

Rotations

Solutions

For AQA GCSE Mathematics (8300) • Foundation tier

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (1 mark)

The point $(3, 1)$ is rotated 180° about the origin.
Write down the coordinates of the image.

A rotation of 180° is a half turn.

A half turn about the origin changes the sign of both coordinates.

$(3, 1) \rightarrow (-3, -1)$

Answer: $(-3, -1)$

2 (1 mark)

To describe a rotation fully you need to give
Tick **one** box.

A full description of a rotation needs three things:

the angle (for example 90°),

the direction (clockwise or anticlockwise),

the centre of rotation (the point it turns about).

(For a 180° rotation the direction does not matter.)

Answer: the angle, the direction and the centre

3 (2 marks)

Rotate shape *A* 90° clockwise about the origin $(0,0)$

Trace shape *A* and put your pencil point on the origin.

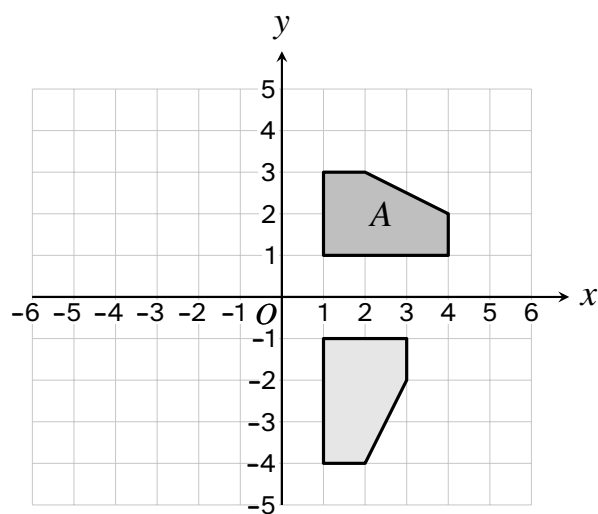
Turn the tracing paper a quarter turn clockwise (the way a clock's hands go).

Or move one vertex at a time.

The vertex $(4,1)$ is 4 right and 1 up from the origin.

After a quarter turn clockwise it is 1 right and 4 down: $(1,-4)$

The image has vertices $(1,-1)$, $(1,-4)$, $(2,-4)$, $(3,-2)$, $(3,-1)$



Answer: $(1,-1)$, $(1,-4)$, $(2,-4)$, $(3,-2)$, $(3,-1)$

Marks: 2 marks for the correct image. 1 mark for a rotation of 90° anticlockwise about the origin, or for the right shape and way round but in the wrong place.

4 (2 marks)

Rotate triangle *B* 180° about the point $(1,1)$

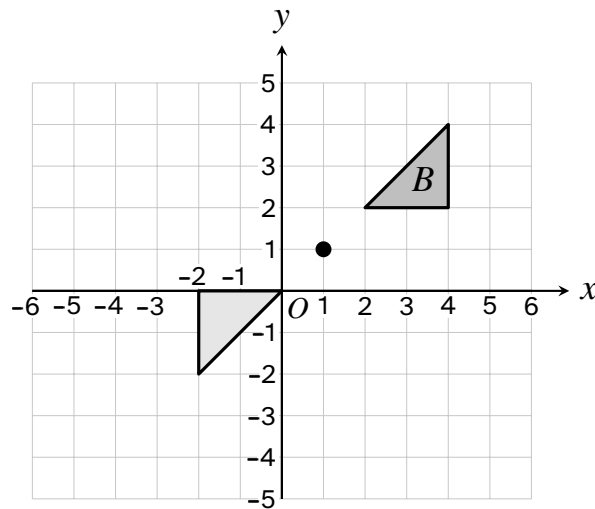
In a half turn each vertex moves to the opposite side of the centre, the same distance away.

The vertex $(4,4)$ is 3 right and 3 up from the centre $(1,1)$.

So its image is 3 left and 3 down from $(1,1)$: $(-2,-2)$

Do the same for the other vertices.

The image has vertices $(0, 0)$, $(-2, 0)$, $(-2, -2)$



Answer: $(0, 0)$, $(-2, 0)$, $(-2, -2)$

Tip: Turn about the point you are given, $(1, 1)$, not the origin. Using the wrong centre is a very common mistake.

Marks: 2 marks for the correct image. 1 mark for a rotation of 180° about a different point.

5 (2 marks)

Rotate shape C 90° anticlockwise about the point $(-1, 2)$

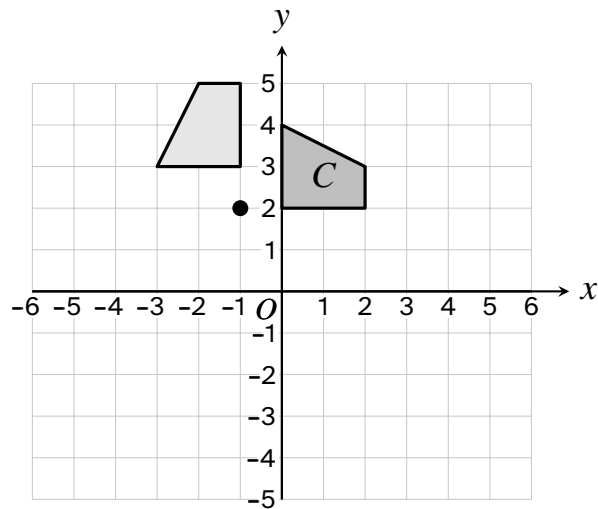
Anticlockwise is the opposite way to a clock's hands.

The vertex $(2, 2)$ is 3 right of the centre $(-1, 2)$.

After a quarter turn anticlockwise it is 3 up from the centre: $(-1, 5)$

The vertex $(0, 2)$ is 1 right of the centre, so it goes to 1 up: $(-1, 3)$

The image has vertices $(-1, 3)$, $(-1, 5)$, $(-2, 5)$, $(-3, 3)$



Answer: $(-1, 3)$, $(-1, 5)$, $(-2, 5)$, $(-3, 3)$

Tip: Turning the wrong way (clockwise instead of anticlockwise) is one of the most common mistakes. Use tracing paper and check the direction before you draw.

Marks: 2 marks for the correct image. 1 mark for the right shape and way round but in the wrong place.

6 (2 marks)

Ella rotates a shape 90° clockwise about the origin.

She says,

‘The vertex at $(4, 1)$ moves to $(-1, 4)$ ’

Is Ella correct?

Tick a box.

Give a reason for your answer.

$(4, 1)$ is 4 right and 1 up from the origin.

A quarter turn clockwise takes it to 1 right and 4 down.

So $(4, 1)$ moves to $(1, -4)$, not $(-1, 4)$

$(-1, 4)$ is where it would go for a rotation of 90° **anticlockwise**.

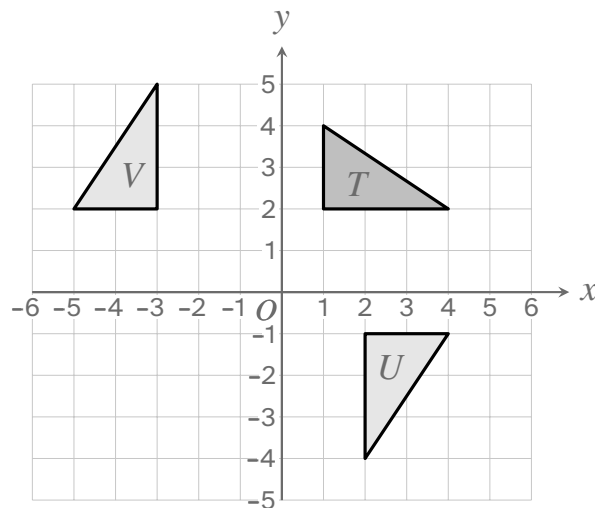
Answer: No: $(4, 1)$ moves to $(1, -4)$

Tip: Draw a quick sketch or use tracing paper. It is easy to mix up the rules for clockwise and anticlockwise if you only try to remember them.

Marks: 1 mark for showing that $(4, 1)$ moves to $(1, -4)$, or a correct sketch. 1 mark for No with a correct reason.

7 (4 marks)

Here is triangle T on a grid.



- (a) Rotate triangle T 90° clockwise about $(0, 0)$
Label the image U .

The vertex $(4, 2)$ is 4 right and 2 up from the origin.

A quarter turn clockwise takes it to 2 right and 4 down: $(2, -4)$

In the same way, $(1, 2) \rightarrow (2, -1)$ and $(1, 4) \rightarrow (4, -1)$

Image U has vertices $(2, -1)$, $(2, -4)$, $(4, -1)$

Answer: $(2, -1)$, $(2, -4)$, $(4, -1)$

Marks: 2 marks for the correct image. 1 mark for 90° anticlockwise about $(0, 0)$, or for the right shape and way round but in the wrong place.

- (b) Rotate triangle T 90° anticlockwise about $(-1, 0)$
Label the image V .

Measure each vertex from the centre $(-1, 0)$.

The vertex $(1, 2)$ is 2 right and 2 up from the centre.

A quarter turn anticlockwise takes it to 2 left and 2 up from the centre: $(-3, 2)$

The vertex $(4, 2)$ is 5 right and 2 up, so it goes to 2 left and 5 up: $(-3, 5)$

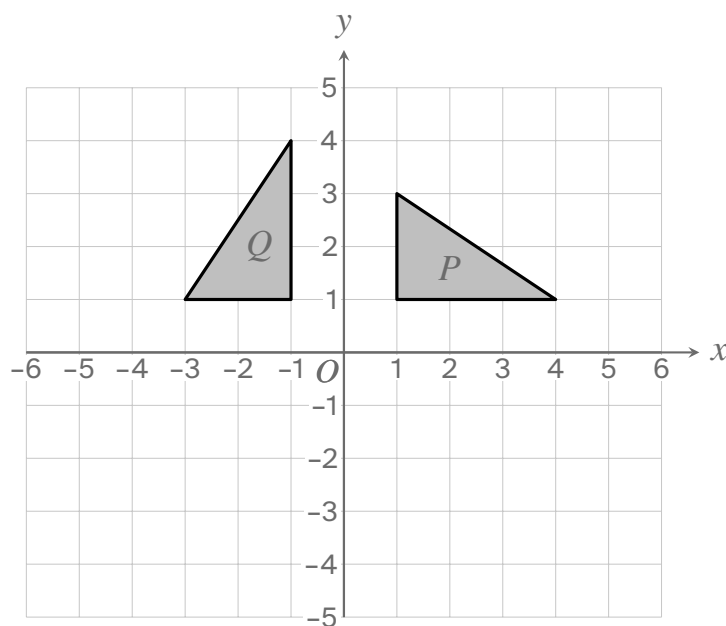
Image V has vertices $(-3, 2)$, $(-3, 5)$, $(-5, 2)$

Answer: $(-3, 2)$, $(-3, 5)$, $(-5, 2)$

Marks: 2 marks for the correct image. 1 mark for 90° anticlockwise about a different centre, or 90° clockwise about $(-1, 0)$.

8 (3 marks)

Describe fully the single transformation that maps triangle P onto triangle Q .



Q is the same size as P but has turned, so it is a rotation.

It has turned a quarter turn anticlockwise: 90° anticlockwise.

Find the centre with tracing paper. Try the origin first.

Turning about $(0, 0)$ takes $(4, 1)$ to $(-1, 4)$, which is a vertex of Q ✓

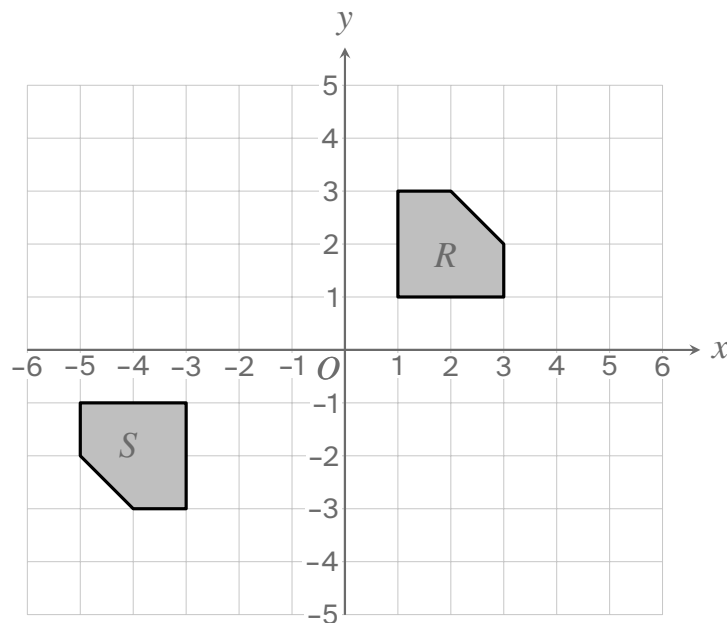
Answer: Rotation, 90° anticlockwise, about $(0, 0)$

Tip: Use the word “rotation” (not “turn”), and give all three facts: angle, direction and centre. Give only **one** transformation, or you get no marks.

Marks: 1 mark for rotation. 1 mark for 90° anticlockwise (or 270° clockwise). 1 mark for the centre $(0, 0)$.

9 (1 mark)

Here are two shapes, R and S .



Kai says,

‘Shape R maps onto shape S by a rotation of 180° about the origin.’

Explain why Kai is wrong.

A 180° rotation is the right kind of turn: S is R upside down.

Check the centre. A half turn about $(0, 0)$ would take $(1, 1)$ to $(-1, -1)$, but $(-1, -1)$ is not a vertex of S .

The centre is halfway between a vertex and its image: $(1, 1) \rightarrow (-3, -1)$, halfway is $(-1, 0)$.

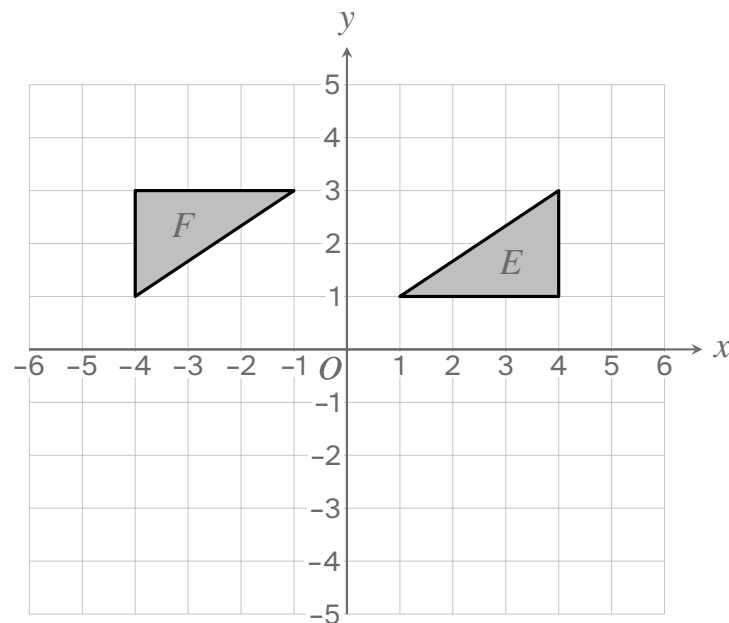
So the centre of rotation is $(-1, 0)$, not the origin.

Answer: The centre is wrong: it is $(-1, 0)$, not the origin

Tip: Do not just say “it is not a rotation”. It **is** a 180° rotation. Test Kai’s centre by rotating one vertex and seeing where it lands.

10 (3 marks)

Describe fully the single transformation that maps triangle E onto triangle F .



F is upside down compared with E , so it is a half turn: a rotation of 180° .

A 180° rotation does not need a direction.

The centre is halfway between any vertex and its image.

$(1, 1)$ on E goes to $(-1, 3)$ on F .

Halfway: $\left(\frac{1+(-1)}{2}, \frac{1+3}{2}\right) = (0, 2)$

Check with another vertex: $(4, 3) \rightarrow (-4, 1)$ also has midpoint $(0, 2)$ ✓

Answer: Rotation, 180° , about $(0, 2)$

Tip: Write the centre as a coordinate with x first: $(0, 2)$, not $(2, 0)$.

Marks: 1 mark for rotation. 1 mark for 180° . 1 mark for the centre $(0, 2)$.
