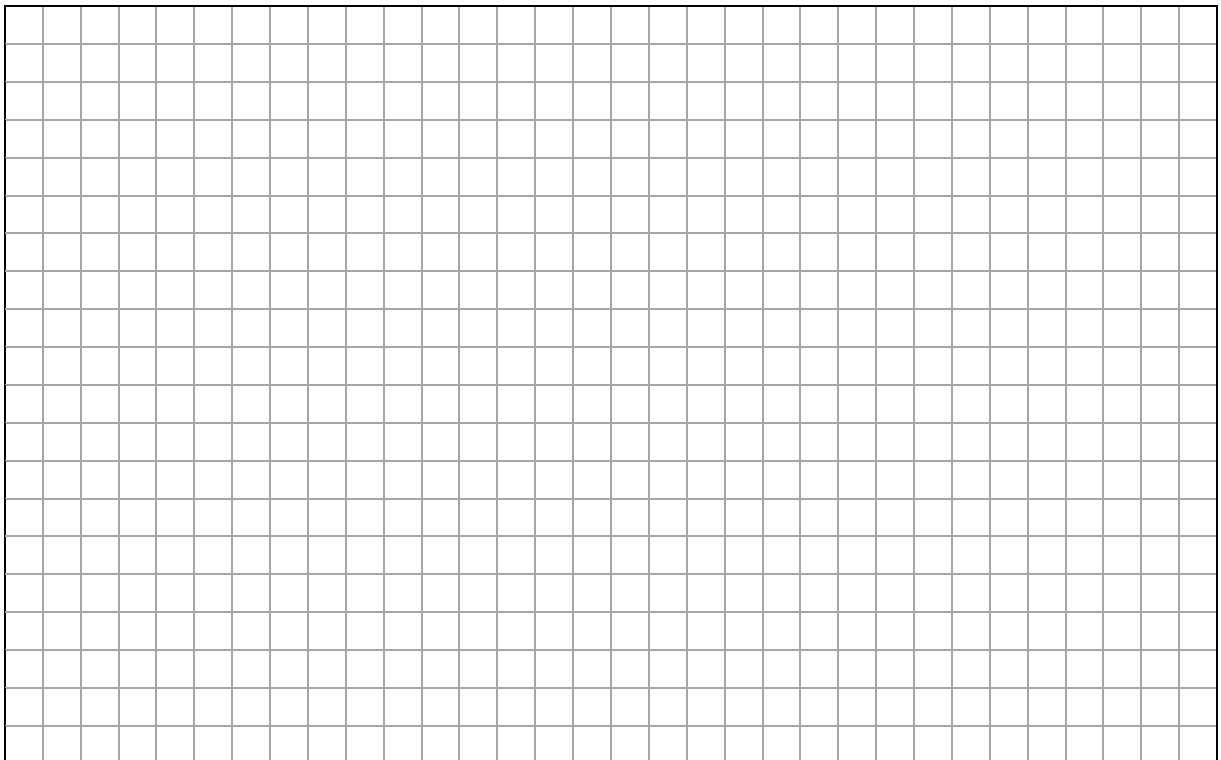


(iii) Investigate if $|z_1| + |z_2| = |z_1 + z_2|$.



(b) Find the complex number z_4 , such that $z_1 = \frac{z_2}{z_4}$.

Give your answer in the form $p + qi$, where $p, q \in \mathbb{Z}$.



Question 2

(30 marks)

- (a) Conor is part of the sales team with a company. He earns a basic salary of €2200 per month. In addition to his salary, he earns a commission of 11% on sales up to the value of €25 000 per month and a commission of 14% on any sales above this.
- (i) During a particular month, Conor made sales amounting to €21 000. Find Conor's gross pay for this month.

A large grid of graph paper with 20 columns and 10 rows. The grid is composed of small squares, with a thicker border around the entire grid.

- (ii) The following month, Conor's gross pay was €6210.
Find the amount of sales that Conor made in that month.

This image shows a full page of blank graph paper. The grid consists of small, equal-sized squares formed by thin gray lines. There are no margins, text, or other markings on the page.

- Work out how much income tax Conor paid for the year.

A large grid of graph paper with 20 columns and 15 rows. The grid is composed of small squares, with a slightly larger square in the top-left corner, likely for a title or header. The grid is empty and ready for use.

- Work out Conor's net take-home pay for the year.

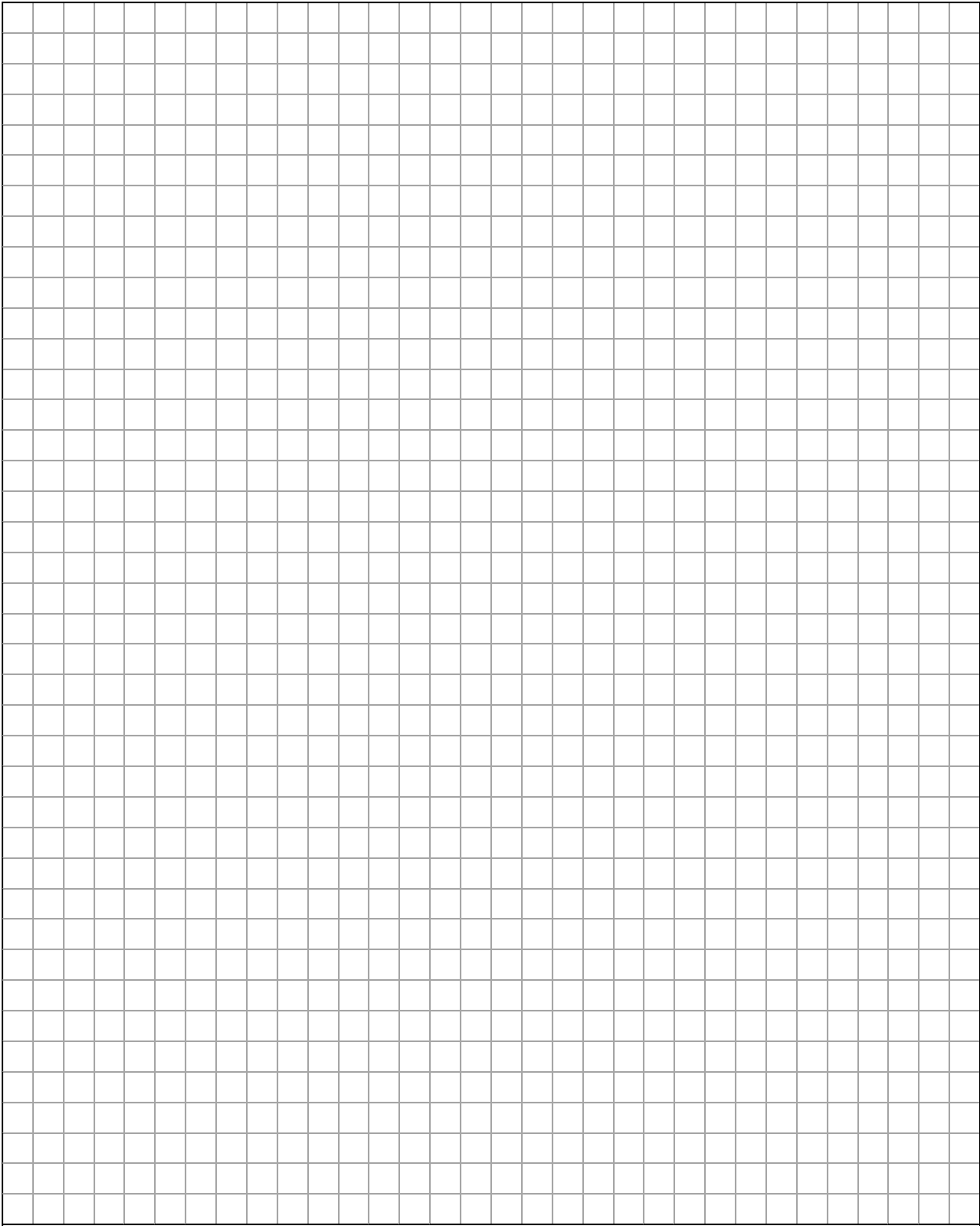
[illegible]

Question 3

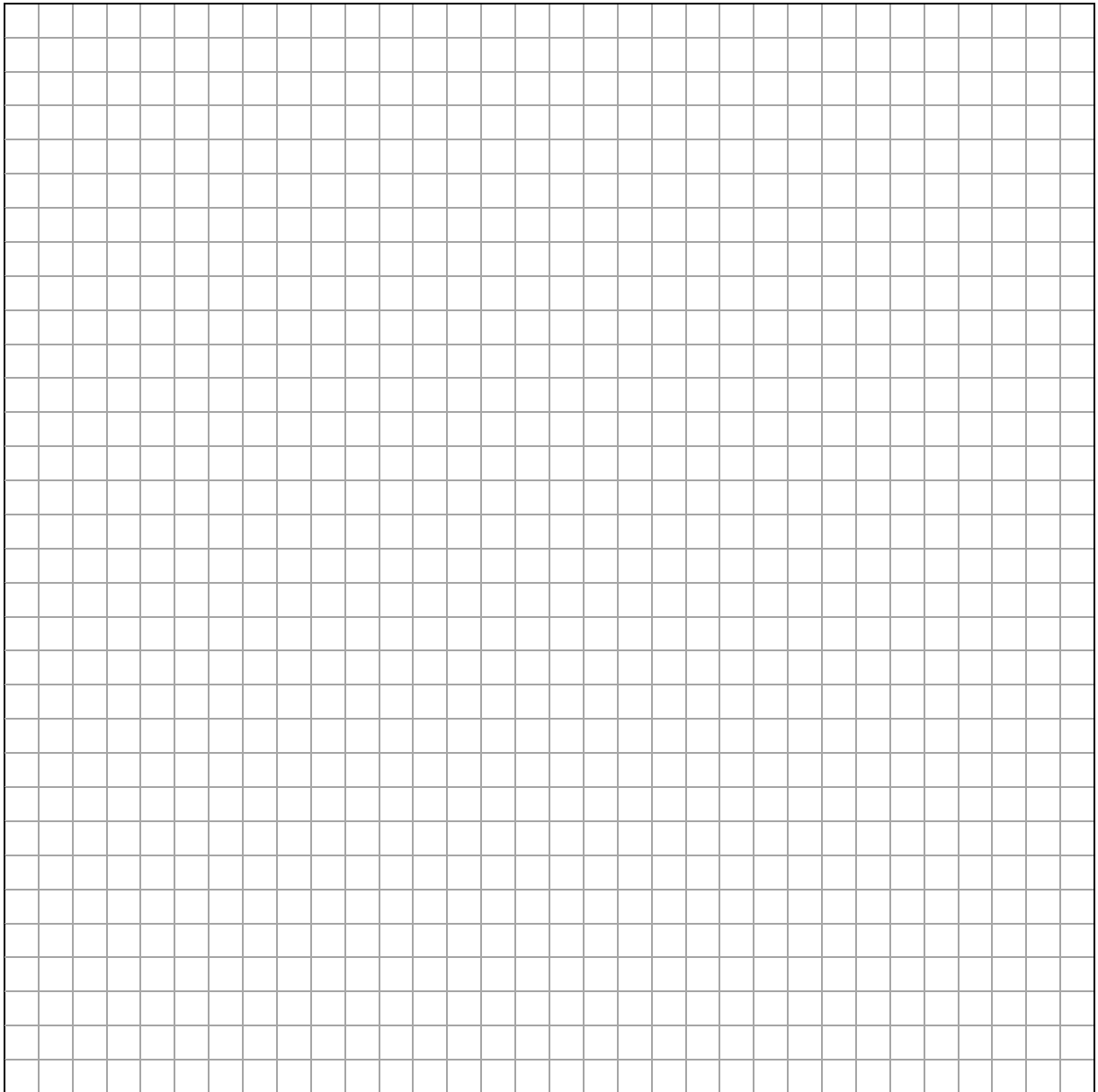
(30 marks)

(a) Solve the simultaneous equations:

$$\begin{aligned} 2x + 3y - 10 &= 0 \\ 3xy - 5x + 7 &= 0. \end{aligned}$$

A large rectangular grid of graph paper, consisting of 20 columns and 30 rows of small squares, intended for the student to show their work in solving the simultaneous equations.

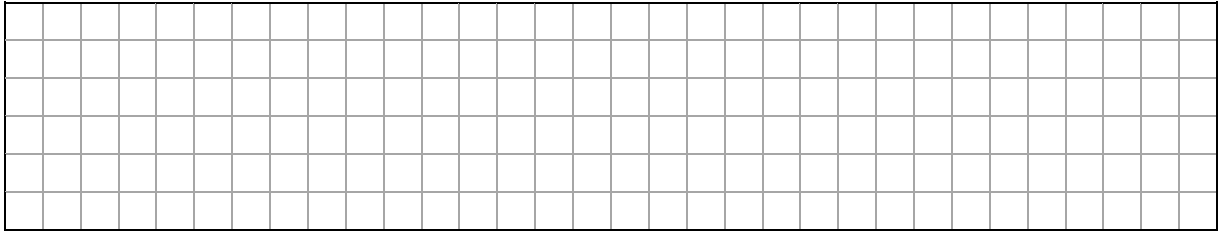
- (b) Find the two values of x for which $3x^2 + 7x - 9 = 0$.
Give your answers correct to one decimal place.



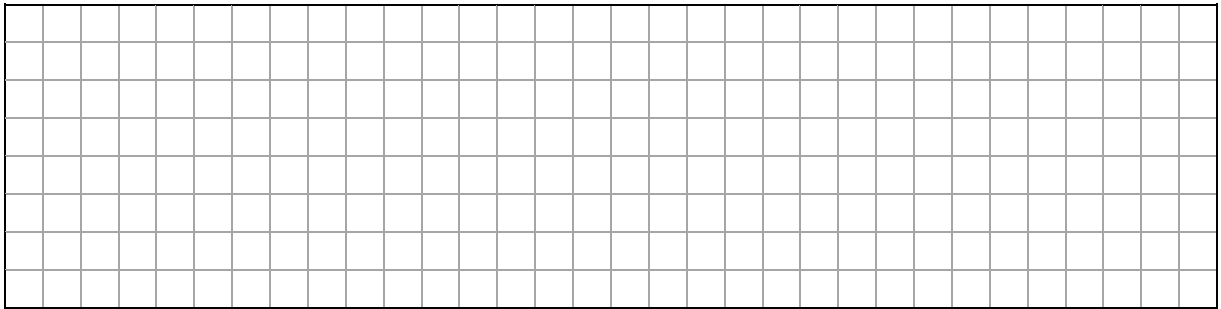
Question 4**(30 marks)**

The function f is defined as $f(x) = x^2 - x - 6$, where $x \in \mathbb{R}$.

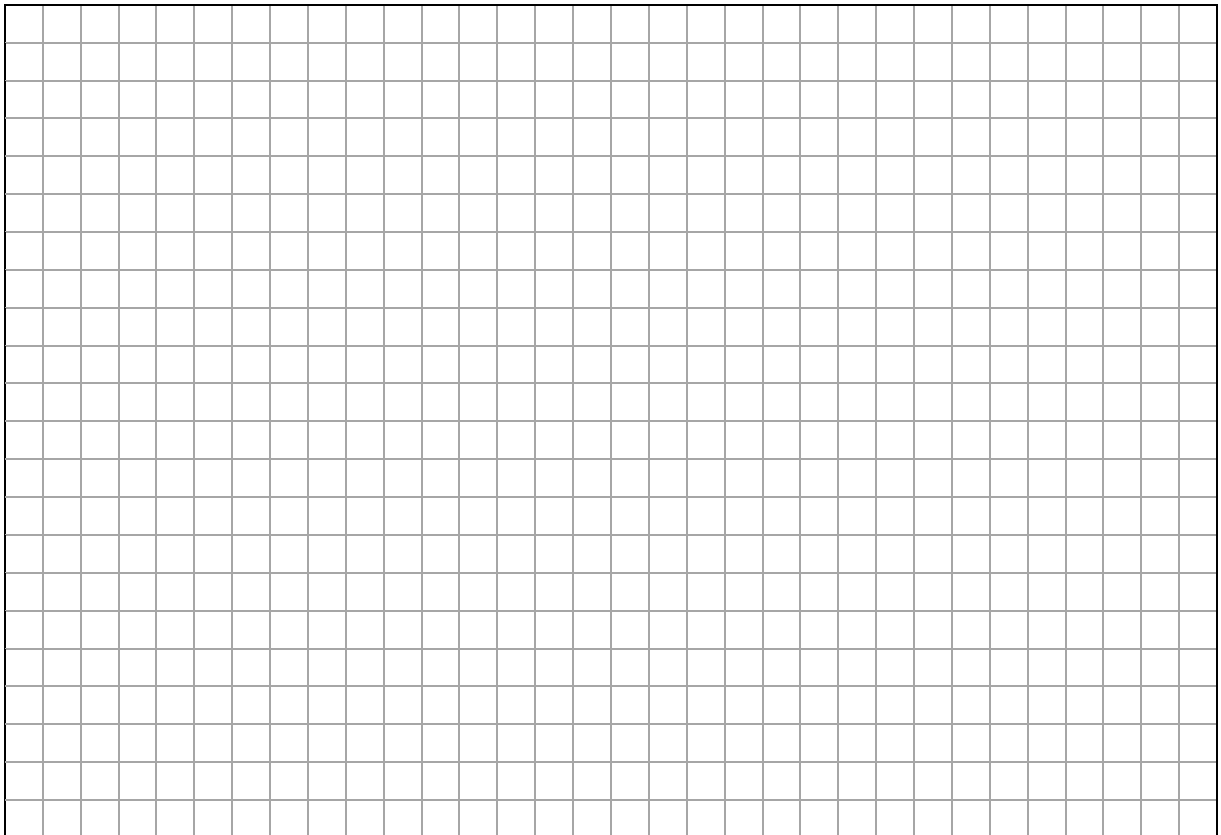
- (a) (i)** Find the co-ordinates of the point at which the graph of f cuts the y -axis.



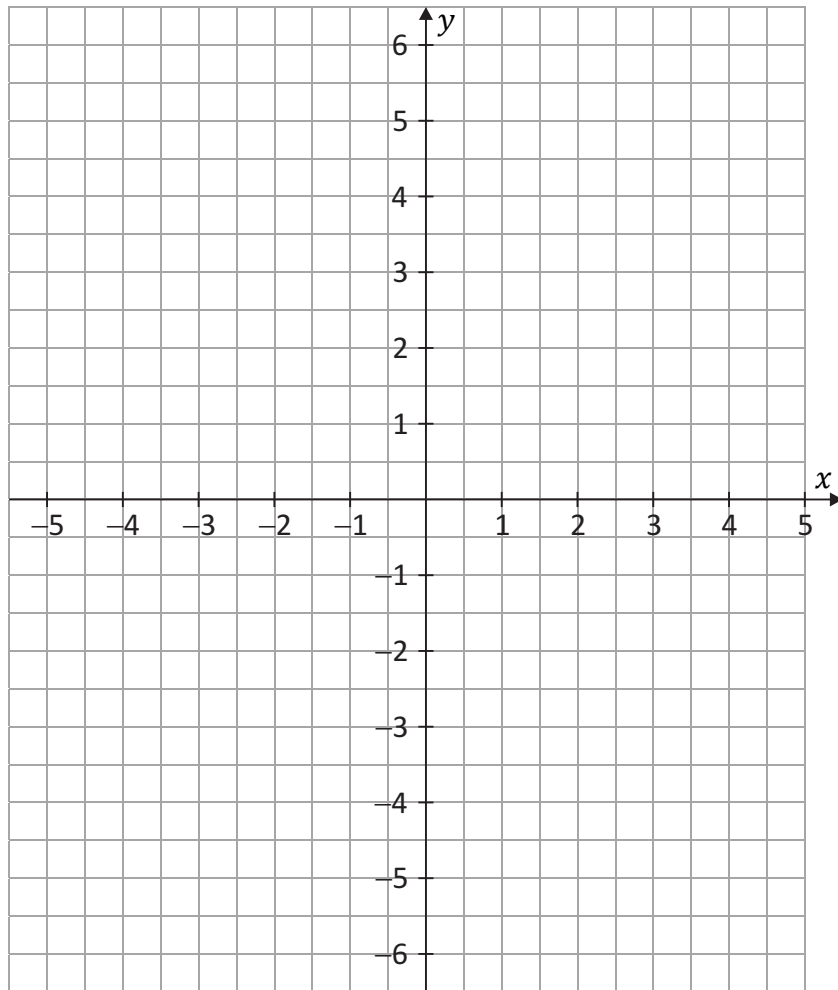
- (ii)** Find the co-ordinates of the points at which the graph of f cuts the x -axis.



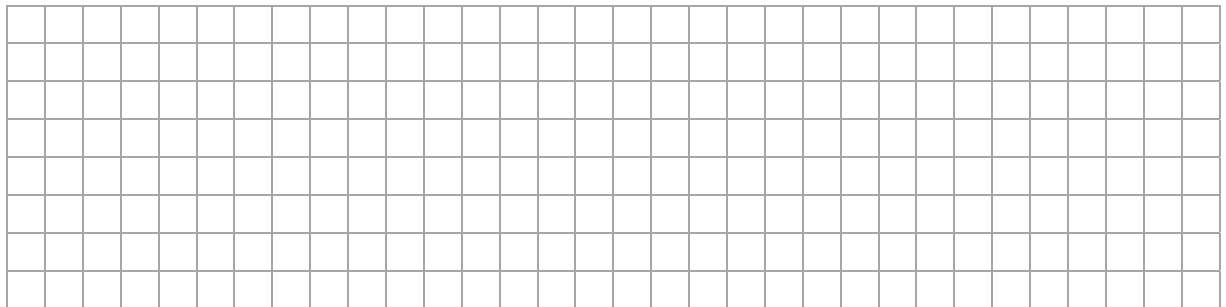
- (b)** Find $f'(x)$, the derivative of $f(x)$.
Hence find the co-ordinates of the minimum point of $f(x)$.



- (c) (i) Sketch the graph of f on the axes below.



- (ii) Use your graph to estimate the roots of the function $g(x) = f(x) + 3$.



(30 marks)

- (i) Work out the loss in mass of the sun in **kilograms per year**.
Give your answer in the form $a \times 10^n$, where $1 \leq a < 10$, $n \in \mathbb{N}$,
and where a is correct to three significant figures.
[Note: 1 year = 365¼ days, 1 tonne = 1000 kg]

[illegible]

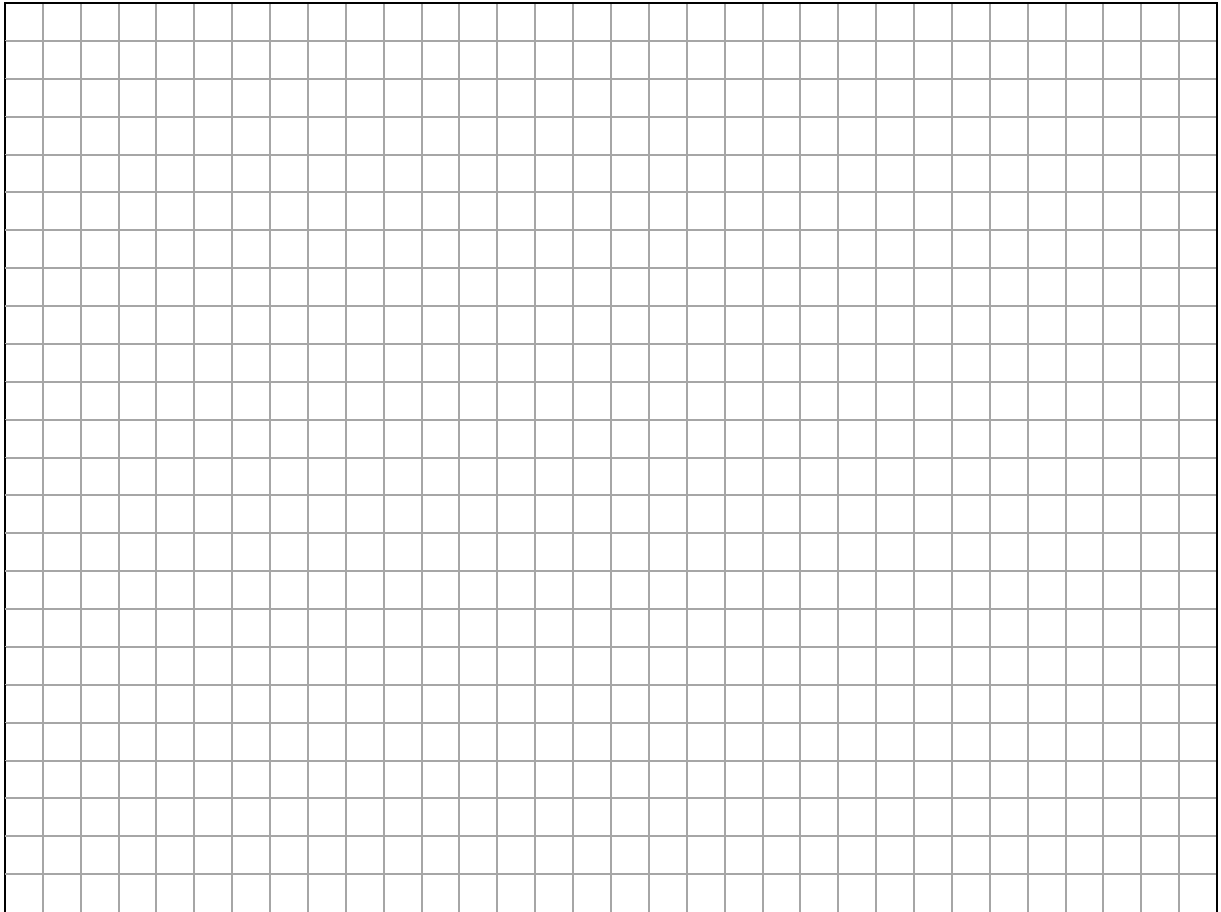
- $$E = mc^2$$

Work out the amount of energy equivalent to the loss in mass of the sun in one year. Give your answer in the form $a \times 10^n$, where $1 \leq a < 10$, $n \in \mathbb{N}$, and where a is correct to four significant figures.

A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 1 cm by 1 cm each. There are 20 columns and 20 rows of squares. A thicker vertical line runs down the left side, creating a margin. A thicker horizontal line runs across the top, creating a header space. The intersection of these two lines forms a rectangular box in the top-left corner, suitable for writing a title or name.

(b) Solve the equation:

$$3^{2x-1} = 27^{(x+2)}.$$




Question 6

(30 marks)

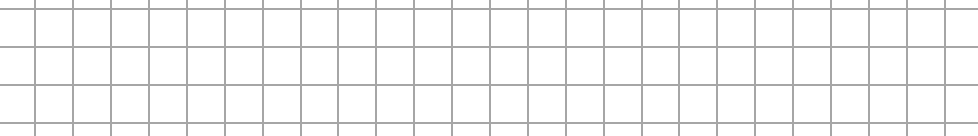
The first four terms of a sequence are shown in the table below.

| Term | Number |
|-------|--------|
| T_1 | 8 |
| T_2 | 13 |
| T_3 | 20 |
| T_4 | 29 |
| T_5 | |
| T_6 | |
| T_7 | |
| T_8 | |

- (a)** Complete the table to show the next four terms in the sequence.



- (b)** Show that the sequence is quadratic.



- (c) (i)** The n th term in the sequence is given by the expression, for $n \in \mathbb{N}$:

$$T_n = n^2 + bn + c, \text{ where } b, c \in \mathbb{Z}.$$

Find the value of b and the value of c .

A blank sheet of graph paper with a grid pattern.

$b =$

$c =$

- (ii)** Find which term in the sequence has a value of 445.

[illegible]

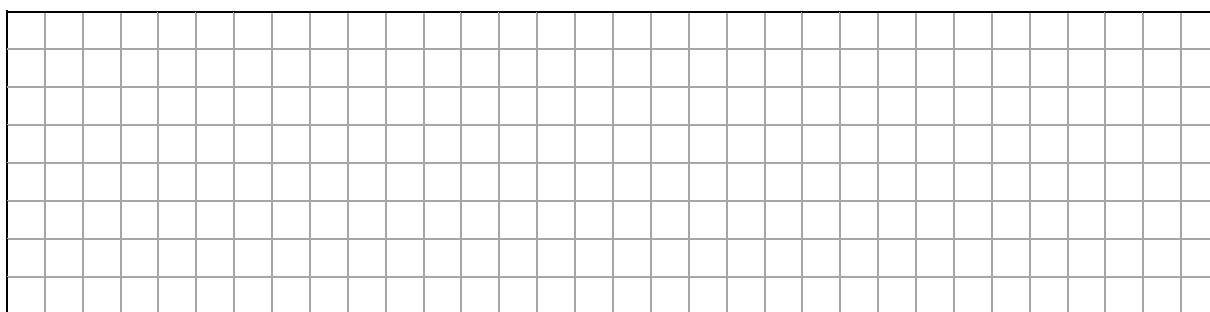
Answer **any three questions** from this section.

Question 7**(50 marks)**

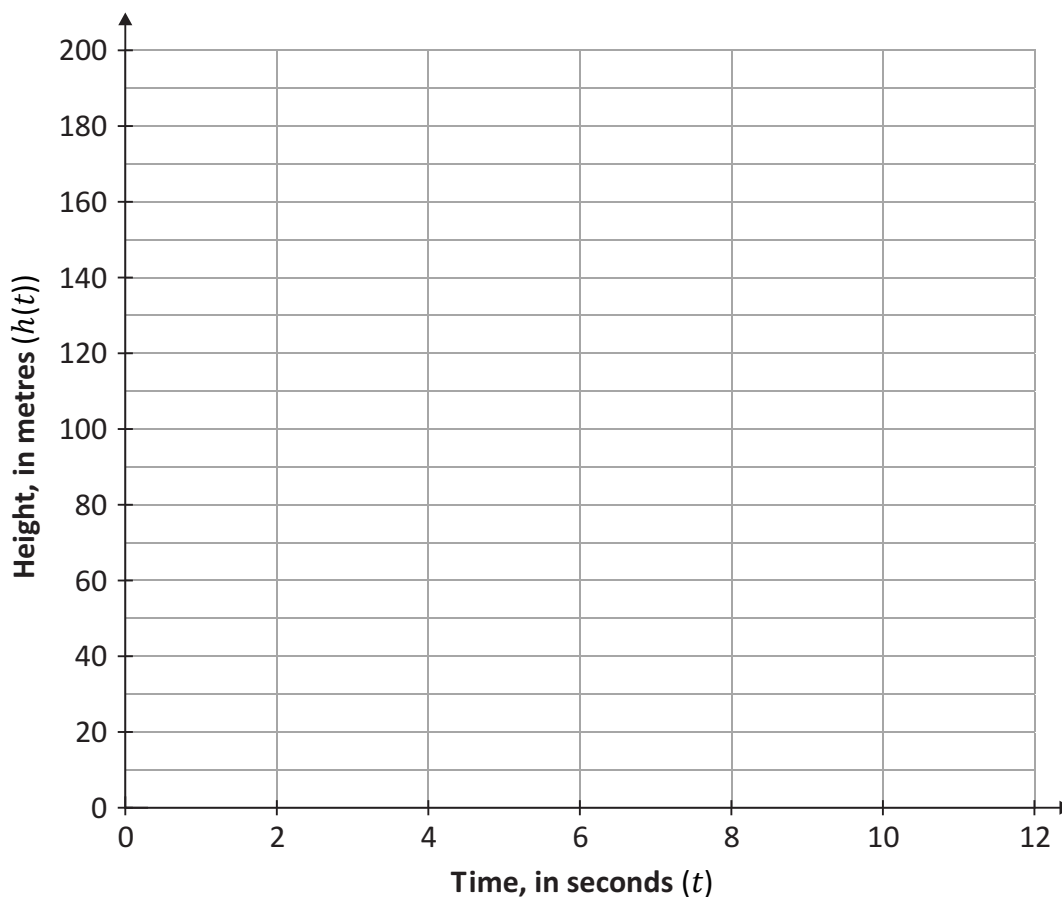
A firework is released vertically into the air from a fixed position on the ground. The height, in metres, of the firework above the ground after t seconds is given by $h(t) = 60t - 4.9t^2$.

- (a) (i) Complete the table below to show the values of $h(t)$ for the given values of t .
Give each value of $h(t)$ correct to the nearest whole number.

| Time (seconds) | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
|-----------------|---|---|---|---|---|-----|----|
| Height (metres) | | | | | | 110 | |



- (ii) Draw the graph of the function $h(t)$ on the axes below for $0 \leq t \leq 12$, where $t \in \mathbb{R}$.



- (b) Use your graph to estimate:
(Show your work on the graph)

(i) the maximum height of the firework above the ground

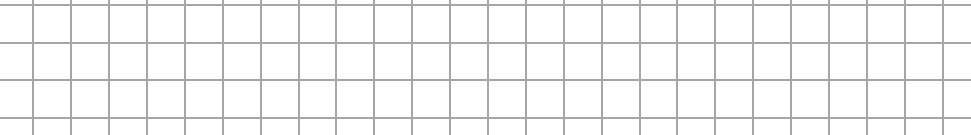
(ii) the time interval at which the firework is 120 m, or more, above the ground.

- (c) (i) Use calculus to find, in terms of t , the rate at which the height of the firework is changing after t seconds.

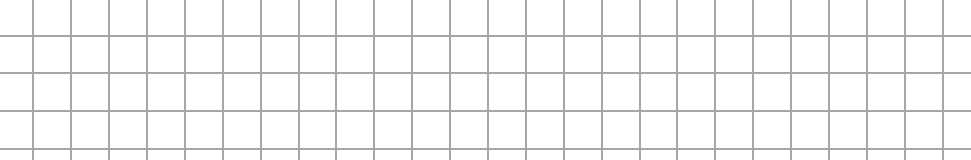
(ii) Use your answer from **part (c)(i)** to find the maximum height of the firework above the ground.

This question continues on the next page.



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- [illegible]

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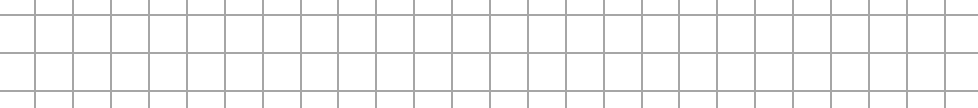
(50 marks)

(a) Complete the table below to show the cost of sending packages of various weights using Quick Way Couriers.

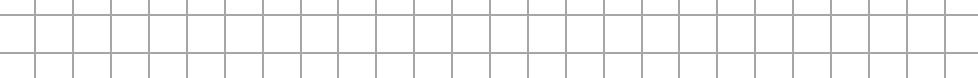
| Weight (kg) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------|---|---|---|---|---|---|---|---|
| Cost (€) | | 8 | | | | | | |

[illegible]

- State clearly the meaning of any letters used in your formula.

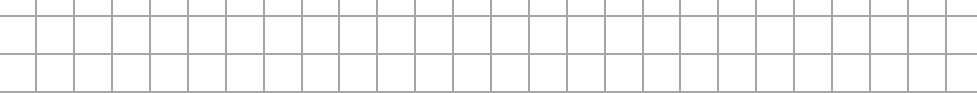


- (ii) Use your answer from **part (b)(i)** to find the cost of sending a 7.5 kg package.



This question continues on the next page.

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- (ii) Complete the table below to show the cost of sending packages of various weights using Next-Day Delivery.

| Weight (kg) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------|---|---|---|---|---|---|---|---|
| Cost (€) | | 7 | | | | | | |

[illegible]

- (iii) On the same grid on page 20, draw a graph to represent the cost of sending a package using Next-Day Delivery (NDD). Label your graph clearly.

[illegible]

- (iv) Use your graphs to find the point at which it is more expensive to use Next-Day Delivery to send a package of the same weight.

[illegible]

- (iv) Verify your answer algebraically.

[illegible]

Question 9**(50 marks)**

A clothing company produces a range of hoodies. The company has fixed costs of €2500 per week and it costs €20 to produce each hoodie.

Market research has found that if the company prices the hoodies at €25 each, they will sell 500 per week, and if they price them at €50 each, they will sell none.

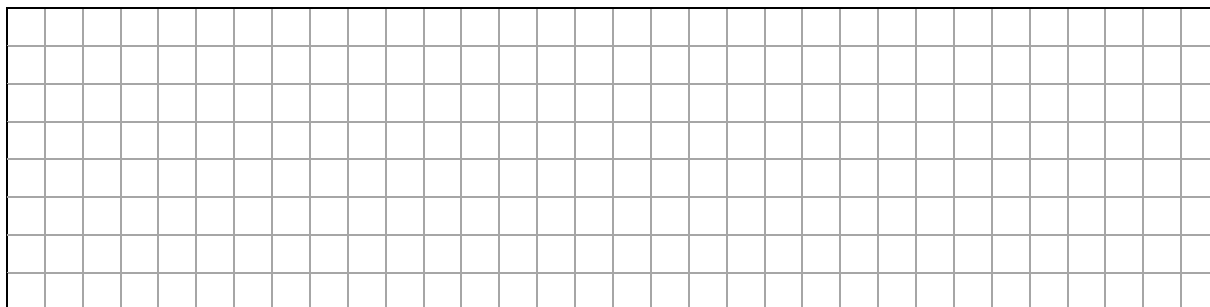


The company prices the hoodies at € x each, where $25 \leq x \leq 50$.

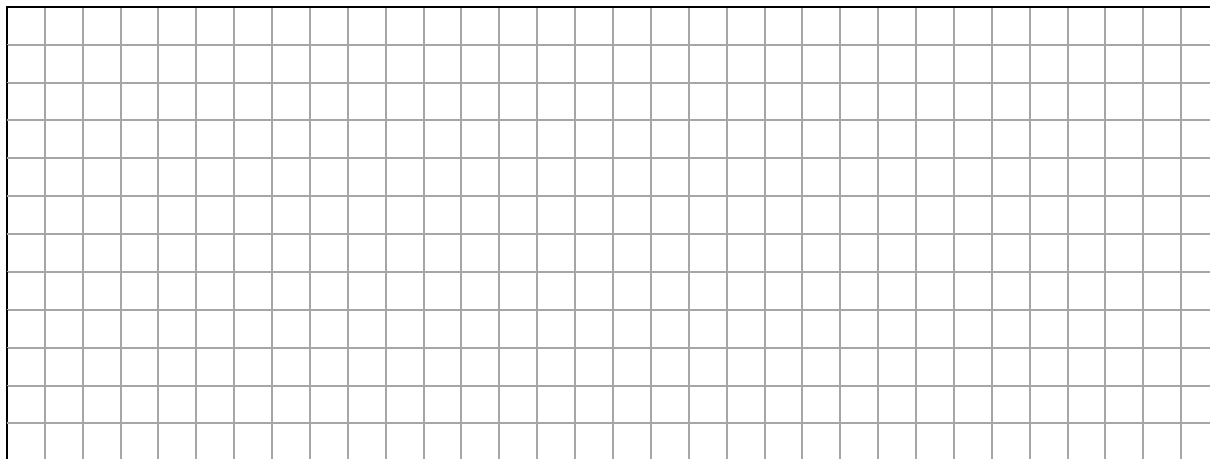
The graph of selling price (€) against weekly sales (units) is shown below.



- (a) (i) Weekly sales (units) can be represented by the straight line on the graph. Find the slope of the line.

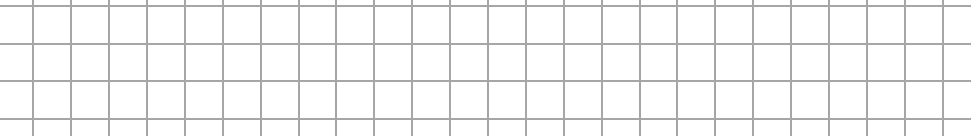


- (ii) Show that the company's weekly sales (units) can be written as $y = -20x + 1000$.

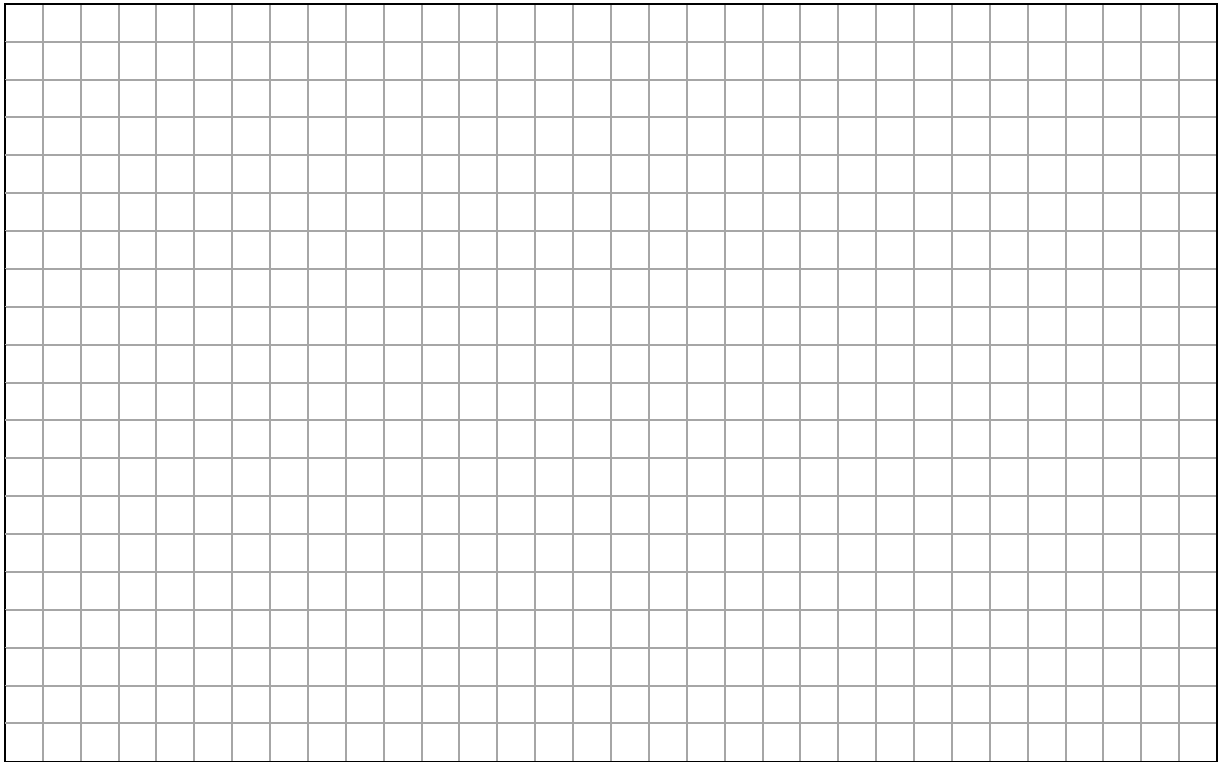


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- A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 10 units wide by 10 units high. There are no margins or additional markings on the page.

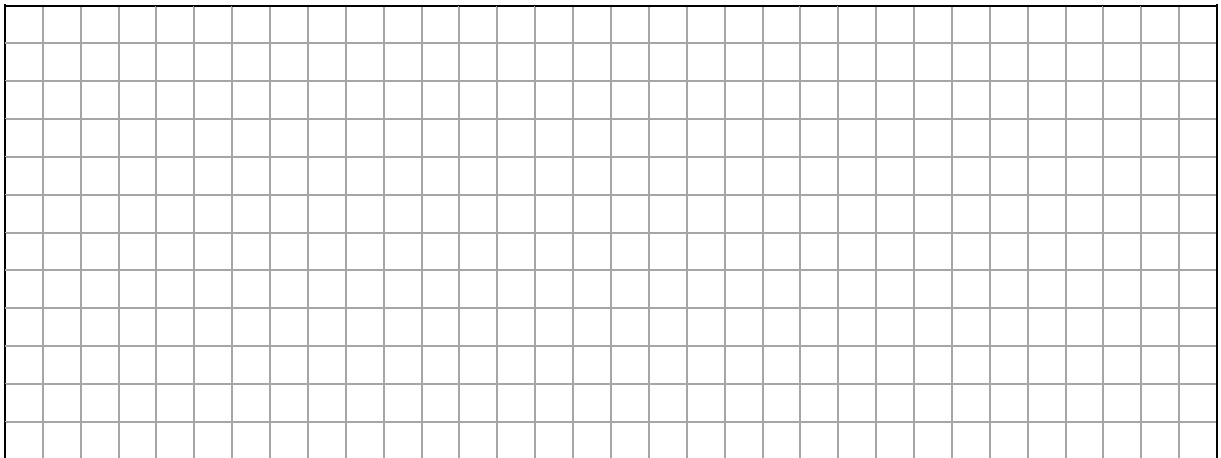
- [illegible]

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- (c) (i) Find the selling price that the company should charge for each hoodie in order to maximise the company's profit.



- (ii) Hence, find the maximum weekly profit that the company can make.

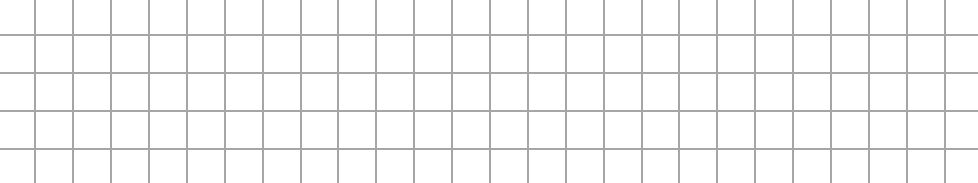


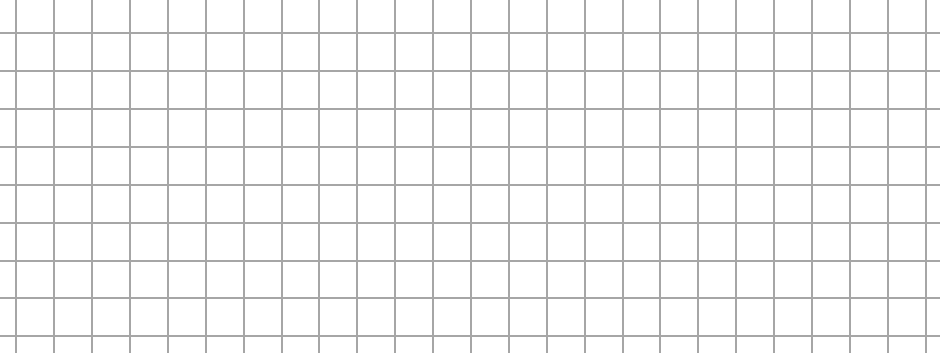
(50 marks)

$$V(t) = 400(1.05)^{-t},$$

(a) (i) Find the capacity (volume) of the water tank.

[illegible]

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- A large grid of graph paper, consisting of 20 columns and 10 rows of squares, intended for drawing a picture.

- 
- A large grid of graph paper, consisting of 20 columns and 15 rows of squares, intended for drawing a picture.

- (b)** A different water tank is filled using two hosepipes, X and Y. Hosepipe X can fill the tank in four hours and hosepipe Y can fill the tank in five hours.

(i) What fraction of the tank can hosepipe X fill in one hour?

[illegible]

(ii) What fraction of the tank can hosepipe Y fill in one hour?

[illegible]

(iii) What fraction of the tank can hosepipes X and Y together fill in one hour?

[illegible]

(iv) How long will it take hosepipes X and Y together to fill the tank?
Give your answer correct to the nearest minute.

A full-page sheet of white graph paper with a light gray grid. The grid consists of small squares, approximately 10 units wide by 10 units high. There are no margins or additional markings on the page.

- On the first day, 5 litres of water leak out of the tank.
Every day after that, it leaks a further 4 litres more than the previous day.

-
- A large grid of graph paper with 20 columns and 10 rows. The grid is composed of small squares, with a thicker border around the entire grid.

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- This image shows a full page of blank graph paper. The grid consists of small, equal-sized squares formed by thin gray lines. There are 20 columns and 20 rows of squares, creating a total of 400 square units. The grid covers the entire area of the page, leaving no margins or other markings.

Label any extra work clearly with the question number and part.

[illegible]

You may use this page for extra work.

Label any extra work clearly with the question number and part.

[illegible]

Label any extra work clearly with the question number and part.

[illegible]

Label any extra work clearly with the question number and part.

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Pre-Leaving Certificate Examination, 2023 – Ordinary Level

Mathematics – Paper 1

Time: 2 hours, 30 minutes

