Cambridge Assessment International Education

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9038285806

CAMBRIDGE INTERNATIONAL MATHEMATICS **0607/51**

Paper 5 Investigation (Core) **May/June 2021**

1 hour 10 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a graphic display calculator where appropriate.
- You may use tracing paper.
- You must show all necessary working clearly, including sketches, to gain full marks for correct methods.
- In this paper you will be awarded marks for providing full reasons, examples and steps in your working to communicate your mathematics clearly and precisely.

INFORMATION

- The total mark for this paper is 36.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **8** pages.

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Answer **all** the questions.

INVESTIGATION **ROLLING SQUARE**

This investigation looks at the path of a point on a square as it rolls along the x-axis.

A square of side 1 cm rolls along the x-axis.
One roll is a turn of 90° clockwise about its bottom right corner.

Diagram 1
Starting position

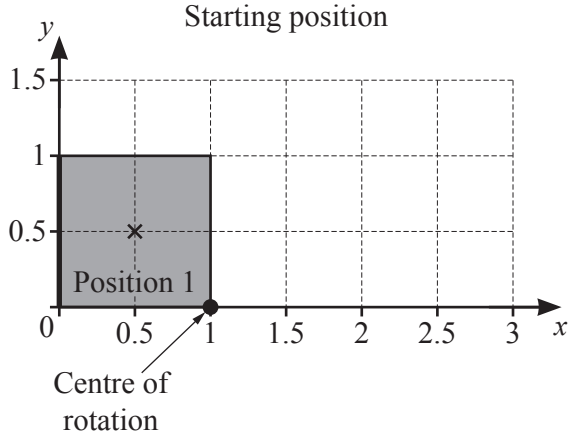


Diagram 2
After one roll

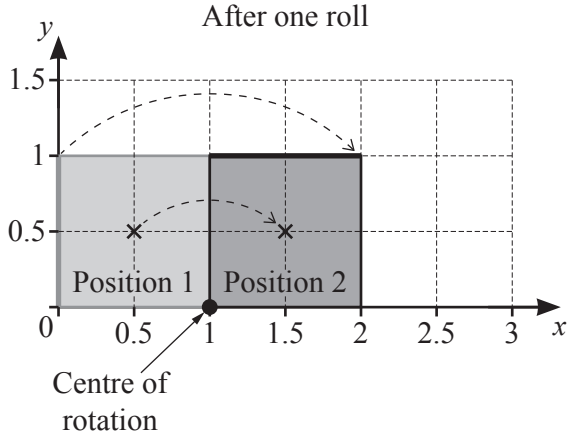
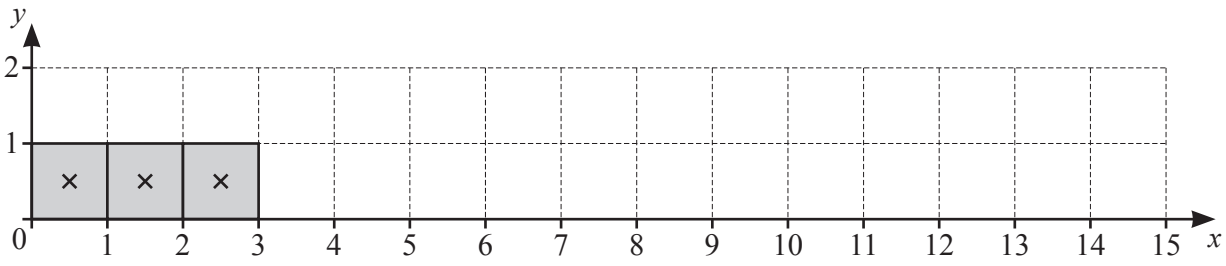


Diagram 1 shows the square in Position 1.
One side of the square is bold to help show the rotation.
The centre of the square is (0.5, 0.5).

Diagram 2 shows the square rolled 90° clockwise about (1, 0) to Position 2.

1 To get to Position 3 the square rolls 90° clockwise about (2, 0).
To get to Position 4 the square then rolls 90° clockwise about (3, 0).

(a) On the diagram below, draw the square in Position 4, Position 5 and Position 6.



[2]

(b) Complete this table to show the x-coordinate of the centre of the square in each position.
You may use the diagram to help you.

Position (n)	1	2	3	4	5	6	...	n
x-coordinate	0.5	1.5	2.5				...	

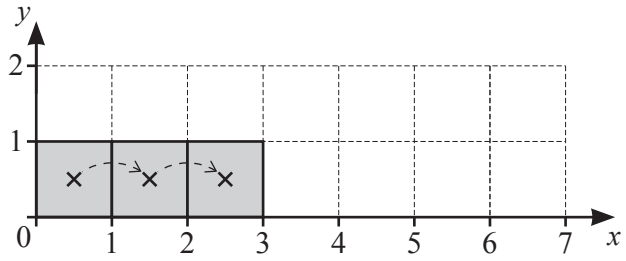
[2]

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(c) Find the x-coordinate of the centre of the square in Position 92.

..... [2]

(d)



(i) The square rolls from Position 1 to Position n.
The centre has moved a distance equal to the circumference of 1 circle.
The radius, r, of the circle is half the diagonal of the square.

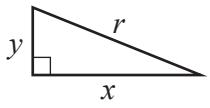
(a) Write down the number of rolls needed.

..... [1]

(b) Write down the value of n.

..... [1]

(ii)

Circumference, C, of circle, radius r.	$C = 2\pi r$
 Hypotenuse, r, of a right-angled triangle with sides r, x and y.	$r^2 = x^2 + y^2$

(a) Show that the radius of the circle is 0.707 cm, correct to 3 decimal places.

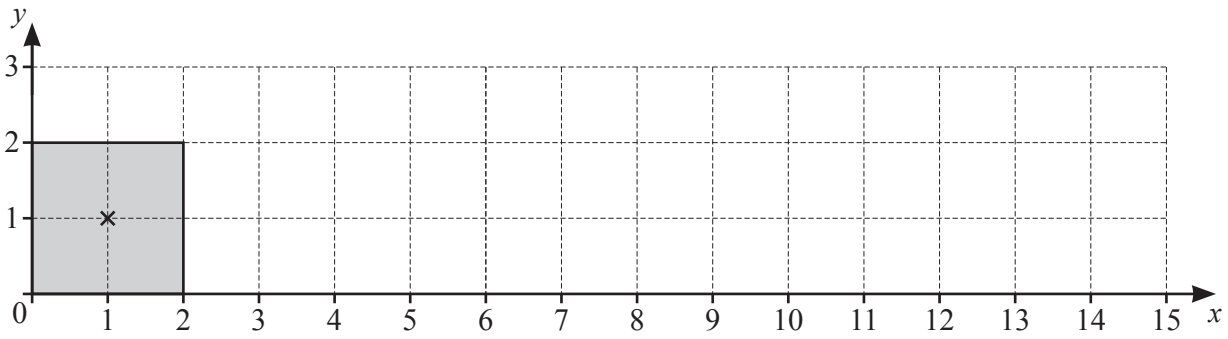
[2]

(b) Find the length of the arc that the centre of the square moves along from Position 1 to Position 2.

..... [2]

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2 The side of the square is now 2 cm.



The square rolls along the x-axis in the same way as in **Question 1**.

(a) Complete the table of x-coordinates of the centre of the square in different positions.

Position (n)	1	2	3	4	5	6		n
x-coordinate	1	3						

[3]

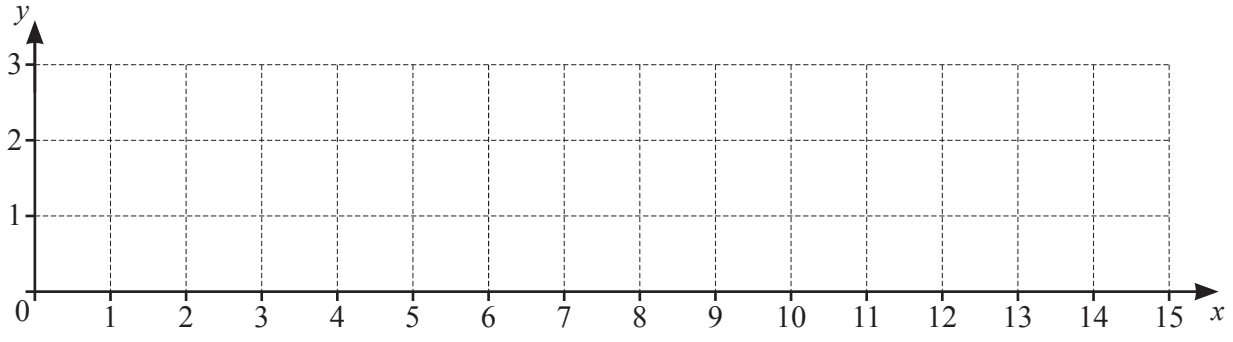
(b) Find the coordinates of the centre of the square in Position 35.

(..... , ...) [3]

3 **(a)** The side of the square is now 3 cm.

Complete the table of x-coordinates of the centre of the square in different positions.
You may use the diagram below to help you.

Position (n)	1	2	3	4	5	6		n
x-coordinate	1.5							



[3]

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(b) The side of the square is now 4 cm.

Complete the table of x-coordinates of the centre of the square in different positions.

Position (n)	1	2	3	4	5	6		n
x-coordinate	2							

[2]

4 Write your expressions from **Questions 1(b)**, **2(a)** and **3** in the table below.
Complete the table using any patterns you notice.

Side of square (w cm)	x-coordinate in Position n
1	
2	
3	
4	
5	
w	

[4]

5 A square of side w cm rolls from Position 1 to Position 120.
At Position 120, the x-coordinate of the centre of the square is 2151.

Find the value of w.

..... [3]

6 A square of side a cm is in Position 1.
The coordinates of the centre of the square are $(11, k)$.

(a) Find the value of k and the value of a.

$k =$ .....

$a =$ ..... [2]

(b) Find the coordinates of the top right corner of the square.

(..... , ...) [1]

(c) Write down the y-coordinate of the centre of the square in Position 400.

..... [1]

Question 7 is printed on the next page.

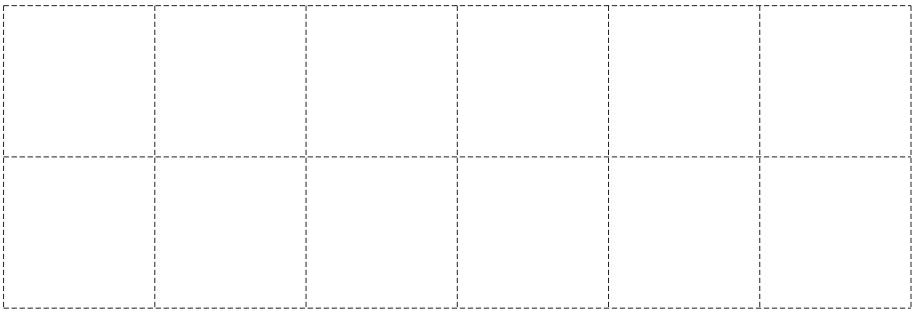
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7 A square rolls along the x-axis.

For the top left corner give a reason why

total distance moved in 2 rolls = total distance moved in 3 rolls.

You may use this grid.



.....

..... [2]

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