



Coimisiún na Scrúduithe Stáit  
State Examinations Commission

Junior Certificate Examination 2019

# Mathematics

Paper 1  
Higher Level

Friday 7 June  
Afternoon 2:00 to 4:30

300 marks

Examination Number				

Centre Stamp

Running Total	
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For Examiner					
Q.	Ex.	Adv. Ex.	Q.	Ex.	Adv. Ex.
1			11		
2			12		
3			13		
4			14		
5					
6					
7					
8					
9					
10			Total		

Grade

## Instructions

There are 14 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. There is space for extra work at the back of the booklet. You may also ask the superintendent for more paper. 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 may lose marks if your solutions do not include supporting work.

You may lose marks if you do not include the appropriate units of measurement, where relevant.

You may lose marks if you do not give your answers in simplest form, where relevant.

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

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### Question 1

**(Suggested maximum time: 5 minutes)**

There are 85 students in third year in Liam's school.

- (a)**  $\frac{2}{5}$  of these students do Business Studies.

Work out the number of these students who do **not** do Business Studies.

- (b)** 26 of the students in third year do Art.

Work out the **percentage** of students in third year who do Art, correct to one decimal place.

[illegible]

The ratio of students to teachers in Liam's school was 15:1.

The school hired one extra teacher, while the number of students stayed the same.

The new ratio of students to teachers was  $a:1$ , where  $a \in \mathbb{Q}$ .

- (c) Put a tick (✓) in the correct box to show which statement is true. Tick **one** box only. Give an example to support your answer.

$$a > 15$$

9

$$a = 15$$

7

$$a < 15$$

7

Example:

**Example:**

**Question 2** (Suggested maximum time: 10 minutes)

**Question 2** (Suggested maximum time: 10 minutes)

- (a)** Write down the four factors of 45, apart from 1 and 45.

Answer: , , ,

- (b)**  $n$  is a whole number bigger than 1. It has just two factors: 1 and  $n$ .  
Put a tick (✓) in the correct box to show what name is given to this type of number.  
Tick **one** box only.

composite

prime

square

□

9

9

- (c)**  $p$  is a whole number. Apart from 1 and  $p$ , the only other factor that  $p$  has is 7. Work out the value of  $p$ .

- (d)** Write down the four factors of  $12k + 8$ , apart from 1 and  $12k + 8$ . Two of the factors should be in terms of  $k$ .

Answer: , , ,

[illegible]

**Question 3** (Suggested maximum time: 5 minutes)

**Question 3** (Suggested maximum time: 5 minutes)

- (a) The distance between the Earth and Mars is at least 56 000 000 km.  
Write this distance in the form  $a \times 10^n$  km, where  $1 \leq a < 10$  and  $n \in \mathbb{N}$ .

[illegible]

- (b)** The diameter of a human hair is roughly 0.0075 cm.  
Write this diameter in the form  $b \times 10^n$  cm, where  $1 \leq b < 10$  and  $n \in \mathbb{Z}$ .

[illegible]

- (c) Lewis was driving at 90 km per hour when he sneezed. During the sneeze, his eyes were closed for half a second. Work out how many metres he travelled in this time.

[illegible]

### Question 4

**(Suggested maximum time: 10 minutes)**

- (a) Katie has a gross annual income of €52 460.  
8.5% of this is **deducted** in pension contributions.  
The amount that is left is Katie's **taxable** income.

- (i)** Work out Katie's taxable income, after the pension contributions have been deducted.

Katie pays income tax on her **taxable** income at a rate of 20% on the first €34 000, and 40% on the balance. She has annual tax credits of €4200.

- (ii)** Work out Katie's net income, after income tax has been deducted.

[illegible]

- Work out what her bill is now. Give your answer in euro, correct to the nearest cent.

- Work out the value of the motorbike when Katie bought it.

A large grid of graph paper with 20 columns and 10 rows. The grid is composed of small squares, with a slightly larger square at the top left corner, likely for a title or header. The grid is empty and ready for use.

**Question 5** (Suggested maximum time: 10 minutes)

**Question 5** (Suggested maximum time: 10 minutes)

The sets  $A$ ,  $B$ , and  $C$  are as follows:

$A$  is the set of multiples of 2 =  $\{2, 4, \dots\}$

$B$  is the set of multiples of 3 =  $\{3, 6, \dots\}$

$C$  is the set of multiples of 4 =  $\{4, 8, \dots\}$ .

- (a) Write down a number that is in  $A \cap B \cap C$ .

Answer:

11/11/2019

[illegible]

- (b)** Explain why  $C$  is a subset of  $A$ .

[illegible]



$A$   
(multiples of 2)

$B$   
(multiples of 3)

$C$   
(multiples of 4)

- (d)** Each of the other five regions in the Venn diagram has some elements.

In **each** of these five regions in the Venn diagram above, write one of the elements in that region.

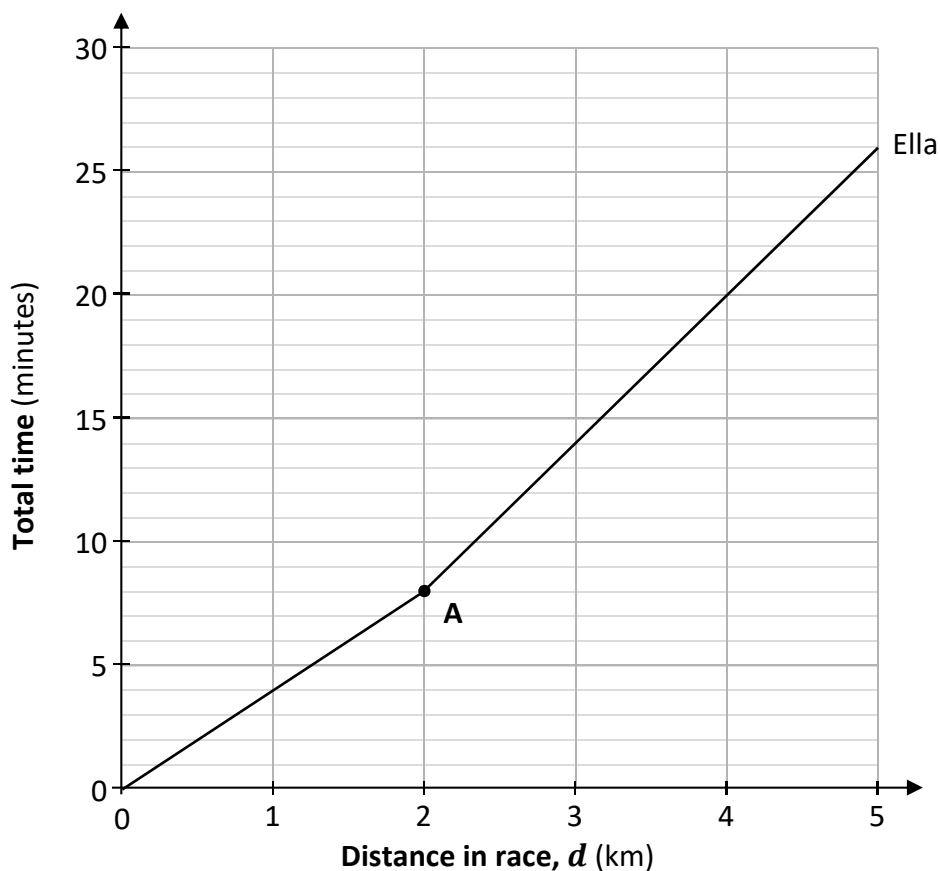
A large rectangular area filled with a uniform grid of small squares, typical of graph paper. The grid consists of 20 columns and 10 rows of squares.

### Question 6

(Suggested maximum time: 20 minutes)

Poppy and Ella ran a 5 km race. The simplified graph below shows the time that it took Ella to run  $d$  km during the race. One of the points on the graph is marked **A**.

Distance is on the horizontal axis so, for example, it took Ella 26 minutes to run the whole 5 km.



The table below shows the total time that it took Poppy and Ella to run each of the given distances in the race.

- (a) Using the figures in the table, **draw** a graph on the diagram above to show the time it took **Poppy** to run  $d$  km during the race, for  $0 \leq d \leq 5$  and  $d \in \mathbb{R}$ .
- (b) Using **Ella's** graph, fill in the three missing values in the table below.

Distance in the race (km)	Total time taken for Poppy (minutes)	Total time taken for Ella (minutes)
1	5	4
2	10	
3	17	
4	24	
5	30	26

- (c) Show that **Poppy's** times in the table do **not** make a quadratic sequence.

[illegible]

- (d) It took Ella 26 minutes to run the 5 km. Work out Ella's **average speed** for the race. Give your answer in km per hour, correct to two decimal places.

[illegible]

- (e) Tick (✓) the correct box to show what happened **Ella's** speed after 2 km, which is marked **A** on the graph. Tick **one** box only. Justify your answer.

Ella's speed increased

☐

Ella's speed decreased

☐

Ella's speed  
stayed the same

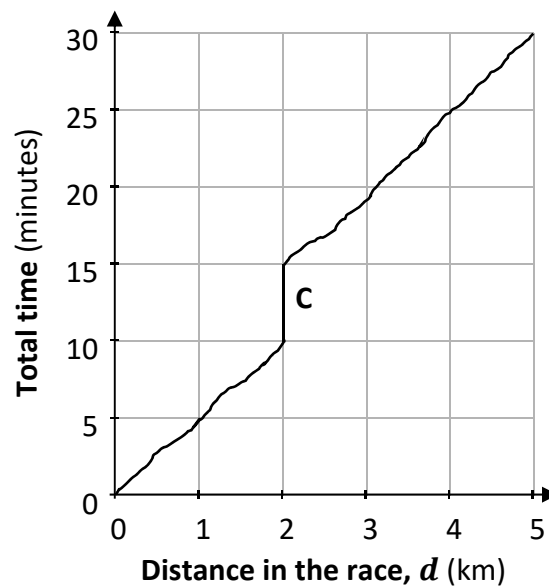
5

Justification:

[illegible]

*This question continues on the next page.*

Ciarán also ran the 5 km race. He drew the graph below to show the time that it took him to run  $d$  km during the race. The part of Ciarán's graph marked **C** is a vertical line.



- (f) What does the part **C** tell us about Ciarán's running at this stage of the race? Give as much detail as possible.

A large grid of graph paper with 20 columns and 10 rows. The grid is composed of small squares, with a slightly larger square at the top left corner, likely for a title or header. The grid is empty and ready for use.

- (g) Brendan says: “Ciarán’s graph does **not** show total time as a **function** of distance ( $d$ )”. Give a reason why Brendan is correct.

### Question 7

**(Suggested maximum time: 5 minutes)**

- (a)** Describe each of the following sets. Be as specific as possible.


- (i) The set of natural numbers,  $\mathbb{N}$ .

[illegible]

- (ii) The set of integers,  $\mathbb{Z}$ .

[illegible]

- (b)** Graph the following inequality on the number line given.

Inequality	Number line
$-3 < x \leq 2$ , where $x \in \mathbb{R}$	 <p>A horizontal number line with tick marks from -4 to 4. An open parenthesis '(' is at -3 and a closed parenthesis ']' is at 2. The segment between -3 and 2 is shaded in light blue.</p>

- (c)** Use algebra to solve the following inequality:

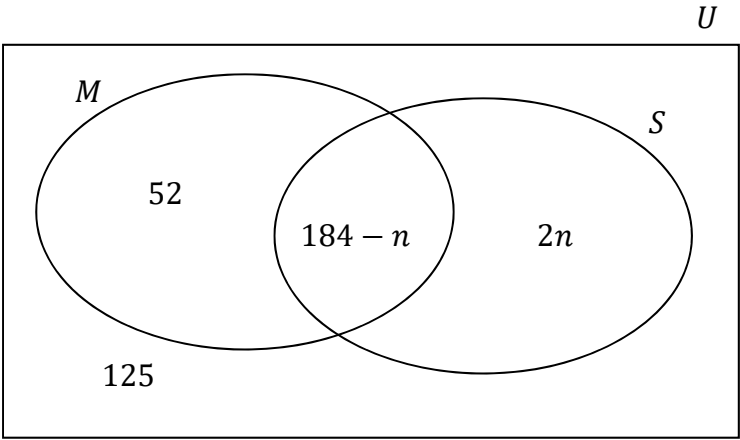
$$-7 < 8 - 3g \leq 11$$

[illegible]

Question 8

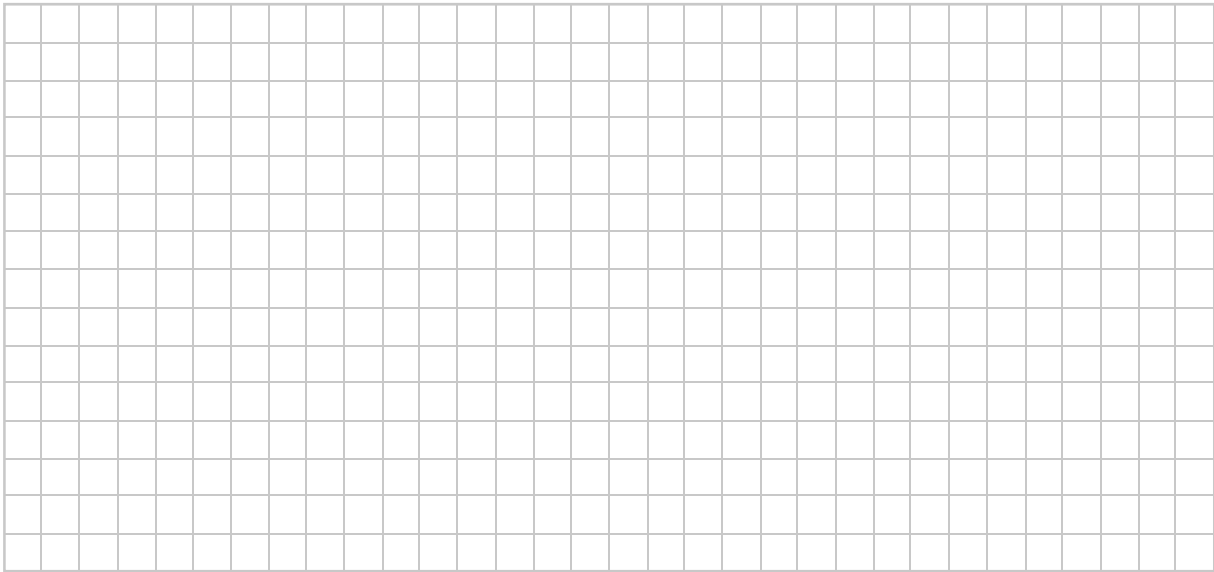
(Suggested maximum time: 5 minutes)

The Venn diagram below shows the number of people in a youth club ( $U$ ) who play music ( $M$ ) and sport ( $S$ ), where  $n \in \mathbb{N}$ .



Work out the **maximum** number of people who could be in the youth club.

Answer:



**Question 9** (Suggested maximum time: 20 minutes)

**Question 9** (Suggested maximum time: 20 minutes)

Gertie writes down the following sequence, which repeats every three terms:

3, 6, 4, 3, 6, 4, 3, ...

The 1st term is 3.

- (a) (i)** Write down the value of the 12th term.

Answer:

\_\_\_\_\_

- (ii)** Work out the value of the 100th term in this sequence.

Answer:

A large grid of 20 columns and 10 rows, intended for drawing. The grid is composed of small squares, with a slightly larger square at the top left corner, likely for a title or drawing area.

- (b)** Describe how to find the value of the  $n$ th term in the sequence, where  $n \in \mathbb{N}$ , **without** listing all the terms from the 1st to the  $n$ th.

[illegible]

*This question continues on the next page.*

Gertie made her sequence 3, 6, 4, 3, 6, 4, 3, ... by picking 3 as the 1st term, and then using **this rule**:

If a term is **odd**, multiply it by 2 to get the next term.

If a term is **even**, add 2 to it and half your answer to get the next term.

For example, 3 is odd, so the next term is  $2 \times 3$ , which is 6.

6 is even, so the next term is  $\frac{1}{2} \times (6 + 2)$ , which is 4.

- (c) A different sequence follows the **same rule**, but has **8 as the 1st term**.  
Work out the next four terms of this sequence.

Answer: 

8
---

, 

--

, 

--

, 

--

, 

--

Working out:

$$\text{2nd term} = \frac{1}{2} \times (8 + 2) =$$

- (d) Ahmed takes **2 as his 1st term**, and makes a sequence using the **same rule**.

State what is unusual about Ahmed's sequence.

It might be helpful to work out some of the terms of his sequence.



- (e) In another sequence using the **same rule**, the **2nd term is 86**.  
Work out the **two** different values that the 1st term could have in this sequence.

Answer: , , ... or , , ...

Working out:

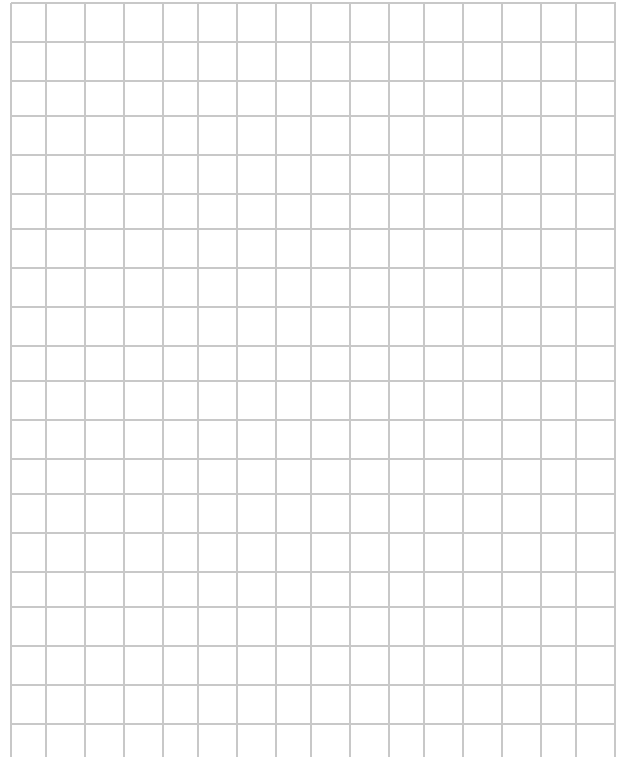
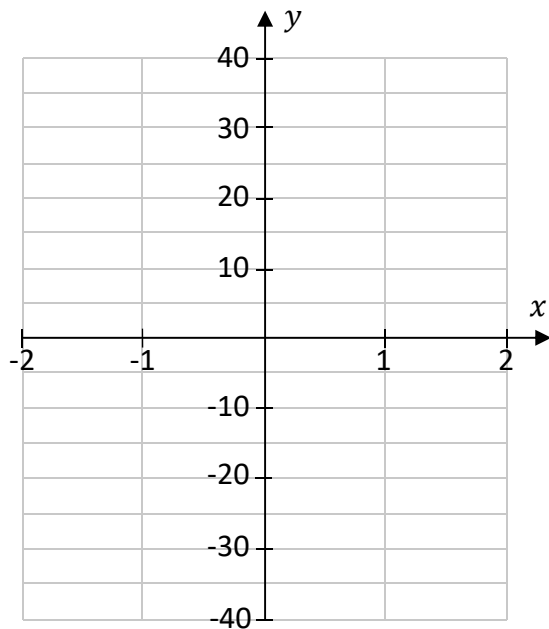
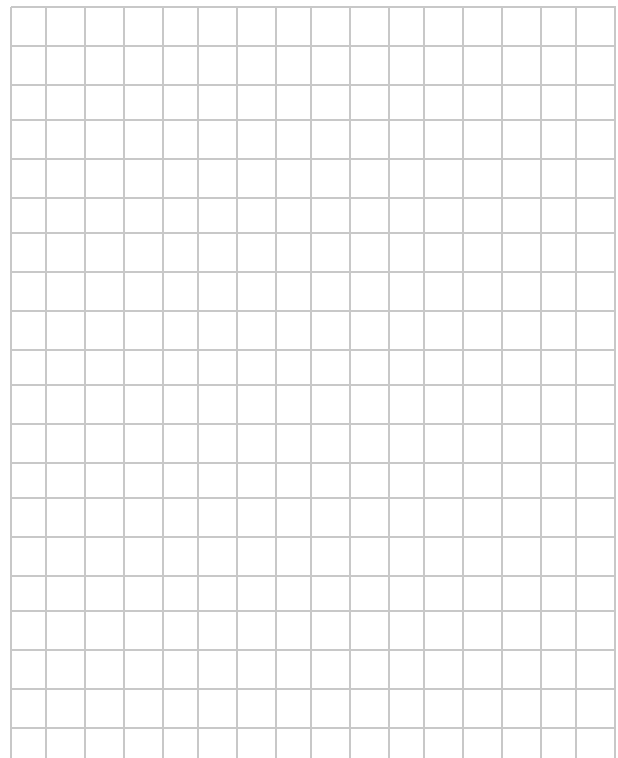
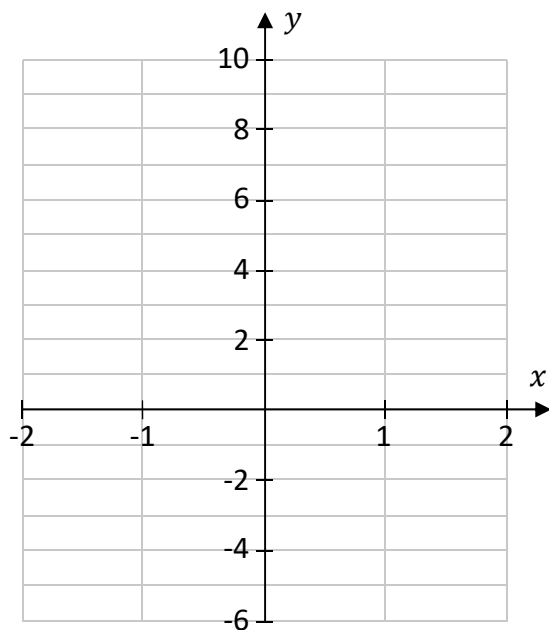
- (f) A different sequence following the **same rule** starts with the number  $k$ , which is **odd**.  
Work out the next three terms of this sequence.  
Give each term in its simplest form in terms of  $k$ .

Answer: , , ,

Working out:

**Question 10****(Suggested maximum time: 10 minutes)**

**Draw** each of the following two functions in the domain  $-2 \leq x \leq 2$ , for  $x \in \mathbb{R}$ .  
Show your working out.

**Function:**  $y = 10x - 4x^2$ **Function:**  $y = 3^x$ 

### Question 11

**(Suggested maximum time: 5 minutes)**

Solve the following equation. Give your answer in the form  $\frac{m}{n}$  where  $m, n \in \mathbb{N}$ .

$$\frac{3x+5}{2} + \frac{x-4}{3} = 16$$

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

### Question 12

**(Suggested maximum time: 10 minutes)**

- (a)** Factorise  $a^2 - 16n^2$ .

[illegible]

- (b)** One of the factors of  $8x^2 + 45x - 18$  is  $x + 6$ .

- (i) Factorise  $8x^2 + 45x - 18$ .

A full-page sheet of white graph paper with a light gray grid pattern. The grid consists of small, uniform squares covering the entire area of the page. There are no margins, text, or other markings on the paper.

- (ii) Write down one quadratic expression in  $x$ , other than  $8x^2 + 45x - 18$ , that has  $x + 6$  as a factor.

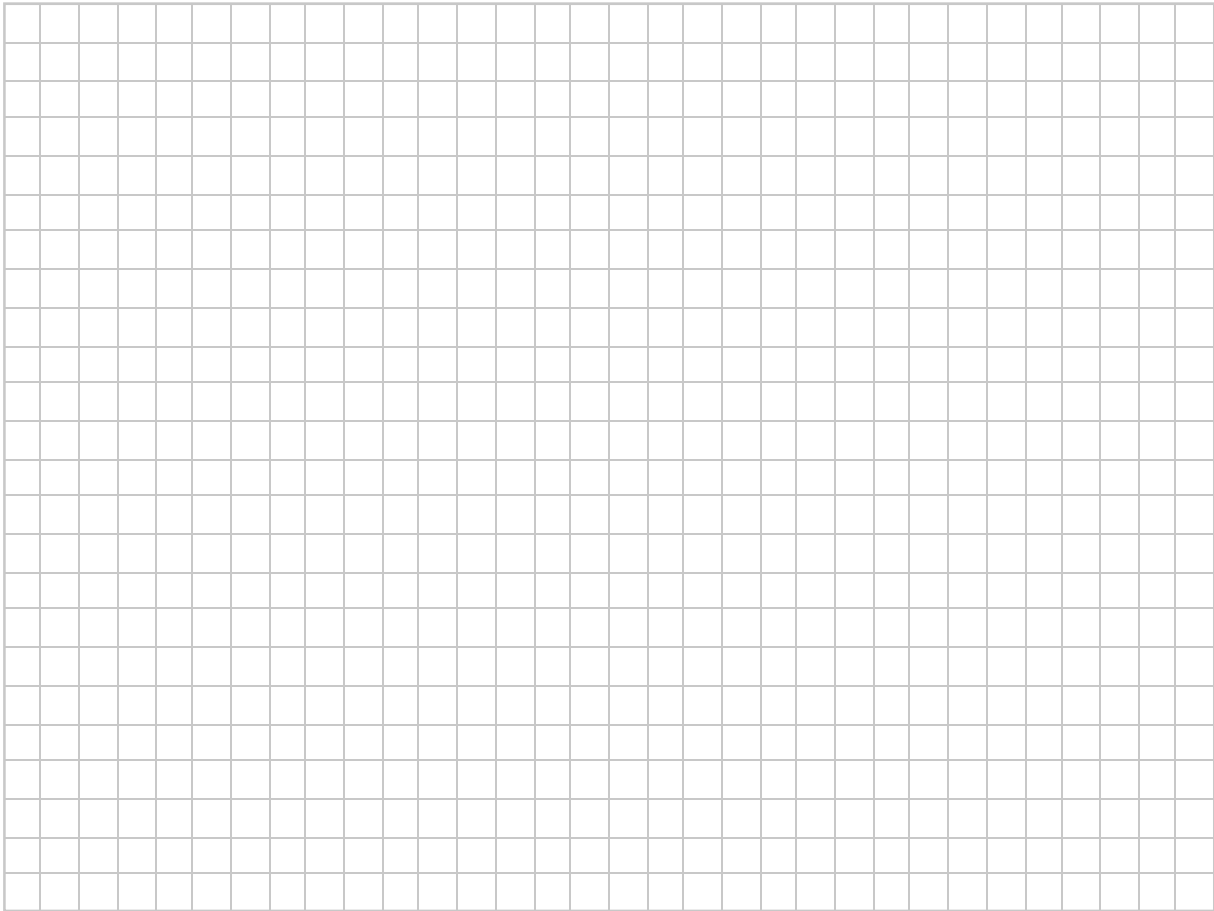
Give your answer in the form  $ax^2 + bx + c$ , where  $a, b, c \in \mathbb{R}$ .

Answer:

--

[illegible]

(c) Show that  $2y + 3$  is a factor of  $2y^3 - 9y^2 - 28y - 15$ .



**(Suggested maximum time: 15 minutes)**

Freda is starting an exercise program. She wants to increase her power output ( $P$ ). One formula for  $P$  is:

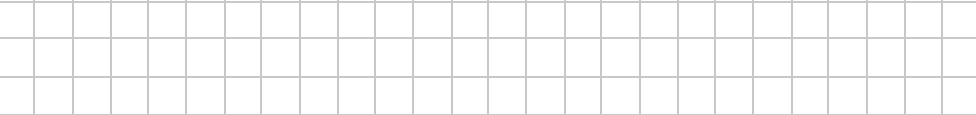
$$P = 36w + 62h + 1800$$

where  $w$  is Freda's weight (in kilograms) and  $h$  is the height (in metres) that she can jump.

- (a)** Work out the value of  $P$  when  $w = 70$  kg and  $h = 0.65$  m.

After one week, Freda's power output ( $P$ ) has **increased by 8**. Her weight ( $w$ ) has not changed.

- (b)** Work out the new value of  $h$  after this week, correct to two decimal places.

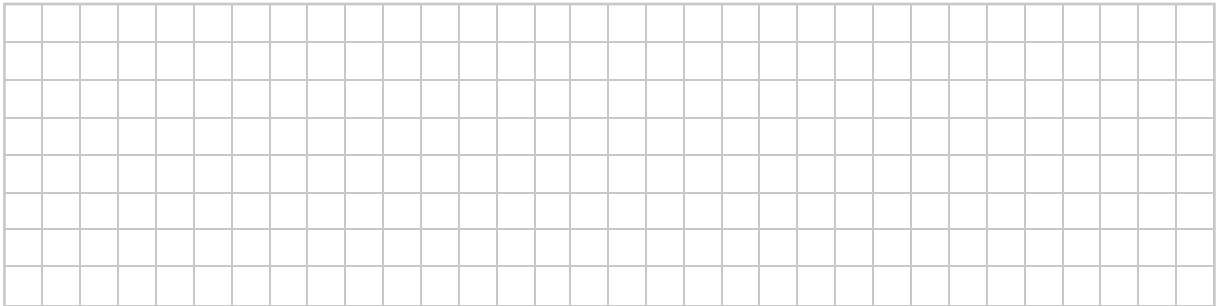
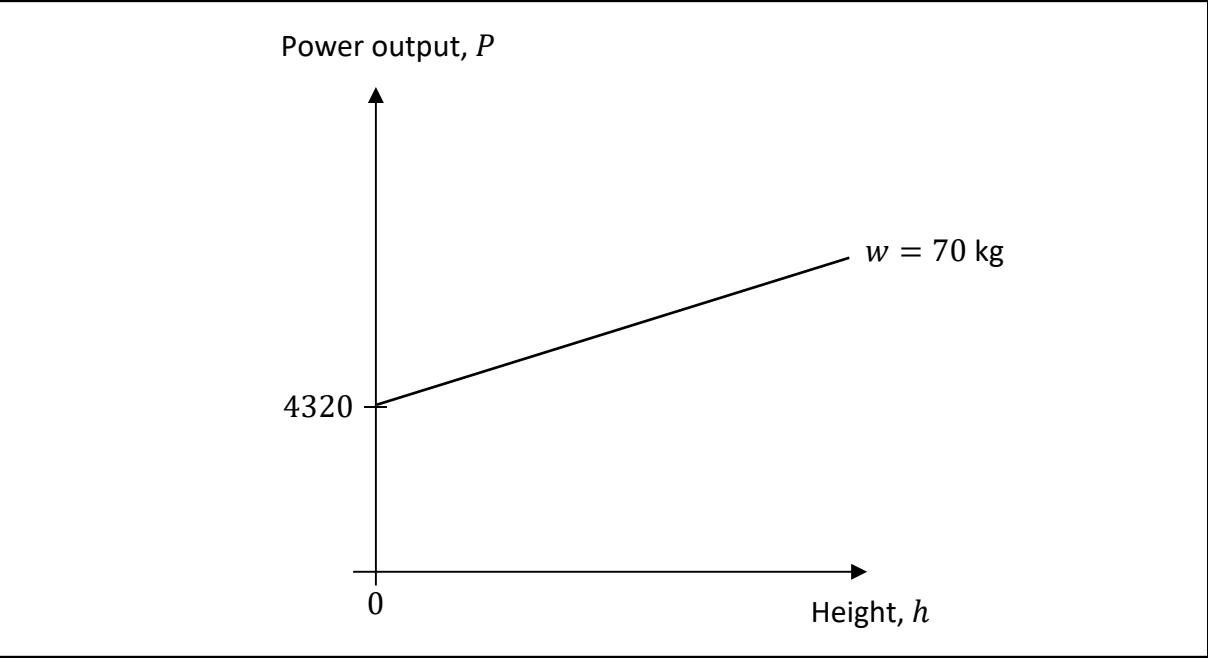


The graph below shows the value of  $P$  for different heights ( $h$ ) when  $w = 70$  kg. This graph cuts the  $y$ -axis when  $P = 4320$ , as shown.

- (c) **Draw** a graph to show the values of  $P$  for different heights ( $h$ ) when  $w = 80$  kg, using the same axes, scales, and domain.

State on the diagram the value of  $P$  where your graph cuts the  $y$ -axis.

*Note:* the axis with  $P$  does not start at 0.



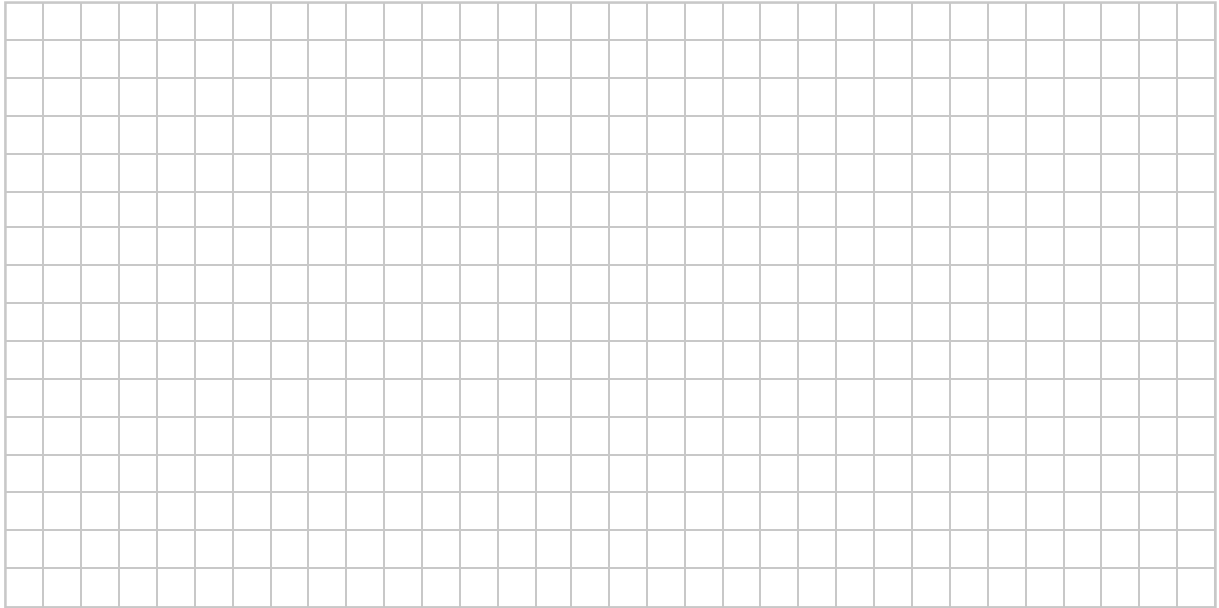
*This question continues on the next page.*

Freda finds a second formula for power output. She sets the two formulas equal. This gives the following identity, where  $f$  is Freda's height (in metres):

$$60w + 80h - 15f - 1300 = 36w + 62h + 1800$$

(d) Use this to write  $h$  in terms of  $w$  and  $f$ .

Answer:  $h =$





Question 14

(Suggested maximum time: 10 minutes)

The first three terms of a sequence are:

Term 1:

Term 2:

Term 3:

$6x - 3$

$x^2 - 2x$

$4x^2 + 3x$

(a) Fill in the following table to write each of the **first differences** in its simplest form in terms of  $x$ .

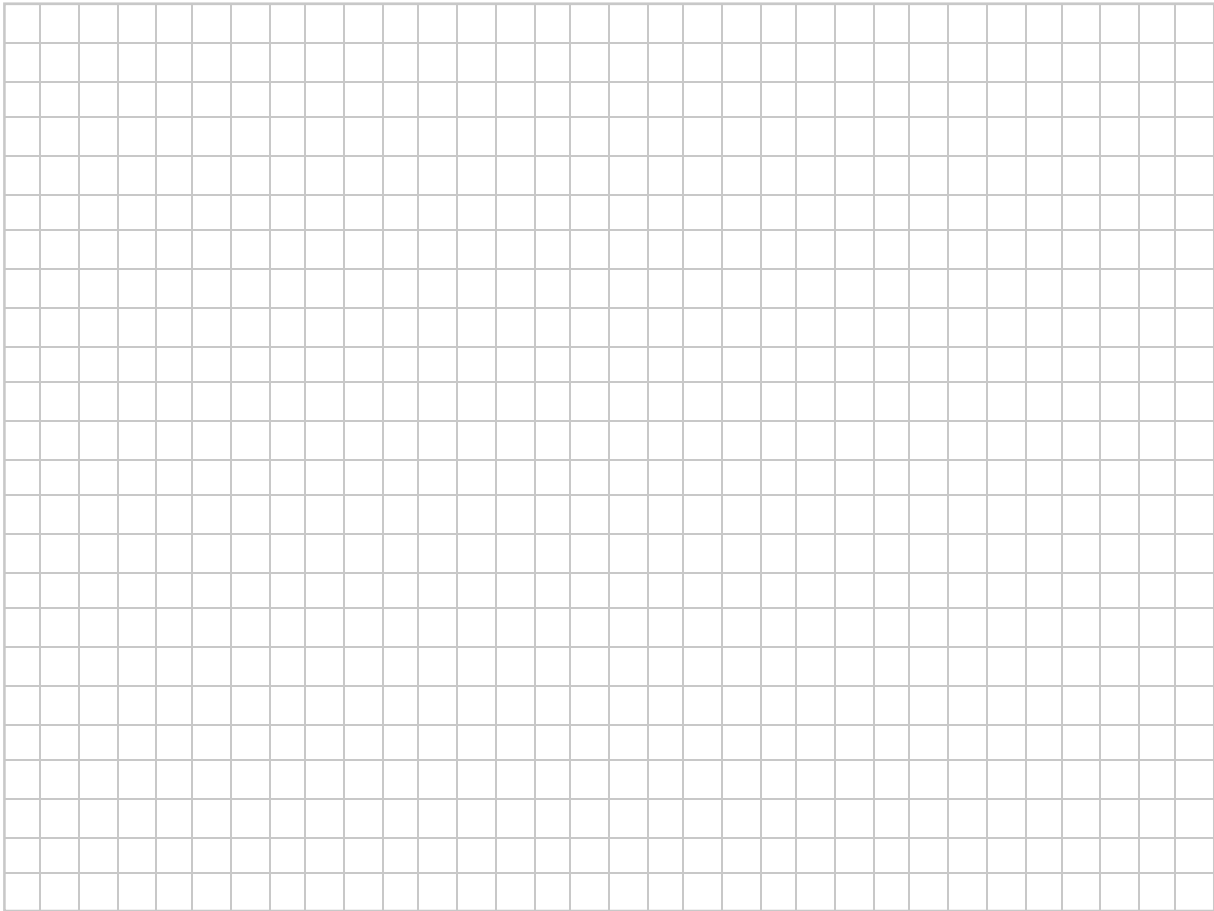
First Difference 1: Term 2 – Term 1	First Difference 2: Term 3 – Term 2
<div> <div><math>x^2 - 2x - (6x - 3) =</math></div> <div></div> </div>	

(b) Show that, if the terms form a linear sequence, then  $2x^2 + 13x - 3 = 0$ .

*This question continues on the next page.*

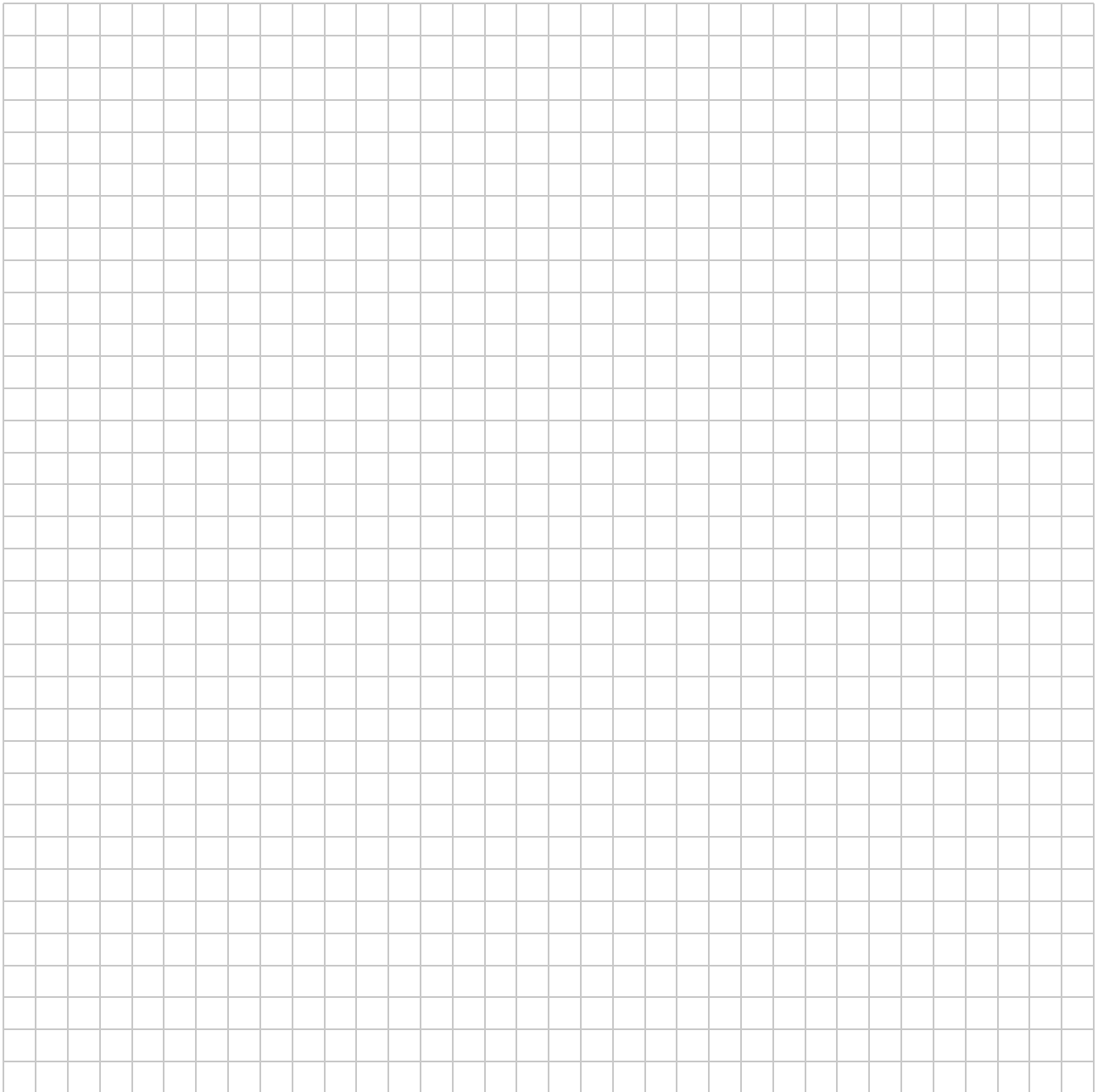
(c) Solve the equation  $2x^2 + 13x - 3 = 0$ . Give each answer correct to three decimal places.

Answer:  and



Page for extra work.

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



Junior Certificate – Higher Level

**Mathematics – Paper 1**

Friday 7 June  
Afternoon 2:00 to 4:30



Coimisiún na Scrúduithe Stáit  
State Examinations Commission

Junior Certificate Examination 2018

# Mathematics

Paper 1  
Higher Level

Friday 8 June  
Afternoon 2:00 to 4:30

300 marks

Examination Number

Centre Stamp

Running Total	
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For Examiner					
Q.	Ex.	Adv. Ex.	Q.	Ex.	Adv. Ex.
1			11		
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Write the make and model of your calculator(s) here:

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**Question 1** (Suggested maximum time: 5 minutes)

**Question 1** (Suggested maximum time: 5 minutes)

- (a) Only one linear pattern begins with “1, 7”.

Fill in the three boxes below so that the numbers form this **linear** pattern.

**Linear pattern:** 1, 7,

--	--	--

[illegible]

- (b)** Many different quadratic patterns begin with “1, 7”.

Fill in the three boxes below so that the numbers form a **quadratic** pattern.

**Quadratic pattern:** 1, 7,

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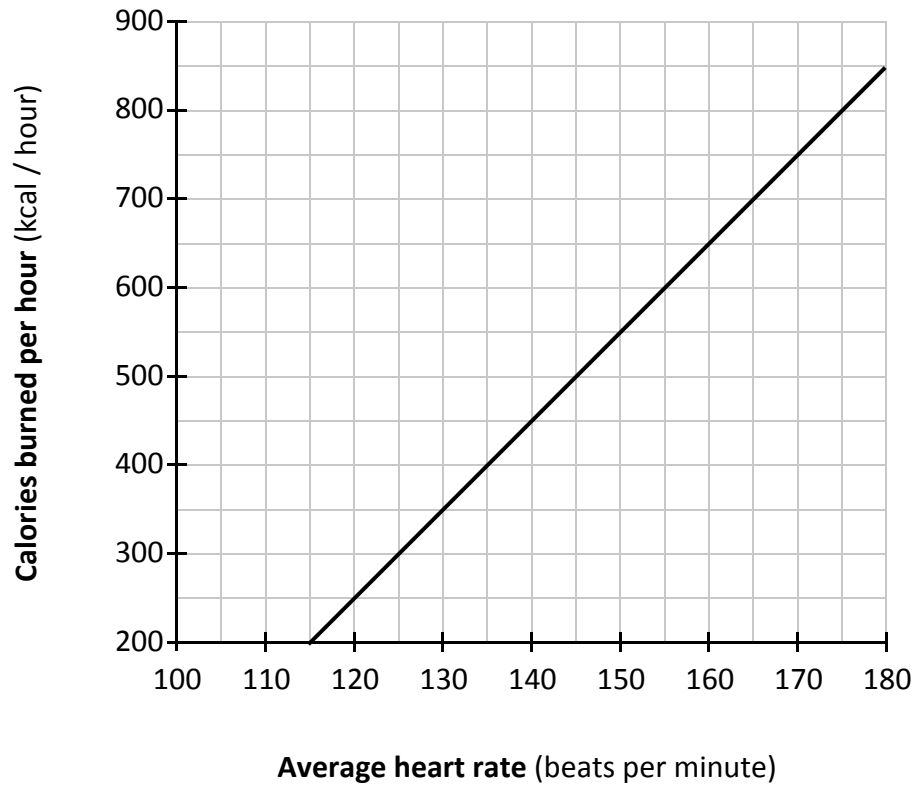
[illegible]

## Question 2

(Suggested maximum time: 15 minutes)

- (a) Phil is an athlete. The graph below shows the number of calories (in kcal) she burns per hour, depending on her average heart rate.

Note: the axes do not start at (0, 0).

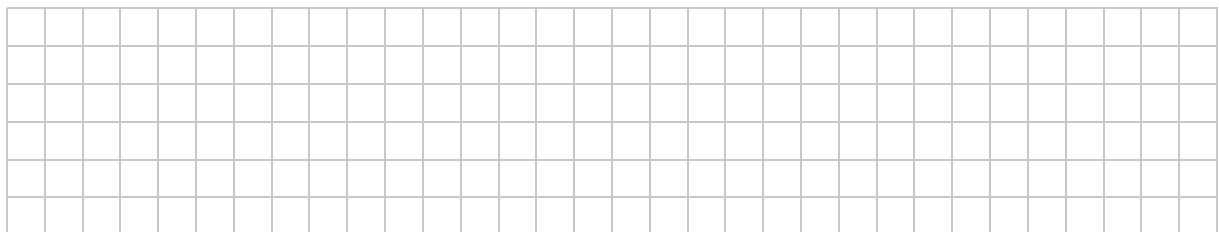


- (i) Use the graph to estimate how many calories Phil would burn in one hour if she had an average heart rate of **170 beats per minute**.

Calories burnt in one hour =  kcal

- (ii) Use the graph to work out Phil's average heart rate when she burns **300 kcal in 30 minutes**.

Average heart rate =  beats per minute





- (b)** Phil runs a series of stages. In each stage she runs a slow run of 60 m, and then a sprint. In each stage after stage 1, she sprints 50 m more than she did in the previous stage.

Complete the table below, showing the distance that she runs slowly and the distance that she sprints in each stage, as well as the total distance per stage.

Give the values in the last row in terms of  $n$ , where appropriate.

Stage	Slow run (metres)	Sprint (metres)	Total distance (metres)
1	60	50	110
2	60	100	160
3	60	150	
4			
5			
$n$			

A full-page sheet of white graph paper featuring a uniform grid of thin gray lines forming small squares. The grid covers the entire area of the page, leaving no margins or additional markings.

*This question continues on the next page.*

- (c)** In one of the stages, Phil:

runs slowly for 60 metres at 2 metres per second, and then sprints 150 metres at 7.5 metres per second.

Work out Phil's **average speed** for this stage, in metres per second.

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

**Question 3** (Suggested maximum time: 5 minutes)

**Question 3** (Suggested maximum time: 5 minutes)

Patrick worked for a weekend washing cars in a garage.

- (a) In total, 35 cars were washed in the garage that weekend. Patrick washed 14 of them. Work out the **percentage** of the cars that Patrick washed.

[illegible]

- (b)** Patrick was paid £200 Sterling for the weekend. He converted this money to US Dollars (\$). The exchange rates are shown below.

€1 = £0.88 Sterling

€1 = \$1.18 US Dollars

Work out how many US Dollars (\$) Patrick got for his £200 Sterling.  
Give your answer correct to the nearest cent.

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

**Question 4** (Suggested maximum time: 5 minutes)

**Question 4** (Suggested maximum time: 5 minutes)

$F$  is the set of **factors** of **12**.

(a) List the six elements of the set  $F$ .

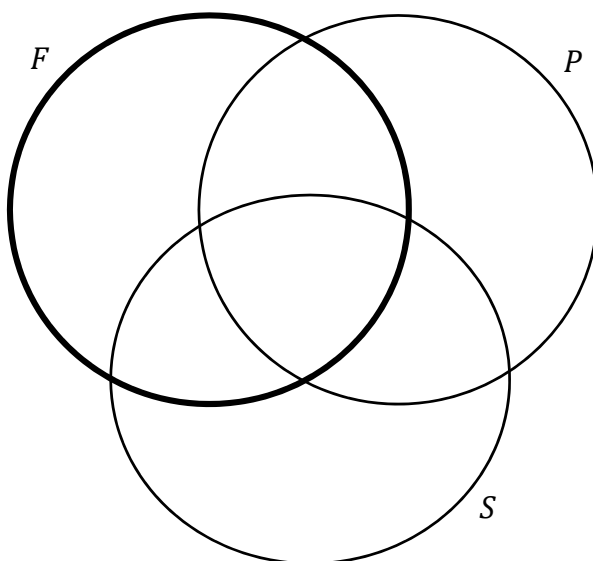
$$F = \left\{ \begin{array}{c} \text{ } \end{array} \right\}$$

The sets  $P$  and  $S$  are as follows:

$P$  is the set of **all prime** numbers

$S$  is the set of **all square** numbers (i.e. all numbers  $n^2$ , where  $n \in \mathbb{N}$ ).

The Venn diagram below shows the sets  $F$ ,  $P$ , and  $S$ .



**(b)** Write each of the factors of 12 from part **(a)** into the correct region in the set  $F$  in the Venn diagram.

[illegible]

### Question 5

**(Suggested maximum time: 10 minutes)**

- (a)** Work out the value of  $3p - 4t^2$ , when  $p = 6$  and  $t = 5$ .

- (b)** Multiply out and simplify  $(2x - 3)(4 - 5x + x^2)$ .

[illegible]

- (c)** Factorise fully  $10de - df - 5ef + 2d^2$ .

**Question 6** (Suggested maximum time: 15 minutes)

**Question 6** (Suggested maximum time: 15 minutes)

A sheet is folded in half a number of times.

$h(x) = 2^x$  is the number of layers after  $x$  folds.

- (a)** Fill in the table to show the number of layers after each of the first 6 folds.

<b>Number of folds, <math>x</math></b>	1	2	3	4	5	6
<b>Number of layers, <math>h(x)</math></b>	2	4	8			

[illegible]

- (b)** List the elements of the domain and the range of  $h(x)$  that are shown in the table above.

Domain =  $\{ \quad , \quad , \quad , \quad , \quad \}$

$$\text{Range} = \left\{ \quad, \quad, \quad, \quad, \quad \right\}$$

- (c) Work out the least number of folds that would be needed to have **more than 500** layers.

[illegible]

- (d)** Work out the number of layers after 12 folds.  
Give your answer in the form  $a \times 10^n$ , where  $a \in \mathbb{R}$ ,  $1 \leq a < 10$ , and  $n \in \mathbb{N}$ .

- (e)** Explain what the following statement means, in terms of folds and layers.

$$h(14) > 10\,000$$

[illegible]

- (f) Put a tick in the correct box to show what kind of pattern is made by the number of layers. Tick (✓) **one** box only. **Justify** your answer.

linear

7

quadratic

9

exponential

7

none of these

7

Justification:

Justification:

*This question continues on the next page.*

- (g)** After a certain number of folds, there are  $k$  layers.

How many layers will there be after 3 **more** folds?

Give your answer in terms of  $k$ .

- (h)** After a certain number of folds, there are  $2^p$  layers.

How many layers will there be after 3 **more** folds?

Give your answer in the form  $2^m$ , where  $m$  is in terms of  $p$ .



**Question 7** (Suggested maximum time: 10 minutes)

**Question 7** (Suggested maximum time: 10 minutes)

Joonas has an unlimited supply of €5 notes and €2 coins.

- (a)** Fill in the table to show three different ways in which he can use these to make exactly €27. One way is already done.

	Number of €5 notes	Number of €2 coins	Total amount of money
Way 1	1	11	€27
Way 2			€27
Way 3			€27

[illegible]

- (b)** Explain how he could use his supply of €5 notes and €2 coins to make every whole number value of money greater than €3 (i.e. to make € $n$  for every  $n \in \mathbb{N}$ , where  $n > 3$ ).

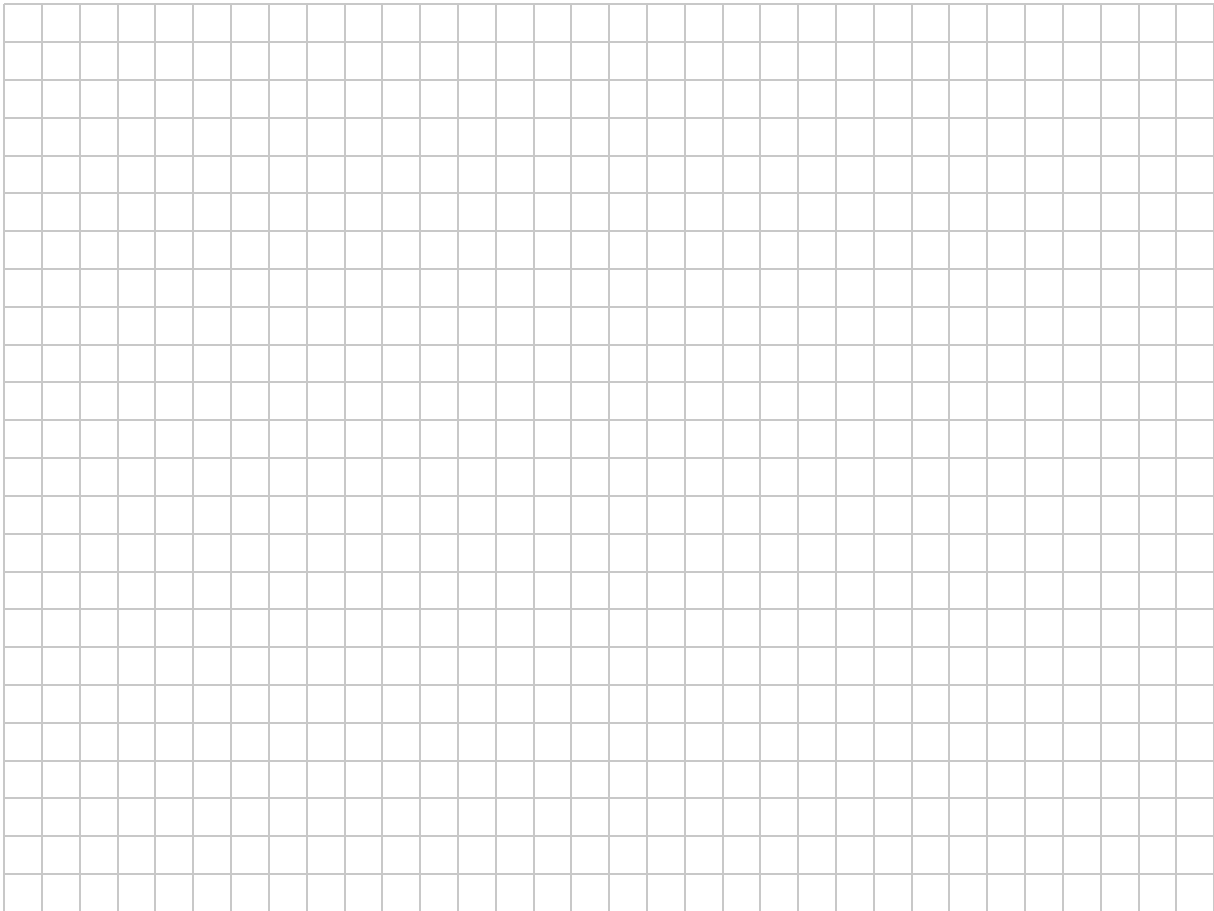
This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

**Question 8**

**(Suggested maximum time: 10 minutes)**

**(a)** Solve the following equation. Give each answer correct to two decimal places.

$$x^2 - 4x - 7 = 0$$





**Question 9** (Suggested maximum time: 15 minutes)

**Question 9** (Suggested maximum time: 15 minutes)

A group of friends makes a video and posts it on YouTube.

They know that they will be paid approximately **€15 for each 10 000 views** of the video.

Use this information to answer the following questions.

- (a)** Work out how many views of the video they would need in order to be paid €45.

- (b)** Work out how much (in euro) they will be paid for **80 000 views** of the video.

- (c) Work out how much (in euro) they will be paid, on average, for **1 view** of the video.

A blank sheet of graph paper featuring a uniform grid of small squares. The grid consists of 20 columns and 10 rows, providing a structured space for drawing or writing.

[illegible]

### Question 10

**(Suggested maximum time: 15 minutes)**

The rates and bands for income tax are as follows:

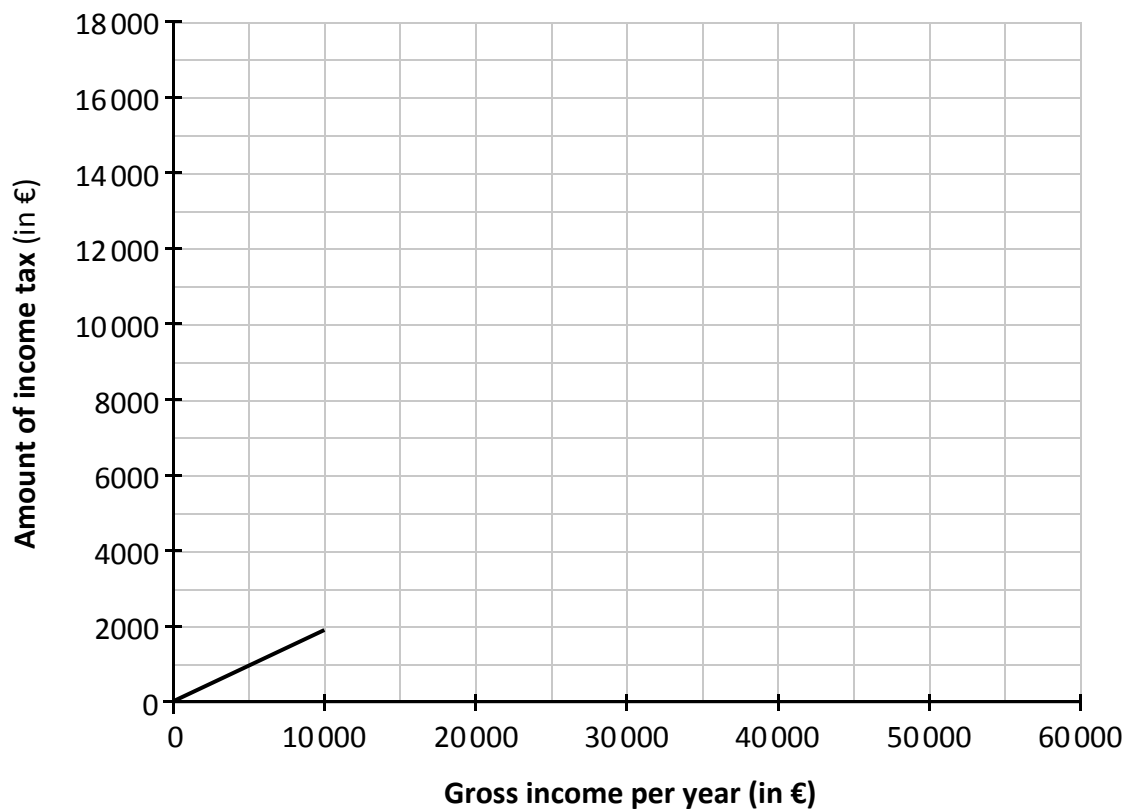
€35 000 @ 20%,  
balance @ 40%.

- (a) Lorna has a gross income of €50 000 for the year.  
Using the rates and bands above, work out her **total** income tax for the year.

[illegible]

- (b)** Complete the **graph** on the next page to show the amount of income tax for every gross income up to €60 000 per year. Show all your working out.

The amount of income tax is shown for gross incomes up to €10 000.



- (c) This graph doesn't take tax credits into account.  
Assume that everyone gets a **tax credit** of €3000.

On the diagram above, **draw** a graph to show the amount of income tax to be paid for every gross income from €15 000 to €60 000 per year, taking this tax credit into account.



Question 11

(Suggested maximum time: 5 minutes)

Write down an inequality in  $x$  represented by each of the number lines shown below.  
 Put a tick (✓) in the correct box in each case to show whether  $x \in \mathbb{N}$ ,  $x \in \mathbb{Z}$ , or  $x \in \mathbb{R}$ .  
 The first one is done.

Number line	Inequality in $x$	Domain (Tick <b>one</b> box only in each case)
	$-3 \leq x < 2$	<div> <math>\mathbb{N}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{Z}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{R}</math>  <input checked="" type="checkbox"/> </div>
		<div> <math>\mathbb{N}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{Z}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{R}</math>  <input type="checkbox"/> </div>
		<div> <math>\mathbb{N}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{Z}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{R}</math>  <input type="checkbox"/> </div>
		<div> <math>\mathbb{N}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{Z}</math>  <input type="checkbox"/> </div> <div> <math>\mathbb{R}</math>  <input type="checkbox"/> </div>



**Question 12** (Suggested maximum time: 10 minutes)

**Question 12** (Suggested maximum time: 10 minutes)

- (a)** Write the following as a single fraction in its simplest form.

$$\frac{2}{n-3} - \frac{5}{2n+5}$$

A full-page sheet of graph paper featuring a uniform grid of thin, light gray lines on a white background. The grid consists of small squares covering the entire area.

- (b)** Show that  $(4x - 3)^2 + 24x$  is **positive** for all values of  $x \in \mathbb{R}$ .

A full-page sheet of white graph paper featuring a uniform grid of thin, light gray horizontal and vertical lines. The grid consists of small squares covering the entire area of the page.

**Question 13** (Suggested maximum time: 10 minutes)

**Question 13** (Suggested maximum time: 10 minutes)

Below are four statements about three **non-empty** sets  $P$ ,  $Q$ , and  $R$  in a universal set  $U$ .

- (a) Put a tick (✓) in the correct box in each case to show whether each statement is **always true**, **sometimes true**, or **never true**.

*Note:*  $P'$  is the complement of the set  $P$ .

		Tick <b>one</b> box only in each case		
	Statement	Always true	Sometimes true	Never true
<b>1</b>	$\#(P \cup Q) = \#(P) + \#(Q)$	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>2</b>	$P \setminus Q = P \cap Q$	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>3</b>	$(P \cap Q)' = P' \cup Q'$	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>4</b>	$P \cup (Q \cap R) = (P \cup Q) \cap (P \cup R)$	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Justification:

### Question 14

**(Suggested maximum time: 10 minutes)**

- (a) Use factors to simplify  $\frac{2n^2+n-15}{n^2-9}$ .

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form a uniform pattern of small squares across the entire surface. There are no margins, text, or other markings present.



Page for extra work.

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

Page for extra work.

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

Page for extra work.

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

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

# Junior Certificate 2018

# Mathematics – Paper 1

Higher Level

Friday 8 June

Afternoon 2:00 to 4:30





Coimisiún na Scrúduithe Stáit  
State Examinations Commission

## Junior Certificate Examination 2017

# Mathematics

Paper 1  
Higher Level

Friday 9 June  
Afternoon 2:00 – 4:30

300 marks

Examination Number

Centre Stamp

Running Total	
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For Examiner					
Q.	Ex.	Adv. Ex.	Q.	Ex.	Adv. Ex.
1			11		
2			12		
3			13		
4			14		
5			15		
6					
7					
8					
9					
10			Total		

Grade

## Instructions

There are 15 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. You may ask the superintendent for more paper. 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 you do not show all necessary work.

You may lose marks if you do not include the appropriate units of measurement, where relevant.

You may lose marks if you do not give your answers in simplest form, where relevant.

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

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**(Suggested maximum time: 10 minutes)**

$$\text{BMI} = \frac{w}{h^2}$$

(a) (i) Geri is an athlete. Her weight is 77.5 kg and her height is 1.63 m. Work out Geri's **BMI**. Give your answer correct to one decimal place.

- Work out her new **weight**. Give your answer in kg, correct to one decimal place.

[illegible]

- Alex's BMI is:  
(tick **one** box only)



**Justification:**

**Question 2** (Suggested maximum time: 5 minutes)

**Question 2** (Suggested maximum time: 5 minutes)

A sports shop buys t-shirts for €25 and sells them for €49.

- (a) (i) Find the **mark up** for the t-shirts (profit as a percentage of cost price).

- (ii) Find the **margin** for the t-shirts (profit as a percentage of selling price). Give your answer correct to the nearest percent.

[illegible]

- (b)** The shop also sells runners, at a **mark up** of 50%.  
Find the **margin** for these runners. Give your answer correct to the nearest percent.

A full-page sheet of white graph paper featuring a uniform grid of thin, light gray horizontal and vertical lines. The grid consists of small squares covering the entire area of the page.

**Question 3** (Suggested maximum time: 5 minutes)

**Question 3** (Suggested maximum time: 5 minutes)

- (a)** Write 868 million in the form  $a \times 10^n$ , where  $n \in \mathbb{Z}$  and  $1 \leq a < 10, a \in \mathbb{R}$ .

- (b)** During the Apollo-11 mission, it took approximately 1.3 seconds for a radio signal to travel 380 000 km.

Find the **average speed** of the radio signal, in km per minute. Give your answer in the form  $a \times 10^n$ , where  $n \in \mathbb{Z}$ , and where  $1 \leq a < 10$  is correct to two decimal places.

- (c)** In 2016, a spacecraft flew around Jupiter, 868 million km from earth.

Find how many minutes it would take a radio signal to travel 868 million km.

Assume that the radio signal would travel at the same speed as your answer to part (b).

### Question 4

**(Suggested maximum time: 5 minutes)**

*Fruitex* and *Juicy* are two drinks.

- (a) A shop buys cartons of *Fruitex* from the UK.  
In December 2015, the exchange rate was  $\text{€}1 = \text{£}0.7241$ .  
The shop bought *Fruitex* for  $\text{£}380$ .

Find the price of the *Fruitex* in euro (€). Give your answer correct to the nearest cent.

- (b)** *Fruitex* and *Juicy* are each made from mixing fruit juice and water. In *Fruitex*, the ratio of fruit juice to water is 3:7.

- (i)** Find how many litres of fruit juice are in 20 litres of *Fruitex*.

[illegible]

20 litres of *Fruitex* is mixed with 40 litres of *Juicy*.

In this 60-litre **mixture**, the ratio of fruit juice to water is 7: 8.

- (ii) Find the ratio of fruit juice to water in *Juicy*. Give your answer in its simplest form.

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

**Question 5** (Suggested maximum time: 10 minutes)

**Question 5** (Suggested maximum time: 10 minutes)

Pete and Maeve are saving to buy an Xbox.

- (a)** Pete has saved €20 to begin with. He saves a further €12 each week.

- (i) Find the **total** amount of money Pete will have saved after 5 weeks.

- (ii) Write an expression in  $n$  for the **total** amount of money Pete will have saved after  **$n$  weeks**.

Pete's total savings after  $n$  weeks:

--	--

- (b)** Maeve has saved €15 to begin with. She saves a further €6 each week.

Write an expression in  $n$  for the **total** amount of money Maeve will have saved after  $n$  weeks.

Maeve's total savings after  $n$  weeks:

--

- (c) Pete will give **one quarter** of his savings to buy the Xbox.

Maeve will give **two thirds** of her savings to buy the Xbox.

The Xbox costs €200.

After how many weeks will they have enough money saved to buy the Xbox?

A full-page sheet of graph paper featuring a uniform grid of thin, light gray lines on a white background. The grid consists of small squares covering the entire area.

**Question 6** (Suggested maximum time: 15 minutes)

**Question 6** (Suggested maximum time: 15 minutes)

Each of the students in sixth year in a particular school has WhatsApp ( $W$ ), Instagram ( $I$ ), or Snapchat ( $S$ ). The numbers who have each app are as follows:

36 students have WhatsApp

40 students have Instagram

54 students have Snapchat

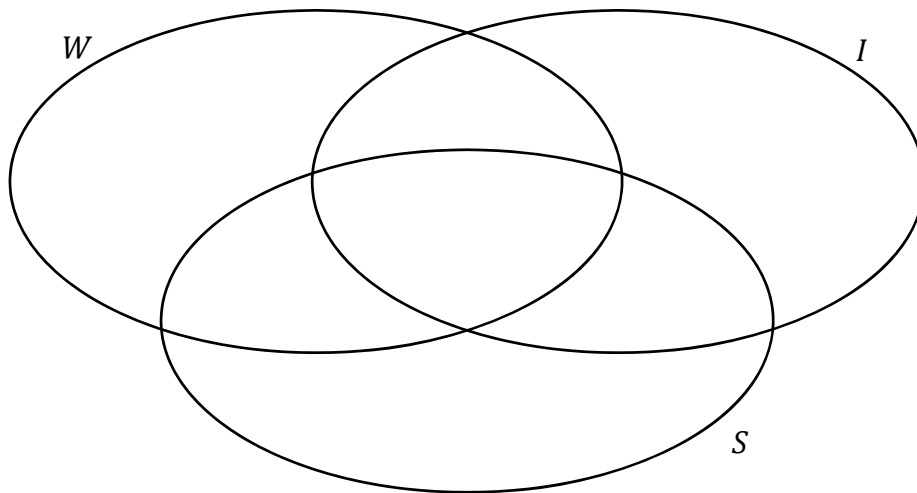
14 students have WhatsApp and Instagram

24 students have Instagram and Snapchat

$x$  students have WhatsApp and Snapchat, but **not** Instagram

8 students have all three apps.

- (a)** Use this information to fill in the Venn diagram below, in terms of  $x$ .



- (b)** There are 80 students in total in sixth year in the school.  
Find the value of  $x$ .

[illegible]

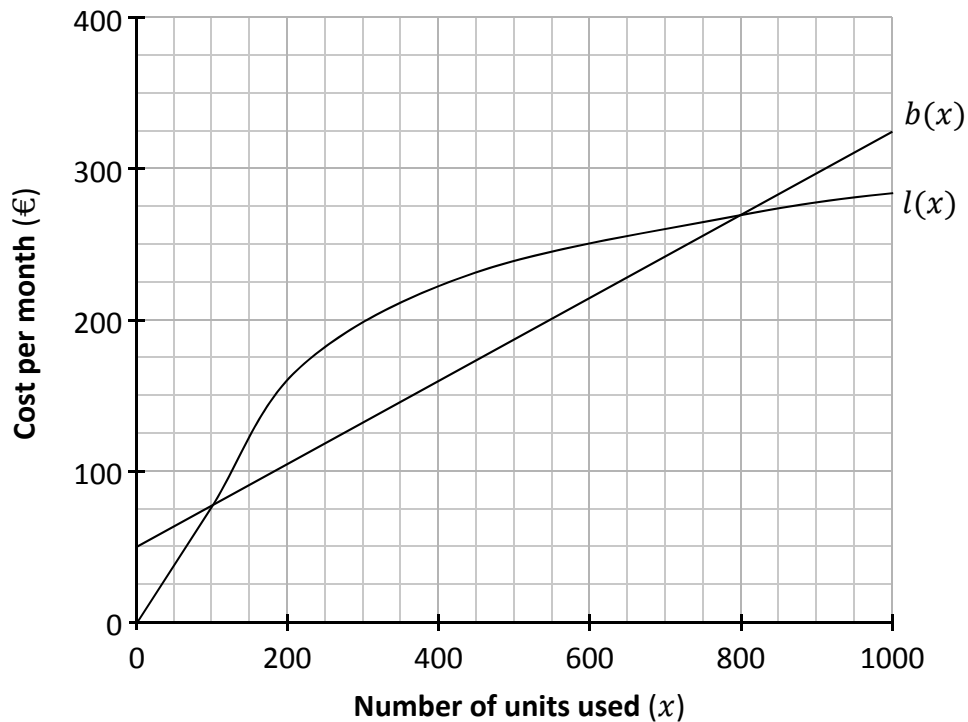




**Question 8** (Suggested maximum time: 15 minutes)

**Question 8** (Suggested maximum time: 15 minutes)

A school can get its electricity from one of two companies, *Buzz* or *Lecky*. The graphs below show the cost of the electricity per month from each company, if the school uses  $x$  units of electricity. The cost from *Buzz* is  $b(x)$ , and the cost from *Lecky* is  $l(x)$ .



One of the companies charges a fixed fee each month, plus a fee for each unit of electricity used.

- (a) State which company charges **no** fixed fee.  
Give a reason for your answer, based on the graph.

[illegible]

- (b)** Write down the **domain** and the **range** of the function  $b(x)$ , as shown on the diagram.

Domain =

--

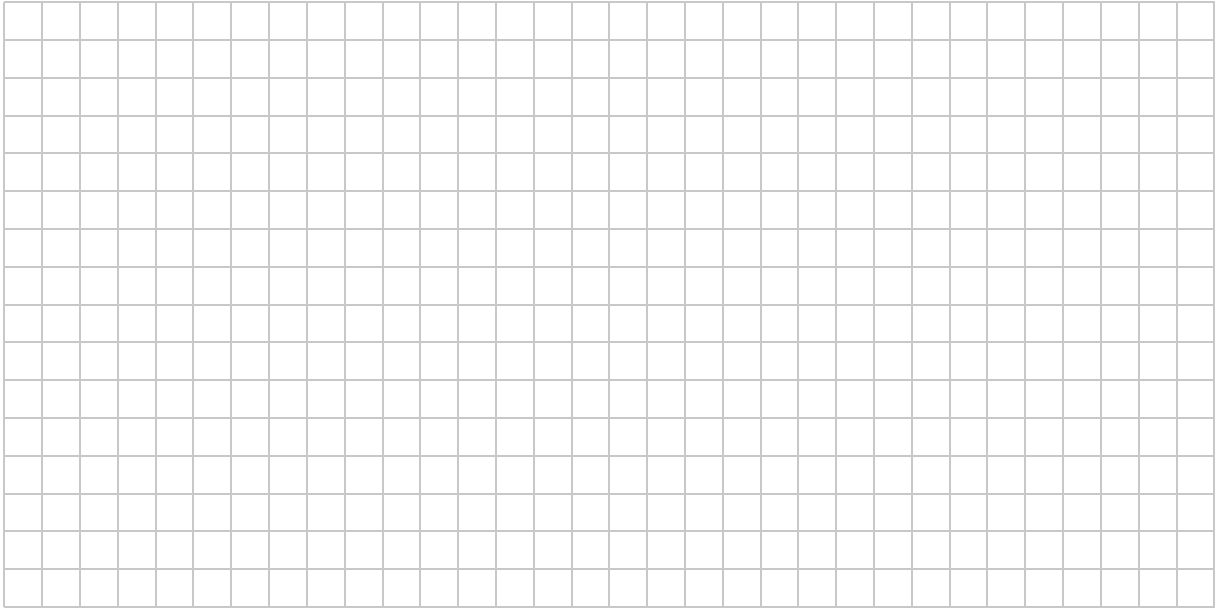
Range =

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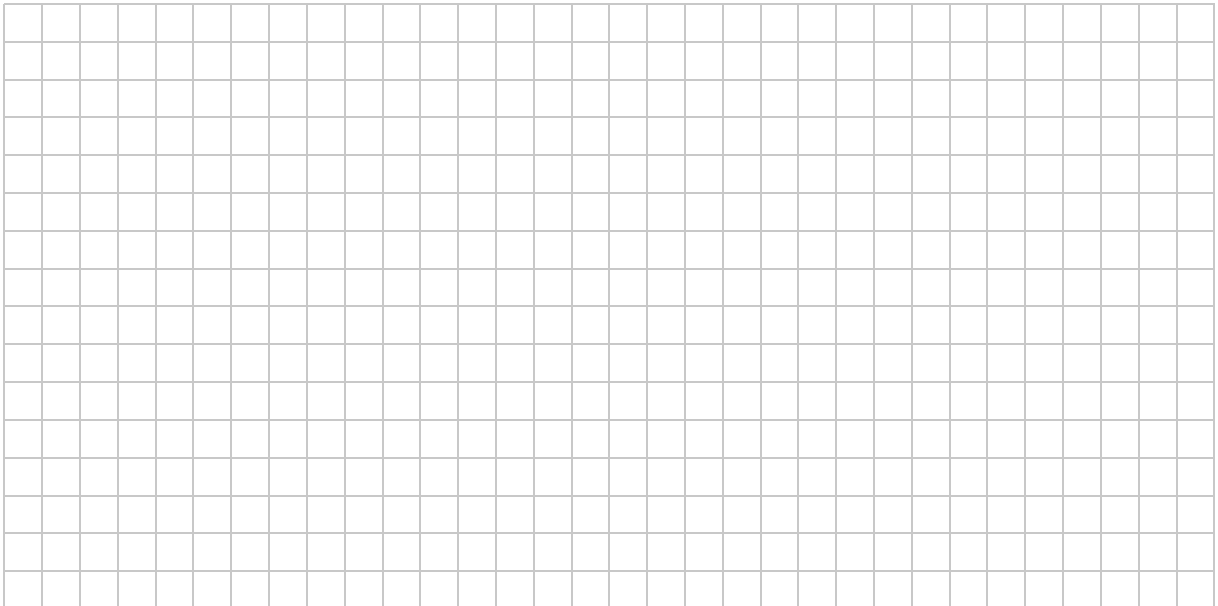


**Question 9****(Suggested maximum time: 15 minutes)**

- (a)** Solve the equation  $x^2 - 2x - 4 = 0$ . Give your answers in the form  $a \pm \sqrt{b}$ , where  $a, b \in \mathbb{N}$ .



- (b)** Given that  $(\sqrt{d})^2 = d$ , multiply out and simplify  $(c + \sqrt{d})^2$ .



- Complete** the table by writing “**Yes**” or “**No**” into each box.  
One row is already done for you: 16 is an element of  $\mathbb{N}$ ,  $\mathbb{Z}$ , and  $\mathbb{Q}$ , but not of  $\mathbb{R} \setminus \mathbb{Q}$ .

		$\mathbb{N}$	$\mathbb{Z}$	$\mathbb{Q}$	$\mathbb{R} \setminus \mathbb{Q}$
Number	16	Yes	Yes	Yes	No
	$\sqrt{6}$				
	$\frac{2}{3}$				
	$-4$				

**(Suggested maximum time: 5 minutes)**

(a)  $2^3 \times 2^5 \times 2^{10}$

[illegible]

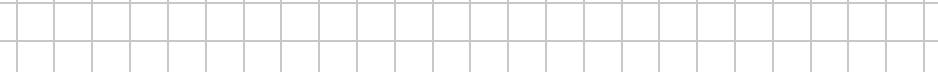
[illegible]

### Question 11

**(Suggested maximum time: 5 minutes)**

- (a) In a particular **linear** sequence, the second term is 40 and the sixth term is 116. Fill in the boxes below to show the rest of the first six terms of this sequence.

,  40 ,  ,  ,  ,  116



- (b)** Orla is asked to write down a **quadratic** sequence. She writes down the following:

5,          6,          9,          14,          22,          30,          41

Exactly **one** of the terms in Orla's sequence is incorrect.

Write down the correct quadratic sequence in the spaces below.

You may only change **one** of the terms in Orla's sequence.

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form a uniform pattern of small squares across the entire surface. There are no margins, text, or other markings on the paper.

**Correct Sequence:**

[illegible]

### Question 12

**(Suggested maximum time: 20 minutes)**

- (a) Factorise  $n^2 - 11n + 18$ .

A blank sheet of graph paper with a grid of squares. The grid consists of 20 columns and 10 rows of small squares. The lines are thin and gray, set against a white background. There are no margins or additional markings on the page.

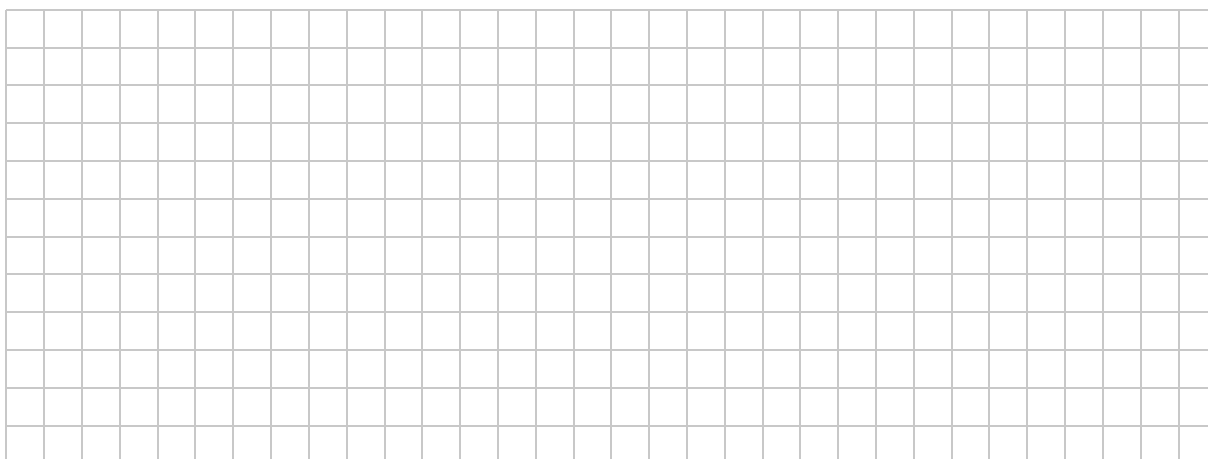
- (b)** Factorise fully  $wy - y - 1 + w$ .

[illegible]

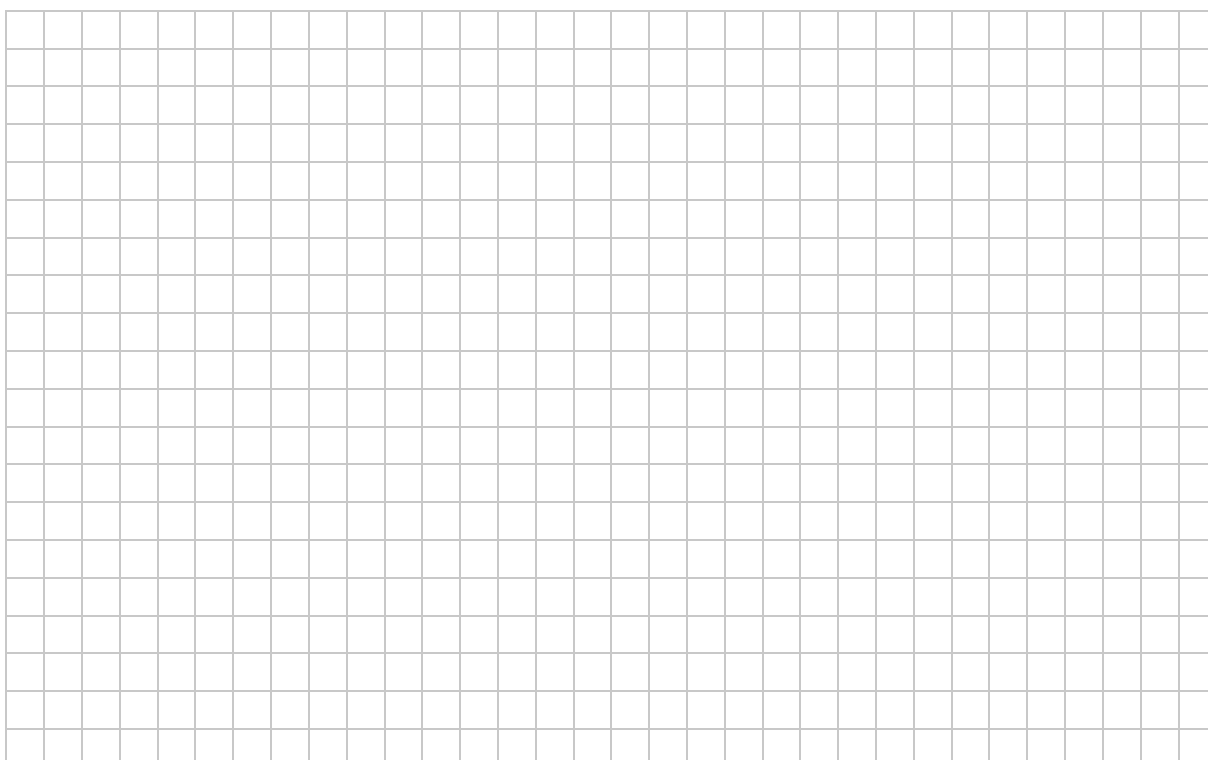
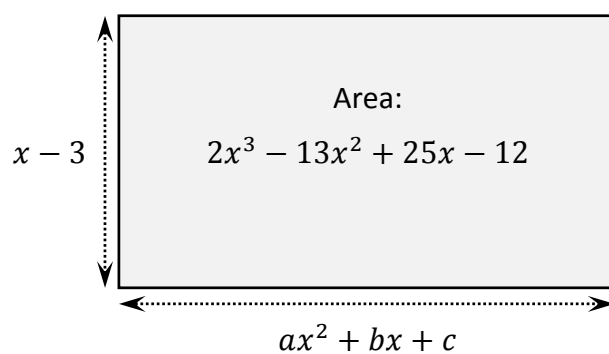
- (c) Find the value of  $\frac{5}{3x-2} - \frac{7}{6x-12}$ , when  $x = 4$ .

*This question continues on the next page.*

- (d) Use factorisation to simplify  $\frac{4e^2-9}{2e^2+3e-9}$ .



- (e) A rectangle has sides of length  $x - 3$  units and  $ax^2 + bx + c$  units, where  $a, b, c \in \mathbb{Z}$ . The **area** of the rectangle is  $2x^3 - 13x^2 + 25x - 12$  square units. Find the value of  $a$ , the value of  $b$ , and the value of  $c$ .



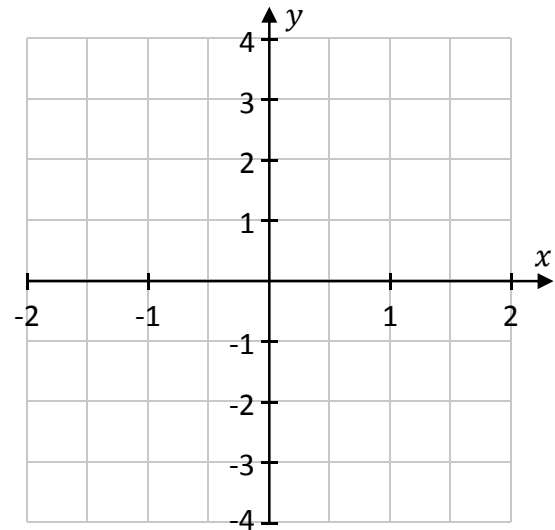
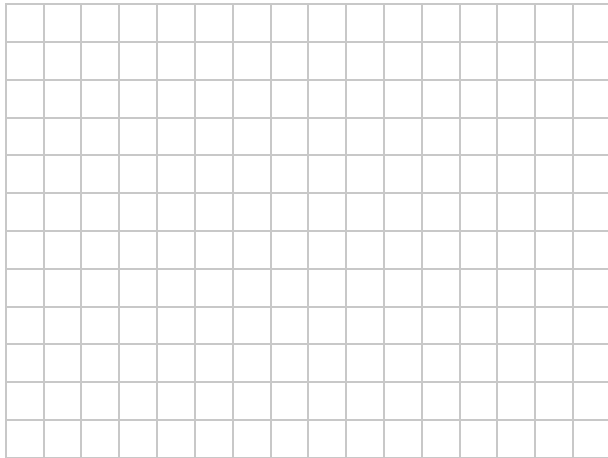


### Question 13

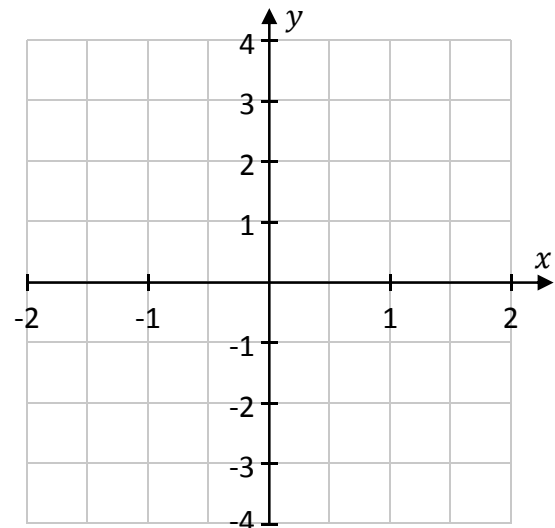
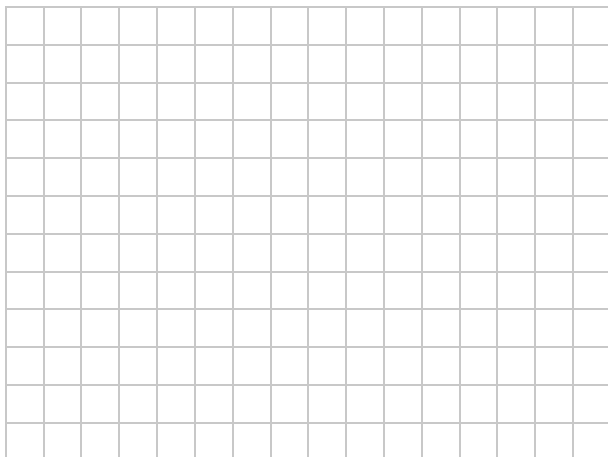
(Suggested maximum time: 10 minutes)

**Draw** each of the following three functions in the domain  $-2 \leq x \leq 2$ , for  $x \in \mathbb{R}$ .

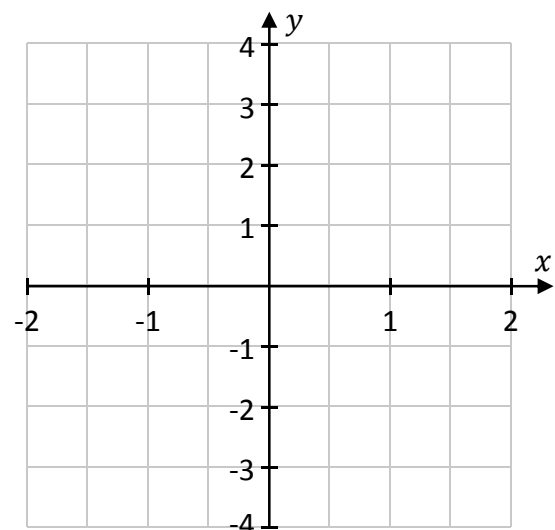
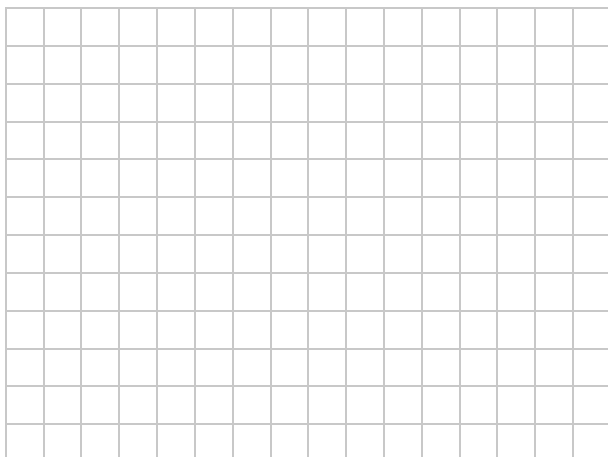
**Function:**  $y = x - 1$



**Function:**  $y = 2 - x^2$



**Function:**  $y = 2^x$



previous

page

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**Question 14** (Suggested maximum time: 10 minutes)

**Question 14** (Suggested maximum time: 10 minutes)

The table below shows some information about regular polygons.

These are shapes where all of the angles are the same size.

<b>Number</b> of angles in the polygon	<b>Part (a)</b> <b>Sum</b> of the angles	<b>Part (c)</b> <b>Size of each</b> angle
3	180°	60°
4	360°	
5		
6		

- (a)** The **sum** of the angles increases in a **linear** pattern.

Complete the column in the table above showing the sum of the angles in each of these shapes.

[illegible]

- (b)** Find a **formula** for the **sum** of the angles in a regular polygon with  $n$  angles.

Remember that these values follow a linear pattern.

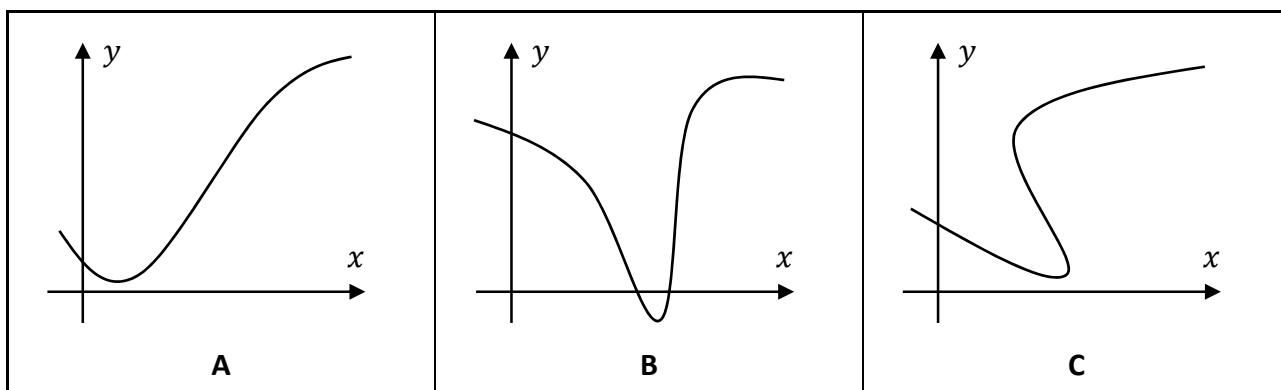
- (c) Complete the column in the table above showing the **size of each** angle in each of these shapes. Remember that, in each polygon, all of the angles are the same size.

**(d)** Find a **formula** for the **size of each** angle in a regular polygon with  $n$  angles.

### Question 15

**(Suggested maximum time: 5 minutes)**

The three curves **A**, **B**, and **C** are shown in the co-ordinate diagrams below. Two of the curves show a function of  $x$ .



Put a tick (✓) in the correct box to show which curve does **not** show a function of  $x$ .  
Give a reason for your answer.

Curve which is **not** a function of  $x$ :  
(tick **one** box only)

**A**



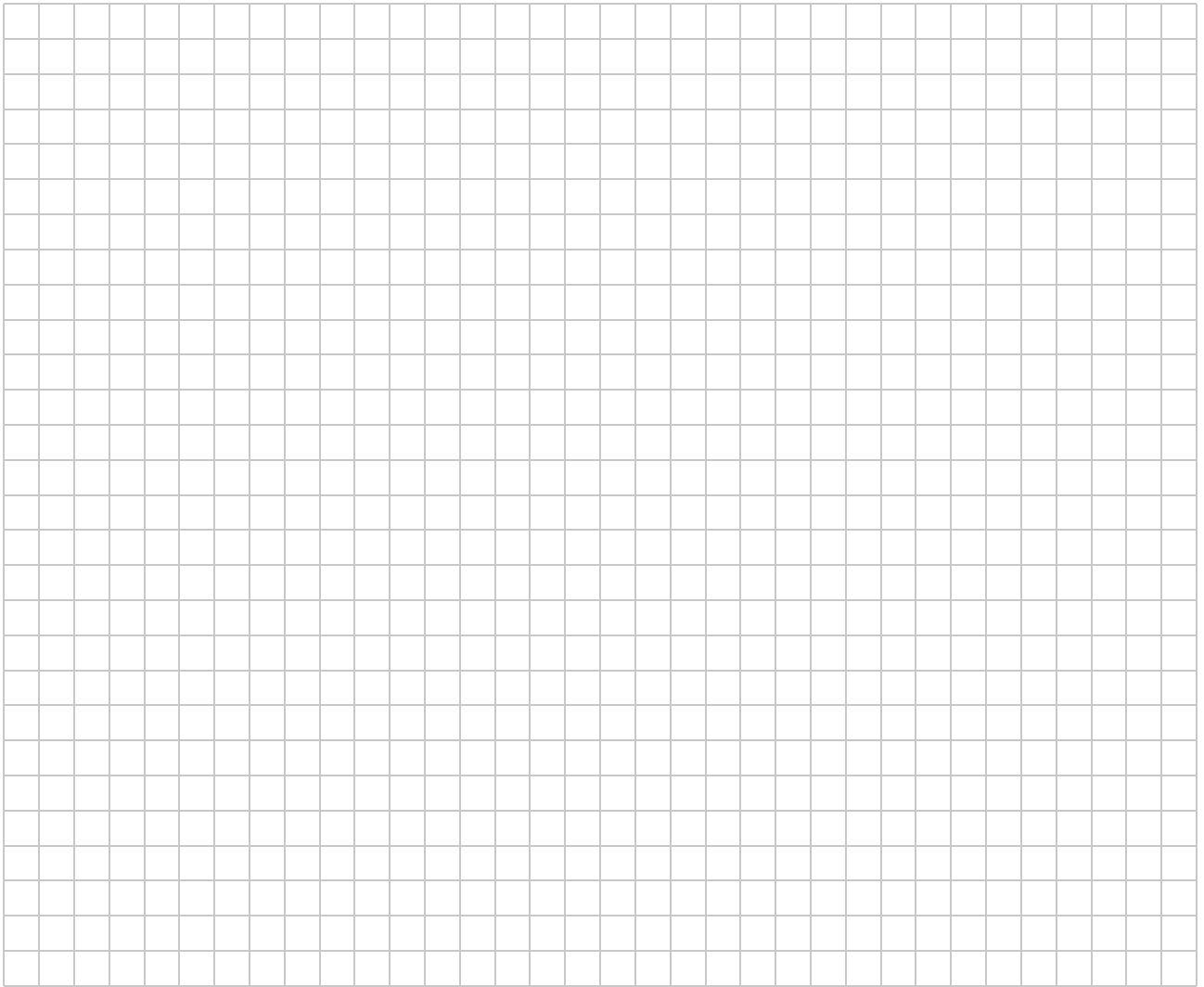
**B**

5

**C**



Reason:



Junior Certificate 2017 – Higher Level  
**Mathematics – Paper 1**  
Friday 9 June  
Afternoon 2:00 – 4:30



Coimisiún na Scrúduithe Stáit  
State Examinations Commission

Junior Certificate Examination 2016

# Mathematics

Paper 1  
Higher Level

Friday 10 June – Afternoon 2:00 to 4:30

300 marks

Examination number
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Centre stamp
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Running total	
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For examiner			
Question	Mark	Question	Mark
1		11	
2		12	
3		13	
4		14	
5			
6			
7			
8			
9			
10		Total	

Grade
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## Instructions

There are 14 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. You may ask the superintendent for more paper. 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 you do not show all necessary work.

You may lose marks if you do not include the appropriate units of measurement, where relevant.

You may lose marks if you do not give your answers in simplest form, where relevant.

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

--

**Question 1** (Suggested maximum time: 10 minutes)

**Question 1** (Suggested maximum time: 10 minutes)

- (a) A bus company increases the price of all of its tickets by 6%.  
**Before** the increase, the price of a ticket from Cork to Dublin was €17.00.

- (i) Find the price of this ticket **after** the increase.

Six months later, the company reduces the price of this ticket back to €17·00.

- (ii) Find the **percentage decrease** in the price of this ticket.  
Give your answer correct to one decimal place.

[illegible]

- (b)** Insert brackets into each of the following statements to make them true. You may need more than one pair of brackets in some of the statements.

- (i)  $5 + 4 \times 2 + 3 = 45$

5 + 4 × 2 + 3 = 45

- (ii)  $5 + 4 \times 2 + 3 = 25$

[illegible]

- (iii)  $5 + 4 \times 2 + 3 = 21$

[illegible]

page	running
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**Question 2** (Suggested maximum time: 10 minutes)

**Question 2** (Suggested maximum time: 10 minutes)

- (a) (i) Write 20 cent as a **fraction** of €20. Give your answer in its simplest form.

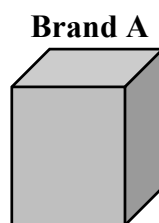
[illegible]

- (ii) Write 0.5 cm as a **fraction** of 2 m. Give your answer in its simplest form.

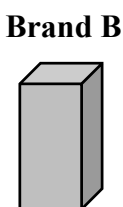
[illegible]

- (b)** A shop sells two brands of orange juice, **Brand A** and **Brand B**, as shown.

- (i)** Find which brand, **A** or **B**, is cheaper per litre.  
Show all of your working out.



2 litres  
€3.60



750 ml  
€1.50

[illegible]

Samantha needs to buy **at least 5 litres** of orange juice.

- (ii) Find the **lowest price** that she could pay to do this, by buying **Brand A**, **Brand B**, or a **combination** of both. Justify your answer fully.

Lowest price =



**Question 3** (Suggested maximum time: 5 minutes)

**Question 3** (Suggested maximum time: 5 minutes)

Conor carries out a survey on all of the 25 students in his class ( $U$ ).

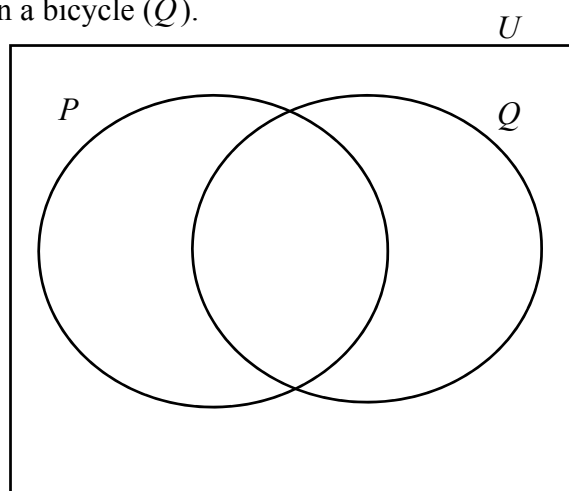
He asks each student if they own a pet ( $P$ ), and if they own a bicycle ( $Q$ ).

6 students own **neither** a pet **nor** a bicycle.

28% of the students own **both** a pet and a bicycle.

The ratio  $\#(P \setminus Q) : \#(Q \setminus P) = 2 : 1$ .

Use this information to fill in the Venn diagram.

[illegible][illegible]

**Question 4** (Suggested maximum time: 5 minutes)

**Question 4** (Suggested maximum time: 5 minutes)

Put a tick (✓) in the correct box in each row of the table below to show whether each statement is always true, sometimes true, or never true, for three **different** sets  $A$ ,  $B$ , and  $C$ .

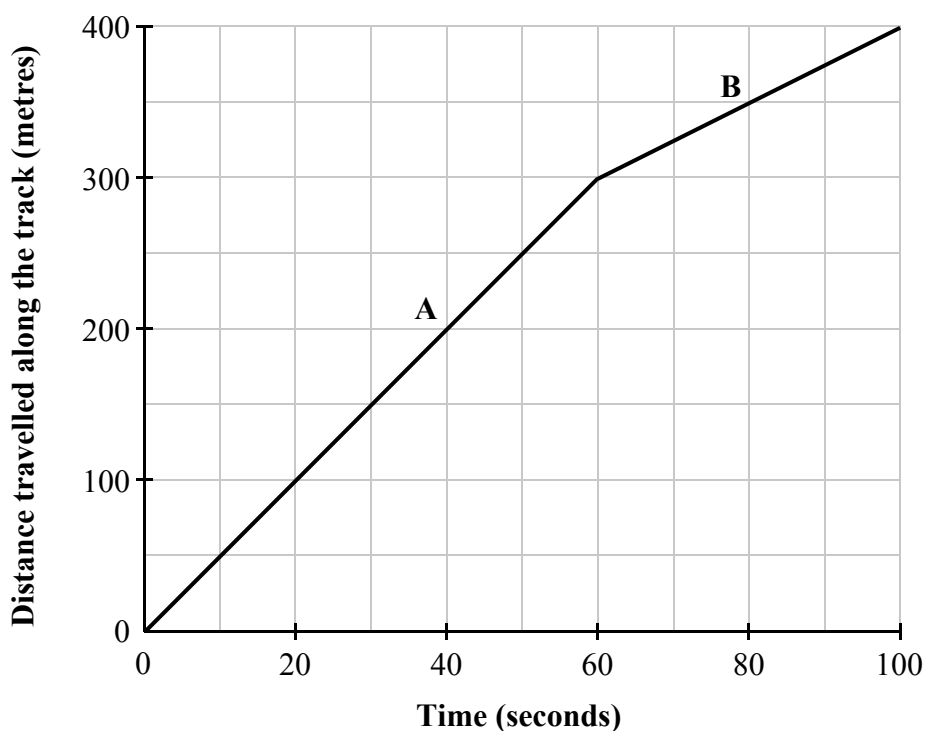
Statement	Tick <b>one</b> box only, for each statement		
	Always true	Sometimes true	Never true
$A \cap B = B \cap A$			
$A \cup B = B \cup C$			
$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$			
$A \cup C = A \cap C$			
$A \setminus B = \{ \}$			

[illegible]

**Question 5** (Suggested maximum time: 10 minutes)

**Question 5** (Suggested maximum time: 10 minutes)

- (a) The graph below shows the distance travelled along a track by Ann over the course of a race. The graph is in two sections, labelled **A** and **B**.



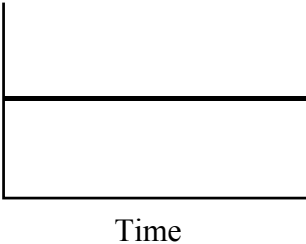
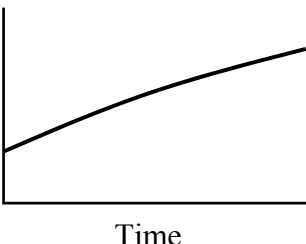
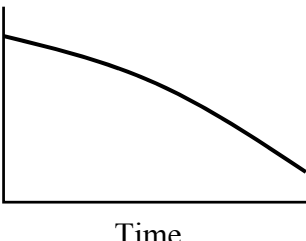
- (i)** Show that Ann's speed in section A is 5 metres per second.

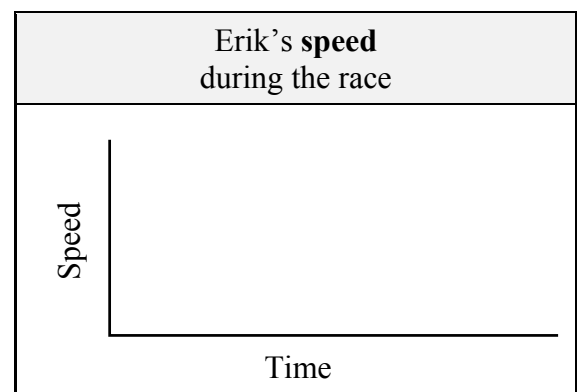
[illegible]

- (ii)** Find Ann's speed in section **B**, in metres per second.

[illegible]

- Complete Table 2**, by writing the correct name next to each graph.

Table 2	
Speed during the race	Name
 <p>A graph with 'Speed' on the vertical axis and 'Time' on the horizontal axis. A horizontal line is drawn at a constant level on the speed axis, indicating that speed does not change over time.</p>	
 <p>A graph with 'Speed' on the vertical axis and 'Time' on the horizontal axis. A curve starts at the origin (0,0) and curves upwards with a decreasing gradient, representing increasing speed that is slowing down (deceleration).</p>	
 <p>A graph with 'Speed' on the vertical axis and 'Time' on the horizontal axis. A curve starts at a point on the speed axis and curves downwards with a decreasing gradient, representing decreasing speed that is slowing down (deceleration).</p>	



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**Question 6** (Suggested maximum time: 10 minutes)

**Question 6** (Suggested maximum time: 10 minutes)

- (a)** Write the following four numbers in order, from the smallest to the biggest.

$\pi$

$$\sqrt{10}$$

3·14

- (b) Put a tick (✓) in the correct box in each row of the table below to show whether each number is **rational** or **irrational**. Give a **reason** for each answer.

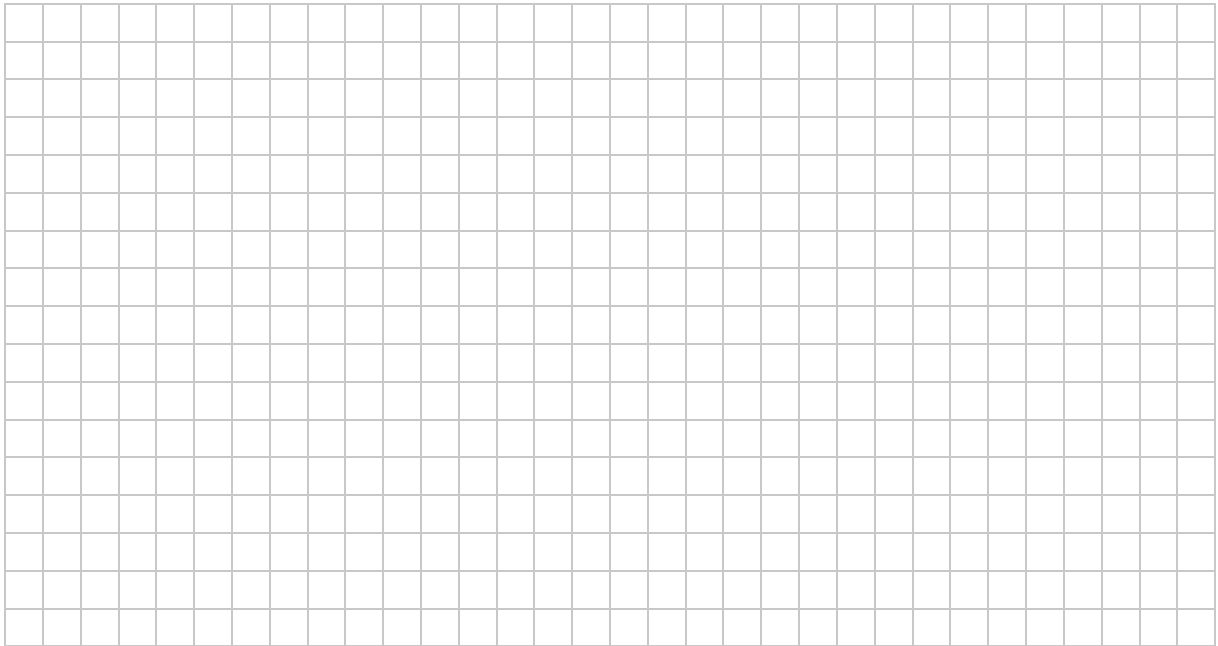
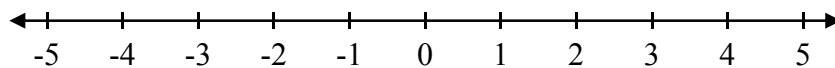
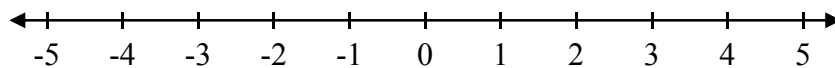
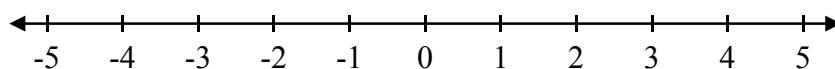
Number	Tick <b>one</b> box only, for each number		Reason
	Rational	Irrational	
$\sqrt{10}$			
$3 \cdot 14$			

- (c) How many digits does the number  $3 \cdot 14 \times 10^{100}$  have, when it is written out fully? Justify your answer.

Answer:	
Justification:	

**Question 7****(Suggested maximum time: 5 minutes)****(a)** Solve the following equation.

$$\frac{2x+4}{3} - \frac{5x-7}{2} = 5$$

**(b)** Graph each of the following inequalities on the number line given.**(i)**  $x < 4$ , where  $x \in \mathbb{N}$ .**(ii)**  $x < 4$ , where  $x \in \mathbb{Z}$ .**(iii)**  $x < 4$ , where  $x \in \mathbb{R}$ .

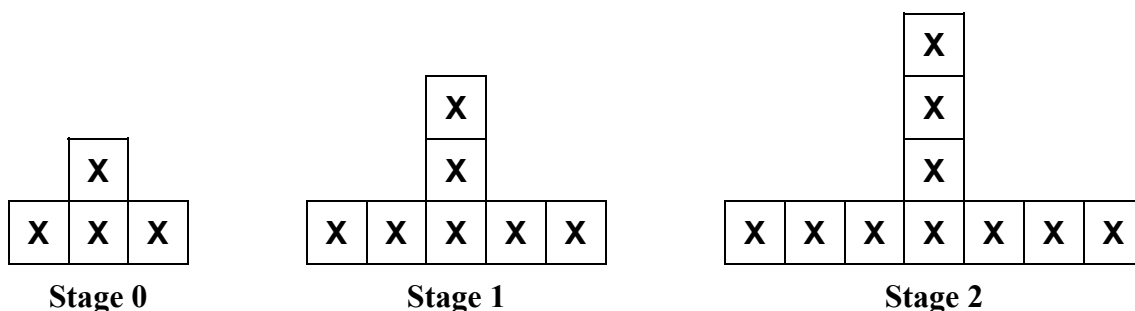
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**Question 8** (Suggested maximum time: 15 minutes)

**Question 8** (Suggested maximum time: 15 minutes)

John makes a sequence where each stage is made up of a certain number of **X**s arranged in a pattern. The first three stages of John's sequence are shown below.

The sequence starts at **stage 0**.



- (a) Draw the next stage of John's sequence.

- (b) Using a table, a graph, or otherwise, write a **formula** to express  $N$  in terms of  $S$ , where  $N$  is the number of **X** s in stage  $S$  of John's sequence.

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

- (c) There are exactly 130 **X**s in stage  $k$  of John's sequence. Find the value of  $k$ .

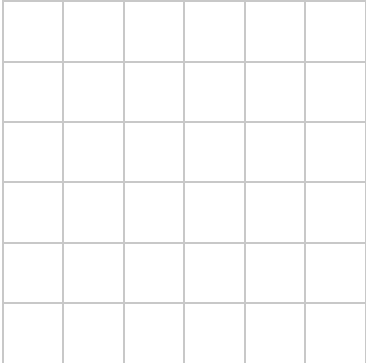
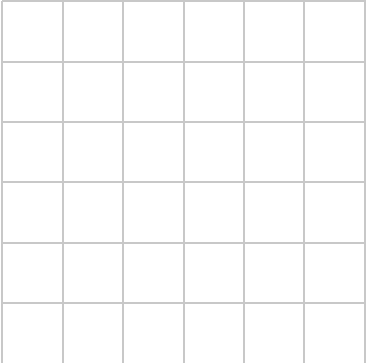
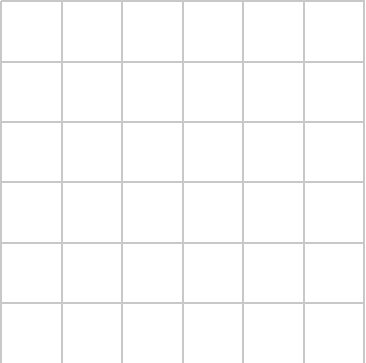
[illegible]

- (d) Yoko is also making a sequence, with each stage made up of a certain number of **X**s arranged in a pattern. In Yoko's sequence, the relationship between  $N$  and  $S$  is given by the formula:

$$N = 1 + 2S,$$

where  $N$  is the number of  $\mathbf{X}$  s in stage  $S$  of the sequence (starting at stage 0).

- (i) **Draw** one possible example of the first three stages of Yoko's sequence in the table below.

Yoko's sequence																	
																	
Stage 0						Stage 1						Stage 2					

- (ii)  $p$  represents the number of  $\mathbf{X}$ s in stage  $y$  of Yoko's sequence.

Write down the number of **X**s in stage  $y + 3$  of Yoko's sequence.

Give your answer in terms of  $p$ .

**Question 9** (Suggested maximum time: 5 minutes)

**Question 9** (Suggested maximum time: 5 minutes)

- (a)** Write each of the following numbers in the form  $3^k$ , where  $k \in \mathbb{Q}$ .

(i) 9

[illegible]

(ii) 1

[illegible]

(iii)  $\sqrt{27}$

[illegible]

(iv)  $\frac{1}{\sqrt[3]{3}}$

[illegible]

- (b)** Write  $(-2n)^4$  in the form  $an^b$ , where  $a, b \in \mathbb{Z}$ .

[illegible]

- (c)  $x$  and  $\sqrt{x^2}$  are **not** always equal.

Give an example of a value of  $x$ , and the corresponding value of  $\sqrt{x^2}$ , which are **not** equal.

$x =$

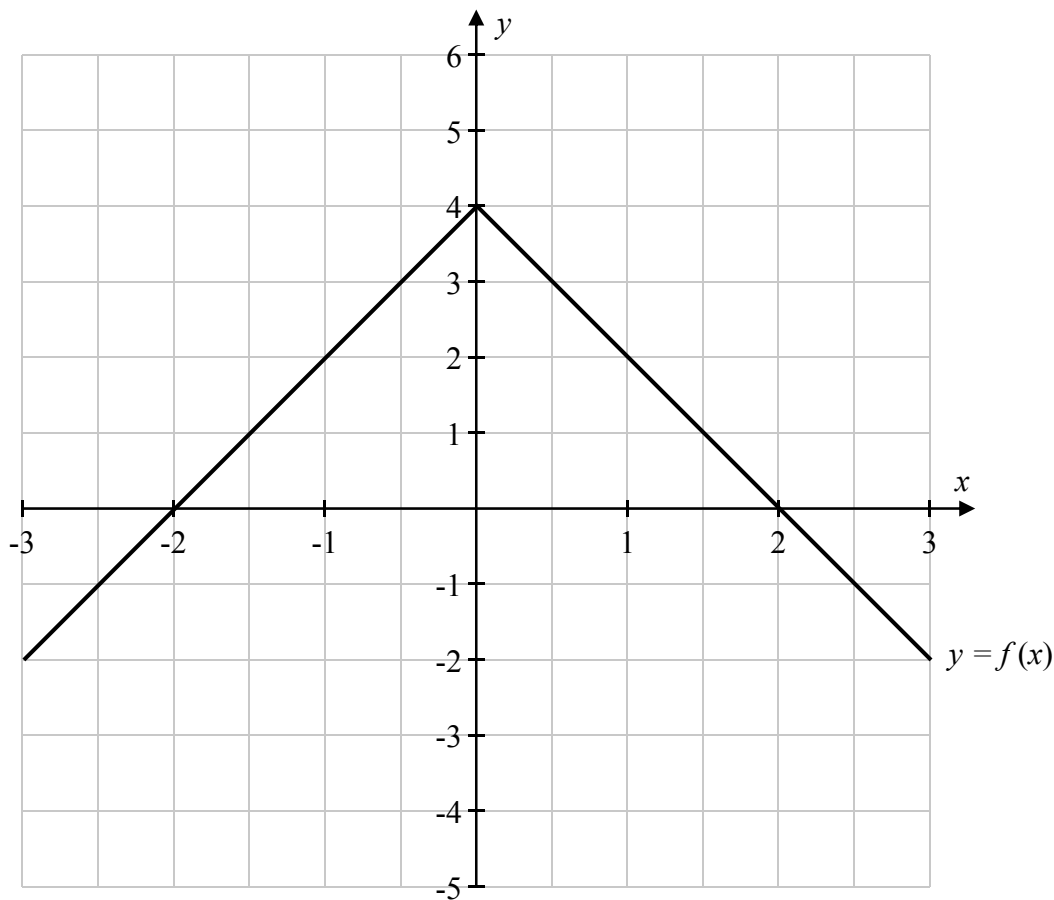
$\sqrt{x^2} =$



Question 10

(Suggested maximum time: 15 minutes)

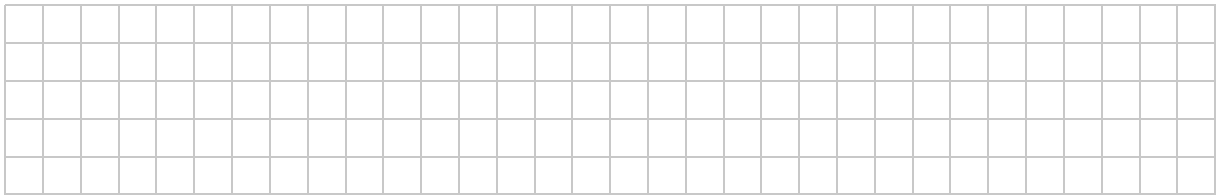
- (a) The graph of the function  $y = f(x)$  is shown on the co-ordinate diagram below, for  $-3 \leq x \leq 3$ ,  $x \in \mathbb{R}$ . The graph is made up of two line segments.



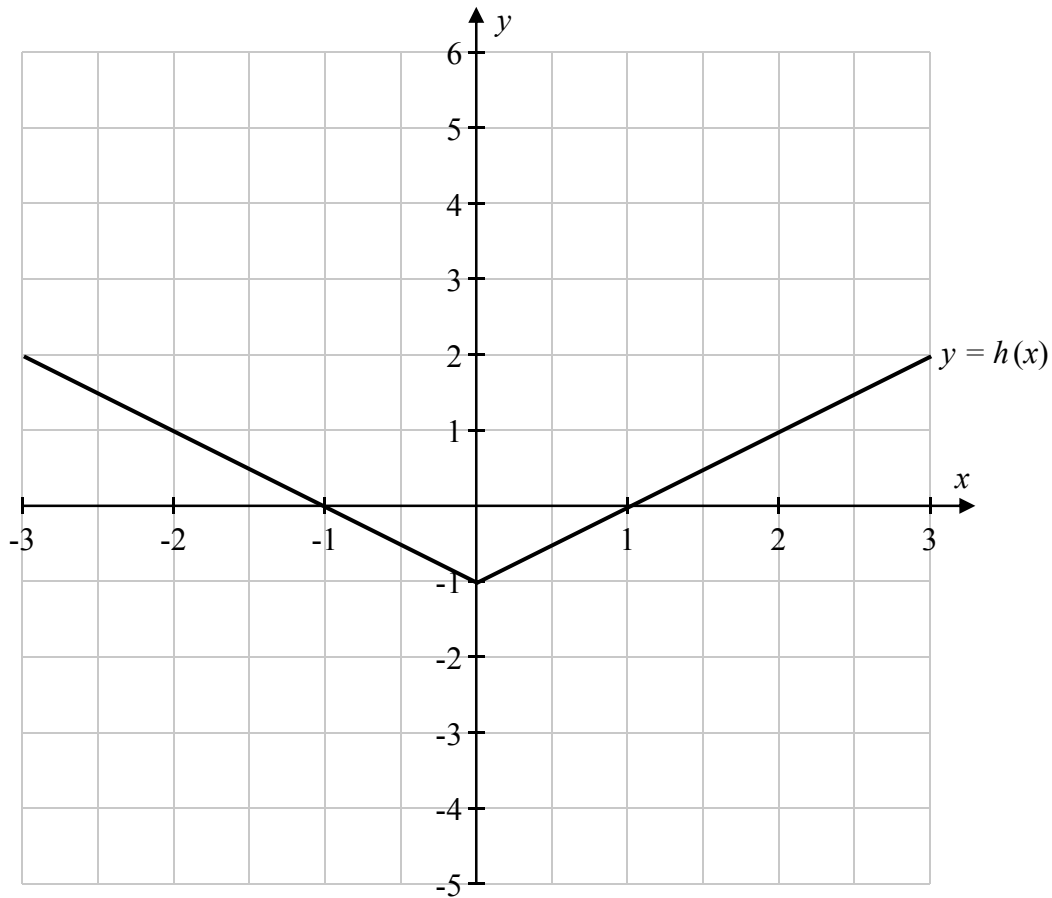
- (i) Fill in the table below to show the value of  $f(x)$  and the value of  $f(x) - 2$  for each of the given values of  $x$ .

$x$	-3	-2	-1	0	1	2	3
$f(x)$							
$f(x) - 2$							

- (ii) Hence, or otherwise, **draw** the graph of  $y = f(x) - 2$  on the co-ordinate diagram above, for  $-3 \leq x \leq 3$ ,  $x \in \mathbb{R}$ .

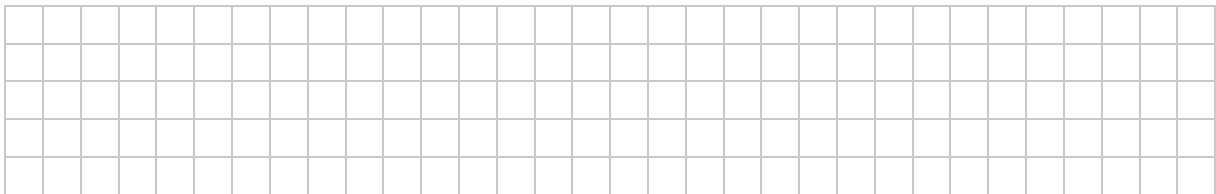


- (b) The graph of a different function,  $y = h(x)$ , is shown on the co-ordinate diagram below, for  $-3 \leq x \leq 3$ ,  $x \in \mathbb{R}$ . The graph is made up of two line segments.

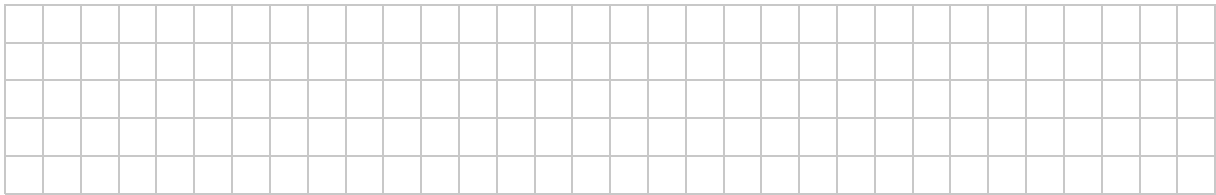


- (i) Fill in the table below to show the value of  $h(x)$  for each of the given values of  $x$ .

$x$	-3	-2	-1	0	1	2	3
$h(x)$							



- (ii) Hence, or otherwise, **draw** the graph of  $y = [h(x)]^2$  on the co-ordinate diagram above, for  $-3 \leq x \leq 3$ ,  $x \in \mathbb{R}$ .



### Question 11

**(Suggested maximum time: 10 minutes)**

- (a) (i)** Multiply out and simplify  $(x + 5)^2$ .

[illegible]

- (ii) Hence, or otherwise, show that the following expression is always divisible by 4.

$$(x+5)^2 - (x-5)^2$$

A blank sheet of graph paper featuring a uniform grid of small squares. The grid consists of 20 columns and 15 rows, providing a structured area for drawing or writing.

- (b)** Factorise each of the following expressions.

- (i)  $25x^2 - 49n^2$




[illegible]

- (ii)**  $2x^2 - 9x - 18$

**Question 12** (Suggested maximum time: 10 minutes)

**Question 12** (Suggested maximum time: 10 minutes)

Three bags are shown in the table below. The mass of each bag (in kg) is also shown.

Bag			
Mass, in kg ( $y \in \mathbb{R}$ )	$y + 5$	19	$2y^2 + 1$

Two of the bags have the same mass (in kg).

- (a) Find the **three** possible positive values of  $y$ .  
Give your irrational answer correct to two decimal places.

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

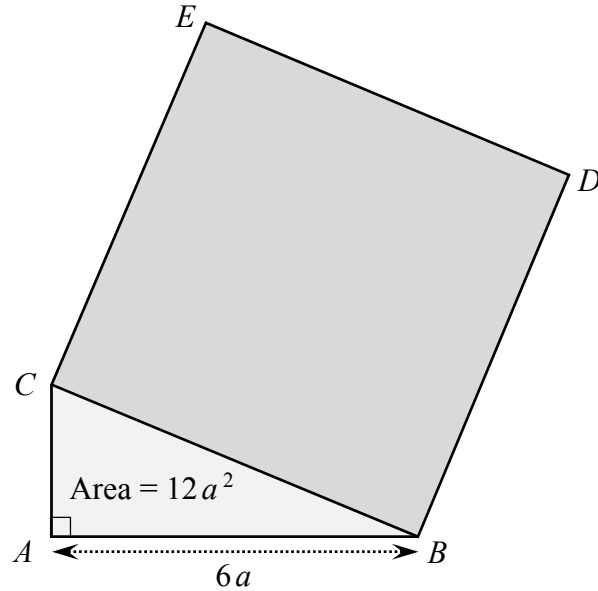
- (b)** Explain why all three bags can **not** have the same mass (in kg).

[illegible]

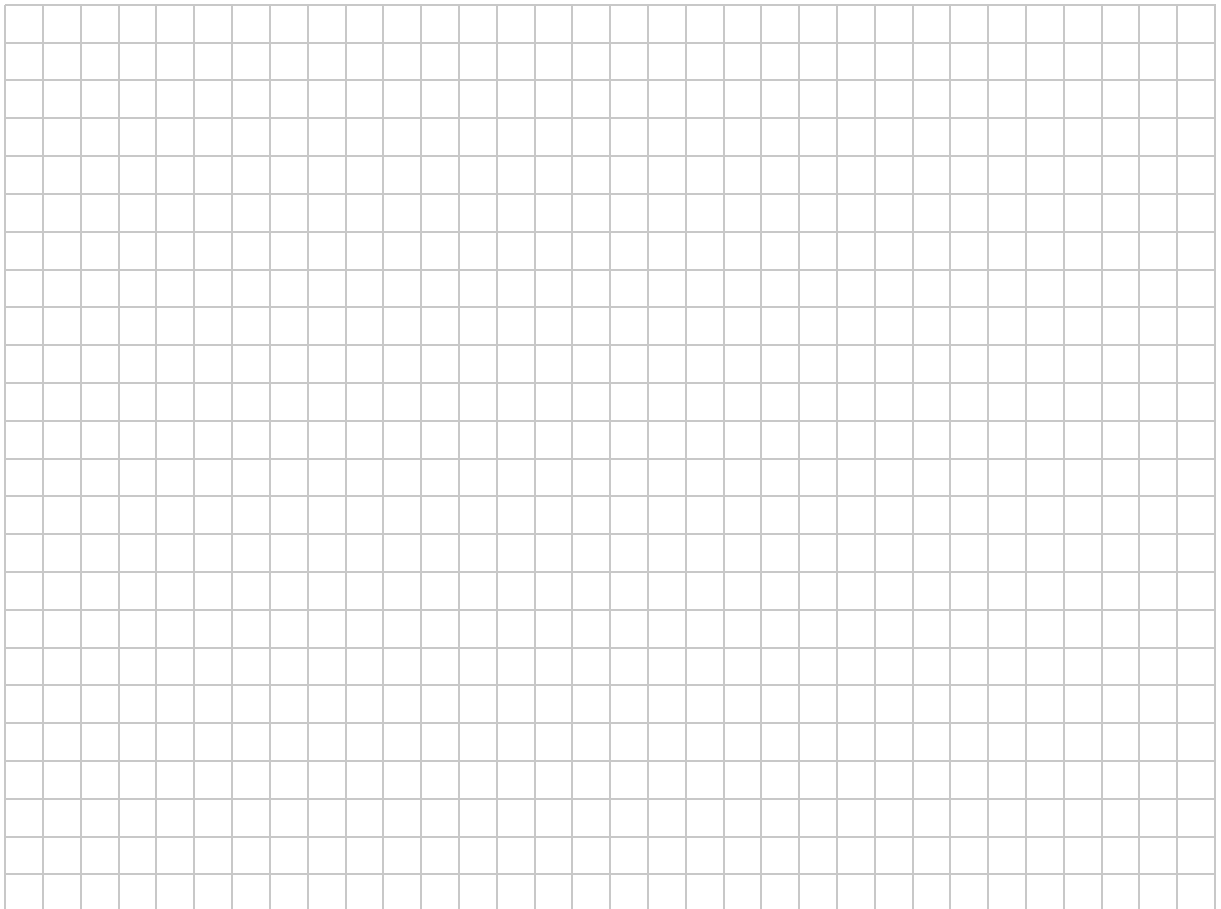
**Question 13****(Suggested maximum time: 10 minutes)**

The right-angled triangle  $ABC$  is shown in the diagram below.  
The square  $BDEC$  is placed on the hypotenuse of this triangle.

The **area** of the **triangle**  $ABC$  is  $12a^2$  square units, where  $a \in \mathbb{R}$ .  
The **length** of the side  $[AB]$  is  $6a$  units.



Find the **area** of the **square**  $BDEC$ , in terms of  $a^2$ .



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The function  $h(x)$  below gives the approximate height of the water at Howth Harbour on a particular day, from 12 noon to 5 p.m.

where  $h(x)$  is the height of the water in centimetres, and  $x$  is the time in hours after 12 noon.

- 



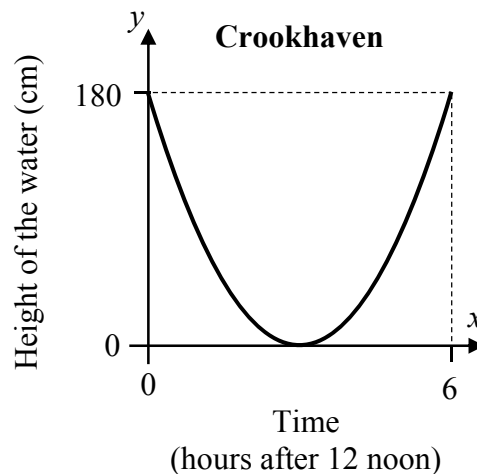
A full page of blank graph paper with a uniform grid of small squares. The grid consists of 20 columns and 20 rows, creating a total of 400 squares. The lines are thin and gray, set against a white background. There are no margins or additional markings on the page.

- [illegible]

On this day, the height of the water at 12 noon was 180 cm, and the height of the water at the lowest point on the graph was 0 cm.

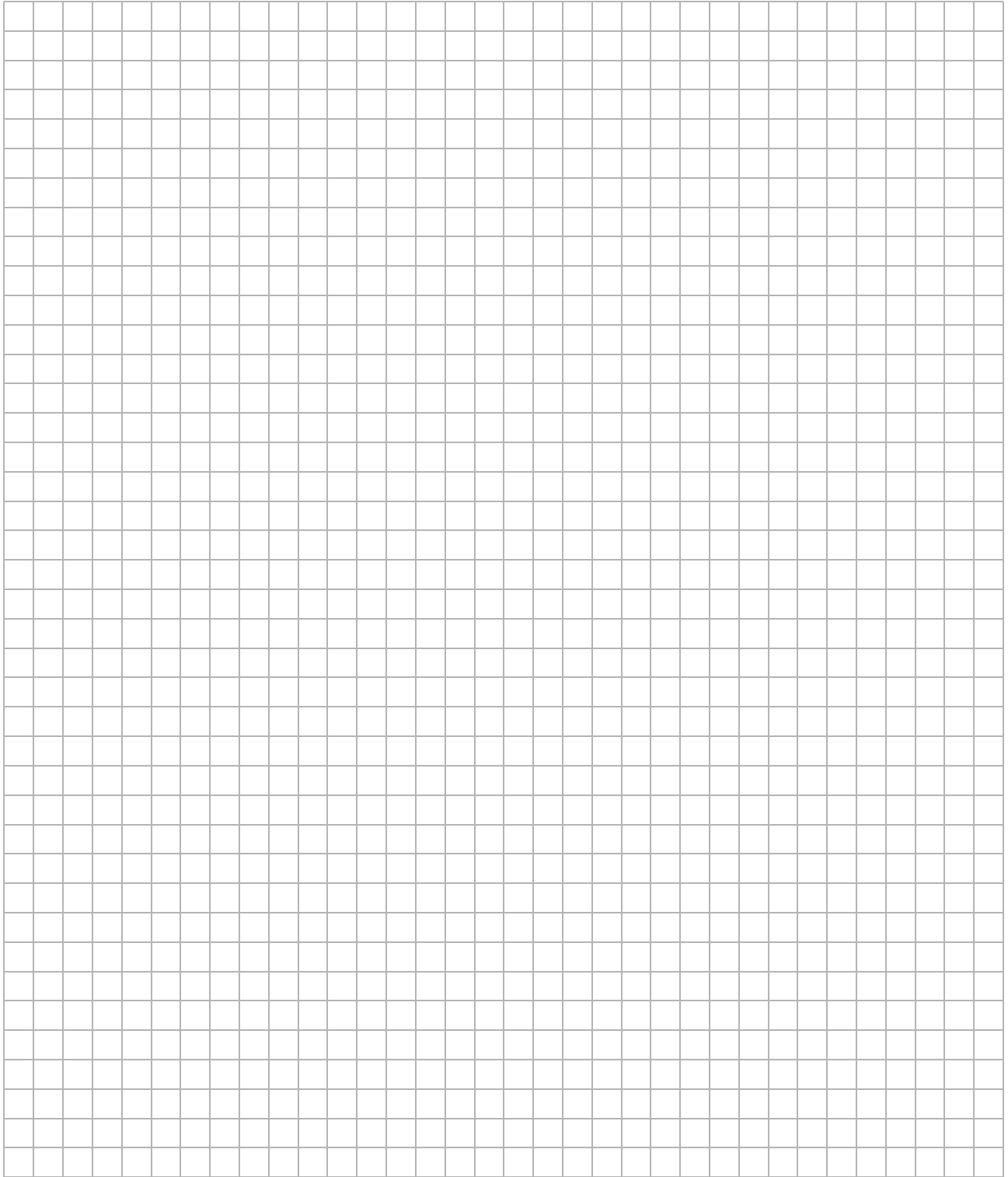
- $$g(x) = ax^2 + bx + c,$$

(i) Find the value of  $c$ .

[illegible]

- 
- This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.

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Junior Certificate 2016 – Higher Level

**Mathematics – Paper 1**

Friday 10 June

Afternoon 2:00 to 4:30





Coimisiún na Scrúduithe Stáit  
State Examinations Commission

Junior Certificate Examination 2015

# Mathematics

Paper 1  
Higher Level

Friday 5 June – Afternoon 2:00 to 4:30

300 marks

Examination number
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Centre Stamp
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Running total	
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For examiner			
Question	Mark	Question	Mark
1		11	
2		12	
3		13	
4		14	
5			
6			
7			
8			
9			
10		Total	

Grade
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## Instructions

There are 14 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. You may ask the superintendent for more paper. 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 all necessary work is not clearly shown.**

**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:

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**Question 1****(Suggested maximum time: 10 minutes)**

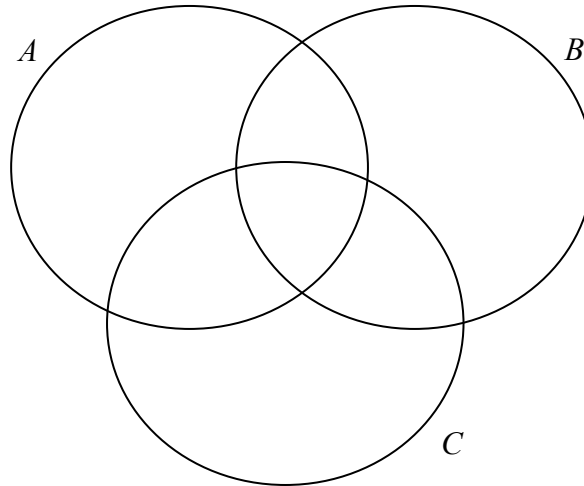
The sets  $A$ ,  $B$ , and  $C$  are as follows:

$$A = \{1, 2, 3, 5, 6, 7\}$$

$$B = \{2, 3, 4, 5, 8, 9\}$$

$$C = \{1, 4, 5, 10\}.$$

(a) Complete the Venn diagram below.



(b) List the elements of each of the following sets.

$$A \cup B = \underline{\hspace{4cm}}$$

$$A \setminus C = \underline{\hspace{4cm}}$$

$$A \cup (B \cap C) = \underline{\hspace{4cm}}$$

(c) Complete the following identity.

$$A \cup (B \cap C) = (A \cup B) \cap (\underline{\hspace{2cm}})$$

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## Question 2

**(Suggested maximum time: 5 minutes)**

- (a)** David weighs 88 kg. The average male triathlete of his height weighs 83 kg.

If David aims to reach this weight, what **percentage decrease** is required?

Give your answer correct to two decimal places.

- (b) Mary's house was worth €200 000.

Mary increased the value of her house by 15% by building a conservatory.

She then increased its value by a further 10% by repaving the driveway.

Find the **total percentage** increase in value.

**Question 3** (Suggested maximum time: 10 minutes)

**Question 3** (Suggested maximum time: 10 minutes)

Eleanor has a **gross** income of €38 500 for the year.

She has an annual tax credit of €3300.

The standard rate cut-off point is €33 800.

The standard rate of income tax is 20% and the higher rate is 40%.

- (a)** Find Eleanor's **net** income for the year (i.e. after tax is paid).

Eleanor receives a pay rise. As a result, her **net** income for the year is €34 780.

- (b) Find Eleanor's new **gross** income for the year.

### Question 4

**(Suggested maximum time: 5 minutes)**

Let  $f(x) = 3x + 5$ , for  $x \in \mathbb{R}$ .

- (a)** Find the value of  $f(7)$ .

- (b) Write  $f(k)$  in terms of  $k$ .

- (c)** Using your answer to part **(b)**, or otherwise, find the value of  $k$  for which  $f(k) = k$ .

**Question 5** (Suggested maximum time: 10 minutes)

**Question 5** (Suggested maximum time: 10 minutes)

The Kelvin scale is one way of measuring temperature.

To convert a temperature from degrees Fahrenheit ( $F$ ) to kelvin ( $K$ ), you:

add  $459 \cdot 67$  to  $F$ , then multiply your answer by 5 and divide by 9.

- (a)** Convert 212 degrees Fahrenheit ( $F$ ) to kelvin ( $K$ ).

- (b)** Write an algebraic formula to express  $K$  in terms of  $F$ .

- (c)** Hence, or otherwise, convert 400 kelvin ( $K$ ) to degrees Fahrenheit ( $F$ ).

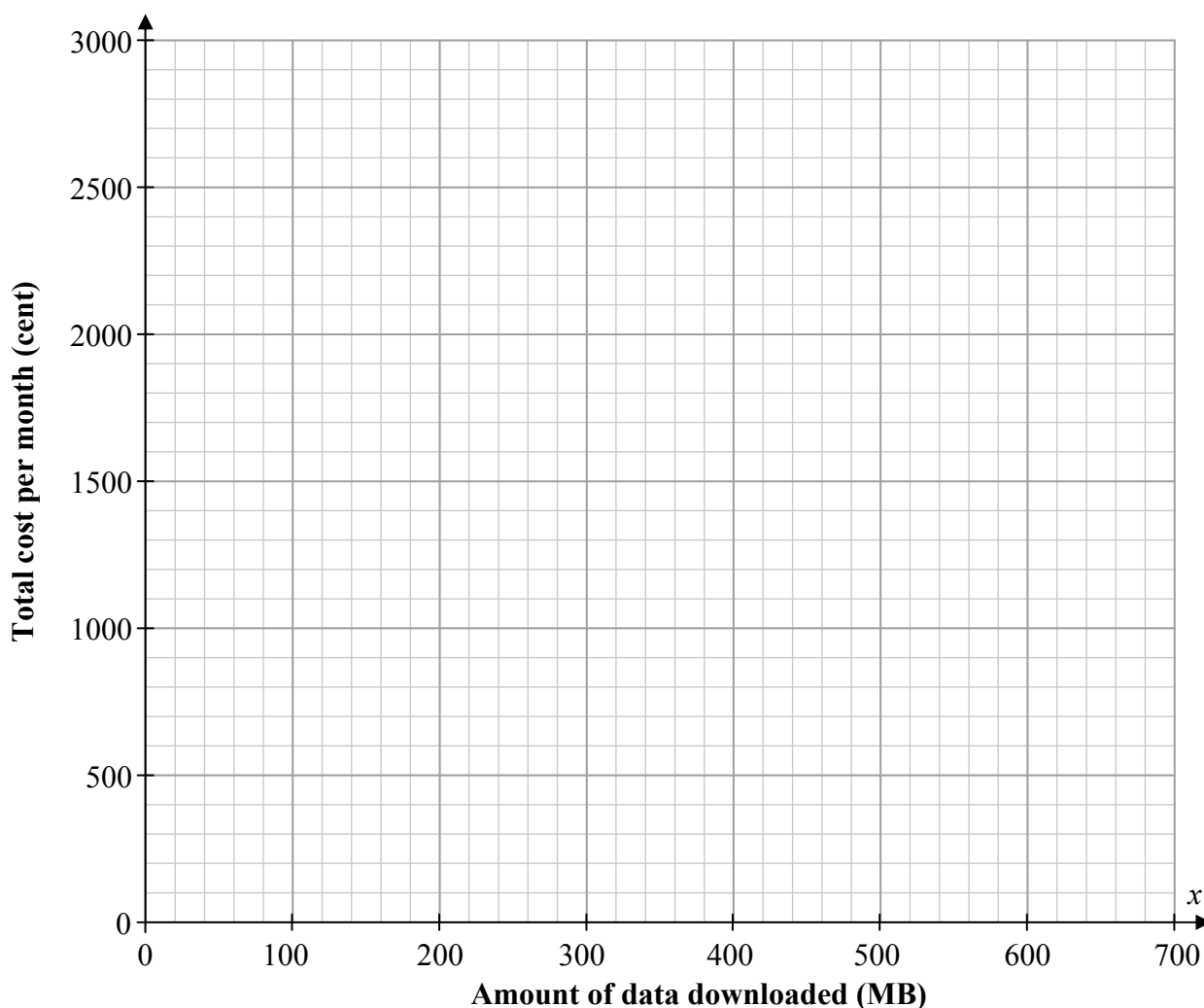
### Question 6

(Suggested maximum time: 15 minutes)

Two mobile phone companies, *Cellulon* and *Mobil*, offer price plans for mobile internet access. A formula, in  $x$ , for the total cost per month for each company is shown in the table below.  $x$  is the number of MB of data downloaded per month.

Phone company	Total cost per month (cent)
<i>Cellulon</i>	$c(x) = 4x$
<i>Mobil</i>	$m(x) = 1000 + 2x$

- (a) Draw the graphs of  $c(x)$  and  $m(x)$  on the co-ordinate grid below to show the total cost per month for each phone company, for  $0 \leq x \leq 700$ . **Label** each graph clearly.





- (b)** Which company charges **no** fixed monthly fee?

Justify your answer, with reference to the relevant **formula** or **graph**.

- (c) Write down the **point of intersection** of the two graphs.

Fergus wants to buy a mobile phone from one of these two companies, and wants his mobile internet bill to be as low as possible.

- (d) Explain** how your answer to part (c) would help Fergus choose between *Cellulon* and *Mobil*.

**Question 7** (Suggested maximum time: 5 minutes)

**Question 7** (Suggested maximum time: 5 minutes)

- (a)** Multiply out and simplify  $(x + 5)(x^2 - 2x + 6)$ .

- (b)** Factorise fully  $ac - ad - bd + bc$ .


- (c) Write the following as a single fraction in its simplest form.

$$\frac{x+2}{3} - \frac{x-3}{4}$$

**Question 8**

**(Suggested maximum time: 5 minutes)**

**(a) Complete** the inequality in  $n$  below so that it has the solution set shown.

Inequality	Solution Set
<div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; width: 80px; height: 30px; margin-right: 10px;"></div> <math>\leq n \leq</math> <div style="border: 1px solid black; width: 80px; height: 30px; margin-left: 10px;"></div> <span style="margin-left: 10px;"><math>, n \in \mathbb{N}.</math></span> </div>	 <p>A horizontal number line with tick marks at 0, 1, 2, 3, 4, 5, and 6. Solid black dots are placed at the positions corresponding to 2, 3, and 4.</p>

**(b) Complete** the inequality in  $x$  below so that there is only **one** possible value of  $x$ , where  $x \in \mathbb{R}$ .

$\leq x \leq$  $, x \in \mathbb{R}.$

**Question 9** (Suggested maximum time: 10 minutes)

**Question 9** (Suggested maximum time: 10 minutes)

- (a) (i)** Factorise  $x^2 + 7x - 30$ .

- (ii)** Hence, or otherwise, solve the equation  $x^2 + 7x - 30 = 0$ .

- (b)** Solve the equation  $2x^2 - 7x - 10 = 0$ .  
Give each answer correct to two decimal places.

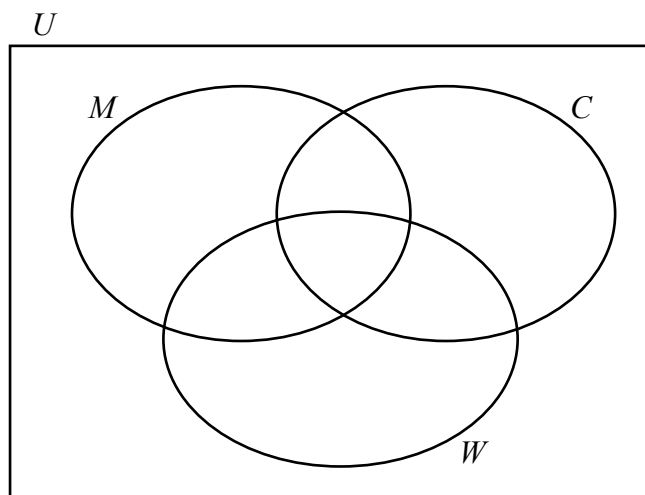
### Question 10

**(Suggested maximum time: 10 minutes)**

A researcher has found old census data about Measles ( $M$ ), Chickenpox ( $C$ ), and Whooping cough ( $W$ ) among 12-year-old children. In a group of 100 children:

- 31 had **none** of these diseases  
 2 had **all three** diseases  
 2 had Measles **and** Chickenpox, but **not** Whooping cough  
 6 had Whooping cough **and** Chickenpox  
 11 had **at least two** diseases  
 18 had Measles  
 40 had Chickenpox.
- 

(a) Use this data to **fill in** the Venn diagram.



**(b)** Find the **probability** that a child chosen at random from the group had Chickenpox.

[illegible]

The table below shows 3 statements. Each statement is written in English and in set notation.

(c) Complete the table.

	English	Set notation
<b>Statement 1</b>	6 had Whooping cough <b>and</b> Chickenpox	$6 = \#(W \cap C)$
<b>Statement 2</b>		$36 = \#(C \setminus M)$
<b>Statement 3</b>	2 had Measles <b>and</b> Chickenpox but <b>not</b> Whooping cough	

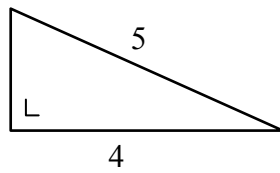
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**Question 11****(Suggested maximum time: 20 minutes)**

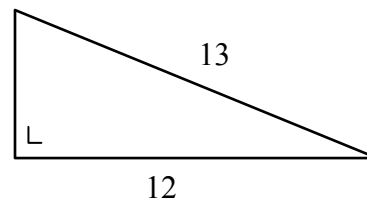
Two right-angled triangles are shown below.

- (a) Find the height of each triangle.

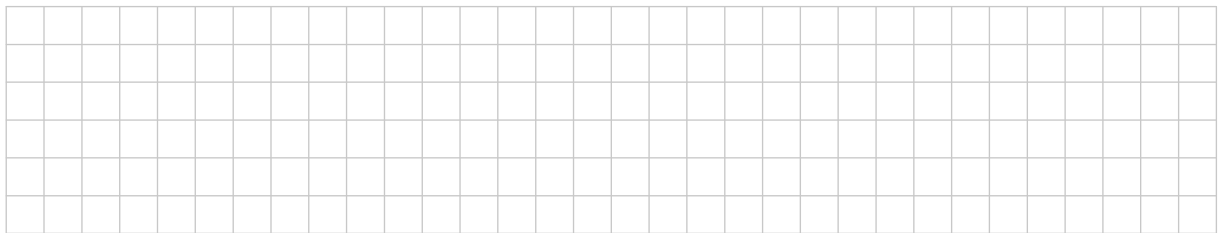
Write each answer in the box below the appropriate diagram.



Height =



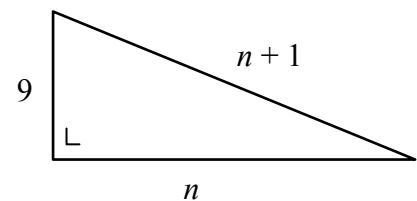
Height =



The triangles above are the first two triangles (with sides of integer lengths) where the hypotenuse is 1 unit longer than the base.

- (b) Another such triangle is shown on the right.  
It has a height of 9 units.

Use the Theorem of Pythagoras to find the value of  $n$ ,  
the length of the base of this triangle.





### Question 12

**(Suggested maximum time: 10 minutes)**

- (a) (i)** Factorise  $n^2 - 1$ .

Hence, or otherwise, answer the following question.

- (ii) The **product** of two **consecutive odd** positive numbers is 399. Find the two numbers.

- (b) Divide  $x^3 + 5x^2 - 29x - 105$  by  $x + 3$ .



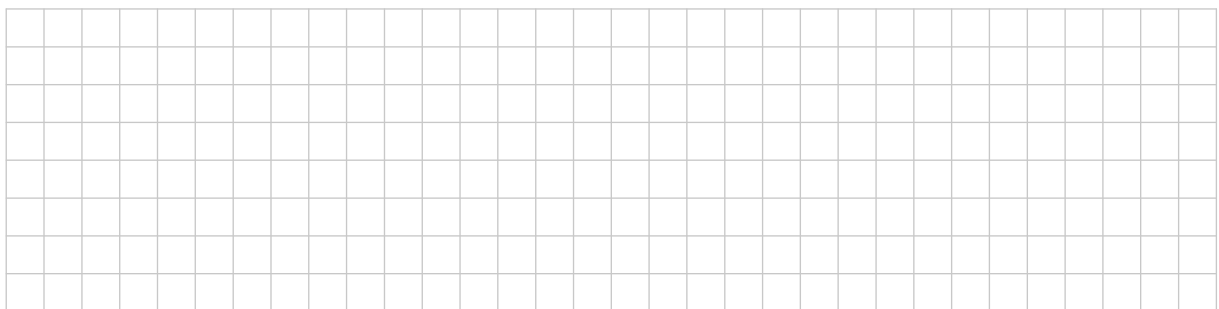
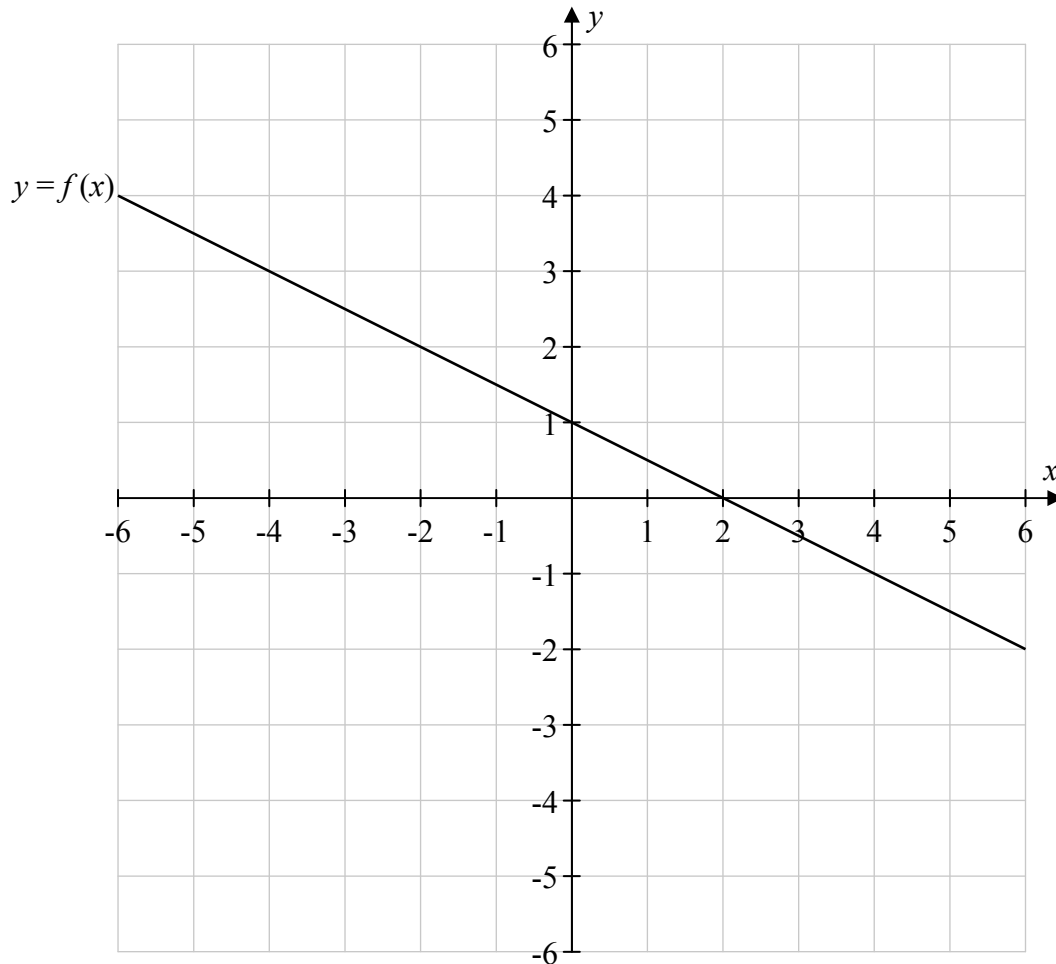
**Question 13****(Suggested maximum time: 5 minutes)**

The graph of the linear function  $y = f(x)$  is drawn on the co-ordinate grid below.

Using the same axes, draw the graph of each of the following functions, where  $-6 \leq x \leq 6$ ,  $x \in \mathbb{R}$ .  
Label each graph clearly.

**(a)**  $y = f(x) + 2$

**(b)**  $y = -f(x)$

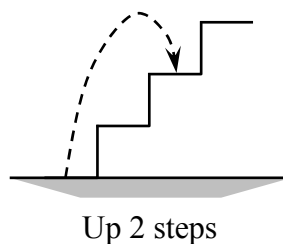
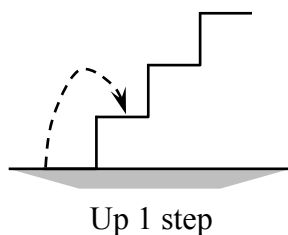


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### Question 14

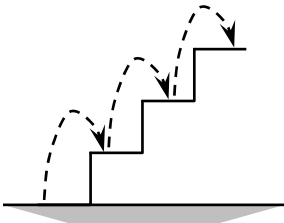
**(Suggested maximum time: 20 minutes)**

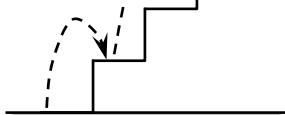
A boxer runs up stairs as part of her training. She can go up 1 step or 2 steps with each stride, as shown.

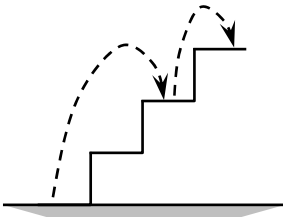


The boxer wants to count how many different ways she can reach the  $n$ th step. She calls this  $T_n$ , the  $n$ th Taylor number.

For example, she has **3** different ways to reach the 3rd step, as shown in the tables below.  
So  $T_3 = 3$ .

<b>3rd step: way 1</b>
Up 1 step, then 1 step, then 1 step
$1 + 1 + 1$


<b>3rd step: way 2</b>
Up 1 step, then 2 steps
$1 + 2$


<b>3rd step: way 3</b>
Up 2 steps, then 1 step
$2 + 1$


- (a)** Find the value of  $T_1$  and  $T_2$ .

$T_1 =$  \_\_\_\_\_

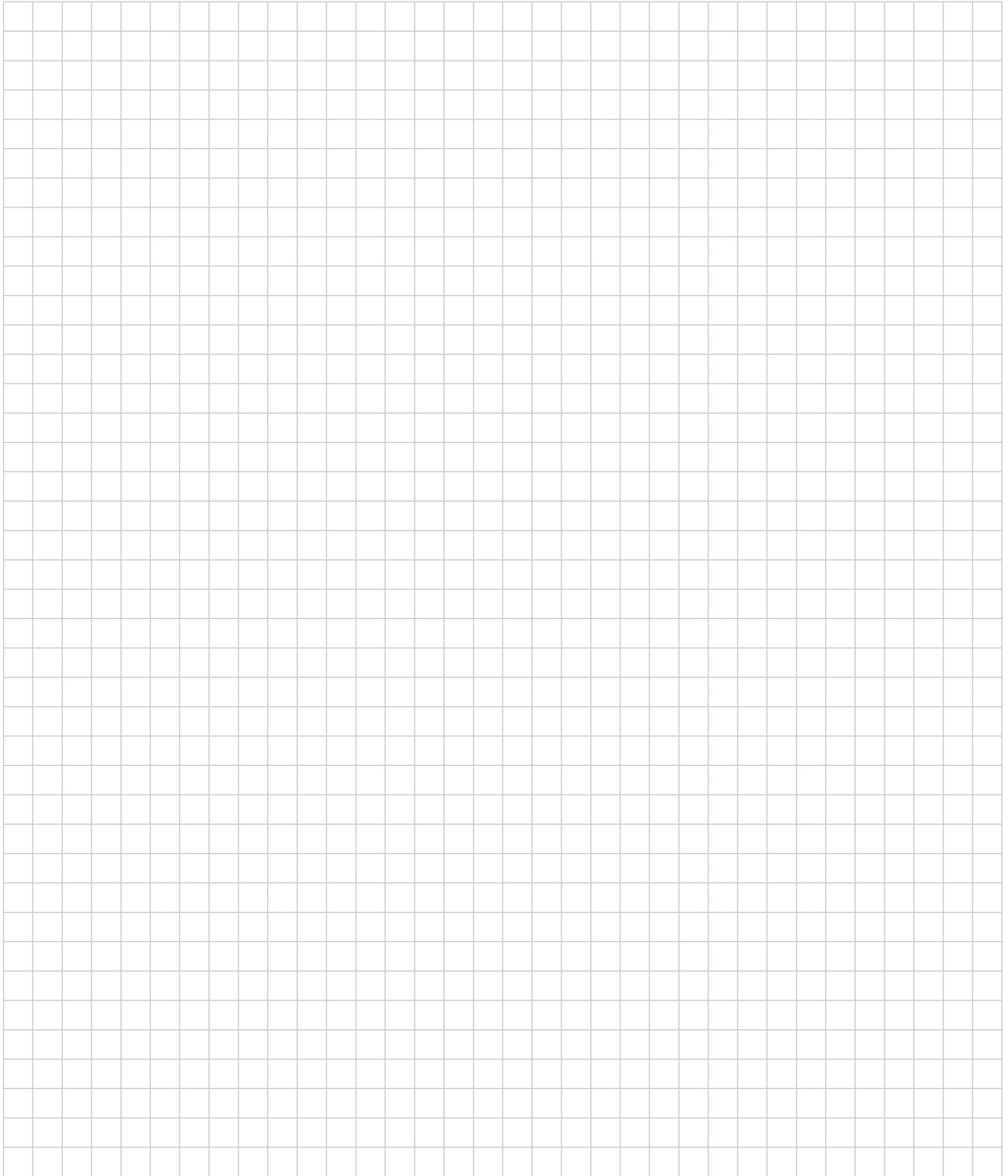
$T_2 =$  \_\_\_\_\_

- (b) **List** all the different ways that she can reach the 4th step; one way is already done for you. Hence **write down** the value of  $T_4$ .

Different ways to reach the 4th step: **1 + 1 + 1 + 1**

Answer:  $T_4 =$  \_\_\_\_\_

(c) (i) **List** the different ways that she can reach the 5th step, if she starts by going up **1 step**.



Junior Certificate 2015 – Higher Level

**Mathematics – Paper 1**

Friday 5 June  
Afternoon 2:00 to 4:30



Coimisiún na Scrúduithe Stáit  
State Examinations Commission

Junior Certificate Examination 2014

Mathematics  
(Project Maths – Phase 2)

Paper 1

Higher Level

Friday 6 June – Afternoon, 2:00 to 4:30

300 marks

Examination number
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Centre stamp
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Running total	
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For examiner			
Question	Mark	Question	Mark
1		11	
2		12	
3		13	
4		14	
5			
6			
7			
8			
9			
10		Total	

Grade
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## Instructions

There are 14 questions on this examination paper. Answer **all** questions.

Questions do not necessarily carry equal marks. To help you manage your time during this examination, a maximum time for each question is suggested. If you remain within these times you should have about 10 minutes left to review your work.

Question 14 carries a total of 50 marks.

Write your answers in the spaces provided in this booklet. You may lose marks if you do not do so. There is space for extra work at the back of the booklet. You may also ask the superintendent for more paper. 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 all necessary work is not clearly shown.

Answers should include the appropriate units of measurement, where relevant.

Answers should be given in simplest form, where relevant.

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

### Question 1

**(Suggested maximum time: 5 minutes)**

- (a)** Place the following numbers in order, starting with the smallest:

$$\frac{3}{2}$$

1.4

$\sqrt{2}$

- (b)** Which one of the following is **not** a rational number? Explain your answer.

$$3\frac{1}{7}$$

3·142

$$\frac{22}{7}$$

$\pi$

- (c) (i)** Find the values of  $\frac{4n^2+1}{13}$ , where  $n \in \{17, 19, 21\}$ .

$n$	$\frac{4n^2 + 1}{13}$
17	
19	
21	

- (ii)** State which **one** of your answers is a natural number, and explain your choice.

## Question 2

(Suggested maximum time: 5 minutes)

- (a) John thinks that he has a method for finding **all** prime numbers. He says that if he uses the formulas in the table below, he will generate the prime numbers. He also says that these formulas will generate **only** the prime numbers.

- (i) Complete the table.

$p$	$6p + 1$	$6p + 5$
0	1	5
1		
2		
3		
4		
5		

- (ii) Give two reasons why his method is not fully correct.

Reason 1:

Reason 2:

- (b) The Swiss mathematician and physicist, Euler, first noticed (in 1772) that the expression  $n^2 - n + 41$  gives a prime number for all positive integer values of  $n$  less than 41.

Explain why it does not give a prime number for  $n = 41$ .





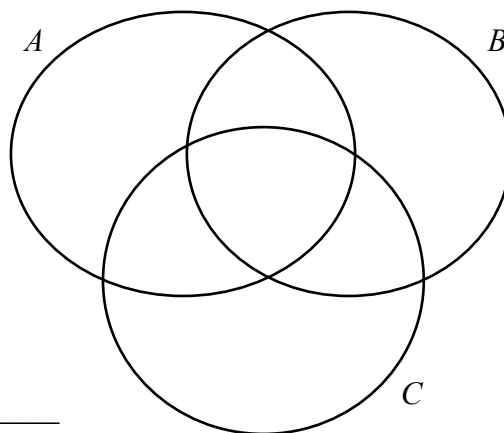
### Question 3

**(Suggested maximum time: 10 minutes)**

- (a)** The sets  $A$ ,  $B$ , and  $C$  are as follows:

$$A = \{2, 3, 4, 5, 6\}, B = \{2, 4, 6, 8, 10\}, \text{ and } C = \{1, 4, 8, 12, 14\}.$$

- (i) Complete the Venn diagram.
- (ii) List the elements of each of the following sets:



$A \cap B =$  \_\_\_\_\_

$$B \setminus (A \cap C) = \underline{\hspace{2cm}}$$

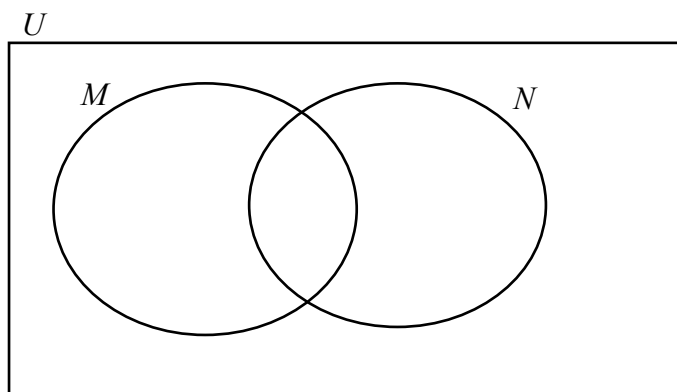
$$(B \setminus A) \cup (B \setminus C) = \underline{\hspace{2cm}}$$

- (iii) Write down a null set, in terms of  $A$ ,  $B$ , and  $C$ . \_\_\_\_\_

- (b) In a table quiz, 100 questions were asked. Team  $M$  answered 72 questions correctly. Team  $N$  answered 38 questions correctly.

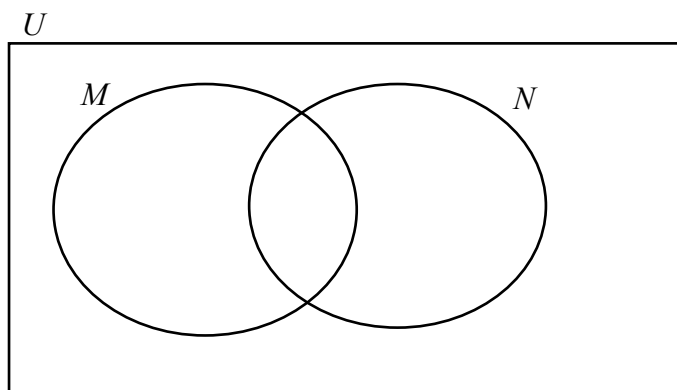
- (i) Find, with the aid of the Venn diagram, the minimum number of questions answered correctly by both teams.

Minimum =



- (ii) Find, with the aid of the Venn diagram, the maximum number of questions answered correctly by both teams.

Maximum =



**Question 4** (Suggested maximum time: 10 minutes)

**Question 4** (Suggested maximum time: 10 minutes)

- (a) Factorise fully  $9a^2 - 6ab + 12ac - 8bc$ .

- (b)** Factorise  $9x^2 - 16y^2$ .

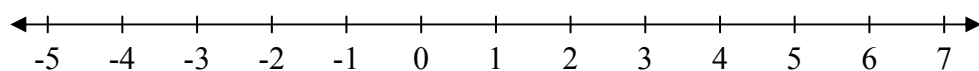
- (c) Use factors to simplify the following:  $\frac{2x^2 + 4x}{2x^2 + x - 6}$ .

**Question 5** (Suggested maximum time: 5 minutes)

**Question 5** (Suggested maximum time: 5 minutes)

Solve the following inequality and show the solution on the number line.

$$-17 \leq 1 - 3x < 13, \quad x \in \mathbb{Z}$$

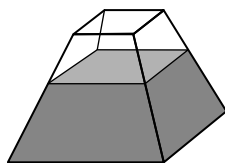


### Question 6

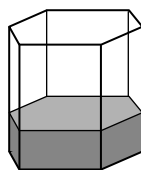
(Suggested maximum time: 10 minutes)

Below are three containers, labelled **1**, **2**, and **3**.

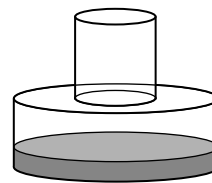
Water is poured into each container at a constant rate, until it is full.



**1**

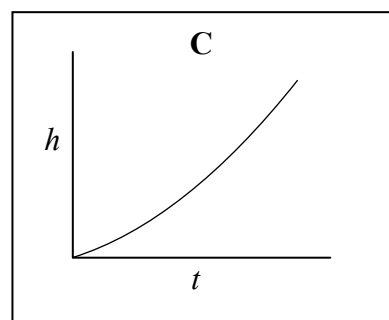
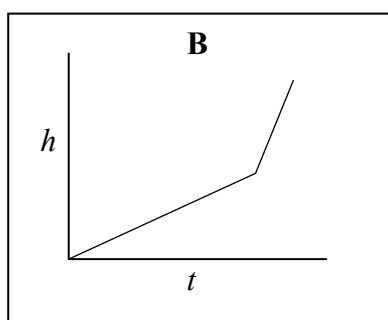
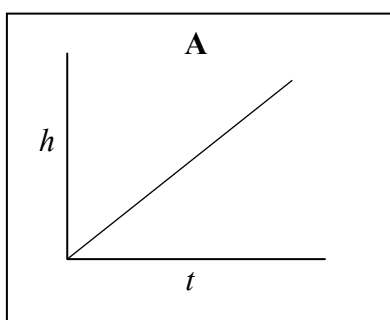


**2**



**3**

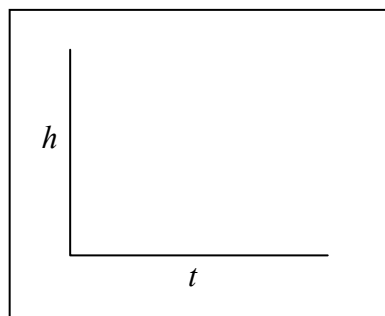
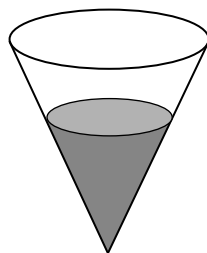
The three graphs, **A**, **B**, and **C**, show the height of the water,  $h$ , in the containers after time  $t$ .



(a) Write **A**, **B**, and **C** in the table below to match each container to its corresponding graph.

Container	1	2	3
Graph			

(b) Another container is shown below. Water is also poured into this container at a constant rate until it is full. Sketch the graph you would expect to get when plotting height ( $h$ ) against time ( $t$ ) for this container.



### Question 7

**(Suggested maximum time: 10 minutes)**

Last year Elena had a gross income of €36 960.

She had to pay Universal Social Charge (USC) and income tax on her gross income.

The rates and bands of USC are as follows.

Income band	Rate of USC
Up to €10 036	2%
Between €10 036 and €16 016	4%
Above €16 016	7%

- (i) Find the amount of USC that was deducted from Elena's gross income last year.

- (ii)** The standard rate of income tax was 20% and the higher rate was 41%.  
The standard rate cut-off point was €32 800.  
Elena paid a total of €4965·60 income tax last year.

Find Elena's tax credits for the year.

- (iii) Find Elena's total deduction (USC and income tax) as a percentage of her gross income. Give your answer correct to the nearest percent.

### Question 8

**(Suggested maximum time: 10 minutes)**

The table shows the height, in metres, of a ball at various times after being kicked into the air.

- (i) Is the pattern of heights in the table linear, quadratic, or exponential? Explain your answer.

<b>Time (seconds)</b>	0	0.5	1	1.5	2	2.5	3
<b>Height (metres)</b>	0.3	3.4	5.7	7.2	7.9	7.8	6.9

- (ii)** Estimate the height of the ball after 3.5 seconds.

- (iii)** Estimate the total time the ball spends in the air. Justify your answer.

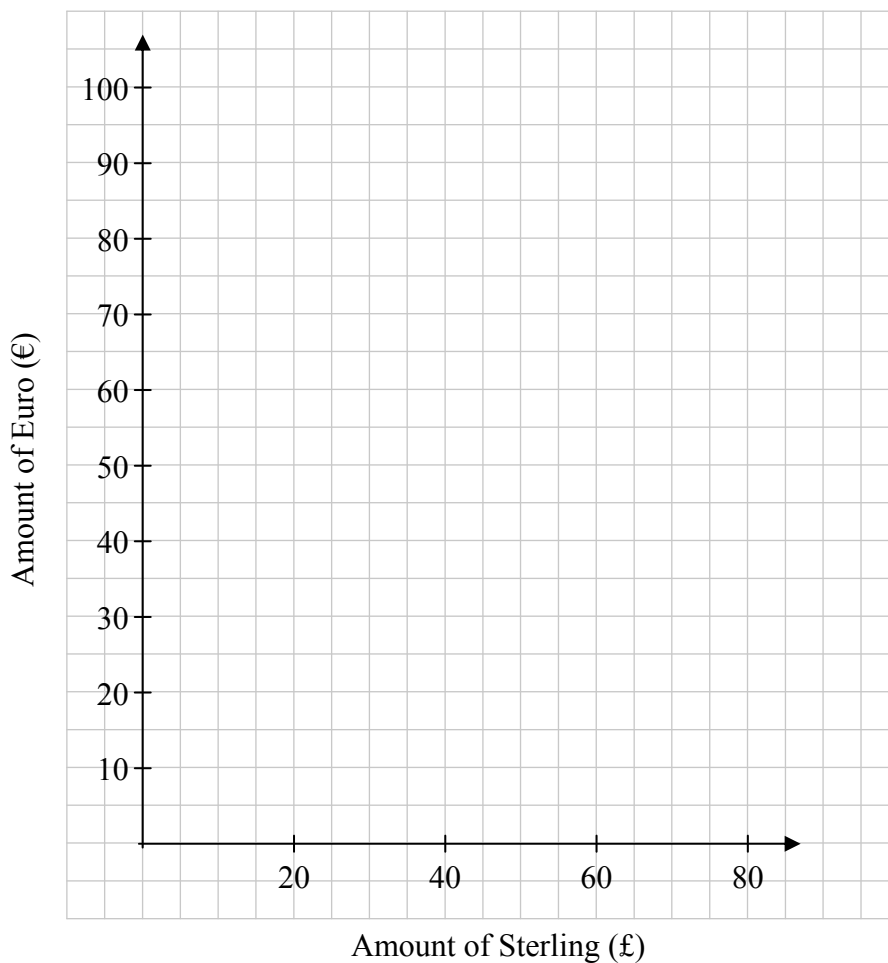
**Question 9****(Suggested maximum time: 15 minutes)**

Jack and Sarah are going on a school tour to England. They investigate how much different amounts of sterling (£) will cost them in euro (€). They each go to a different bank.

Their results are shown in the table below.

Amount of sterling (£)	Cost in euro (€) for Jack	Cost in euro (€) for Sarah
20	33	24
40	56	48
60	79	72
80	102	96

- (i) On the grid below, draw graphs to show how much the sterling will cost Jack and Sarah, for up to £80.

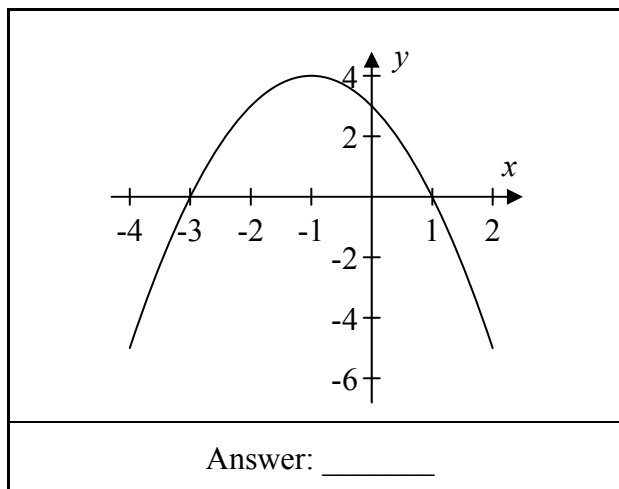
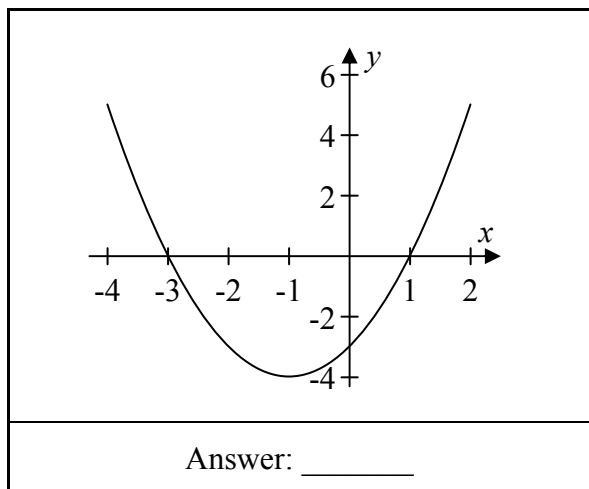




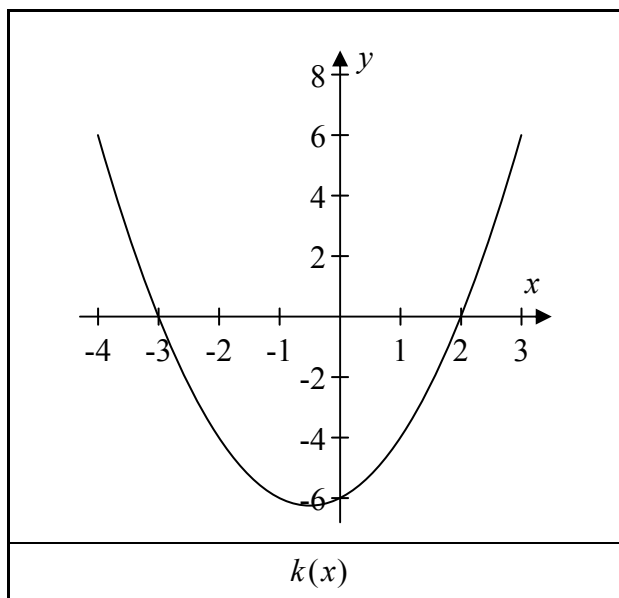
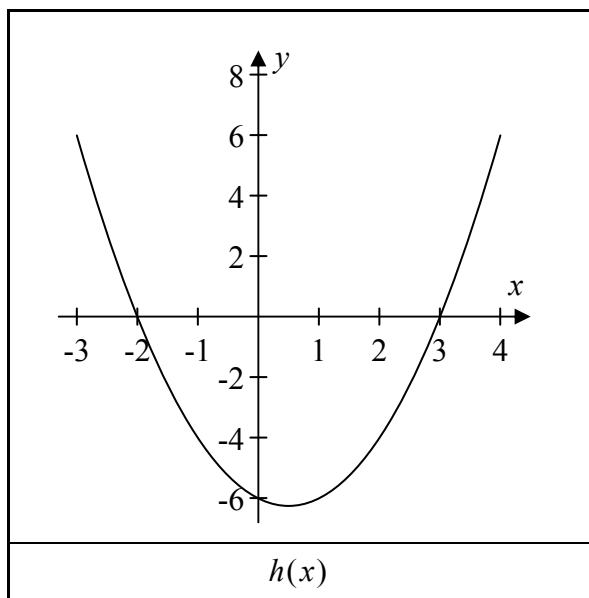
### Question 10

(Suggested maximum time: 10 minutes)

- (a) The graphs of the functions  $f(x) = x^2 + 2x - 3$  and  $g(x) = -x^2 - 2x + 3$  are shown below. Identify each graph by writing  $f(x)$  or  $g(x)$  in the space provided below the graph.



- (b) The graphs of the functions  $y = h(x)$  and  $y = k(x)$  are shown below.



Write down the roots of each function.

Hence, or otherwise, write down an equation for each function.

Roots of  $h(x)$ :

Equation:  $h(x) =$

Roots of  $k(x)$ :

Equation:  $k(x) =$



### Question 11

**(Suggested maximum time: 10 minutes)**

$x$  is a real number.

One new number is formed by increasing  $x$  by 1.

A second new number is formed by decreasing  $x$  by 2.

- (i)** Write down each of these new numbers, in terms of  $x$ .

Increase $x$ by 1:	
Decrease $x$ by 2:	

- (ii) The product of these two new numbers is 1.  
Use this information to write an equation in  $x$ .

- (iii)** Solve this equation to find the two possible values of  $x$ .  
Give each of your answers correct to 3 decimal places.

### Question 12

**(Suggested maximum time: 15 minutes)**

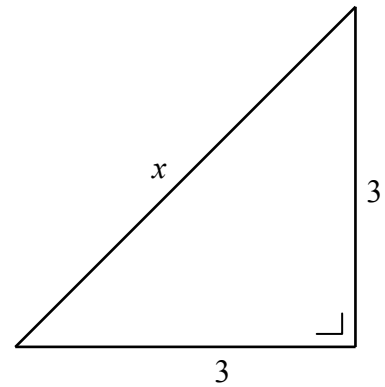
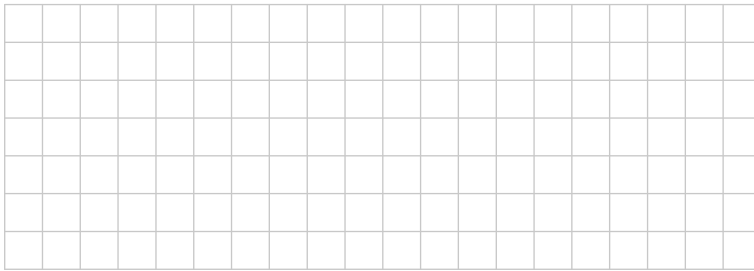
- (a)** Simplify  $(6x-3)(2x-1)$ .

$$\begin{aligned} 2x - 3y &= 18 \\ 5x + 9y &= -10. \end{aligned}$$

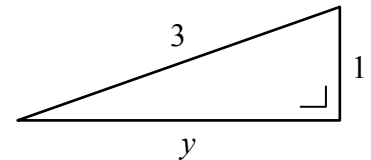
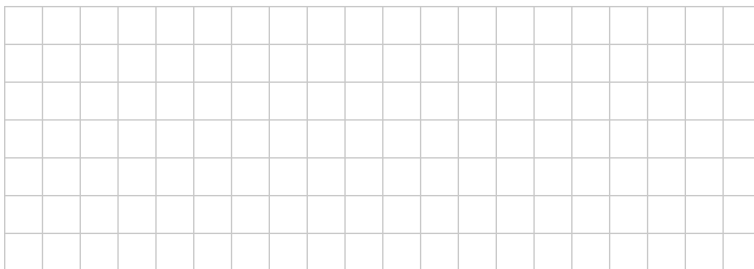
**Question 13**

(Suggested maximum time: 5 minutes)

- (i) Use the diagram on the right to calculate the value of  $x$ .  
Give your answer in surd form.

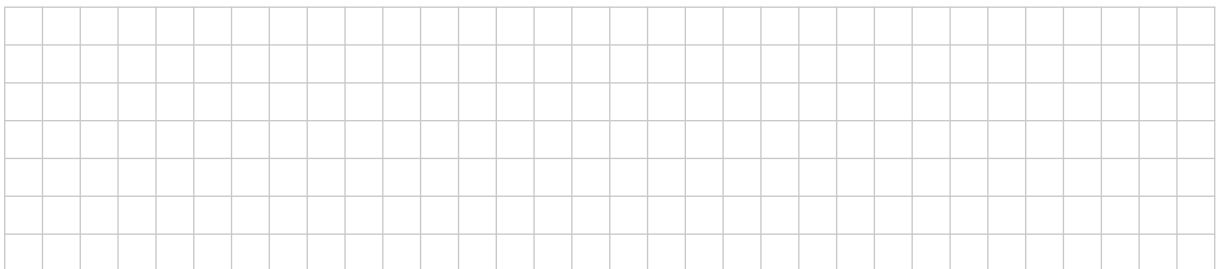
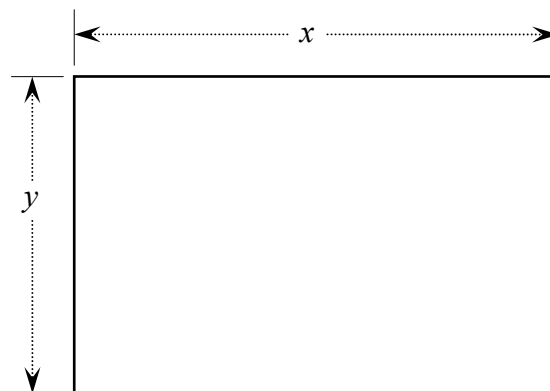


- (ii) Use the diagram below to calculate the value of  $y$ . Give your answer in surd form.



- (iii) A rectangle with sides of length  $x$  and  $y$  is drawn using the values of  $x$  and  $y$  from parts (i) and (ii), as shown below.

Write the **perimeter** of this rectangle in the form  $a\sqrt{2}$ , where  $a \in \mathbb{N}$ .



**Question 14** (Suggested maximum time: 20 minutes)

**Question 14** (Suggested maximum time: 20 minutes)

- (i)  $g$  is the function  $g: x \mapsto x-1$ , where  $x \in \mathbb{R}$ . Find the value of each of the following.

A coordinate plane with a grid. The x-axis and y-axis are shown. The y-axis has labels  $g(3)$  and  $g(-2)$ . A horizontal line is drawn at the level of  $g(-2)$ .

- (ii)**  $f$  is the function  $f: x \mapsto 2x^2 - x - 6$ , where  $x \in \mathbb{R}$ .

Using the same axes and scales, draw the graphs of the functions  $y = f(x)$  and  $y = g(x)$  in the domain  $-2 \leq x \leq 3$ .

Use your graphs from **(ii)** to estimate:

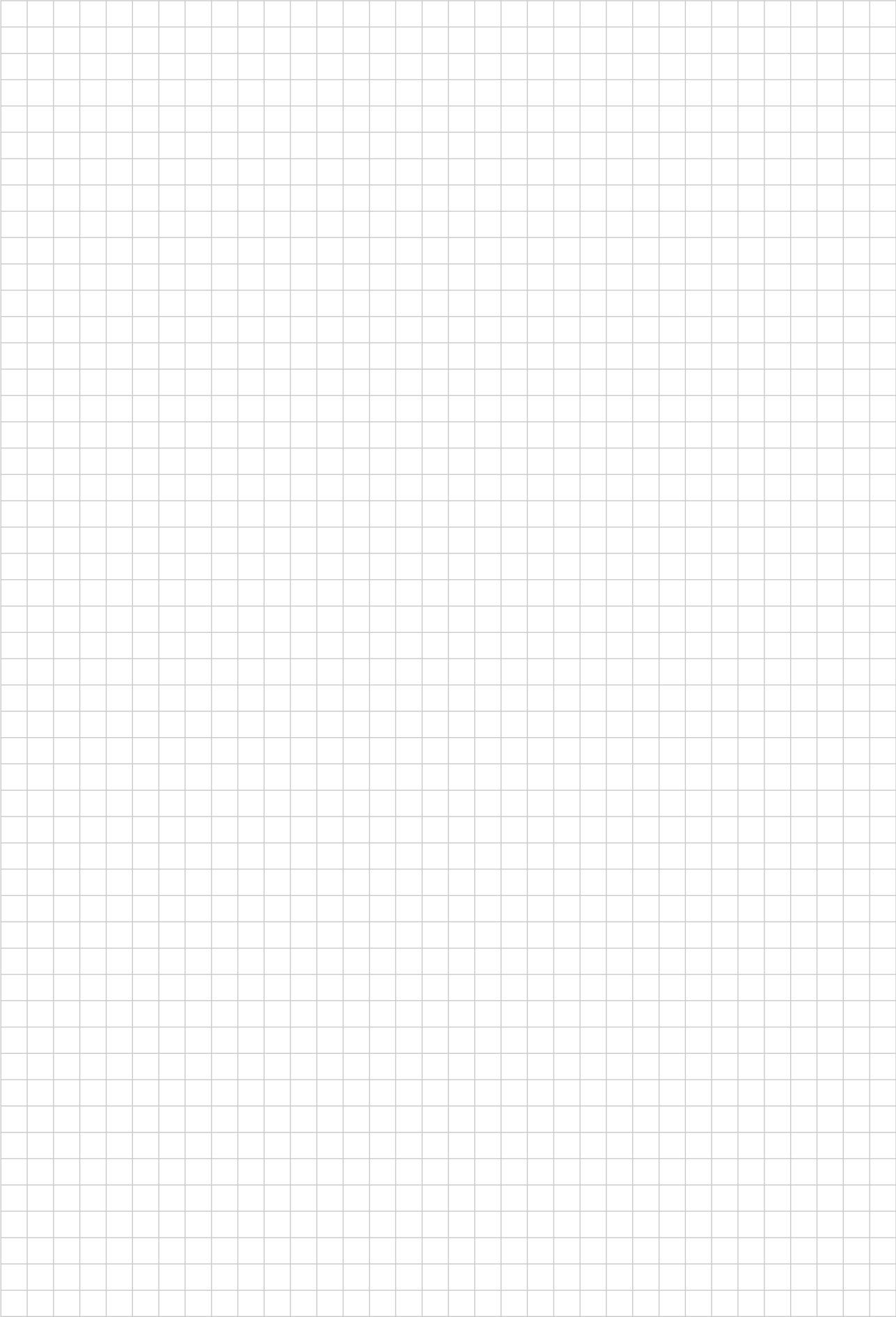
(iii) the minimum value of  $f(x)$

(iv) the range of values of  $x$  for which  $f(x) < 0$

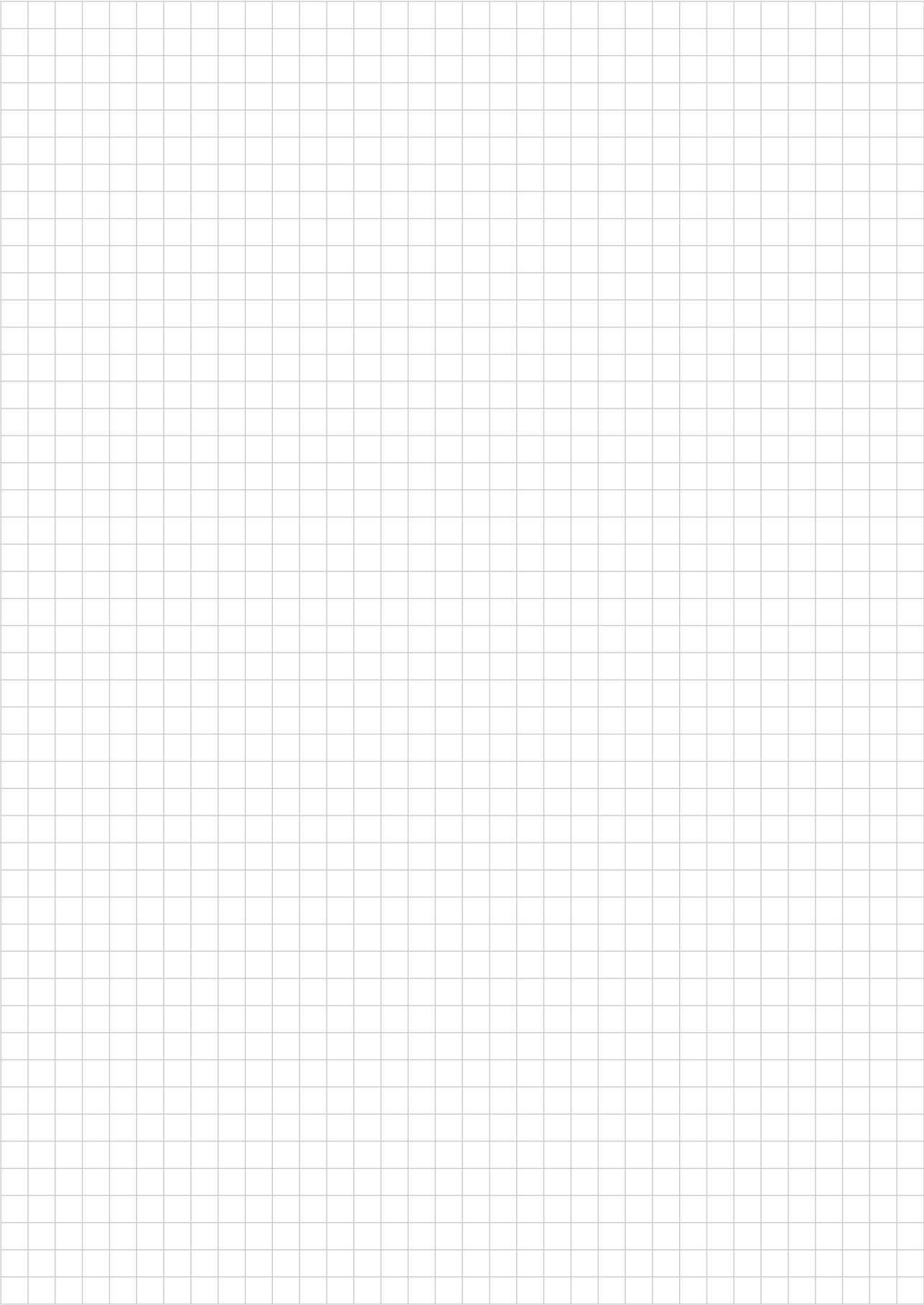
(v) the range of values of  $x$  for which  $g(x) \geq 0$ .

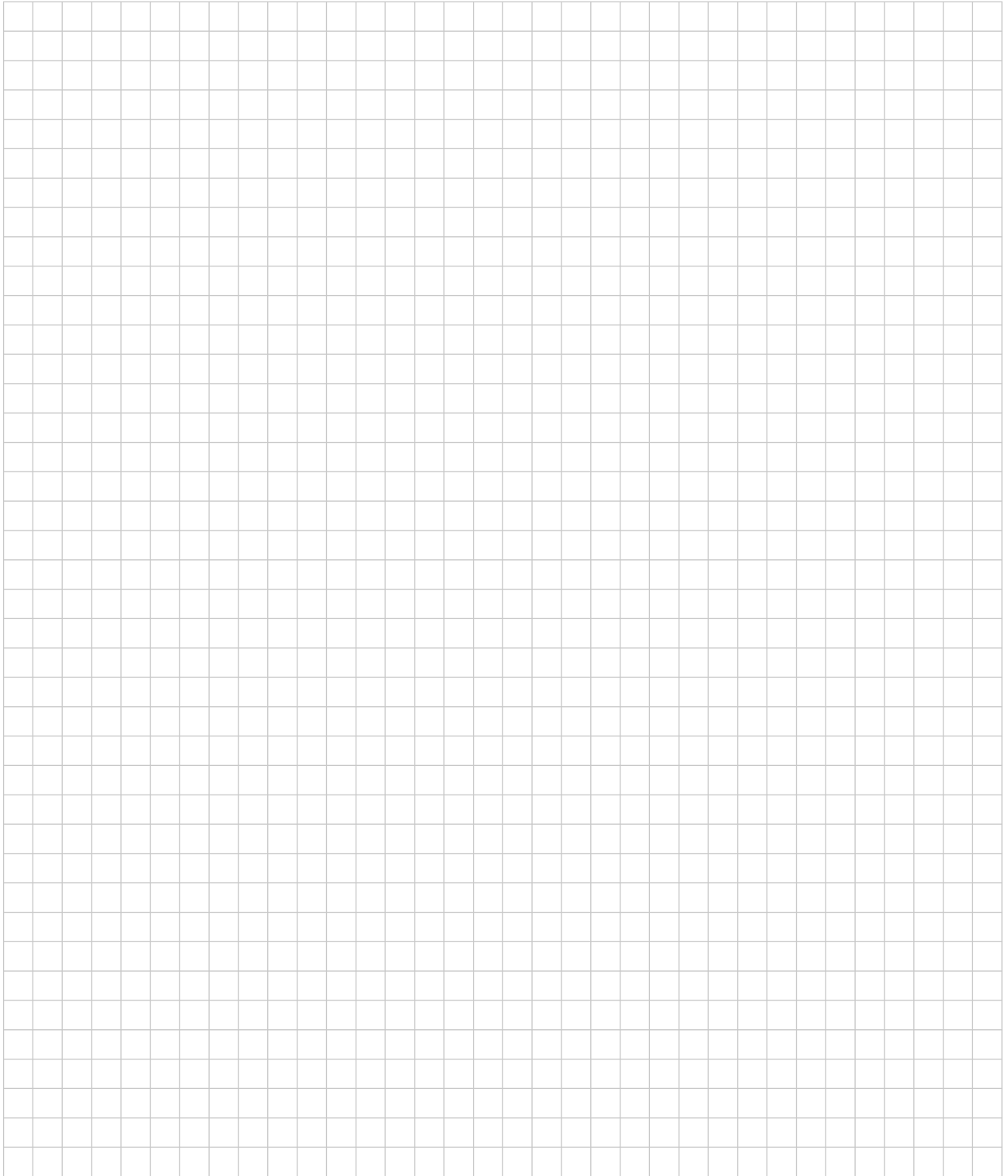
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You may use this page for extra work.





Junior Certificate 2014 – Higher Level

## Mathematics (Project Maths – Phase 2) – Paper 1

Friday 6 June

Afternoon, 2:00 to 4:30





# **Coimisiún na Scrúduithe Stáit**

# **State Examinations Commission**

**JUNIOR CERTIFICATE EXAMINATION, 2013**

**MATHEMATICS – HIGHER LEVEL**

**PAPER 1 (300 marks)**


**FRIDAY, 7 JUNE – AFTERNOON, 2.00 to 4.30**

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Attempt **ALL** questions.

Each question carries 50 marks.

**Graph paper may be obtained from the superintendent.**

The symbol  indicates that supporting work must be shown to obtain full marks.


---

1. (a) Adam got 24 marks from a total of 30 marks in a class test.

 What percentage mark did Adam get?

- (b) (i) Place the following numbers in order, starting with the smallest number:

$$4^{\frac{1}{2}}, \quad 4^{-2}, \quad 2^0, \quad 2^{-3}.$$

- (ii)  By rounding correct to the nearest whole number,  
estimate the value of


$$\frac{7 \cdot 72}{2 \cdot 35} + (3 \cdot 4)^2 \left( \frac{8 \cdot 65}{2 \cdot 9} - \sqrt{1 \cdot 49} \right).$$

Then, evaluate

$$\frac{7 \cdot 72}{2 \cdot 35} + (3 \cdot 4)^2 \left( \frac{8 \cdot 65}{2 \cdot 9} - \sqrt{1 \cdot 49} \right),$$

correct to one decimal place.

- (c) Ciara invested €30 000 for three years at 3% per annum compound interest.


- (i)  Calculate the amount of the investment at the end of two years.

At the end of two years a sum of money was withdrawn. The money which remained amounted to €12 181.81 at the end of the third year.


- (ii)  Calculate the sum of money withdrawn at the end of two years.

2. (a) The lengths of two pieces of timber are in a ratio of 5 : 2.

The larger piece measures 250 mm.


 Find the length of the shorter piece.


- (b) Each week David is paid €14 per hour for the first 35 hours worked and €21 per hour for any hours worked after that.

(i)  Last week he worked 38 hours. Calculate his gross pay for last week.

The standard rate of income tax is 20% and the higher rate is 41%.

The standard rate cut-off point is €230 per week and he has a tax credit of €62 per week.

(ii)  Calculate David's take-home pay after tax has been deducted.


(iii)  What percentage of his gross pay is his take-home pay?


Give your answer correct to the nearest whole number.


- (c) A survey was carried out in a class to find which of the films A, B or C the students had seen.

The following data was collected:

42% saw film A	41% saw film B	45% saw film C
12% saw both A and B	18% saw both B and C	15% saw both A and C
15% saw none of these films.		

(i)  Represent this information on a Venn diagram.

(ii)  What percentage of the students in the class saw all three films?

(iii)  What percentage of the students in the class saw two or more of the films?

3. (a) ✎ Solve for  $x$ :

$$3x - [5 - (x - 3)] = 6.$$

(b) (i) ✎ Find the largest possible value of  $n$  such that

$$5n + 48 > 8n - 6, \quad n \in \mathbb{N}.$$

(ii)  $x$  represents an even number. Explain why  $x + 2$  is the next even number.

(iii) If one third of the smaller even number is subtracted from half of the larger even number the result is 8.

✎ Find the value of  $x$ .

(c) (i) ✎ Given that  $a^2 = \frac{bc^2 + a + c}{b}$ ,

$$\text{show that } b = \frac{1}{a - c}.$$

(ii) ✎ If  $a = 1\frac{1}{2}$  and  $c = 2\frac{1}{3}$ , find the value of  $b$ .

4. (a) ✎ Express in its simplest form:

$$\frac{5-x}{5} + \frac{x-4}{4}.$$

- (b) (i) Factorise  $8x^2 - 12x$ .

- (ii) Factorise  $4x^2 - 12x + 9$ .

- (iii) ✎ Simplify  $\frac{8x^2 - 12x}{4x^2 - 12x + 9}$ .

- (c) A teacher checks out the cost of calculators for her students on two websites, C and D.  
On website C, for €480, she can get a class set of calculators, one for each student.  
On website D, for the same price, she can get 4 extra calculators.  
If  $x$  represents the number of students in her class,

- (i) write an expression in  $x$  for the cost per calculator on website C  
and an expression in  $x$  for the cost per calculator on website D.

The cost per calculator on website D is €6 cheaper than the cost per calculator on website C.

- (ii) ✎ Use this information to form an equation in  $x$  and solve it to find  
the number of students in the class.

5. (a) ✎  $g(x) = \sqrt{5x-2}$ ,  $x \in \mathbb{N}$ . Find  $g(2)$ .

Give your answer in the form  $a\sqrt{a}$ ,  $a \in \mathbb{N}$ .

- (b) (i) ✎ Solve the equation  $x^2 = 3x + 2$ .

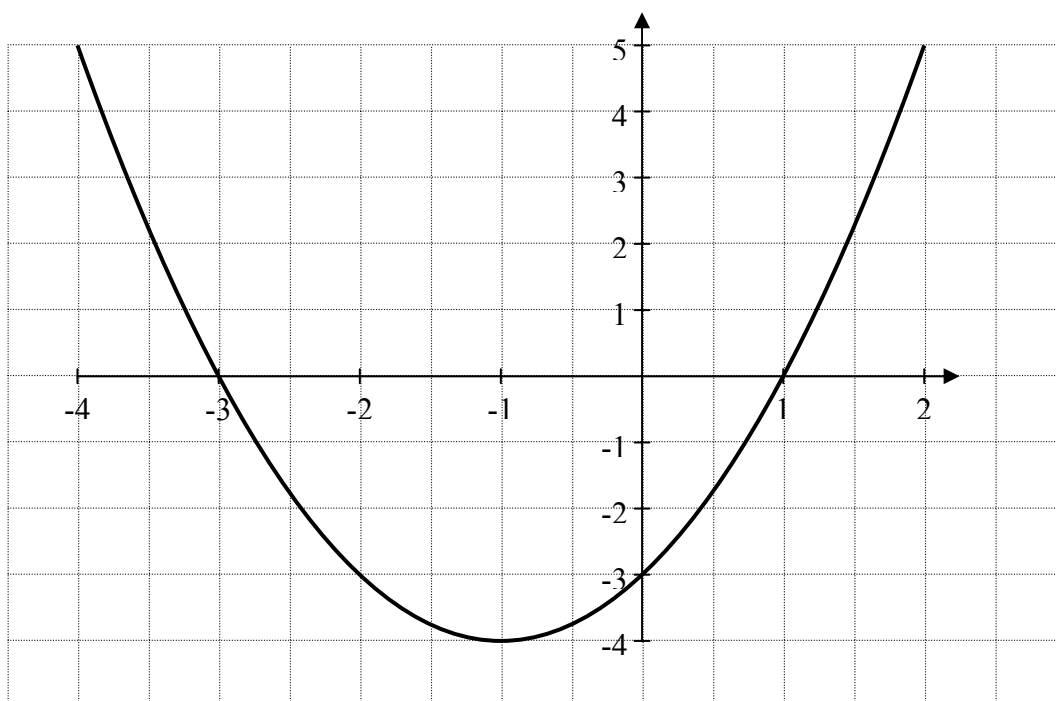
Give your answers correct to two decimal places.

- (ii) ✎ Hence, or otherwise, find two values for  $p$  for which  $p = 3\sqrt{p} + 2$ .

Give your answers correct to one decimal place.

- (c) The diagram below shows part of the graph of the function

$$f: x \rightarrow x^2 + bx + c, \text{ where } x \in \mathbb{R} \text{ and } b, c \in \mathbb{Z}.$$



- (i) The graph cuts the  $x$  axis at  $(-3, 0)$  and  $(1, 0)$ , as shown in the diagram.

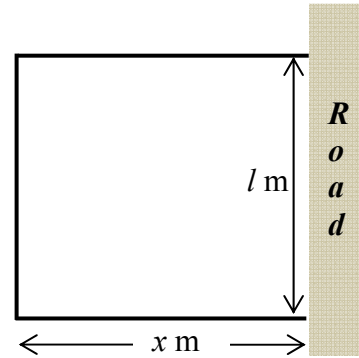
✎ Calculate the value of  $b$  and the value of  $c$ .

- (ii) The graph has a minimum point at  $(-1, 4)$ .

Write down the equation of the axis of symmetry of the function in the form  $x = k$ , where  $k \in \mathbb{Z}$ .

- (iii) ✎ Show that  $f(x+1) = x^2 + 4x$ .

- 6.** A rectangular site, with one side facing a road,  
is to be fenced off.  
The side facing the road, which does not require fencing,  
is  $l$  m in length.  
The sides perpendicular to the road are  $x$  m in length.  
The length of fencing that will be used to enclose  
the rest of the site is 140 m.



- (a) ✎ Write an expression, in terms of  $x$ , for the length ( $l$ ) of the side facing the road.
- (b) (i) ✎ Show that the area of the site, in  $\text{m}^2$ , is  $-2x^2 + 140x$ .
- (ii) Let  $f$  be the function  $f: x \rightarrow -2x^2 + 140x$ .  
✎ Evaluate  $f(x)$  when  $x = 0, 10, 20, 30, 40, 50, 60, 70$ .  
Hence, draw the graph of  $f$  for  $0 \leq x \leq 70$ ,  $x \in \mathbb{R}$ .
- (c) Use your graph from part (b) to estimate:
- (i) ✎ the maximum possible area of the site
- (ii) ✎ the area of the site when the road frontage ( $l$ ) is 30 m long.

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# **Coimisiún na Scrúduithe Stáit State Examinations Commission**

**JUNIOR CERTIFICATE EXAMINATION, 2012**

**MATHEMATICS – HIGHER LEVEL**

**PAPER 1 (300 marks)**

**FRIDAY, 8 JUNE – AFTERNOON, 2.00 to 4.30**

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Attempt **ALL** questions.

Each question carries 50 marks.

**Graph paper may be obtained from the Superintendent.**


The symbol  indicates that supporting work must be shown to obtain full marks.

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1. (a) (i) List the divisors of 30.  
(ii) State which of these divisors are prime numbers.
- (b) (i) €900 is invested for two years at 3% per annum compound interest.  
✎ Find the value of the investment at the end of the second year.
- (ii) John has a gross weekly wage of €600.  
After tax his net weekly wage is €554.  
✎ Calculate his tax credits if he is taxed at the standard rate of 20%.
- (c) (i) ✎ By rounding to the nearest whole number, estimate the value of
- $$\frac{3 \cdot 89 \times 7 \cdot 24 - \sqrt{8 \cdot 94}}{8 \cdot 52 - 3 \cdot 65}.$$
- (ii) ✎ Evaluate  $\frac{3 \cdot 89 \times 7 \cdot 24 - \sqrt{8 \cdot 94}}{8 \cdot 52 - 3 \cdot 65}$ , correct to two decimal places.
- (iii) ✎ Simplify  $\sqrt{5}(\sqrt{2} + \sqrt{5}) - \sqrt{8}(\sqrt{2} - \sqrt{5})$  without the use of a calculator.  
Express your answer in the form  $a + b\sqrt{c}$ , where  $a, b, c \in \mathbb{N}$ .

2. (a) Fuel consumption in a car is measured in litres per 100 km.

Alan's car travels 1250 km on a tank of 68 litres.

 Calculate his car's fuel consumption in litres per 100 km.



- (b)  $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12\}$  is the universal set.  
 $P = \{3, 5, 6, 8, 10\}$ ,  $Q = \{2, 4, 6, 8, 10, 12\}$  and  $R = \{2, 5, 6, 7, 9, 12\}$   
are three subsets of  $U$ .


- (i) Represent the above information on a Venn diagram.

Hence list the elements of:

(ii)  $(P \cup Q \cup R)'$

(iii)  $(P \cap Q) \setminus R$ .


- (c) An electronics company imports tablet computers from China at a cost of 696 Yuan (元) per tablet.

- (i)  Find the cost of each tablet, in euro, if  $\text{€}1 = 8.7 \text{ 元}$ .




The company must also pay a shipping cost on each tablet imported.

By selling a tablet at  $\text{€}105.40$ , the company can make a profit of 24%.

- (ii)  Find the shipping cost per tablet.

The company imports 1000 tablets from China. It sells 600 of them at  $\text{€}105.40$  each (i.e. at a profit of 24%) and the remainder at a profit of 15%.

- (iii)  Find the overall profit, in euro, made by the company.

3. (a) ✎ Given that 1 billion is a thousand million, find the sum of €3.6 billion and €700 million.

Give your answer in the form  $a \times 10^n$  where  $n \in \mathbb{N}$  and  $1 \leq a < 10$ .

(b) (i) ✎ Simplify  $\frac{6x^2 - 17x + 12}{3x - 4}$ .

(ii) ✎ Factorise  $4c^2 - 3d - 2cd + 6c$ .

(iii) ✎ Express in its simplest form:

$$\frac{5}{x-3} - \frac{3}{x-2}$$

- (c) Roisín cycled from Wicklow to Bray, a distance of 30 km. She left Wicklow at 10:30 and arrived in Bray at 12:20, having stopped in Greystones for 20 minutes. Greystones is 22 km from Wicklow.

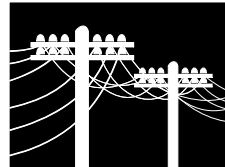


- (i) Roisín's average speed between Wicklow and Greystones was  $x$  km/h. Write an expression in  $x$  for the time taken for this part of her journey.
- (ii) Her average speed for the second part of her journey, between Greystones and Bray, was 6 km/h slower than her speed between Wicklow and Greystones. Write an expression in  $x$  for the time it took to complete the second part of her journey.
- (iii) Write an equation in  $x$  to represent the above information.
- (iv) ✎ Solve the equation to find Roisín's speed for each part of the journey.

4. (a) ✎ Graph on the number line the solution set of

$$4 - x \geq 2x - 5, x \in \mathbb{N}.$$

- (b) Electricity is charged to a consumer at a day rate and at a night rate.



Day rate units are charged at 14 cent per unit and night rate units are charged at 7 cent per unit.

A consumer uses a total of 1100 units for a billing period, at a cost of €129.50.

- (i) By letting  $x$  equal the number of day rate units used and  $y$  equal the number of night rate units used, write two equations to represent the above information.
- (ii) ✎ Solve these equations to find the number of each type of unit used.
- (c) (i) ✎ Solve the equation  $x^2 - 6x + 4 = 0$ ,  
giving your answer in the form of  $a \pm \sqrt{b}$ , where  $a, b \in \mathbb{N}$ .
- (ii) ✎ Hence, or otherwise, find two values for  $p$  for which  
 $(3 + p)^2 - 6(3 + p) + 4 = 0$ .
- (iii) ✎ Show that the sum of the two values of  $p$  is zero.

5. (a) ✎ Given that  $4d = \frac{2c}{3} + \frac{a}{5}$ , write  $a$  in terms of  $c$  and  $d$ .

(b) (i) ✎ Find the value of  $3x^2 - 5x + \frac{4}{x}$ , when  $x = \frac{2}{3}$ .

(ii) ✎ Solve the equation  $\frac{x-1}{3} - \frac{5x+2}{4} = 1$ .


(c) Let  $f$  be the function  $f: x \rightarrow 10 - x - 2x^2$ .

(i) ✎ Draw the graph of  $f$  for  $-3 \leq x \leq 3$ ,  $x \in \mathbb{R}$ .


(ii) Use your graph to estimate the maximum value of  $f(x)$ .


(iii) Use your graph to estimate the values of  $x$  for which  $f(x) = 6$ .

**6. (a)** Let  $g$  be the function  $g : x \rightarrow 2^{x-3}$ .

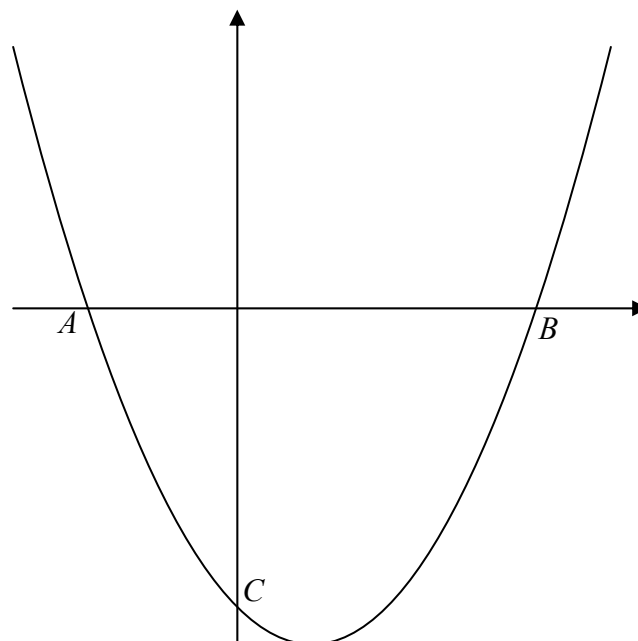
 Find the value of  $g(3)$ .

**(b)** Let  $f$  be the function  $f : x \rightarrow x^2 - 3x$ .

**(i)**  Express  $f(t)$  and  $f(2t + 1)$  in terms of  $t$ .

**(ii)**  Hence, find the values of  $t$  for which  $f(t) = f(2t + 1)$ .

**(c)** The diagram shows part of the graph of the function  $f : x \rightarrow x^2 - 2x - 8, x \in \mathbb{R}$ .



**(i)** The graph intersects the  $x$  axis at  $A$  and  $B$  and the  $y$  axis at  $C$ .

 Find the co-ordinates of  $A$ ,  $B$  and  $C$ .

**(ii)** Hence, write down the range of values of  $x$  for which  $x^2 - 2x - 8 \leq 0$ .

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# **Coimisiún na Scrúduithe Stáit State Examinations Commission**

**JUNIOR CERTIFICATE EXAMINATION, 2011**

**MATHEMATICS – HIGHER LEVEL**

**PAPER 1 (300 marks)**

**FRIDAY, 10 JUNE – AFTERNOON, 2.00 to 4.30**

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Attempt **ALL** questions.

Each question carries 50 marks.


**Graph paper may be obtained from the superintendent.**

The symbol  indicates that supporting work must be shown to obtain full marks.


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1. (a) Peter and Anne share a lotto prize in the ratio  $3\frac{1}{2}$  to  $2\frac{1}{2}$ .  
Peter's share is €35 000.





 What is the total prize fund?

- (b) (i) The diameters of Venus and Saturn are  $1.21 \times 10^4$  km and  $1.21 \times 10^5$  km.

 What is the difference between the diameters of the two planets?

Give your answer in the form of  $a \times 10^n$  where  $n \in \mathbb{Z}$  and  $1 \leq a < 10$ .

- (ii)  Write  $\frac{\sqrt{3} \times 27}{3^2}$  in the form of  $3^n$  where  $n \in \mathbb{Q}$ .

- (c) (i)  By rounding to the nearest whole number estimate the value of

$$\frac{\sqrt{(7 \cdot 17)^2 + 14 \cdot 59}}{8 \cdot 29 - 1 \cdot 64 \times 2 \cdot 23}.$$


Then evaluate  $\frac{\sqrt{(7 \cdot 17)^2 + 14 \cdot 59}}{8 \cdot 29 - 1 \cdot 64 \times 2 \cdot 23}$ , correct to one decimal place.

- (ii) Úna and Conor were travelling to South Africa.

They bought 5760 rand in the bank.

The bank charged them €630, which included a 5% service charge.




 What was the value of the euro in rand (the exchange rate) on that day?

2. (a) A computer salesperson is paid an annual salary of €30 000.

He is also paid a commission of 4% on sales.

Last year the salesperson earned €38 000.

 Calculate the value of the sales.


(b) Aoife is single and earned €40 000 last year. Aoife's tax credits are listed below.

Single Person Tax Credit	€1830
PAYE Tax Credit	€1830
Rent Allowance Tax Credit	€400
Trade Union Payment Tax Credit	€70

(i)  Calculate Aoife's total tax credits.

The standard rate cut-off point for a single person was €36 400.

The standard rate of income tax was 20% and the higher rate was 41%.


(ii)  Calculate the tax paid by Aoife on her income.


Aoife also had to pay a 2% income levy on her gross income.

(iii)  Calculate Aoife's net income after all deductions had been made.


(c)  $U$  is the universal set and  $P$  and  $Q$  are two subsets of  $U$ .

$\# U = 30$ ,  $\# P = 16$  and  $\# Q = 6$ .

(i)  Find with the aid of a Venn diagram the minimum value of  $\# (P \cup Q)'$ .

(ii)  Find with the aid of a Venn diagram the maximum value of  $\# (P \cup Q)'$ .

$\# U = u$ ,  $\# P = p$ ,  $\# Q = q$  and  $\# (P \cup Q)' = x$ .

(iii)  Show with the aid of a Venn diagram, that if  $p > q$  and  $x$  is a maximum, then  $u = p + x$ .

3. (a) ✎ Given that  $t^2 - s = r$ , express  $t$  in terms of  $r$  and  $s$ .

(b) (i) ✎ Divide  $3x^2 + 5x - 28$  by  $x + 4$ .

(ii) ✎ Solve the equation  $\frac{4x+2}{5} - \frac{6-x}{3} = -5$ .

(c) A car park can accommodate cars and mini-buses.  
On a particular day there were  $x$  cars and  $y$  mini-buses  
in the car park, giving a total of 520 vehicles.  
The parking area for a car is  $7 \text{ m}^2$  and the parking area  
for a mini-bus is  $12 \text{ m}^2$ .



On that day a total area of  $3840 \text{ m}^2$  was occupied by cars and mini-buses.

(i) Write down two equations to represent the above information.

(ii) ✎ Solve these equations to find the number of cars and the number of  
mini-buses in the car park on that day.

There is a flat rate charge per day for parking.

The flat rate for mini-buses is 3 times that for cars. On that day €3000 was taken in.

(iii) ✎ What is the flat rate for cars?

4. (a) ✎ Graph on the number line the solution set of

$$-2x + 1 > -7, x \in \mathbb{N}.$$

- (b) (i) Factorise  $x^2 - 1$ .

- (ii) ✎ Factorise fully  $ax - 3 - a + 3x$ .

- (iii) Factorise  $6x^2 + x - 35$ .

- (c) The new Lansdowne Road stadium has seating capacity for 200 journalists.  
It was decided initially that this seating would be in  $x$  rows of equal value.

- (i) Write, in terms of  $x$ , the number of seats per row required to accommodate the 200 journalists.

During the construction it was decided to have 3 fewer rows to accommodate the 200 journalists.

- (ii) Write, in terms of  $x$ , the number of seats per row now required.

It was found that 15 extra seats per row were required compared to the initial plan.

- (iii) ✎ Write an equation using the above information and solve for  $x$ .



5. (a) ✎ Given that  $f(x) = 3x - 4$  and that  $f(k) = 11$ , find the value of  $k$ .

(b) Let  $f$  be the function  $f: x \rightarrow 7x - x^2$ .

✎ Draw the graph of  $f$  for  $0 \leq x \leq 7$ ,  $x \in \mathbb{R}$ .

(c) The formula for the height,  $y$  metres, of a golf ball above ground level  $x$  seconds after it is hit, is given by  $7x - x^2$ .

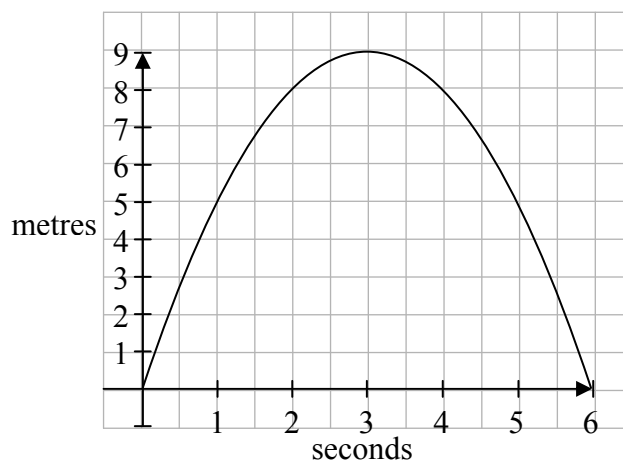
Use your graph from part (b):

(i) ✎ to find the maximum height reached by the golf ball

(ii) ✎ to estimate the number of seconds the golf ball was more than 2 metres above the ground.

The graph below represents the flight of another golf ball.

The flight of the golf ball is given by the formula  $ax - x^2$ ,  $x \in \mathbb{R}$ .



(iii) ✎ Find the value of  $a$ .

6. (a) ✎ When  $a = \frac{1}{4}$ , find the value of  $\frac{a+5}{3} - \frac{a+4}{2}$ .

(b) (i) ✎ Express in its simplest form:

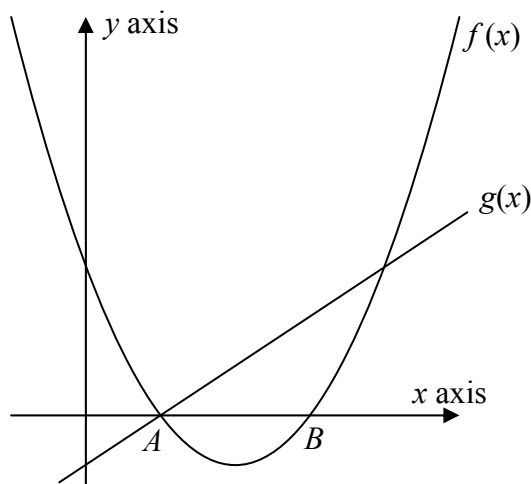
$$\frac{4}{x-1} - \frac{5}{x+2}.$$

(ii) ✎ Hence, or otherwise, solve the equation:

$$\frac{4}{x-1} - \frac{5}{x+2} = \frac{3}{2},$$

giving your answers correct to one decimal place.

(c) The diagram below shows part of the graphs of the functions  
 $f(x) = x^2 - 4x + 3$  and  $g(x) = x + k$ .



The graph of  $f(x)$  cuts the  $x$  axis at  $A$  and  $B$ .

The graphs of  $f(x)$  and  $g(x)$  intersect at  $A$ .

(i) ✎ Find the coordinates of  $A$  and the coordinates of  $B$ .

(ii) ✎ Find the value of  $k$ .

(iii) ✎ Verify that  $f(x)$  and  $g(x)$  intersect also at the point  $(4, 3)$ .

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# **Coimisiún na Scrúduithe Stáit State Examinations Commission**

**JUNIOR CERTIFICATE EXAMINATION, 2010**

**MATHEMATICS – HIGHER LEVEL**

**PAPER 1 (300 marks)**


**FRIDAY, 11 JUNE – AFTERNOON, 2.00 to 4.30**

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Attempt **ALL** questions.

Each question carries 50 marks.

**Graph paper may be obtained from the Superintendent.**


The symbol  indicates that supporting work must be shown to obtain full marks.

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1. (a) The price of a litre of petrol on the 1<sup>st</sup> of August was €1.20.  
The price on the 1<sup>st</sup> September was €1.17.


 Calculate the percentage decrease over this period.



- (b) (i)  By rounding correct to the nearest whole number, estimate the value of

$$\frac{3 \cdot 8}{4 \cdot 23} + (2 \cdot 97)^3 \div \sqrt{9 \cdot 16}.$$

Then, evaluate  $\frac{3 \cdot 8}{4 \cdot 23} + (2 \cdot 97)^3 \div \sqrt{9 \cdot 16}$ ,  
correct to one decimal place.


- (ii)  By putting the largest number first, place the following numbers in

order:  $\frac{7}{6}$ ,  $\frac{\sqrt{6}}{2}$ ,  $(1 \cdot 11)^2$ ,  $\sqrt{1 \cdot 3456}$ .

- (c) (i) The standard rate of income tax is 20% and the higher rate is 41%.  
The standard rate cut-off point is €36 500.  
Aisling has a gross income of €47 500 and total tax credits of €1830.

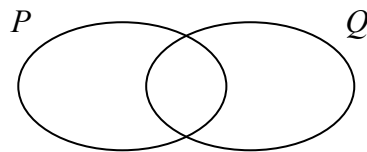
 Calculate Aisling's net income.

- (ii) The following year Aisling's gross income increases.  
The tax rates, cut-off point and tax credits remain unchanged.  
Her net tax now amounts to €15 105.

 What is her new gross income?

2. (a)  $P$  is the set of divisors of 12.  $Q$  is the set of divisors of 9.

 Using this information copy and complete the Venn diagram.



- (b) A group of 100 students were asked if they had a presence on particular social networking websites  $A$ ,  $B$  and  $C$ .


24 students had a presence on  $A$  only, 40 had a presence on  $B$  and 50 had a presence on  $C$ .


14 students had a presence on  $A$  and  $B$  but not on  $C$ .

18 students had a presence on  $A$  and  $C$  but not on  $B$ .

8 students had a presence on  $B$  and  $C$  but not on  $A$ .

4 students stated that they did not have a presence on any of the websites.

- (i)  Using  $x$  to represent the number of students who had a presence on all three websites, construct a Venn diagram and solve for  $x$ .



- (ii)  Hence, calculate the ratio of students with a presence on  $B$  only to the students with a presence on  $C$  only.



- (c) €2000 was invested at  $r\%$  for 2 years compound interest.

A tax of 25% was deducted each year from the interest gained.

At the end of the first year the investment amounted to €2030, after tax was deducted.

- (i)  Calculate the rate of interest  $r\%$ .
- (ii)  Find the amount of the investment at the end of 2 years, after tax has been deducted.

3. (a) ✎ Write the reciprocal of 10 000 in the form  $1 \times 10^n$ , where  $n \in \mathbf{Z}$ .

- (b) A builders' supplier sells two types of copper pipes.

One has a narrow diameter and costs € $x$  per length.

The other has a wider diameter and costs € $y$  per length.



Tony buys 14 lengths of the narrow diameter pipes and 10 lengths of the wider diameter pipes at a cost of €555.

Gerry buys 12 lengths of the narrow diameter pipes and 5 lengths of the wider diameter pipes at a cost of €390.

- (i) Write two equations to represent the above information.

- (ii) ✎ Solve these equations to find the cost of a length of each type of copper pipe.

- (c) (i) ✎ Express in its simplest form:

$$\frac{3}{x+1} - \frac{2}{x+4}.$$

- (ii) ✎ Hence, or otherwise, solve the equation:

$$\frac{3}{x+1} - \frac{2}{x+4} = \frac{1}{3},$$

giving your answers in the form  $a \pm b\sqrt{b}$ , where  $a, b \in \mathbf{N}$ .

4. (a) ✎ Solve  $3(x - 2) - 5(x - 3) = 1$ .

(b) (i) ✎ Simplify fully

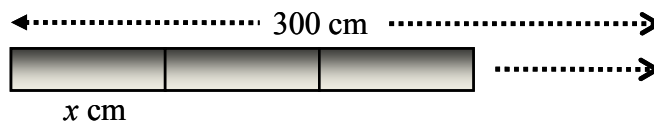
$$(3x - 4)(2x^2 + 5x - 2).$$

(ii) ✎ List the elements of the solution set of

$$-5 \leq 3x - 2 < 7, \quad x \in \mathbf{Z}.$$

(c) Rectangular tiles are to be placed side by side on a wall.  
Each tile has a length of  $x$  cm.

$\frac{300}{x}$  of these tiles are required.



(i) If each tile was 1 cm longer, write down an expression in  $x$  for the number of tiles that would now be required.

(ii) If the longer tiles were used, the number of tiles required would decrease by 10.

✎ Write an equation in  $x$  to represent this information.

(iii) ✎ Solve this equation to find the value of  $x$ .

5. (a) ✎ Given that  $c = \sqrt{y - x}$ , write  $x$  in terms of  $c$  and  $y$ .

(b) (i) ✎ When  $m = \frac{2}{5}$  and  $n = \frac{5}{4}$ , find the value of  $\frac{1}{2m} - \frac{1}{3n}$ .

Write your answer in the form  $\frac{a}{b}$ , where  $a, b \in \mathbf{N}$ .


(ii) ✎ Use factors to simplify  $\frac{3x^2 - 19x - 14}{x^2 - 49}$ .

(c) Let  $f$  be the function  $f: x \rightarrow -x^2 - 4x + 5$ ,  $x \in \mathbf{R}$ .


(i) ✎ Find the co-ordinates of the points where the graph of  $f(x)$  cuts the  $x$ -axis.

(ii) ✎ Solve  $f(x) = f(x + 1)$ .


**6. (a)** Let  $h$  be the function  $h : x \rightarrow \sqrt{x+4}$ .


 Show that  $h(0) > h(-4)$ .

**(b)** Let  $f$  be the function  $f : x \rightarrow x^2 + 5x$  and let  $g$  be the function  $g : x \rightarrow x + 2$ .

 Using the same axes and scales, draw the graph of  $f$  and the graph of  $g$ ,  
for  $-5 \leq x \leq 1$ ,  $x \in \mathbf{R}$ .

**(c)** Use your graphs from part **(b)** to estimate:

**(i)**  The minimum value of  $f(x)$

**(ii)**  The values of  $x$  for which  $f(x) = g(x)$

**(iii)** The range of values of  $x$  for which  $f(x) \leq g(x)$ .

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# **Coimisiún na Scrúduithe Stáit State Examinations Commission**

**JUNIOR CERTIFICATE EXAMINATION, 2009**

**MATHEMATICS – HIGHER LEVEL**

**PAPER 1 (300 marks)**

**THURSDAY, 4 JUNE – MORNING, 9:30 to 12:00**

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Attempt **ALL** questions.

Each question carries 50 marks.

**Graph paper may be obtained from the superintendent.**

The symbol  indicates that supporting work must be shown to obtain full marks.

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1. (a) In a school library, 28% of the books are classified as fiction and the remainder as non-fiction.

There are 3240 non-fiction books in the library.



Find the number of books which are classified as fiction.



- (b) (i) Given that  $x = 2 \times 10^{-3}$  and  $y = 7 \times 10^{-4}$ , evaluate  $x + 8y$ .  
Express your answer in the form  $a \times 10^n$ ,  
where  $n \in \mathbf{Z}$  and  $1 \leq a < 10$ .

- (ii) A supermarket has a special offer on three different brands of packets of soap.

The following table gives details of the offer:

Brand	No. of bars per packet	Weight of each bar	Price of packet
A	3	100g	€1.35
B	6	100g	€2.40
C	4	125g	€2.38



Which brand has the cheapest price per gram?


- (c) A man travels from Arklow to Blanchardstown, a distance of 90 km. He leaves Arklow at 09:25 and arrives in Blanchardstown at 10:55.

- (i) Calculate his average speed for the journey.




He continues from Blanchardstown to Cootehill, a distance of 112 km. He increases his average speed by 4 km/h for this section of his journey.

- (ii) At what time does he arrive in Cootehill?




2. (a) Eight workers can build a cabin in 60 hours.

 How many workers are needed if the cabin is to be built in 32 hours?



- (b) A group of 49 students was asked which fruit each liked.  
28 said they liked apples. 25 said they liked pears while 26 said they liked oranges.  
8 said they liked all three types of fruit.  
17 said they liked pears and oranges. 11 said they liked apples and oranges.  
5 said they did not like any of the three types of fruit.  
Let  $x$  represent those students who liked apples and pears but not oranges.
- (i)  Represent the above information on a Venn diagram.
- (ii)  Calculate the value of  $x$ .
- (iii)  Calculate the percentage of students who liked one type of fruit only.  
Give your answer correct to the nearest whole number.



- (c) Three business partners, Aideen, Brian and Caroline, invest €30 000, €40 000 and €70 000 respectively. At the end of each year, 22.5% of the profit made is placed in reserve and the remainder is divided among the partners in proportion to their investments.
- (i)  Given that in 2007, the profit amounted to €12 880, calculate the amount placed in reserve.
- (ii)  In 2008, Caroline's portion of the profit was €9331. Calculate how much Aideen and Brian each received in 2008.
- (iii)  Calculate the amount placed in reserve in 2008.

3. (a) ✎ Simplify:

$$(2x - 3)(4 - 5x).$$

(b) (i) ✎ Given that  $x = 2t - 1$  and  $y = \frac{2}{3}t + 2$ , express  $3x - y + 2$  in terms of  $t$ , in its simplest form.

(ii) ✎ Hence, find the value of  $t$  when  $3x - y + 2 = 0$ .

(c) A swimming pool can be filled by a large pipe operating alone in 4 hours.

(i) What fraction of the pool can be filled by this pipe in 1 hour?

The swimming pool can be filled by a small pipe operating alone in  $x$  hours.

(ii) ✎ Derive an expression in  $x$  for the fraction of the pool filled by the two pipes working together in 1 hour.

It takes 3 hours for the two pipes working together to fill the pool.

(iii) ✎ Find  $x$ .



4. (a) ✎ Given that  $y = \sqrt{2x - a}$ ,  
find the value of  $y$  when  $x = 4$  and  $a = -1$ .

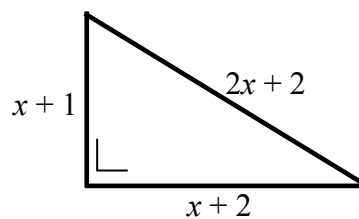
- (b) (i) ✎ Graph on the number line the solution set of  
 $-3 < 4x + 7 \leq 23, x \in \mathbf{R}$ .

- (ii) ✎ Solve the following simultaneous equations:

$$x = -\frac{1}{2}y + 36$$

$$y = 2x + 12.$$

- (c) The lengths of the sides of a right-angled triangle are as shown in the diagram.



- (i) Using the theorem of Pythagoras, write an equation in  $x$ .
- (ii) ✎ Solve this equation to find  $x$  correct to 2 decimal places.

**5.** (a) ✎ Given that  $f(x) = 5x - 12$  and that  $f(a) = a$ , find the value of  $a$ .

(b) (i) Let  $f$  be the function  $f: x \rightarrow 5x - 4$  and  $g$  be the function  $g: x \rightarrow 3x + 1$ .

✎ Using the same axes and scales, draw the graph of  $f$   
and the graph of  $g$ , for  $0 \leq x \leq 3$ ,  $x \in \mathbf{R}$ .

(ii) From your graphs, write down the co-ordinates of the point of intersection of the two lines.

(c) Let  $f$  be the function  $f: x \rightarrow 2x^2 + x - 15$ .

(i) ✎ Draw the graph of  $f$  for  $-4 \leq x \leq 3$ ,  $x \in \mathbf{R}$ .

(ii) ✎ Use your graph to find the minimum value of  $f(x)$ .

(iii) ✎ Use your graph to find the range of values of  $x$  for which  $f(x) \geq 0$ .


- 6. (a)**  Express in its simplest form:


$$\frac{x+7}{5} + \frac{3-x}{4}.$$

- (b) (i)** Factorise  $25x^2 - 36y^2$ .

- (ii)** Factorise  $11x^2 + 75x - 14$ .

- (iii)**  Simplify  $(3-4x)^2 - (3-5x)^2$ .

- (c) (i)**  Solve  $\frac{6}{x} + \frac{6}{x+2} = \frac{5}{2}$ ,  $x \in \mathbf{R}$ .

- (ii)**  Hence, or otherwise, find the two values of  $t \in \mathbf{R}$ , for which

$$\frac{6}{2t-1} + \frac{6}{2t+1} = \frac{5}{2}.$$

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# **Coimisiún na Scrúduithe Stáit State Examinations Commission**

**JUNIOR CERTIFICATE EXAMINATION, 2008**

**MATHEMATICS – HIGHER LEVEL**

**PAPER 1 (300 marks)**


**THURSDAY, 5 JUNE – MORNING, 9:30 to 12:00**

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Attempt **ALL** questions.

Each question carries 50 marks.

**Graph paper may be obtained from the superintendent.**

The symbol  indicates that supporting work must be shown to obtain full marks.

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1. (a) ✍ Given that the speed of sound in air is 330 metres per second, express this speed in km/h.



- (b) (i) ✍ Wendy estimates the value of  $527 + 889 + 436$  by rounding each number to the nearest hundred.  
Find the estimated value.

- (ii) Three students rent a house for a period of 8 months.  
The refuse charges are €16.80 per month.  
The electricity bill amounts to €84 every two months.  
The television and broadband charges are €324 for the period of the rental.  
✍ How much should each of the three students pay monthly for these charges?

- (c) (i) Walter borrows €5000 for three years at 4% per annum compound interest.  
He repays €1800 at the end of each of the first two years.  
✍ How much must he repay at the end of the third year to clear his loan?
- (ii) Walter wishes to pay off his loan in equal instalments at the end of the first and second year. The rate remains at 4% per annum compound interest.  
✍ How much would he need to repay, at the end of each year, to clear his loan after two years? Give your answer correct to the nearest cent.

2. (a) A is the set of prime numbers less than 13.

(i) List the elements of the set A.

$B = \{1, 3, 5, 7, 9, 11\}$ .

(ii) Write down the elements of the set  $B \setminus A$ .

(b) Two brands of blackcurrant squash drinks contain concentrated juice and sugar.

In brand A, the ratio of concentrated juice to sugar is 19:1.

In brand B, the ratio of concentrated juice to sugar is 9:1.

(i) ✍ What is the volume of concentrated juice in  
500 ml of brand A?

(ii) ✍ What is the volume of sugar in  
300 ml of brand B?

500 ml of brand A is mixed with 300 ml of brand B.

(iii) ✍ What is the ratio of the concentrated juice to the sugar in the mixture?



(c) In 2006, the average costs of running a car for the year were as follows:  
road tax €485, petrol €1440, servicing €650 and insurance €425.

(i) ✍ What was the total cost of running the car in 2006?

In 2007, the petrol costs went up by 5%, the cost of servicing went up by 15%  
and the cost of insurance went down by 10%.

(ii) ✍ Given that the total running costs increased by 4.6% in 2007, calculate  
the percentage (%) increase in the road tax for 2007, giving your  
answer correct to one decimal place.



3. (a) When 23 is added to 4 times a certain number, the answer is 11.



Find this number.

- (b) An examination paper consists of 40 questions.

5 marks are given for each correct answer.


3 marks are deducted for each incorrect answer.

Kenny answered all 40 questions, getting  $x$  correct and getting  $y$  incorrect.

His total score for the examination was 56 marks.




- (i) Write two equations to represent the above information.

- (ii)  Solve these equations to find how many questions Kenny answered correctly.

- (c) (i)  Express in its simplest form:

$$\frac{1}{2x-3} - \frac{1}{x+3}.$$

- (ii)  Hence, or otherwise, solve the equation:

$$\frac{1}{2x-3} - \frac{1}{x+3} = 2,$$

giving your answers correct to two decimal places.

4. (a) ✎ Given that  $f(x) = kx + 8$  and that  $f(9) = 44$ , find the value of  $k$ .

(b) (i) Factorise  $28x^2 - 3x - 1$ .

(ii) ✎ Solve  $\frac{-47x - 30}{7} = x^2$ .

(c) In a certain week,  $x$  people shared equally in a club lotto prize of €2000.

(i) Write down an expression in  $x$  for the amount that each person received.

The following week,  $x + 1$  people shared equally in the prize of €2000.

(ii) Write down an expression in  $x$  for the amount that each person received that week.

In the second week, each winner received €100 less.

(iii) Write down an equation in  $x$  to represent the above information.

(iv) ✎ Solve this equation to find the value of  $x$ .

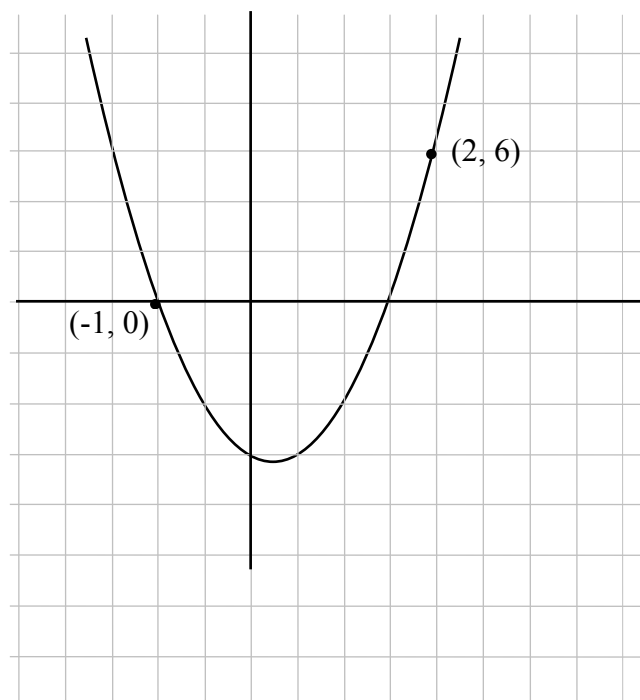


5. (a) ✎ Given that  $3d = b(c + a)$ , write  $c$  in terms of  $a$ ,  $b$  and  $d$ .

(b) (i) ✎ When  $x = \frac{1}{2}$ , find the value of  $\frac{3}{x+2} - \frac{1}{2x+4}$ .

(ii) ✎ Divide  $6x^3 - 13x^2 + 27x - 14$  by  $3x - 2$ .

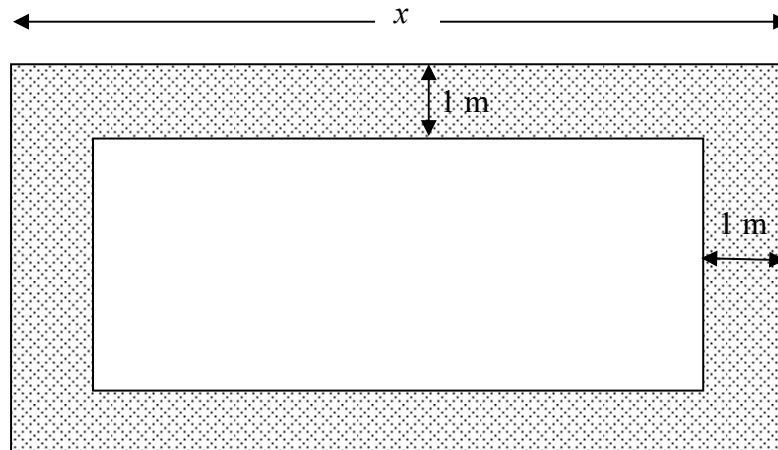
(c) Let  $f$  be the function  $f: x \rightarrow 4x^2 + bx + c$ ,  $x \in \mathbf{R}$  and  $b, c \in \mathbf{Z}$ .  
The points  $(2, 6)$  and  $(-1, 0)$  lie on the graph of  $f$ , as shown in the diagram.





(i) ✎ Find the value of  $b$  and the value of  $c$ .

(ii) ✎ Solve  $f(x) = -6$ .

- 6. (a)** The diagram shows a rectangular garden of perimeter 24 m.  
 The length of the garden is  $x$  m.  
 Write down an expression in  $x$  for the width of the garden.



- (b)** Paving of width 1 m is placed around the garden as shown.
- (i)** Write expressions in  $x$  for the length and width of the inner section.
  - (ii)**  Show that the area, in  $\text{m}^2$ , of the inner section is  $-x^2 + 12x - 20$ .
- (c)** The area of the inner section is represented by the function:
- $$f: x \rightarrow -x^2 + 12x - 20.$$
- (i)**  Draw the graph of  $f$  for  $2 \leq x \leq 10$ ,  $x \in \mathbf{R}$ .
  - (ii)** Write down the maximum possible area of the inner section.

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