



General Certificate of Secondary Education  
2023

Centre Number

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Candidate Number

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## Physics

Unit 3 Practical Skills

Booklet B

Higher Tier

[GPY34]

TUESDAY 27 JUNE, MORNING

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**MV24**

### Time

1 hour 15 minutes, plus your additional time allowance

### Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

**Do not write on blank pages.**

Complete in black ink only.

Answer **all** questions.

## **Information for Candidates**

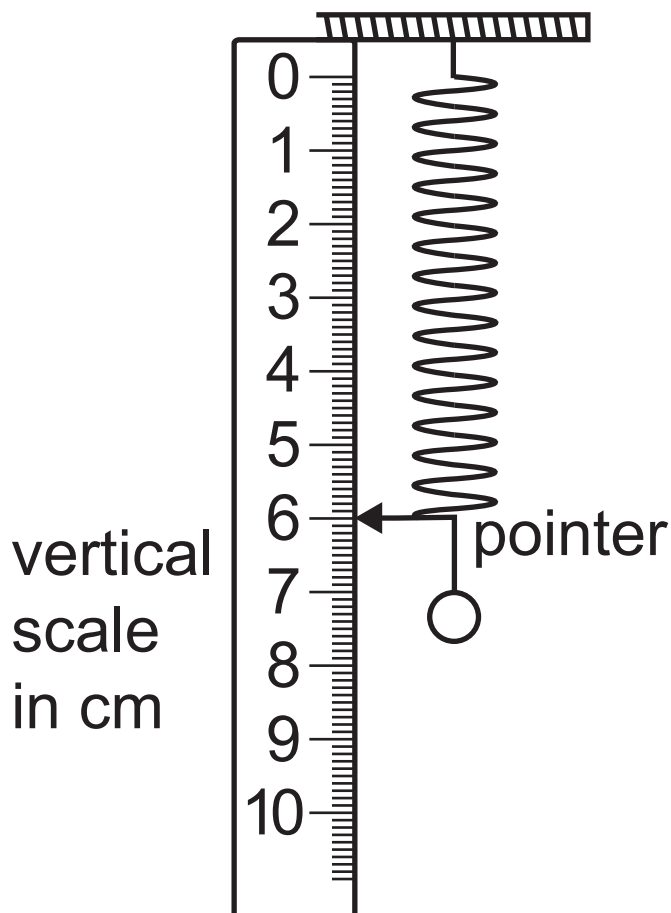
The total mark for this paper is 70.

Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

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**(Questions start overleaf)**

- 1 A student investigates the stretching of a spring using the apparatus shown below. The scale reading was recorded when an increasing force was used to stretch the spring. The force was in the form of slotted masses.



- (a) What should the student do to make an accurate scale reading? [1 mark]

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The measurements of slotted mass and reading on the scale are shown in the table below.

		<b>Column 1</b>	<b>Column 2</b>
<b>Mass/g</b>	<b>Scale reading/cm</b>		
0	6.0		
50	8.0		
100	10.0		
150	12.0		
200	14.0		

**(b) (i)** Complete the table by calculating the force, giving your answer to **1 decimal place**. Insert the values into **column 1** of the table, to which you should add an appropriate heading with unit. [4 marks]

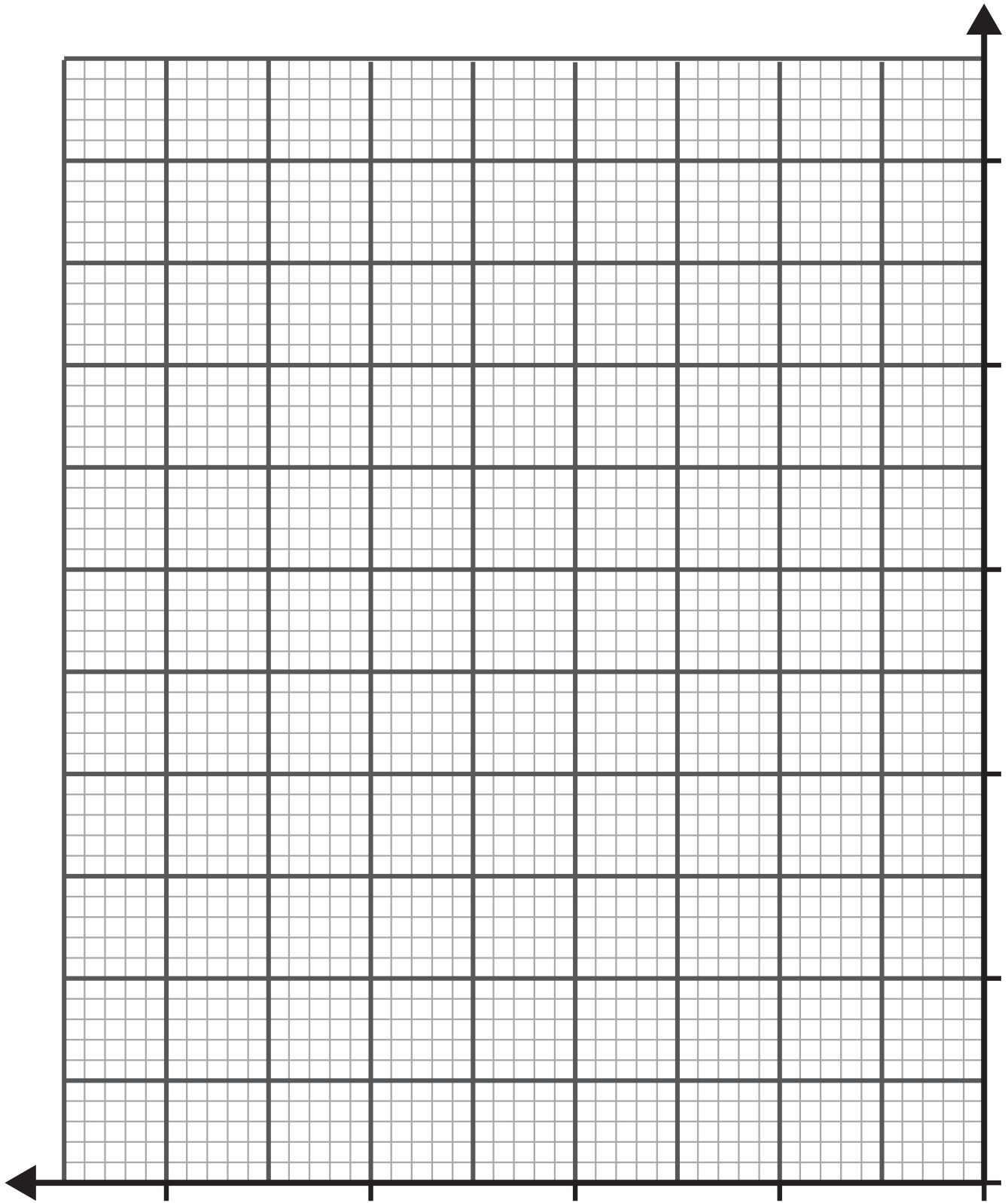
(ii) Complete the table by calculating the extension of the spring for each value of stretching force. Insert the values into **column 2** of the table, to which you should add an appropriate heading with unit.

Give your values of extension to **1 decimal place**. [4 marks]

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**(Questions continue overleaf)**

**(c) (i)** Plot a graph of force (y-axis) against extension (x-axis).  
Label the x-axis with the quantity and its unit.  
Use  $\odot$  or  $\times$  to clearly mark your points. [6 marks]



(ii) The relationship between the stretching force  $F$ , the spring constant  $k$  and the extension  $e$  is given by the equation

$$F = ke$$

Using your graph, find the value of the spring constant  $k$ .

**Show clearly how you get your answer.**

State the unit of  $k$ . [4 marks]

$$k = \underline{\hspace{10em}}$$

$$\text{Unit} = \underline{\hspace{10em}}$$

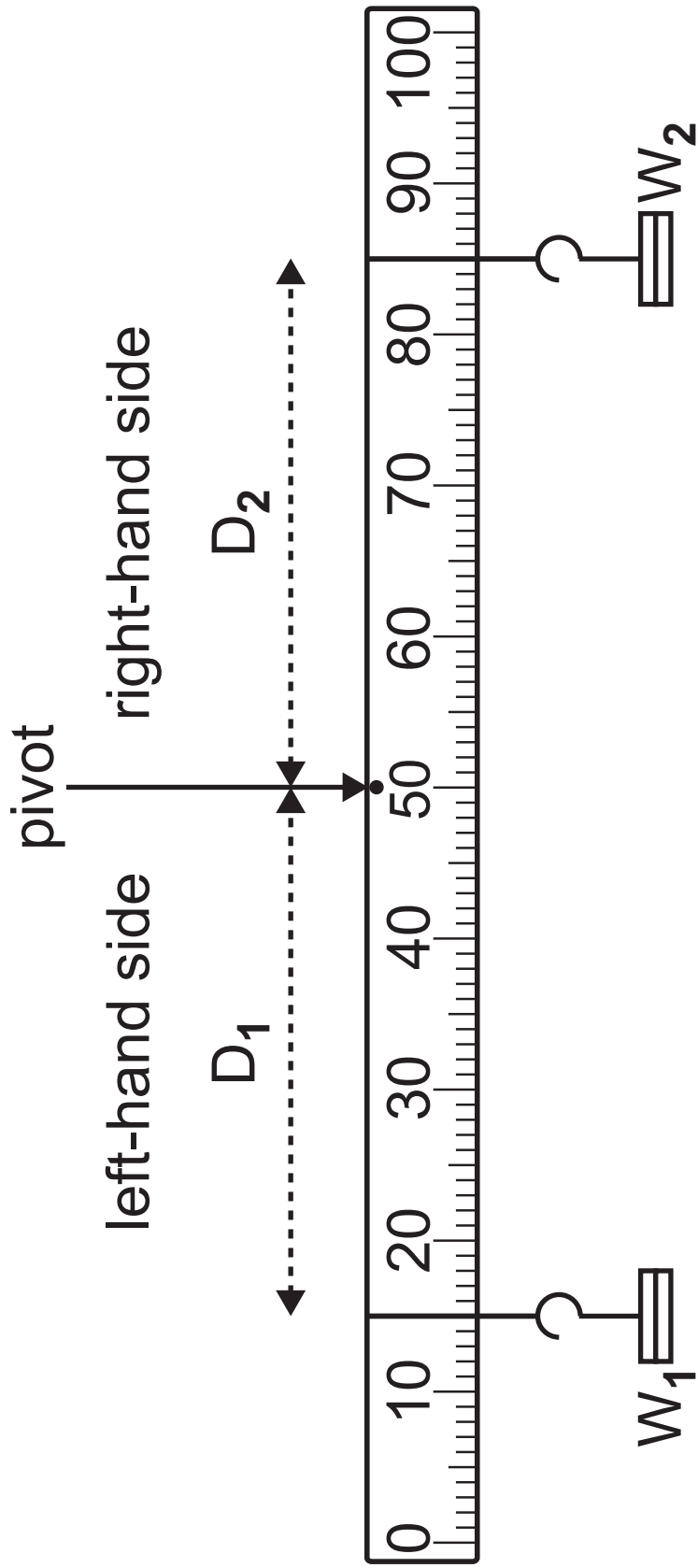
(iii) On the grid on page 9, draw the graph that would be obtained if a spring had a spring constant **twice** the value of the one used.

[3 marks]

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**(Questions continue overleaf)**

- 2 (a)** The diagram opposite shows the equipment that can be used to verify the Principle of Moments.  
Different weights were placed at various positions on both sides of the metre rule and their position adjusted until the metre rule was balanced.



- (i) Using the Principle of Moments, complete the table by inserting the distance from the pivot,  $D_1$  or  $D_2$ . Write your answers in the appropriate blank space. [3 marks]

Left-hand side		Right-hand side	
$W_1/N$	$D_1/cm$	$W_2/N$	$D_2/cm$
2		3	10
1	25	2	
3		1.5	24

You may use the space below for your calculations.

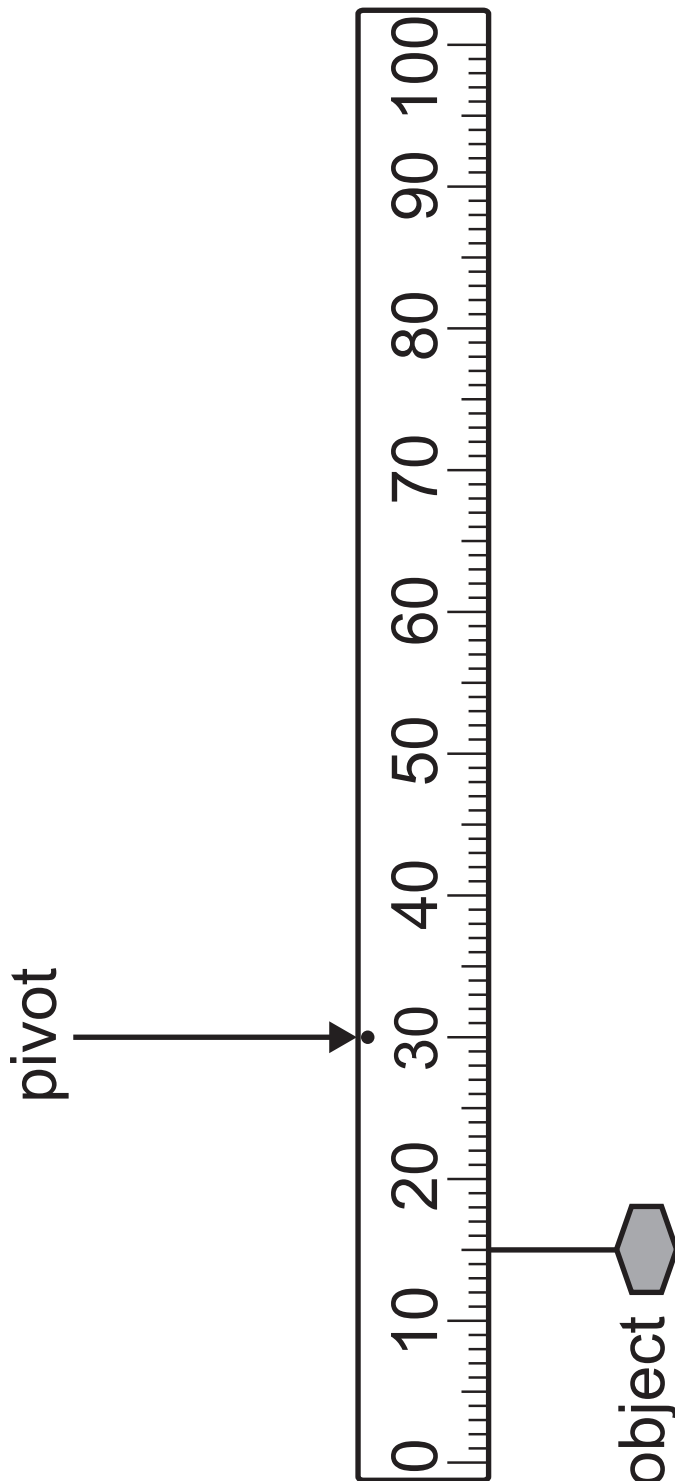
**(ii)** A 4 N weight was placed 40 cm from the pivot on the left-hand side. Explain why it is not possible to position a 2 N weight on the right-hand side to balance the metre rule. [2 marks]

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**(b)** The weight of an object can be found using a metre rule and applying the Principle of Moments. The diagram below shows the arrangement that could be used.



(i) On the diagram, mark with an X the position of the centre of gravity of the metre rule. [1 mark]

(ii) What is the direction of the moment produced by the weight of the metre rule? [1 mark]

\_\_\_\_\_

(iii) Using the information from the diagram on page 16, calculate the weight of the object attached to the metre rule. [4 marks]  
The weight of the metre rule is 1.5 N.  
**Show clearly how you get your answer, starting with the equation you plan to use.**

Weight of the object = \_\_\_\_\_ N

**(iv)** Describe what should be done to make your measured value for the weight of the object more reliable.  
[2 marks]

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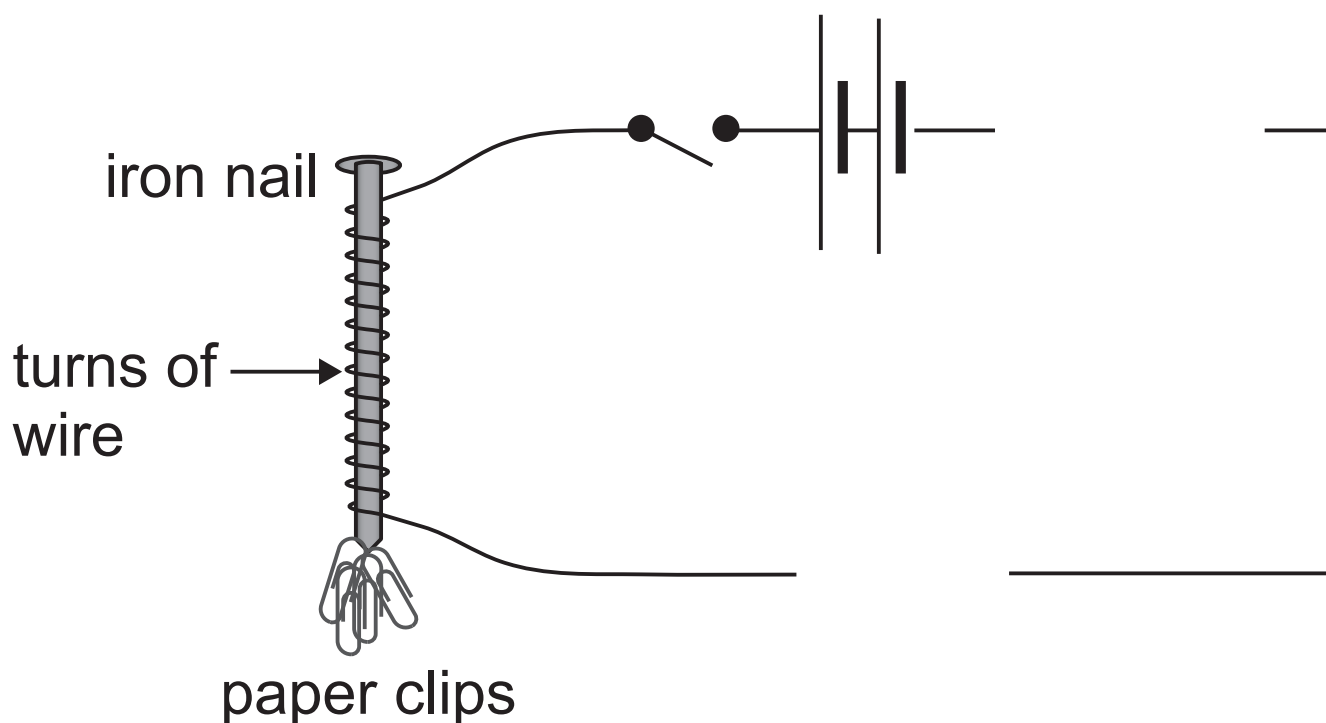
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**(Questions continue overleaf)**

**3** An electromagnet can be made by wrapping wire around an iron nail to form a coil as shown below.

To investigate how the number of turns on the coil affects the strength of the electromagnet the apparatus shown below was used.



The electromagnet was used to pick up paper clips.

A coil of 10 turns was first used. The number of turns was increased in steps of 5 turns until finally a coil of 30 turns was used. For each coil with different numbers of turns the number of paper clips that were picked up by the electromagnet was counted.

**(a) (i)** It is important that the current is the same for each coil.

Add **two** components to the circuit, in the gaps provided, that would allow this to be done.

Use the correct symbols for the components. [2 marks]

**(ii)** Describe how the components are used to achieve this constant current. [2 marks]

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**(b)** The table below shows the results of this experiment.

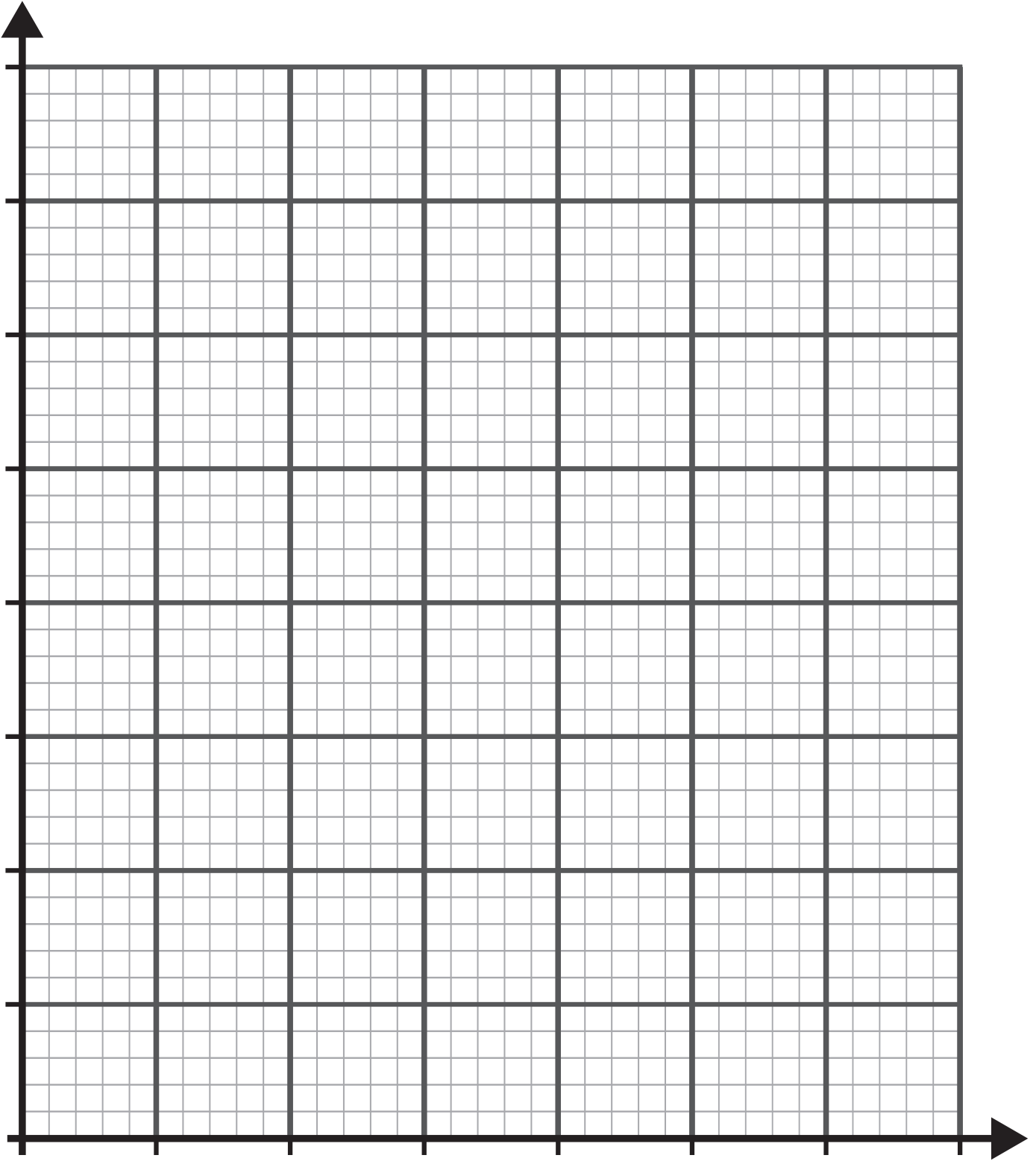
<b>Number of turns on the coil</b>	<b>Number of paper clips picked up</b>
10	4
15	6
20	8
25	10
30	12

**(i)** On the grid opposite, plot the graph of the number of paper clips picked up (y-axis) and the number of turns on the coil (x-axis).

Use  $\odot$  or  $\times$  to clearly mark your points.

Label each axis with the quantity and unit, if appropriate.

Draw the best fit line through the points. [6 marks]



(ii) The relationship between the number of coils and the number of paper clips picked up is shown below.

$$\text{number of paper clips} = k \times \text{number of coils}$$

Using the graph, find the value of  $k$ .

[3 marks]

**Show clearly how you get your answer.**

$k =$  \_\_\_\_\_

(c) In another investigation, the number of turns on the coil was kept constant and the current changed. The number of paper clips picked up for each value of the current in the electromagnet was counted.

(i) For this investigation, name the **dependent** variable.

Explain your answer. [2 marks]

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(ii) For this investigation, name the **independent** variable.

Explain your answer. [2 marks]

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(iii) For this investigation, name a **controlled** variable.

Explain your answer. [2 marks]

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The results of the investigation are shown in the table below.

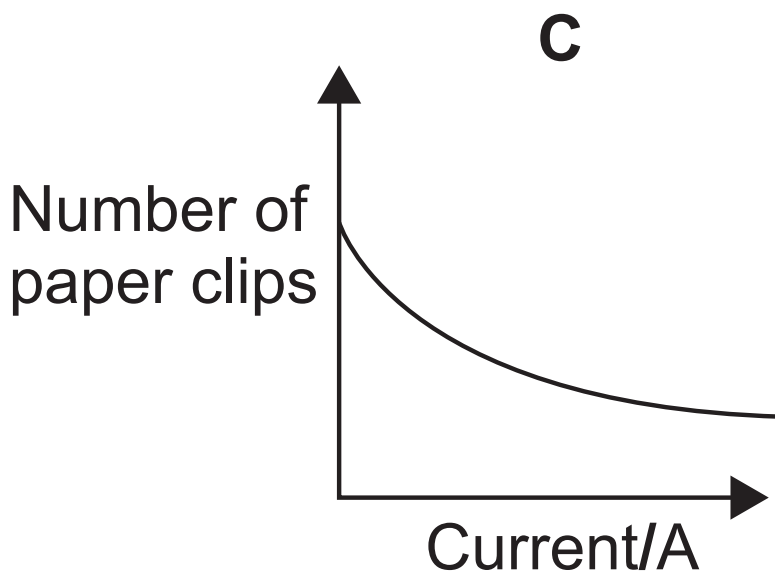
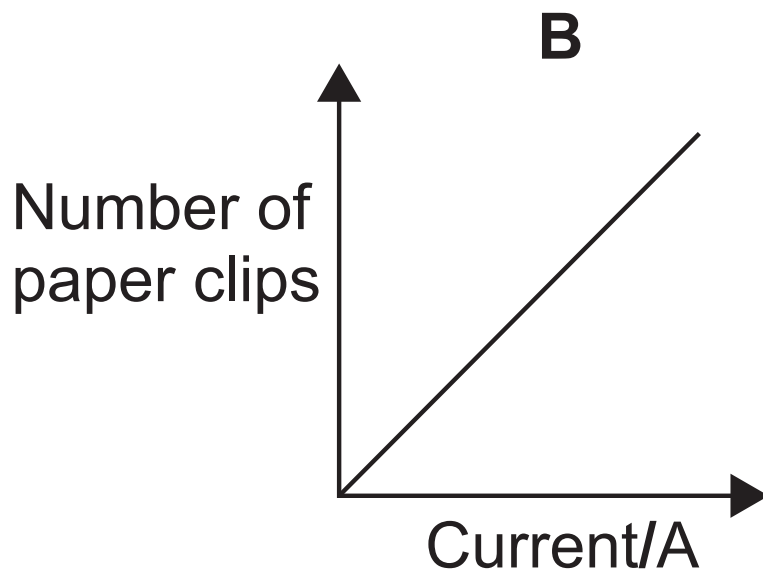
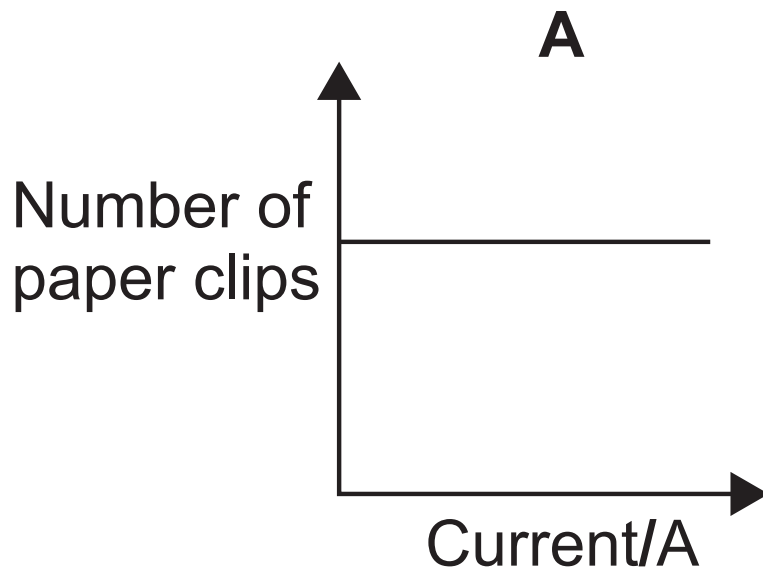
<b>Current/A</b>	<b>Number of paper clips picked up</b>
0.5	2
1.0	4
1.5	6
2.0	8
2.5	10

**(iv)** If a graph was plotted using these values, which one of the graphs shown opposite would be obtained? Explain your answer. [2 marks]

Graph \_\_\_\_\_

Explanation \_\_\_\_\_

\_\_\_\_\_

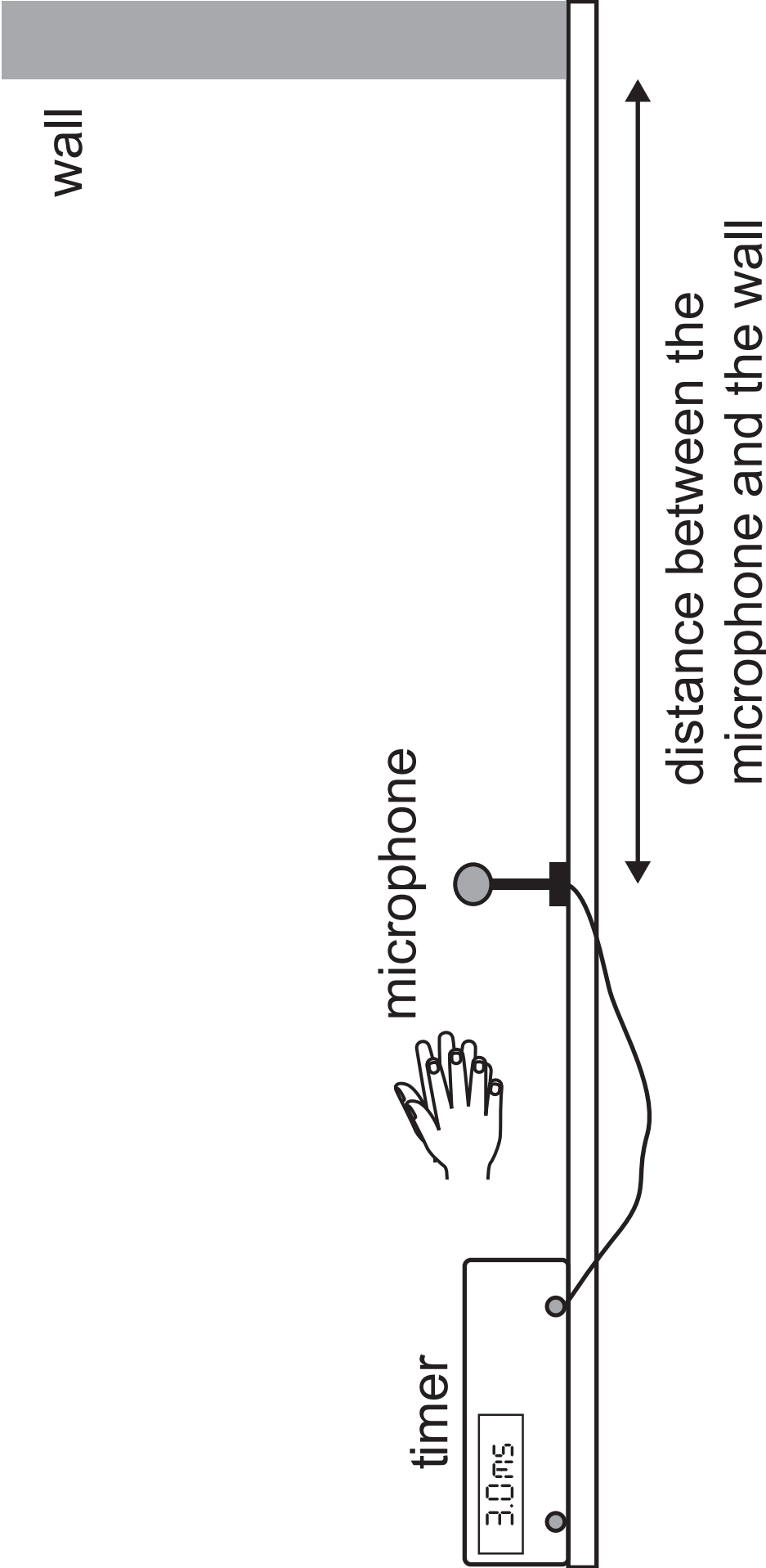


**4 (a)** The reflection of sound from a wall is known as an echo.

Echoes can be used to measure the speed of sound using the apparatus shown opposite.

A loud sound is made by clapping hands. The sound travels to a microphone which starts the timer.

When the sound has been reflected by the wall it reaches the microphone for a second time and the timer is stopped.



wall

microphone

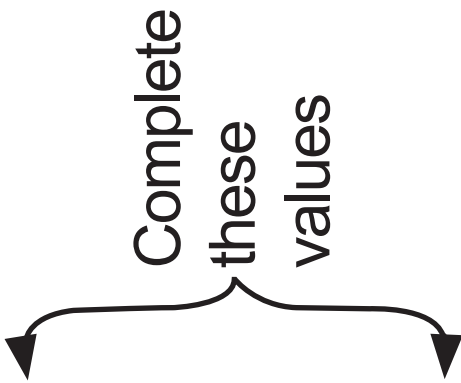
timer

3.0ms

distance between the microphone and the wall

The experiment is repeated as the distance between the microphone and the wall is changed.

The results are shown in the table below.



Distance between the microphone and the wall/m	Time shown on the timer/ milliseconds	Time to travel the distance between the microphone and the wall/ milliseconds
0.25	1.5	
0.50	3.0	1.5
0.75	4.6	2.3
1.00	4.0	2.0
1.25	7.6	3.8
1.50	9.0	

Note 1 millisecond (ms) = 0.001 s

(i) Some of the results are shown in the table on page 30, but two have been left blank.

Complete the table by calculating the time taken for the sound to travel the distance between the microphone and the wall for those values left blank.

Give your values to **1 decimal place**.  
**Remember, the timer shows the time it takes the sound to travel to the wall and return to the microphone.** [3 marks]

(ii) One of the time measurements is clearly anomalous.

Circle the anomalous time value.  
[1 mark]

(iii) What is best experimental practice when an anomalous result is noticed?  
[1 mark]

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**(b) (i)** On the grid opposite, plot a graph of distance between the microphone and the wall (y-axis) against the time to travel between the microphone and the wall (x-axis).

Plot the results, using  $\odot$  or  $\times$  to clearly show the points.

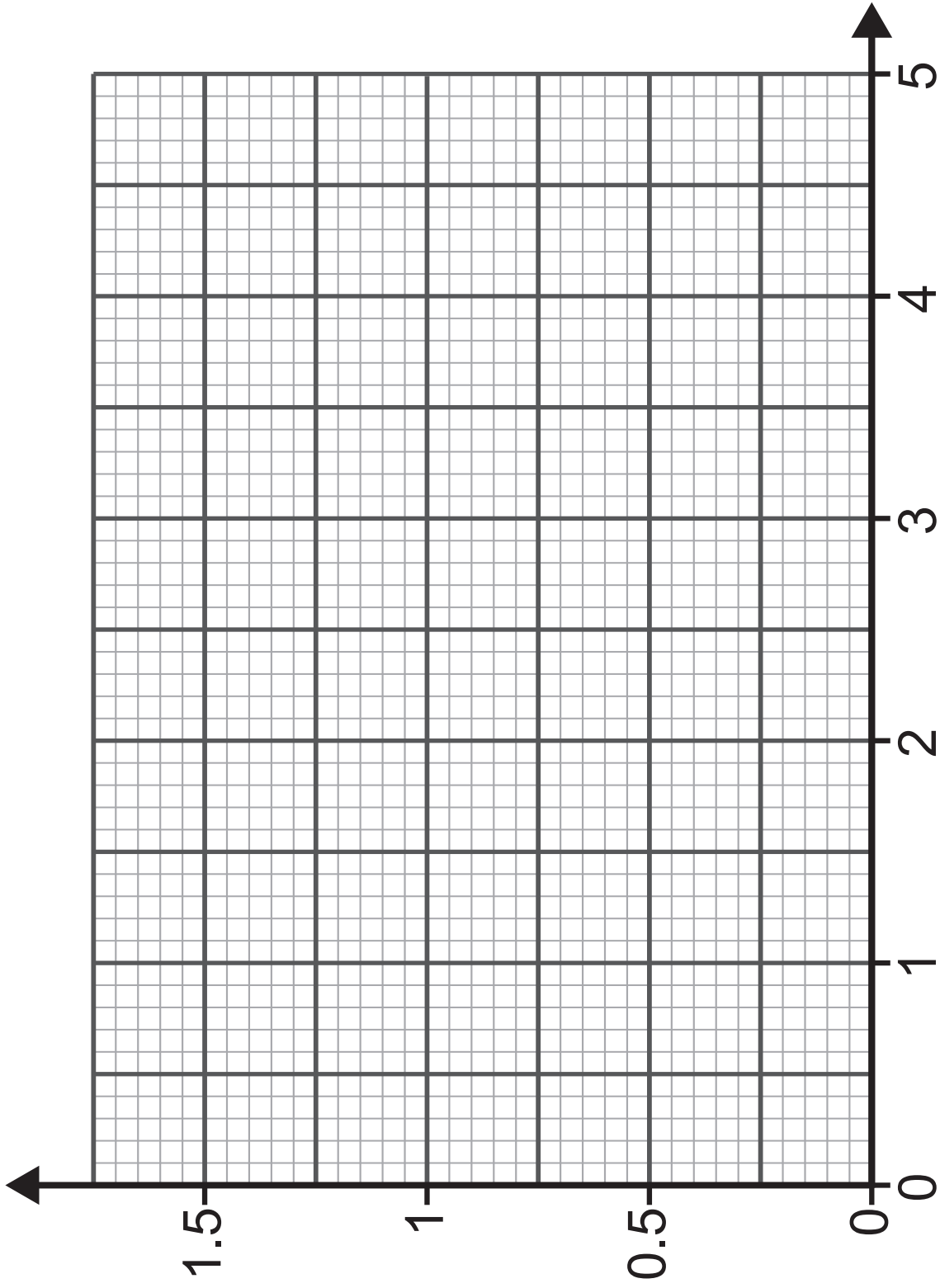
Draw the line of best fit through your points. [4 marks]

**(ii)** Calculate the gradient of your best fit line.

Give your answer to **three decimal places**.

**Show clearly how you get your answer.** [2 marks]

Gradient = \_\_\_\_\_ m/ms



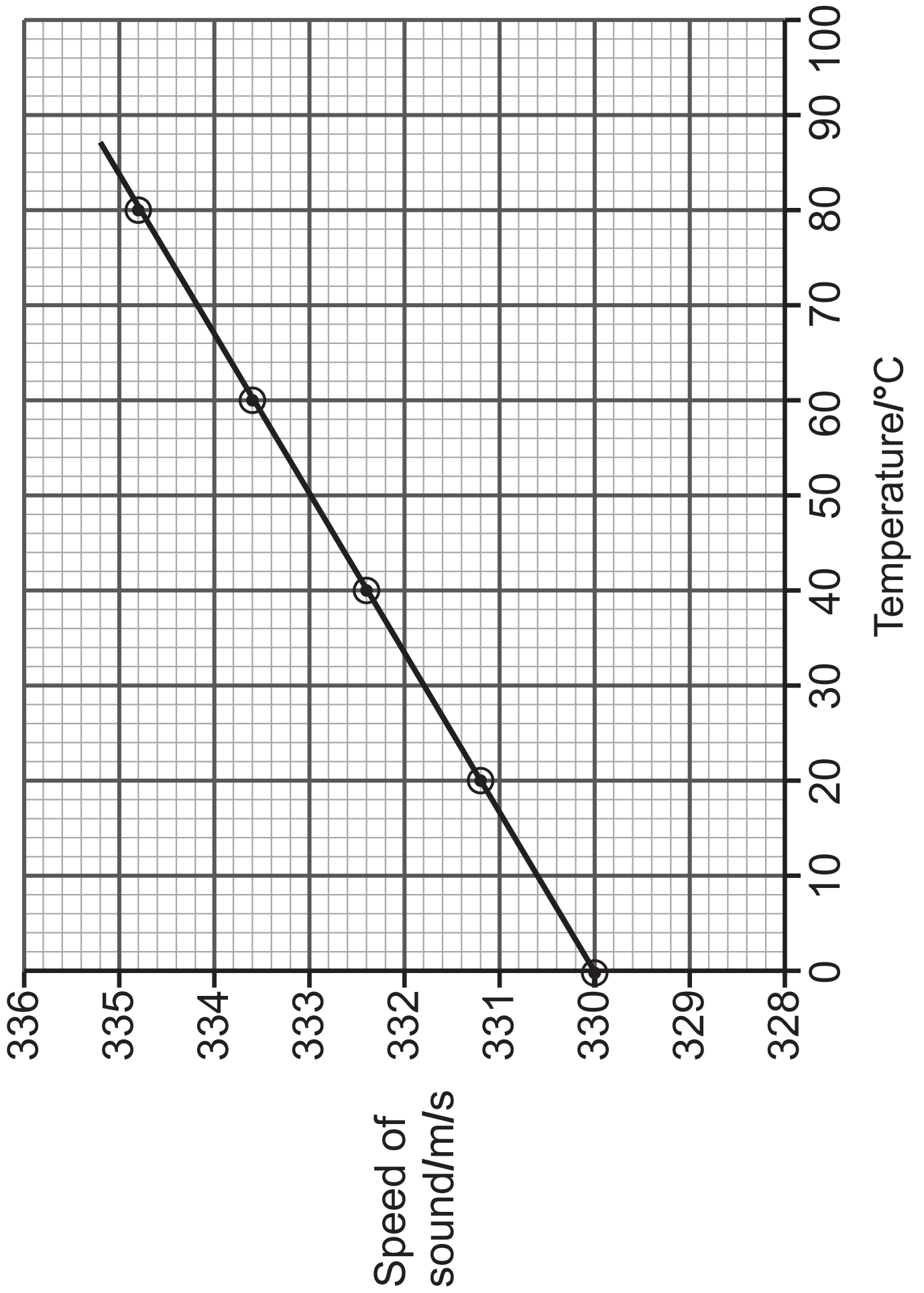
Distance between the microphone and the wall/m

Time to travel between the microphone and the wall/milliseconds

**(iii)** Convert the gradient value, which is given in metres per millisecond, to give the speed of sound in metres per second (m/s). [1 mark]

Speed of sound = \_\_\_\_\_ m/s

**(c)** The speed of sound depends on the temperature of the air.  
The graph opposite shows how the speed of sound changes as the air temperature changes.



The equation below shows how the speed of sound in air and the temperature of the air are related.

$$V = Z \times \textit{temperature} + 330$$

$V$  = speed of sound in air

$Z$  = is a constant

Using the graph, find the value of  $Z$ .

[2 marks]

**Show clearly how you get your answer.**

$Z =$  \_\_\_\_\_

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**This is the end of the  
question paper**

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	

<b>Total Marks</b>	
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Examiner Number

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