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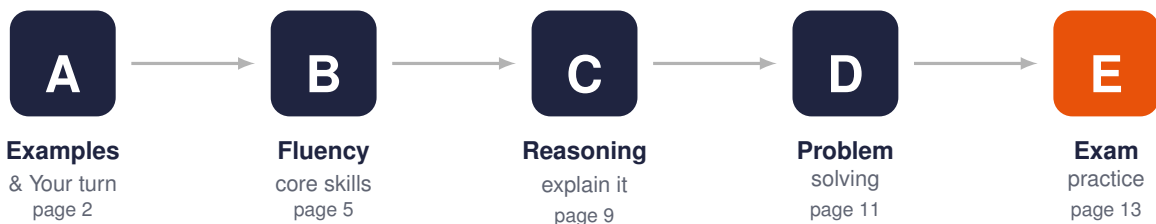
GCSE MATHEMATICS • GEOMETRY

Transformations

Worksheet

Pearson Edexcel GCSE (1MA1) & International GCSE (4MA1) • No calculator

Free Transformations worksheet for GCSE and iGCSE Maths, with full worked solutions



Tap a section to jump straight to it

By the end of this worksheet you can: translate a shape by a column vector • reflect, rotate and enlarge shapes on a grid, including fractional scale factors • describe a single transformation fully • *Higher*: negative scale factors, combined transformations and invariant points.

Which questions are for me?

FOUNDATION Everyone starts here. These skills appear on both tiers.

HIGHER Higher only: negative scale factors, combined transformations and invariant points. Grades 6 to 9.

Every section has both, clearly labelled. Questions get harder as you go, and every skill in Sections A to D is needed in Section E.

Track your progress

Section	B	C	D	E
Foundation marks	23	10	13	15
Higher marks	16	14	17	15
My score				

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Date



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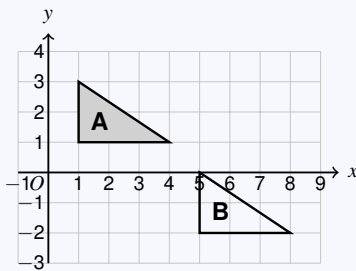
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A**Worked examples & Your turn**

Read each example carefully. Cover it up, then answer the question beside it using the same method.

FOUNDATION*Everyone starts here***Worked example A1**

Translate shape A by the vector $\begin{pmatrix} 4 \\ -3 \end{pmatrix}$. Label the image B .

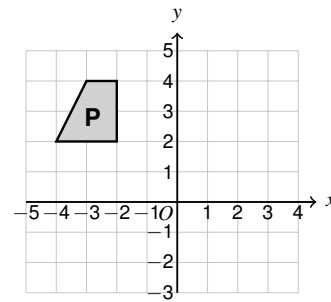


4 right and 3 down: move every vertex.

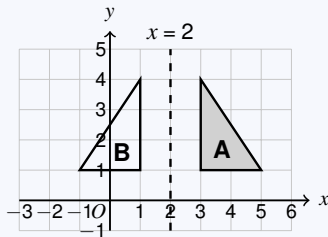
shape B

Your turn A1

Translate shape P by the vector $\begin{pmatrix} 5 \\ -4 \end{pmatrix}$

**Worked example A2**

Reflect shape A in the line $x = 2$. Label the image B .

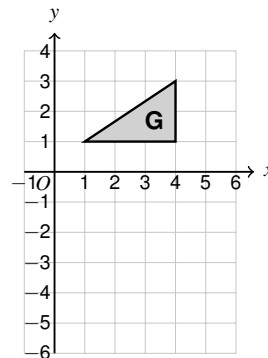


Each vertex is the same distance from $x = 2$ on the other side.

shape B

Your turn A2

Reflect shape G in the line $y = -1$

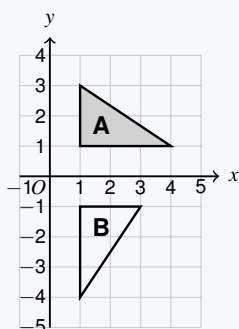


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Worked example A3

Rotate shape A 90° clockwise about O . Label the image B .

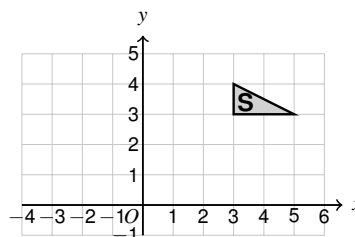


Use tracing paper, or turn each vertex: $(x, y) \rightarrow (y, -x)$.

shape B

Your turn A3

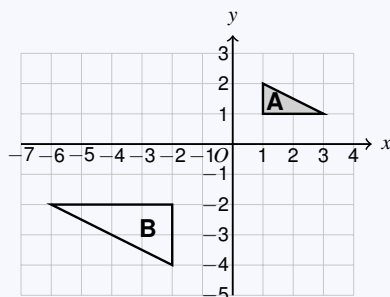
Rotate shape S 180° about the point $(1, 3)$

**HIGHER**

Higher only: negative scale factors, combined transformations and invariant points

Worked example A4: a negative scale factor

Enlarge shape A by scale factor -2 , centre O . Label the image B .

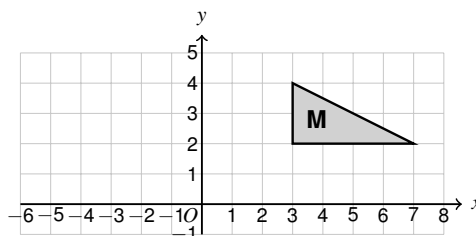


Each point goes through O and twice as far out on the other side.

shape B

Your turn A4

Enlarge shape M by scale factor $-\frac{1}{2}$, centre $(-1, 2)$



Worked example A5: combined transformations

A shape is reflected in the x -axis, then in the y -axis. Describe the single transformation that has the same effect.

$(x, y) \rightarrow (x, -y) \rightarrow (-x, -y)$: every point is turned through 180° about O .

rotation 180° about O

Your turn A5

A shape is reflected in the line $y = x$, then rotated 90° clockwise about O . Describe the single transformation that has the same effect.

Worked example A6: invariant points

Which of $(2, 2)$, $(3, -3)$ and $(-1, -1)$ are invariant under a reflection in the line $y = x$?

A point is invariant if it does not move: here, the points on the line $y = x$.

$(2, 2)$ and $(-1, -1)$

Your turn A6

Which of $(1, 3)$, $(3, 1)$ and $(0, 0)$ are invariant under a rotation of 90° about $(1, 3)$?

Worked example A7: using a vector

A translation maps $(3, 5)$ to $(7, 2)$. Where does it map $(-1, 4)$?

The vector is $\begin{pmatrix} 7-3 \\ 2-5 \end{pmatrix} = \begin{pmatrix} 4 \\ -3 \end{pmatrix}$

$(3, 1)$

Your turn A7

A translation maps $(-2, 6)$ to $(1, 1)$. Where does it map $(4, 0)$?



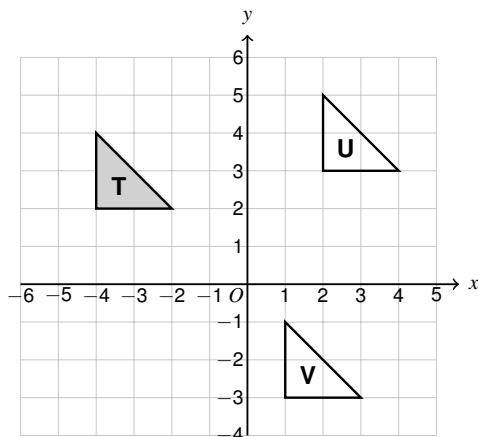
B**Fluency**

Each question is a designed sequence. From one part to the next, ask yourself: what changed, and what did it do to the answer?

FOUNDATION

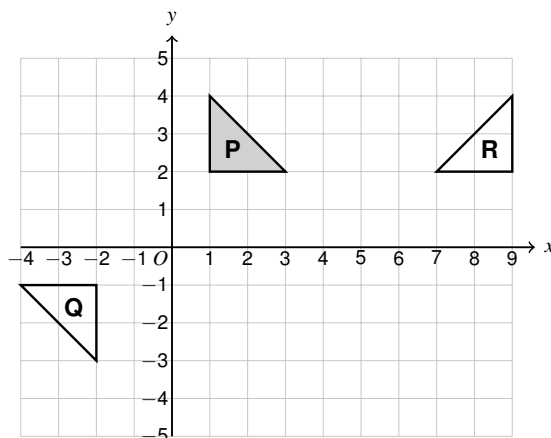
Everyone starts here

- B1**
- (a) Translate T by $\begin{pmatrix} 4 \\ -1 \end{pmatrix}$
 - (b) Translate T by $\begin{pmatrix} -1 \\ -4 \end{pmatrix}$
 - (c) Write down the vector that maps T to U
 - (d) Write down the vector that maps T to V



[4 marks]

- B2**
- (a) Reflect P in the y -axis.
 - (b) Reflect P in the x -axis.
 - (c) Describe fully the transformation that maps P to Q
 - (d) Describe fully the transformation that maps P to R

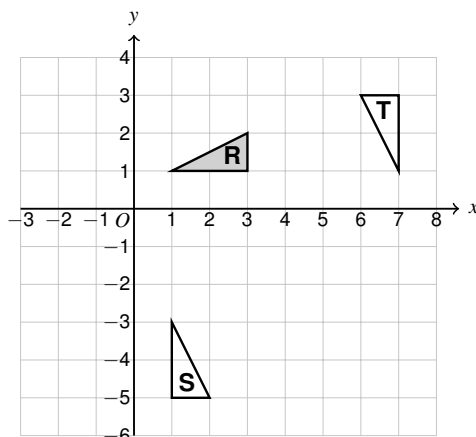


[4 marks]



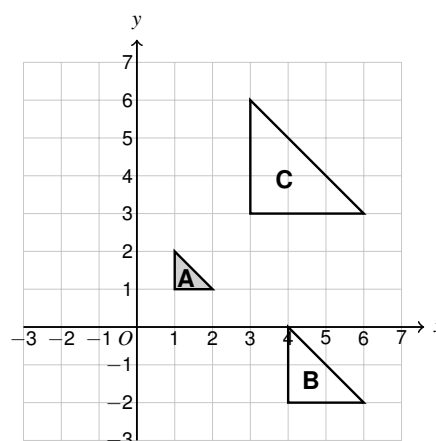
FOUNDATION *continued: rotations, enlargements and coordinates*

- B3** (a) Rotate R 90° anticlockwise about O
 (b) Rotate R 180° about $(2, 0)$
 (c) Describe fully the transformation that maps R to S
 (d) Describe fully the transformation that maps R to T



[4 marks]

- B4** Describe fully the single transformation that maps
 (a) A to B (b) A to C
 (c) B to A (d) C to A

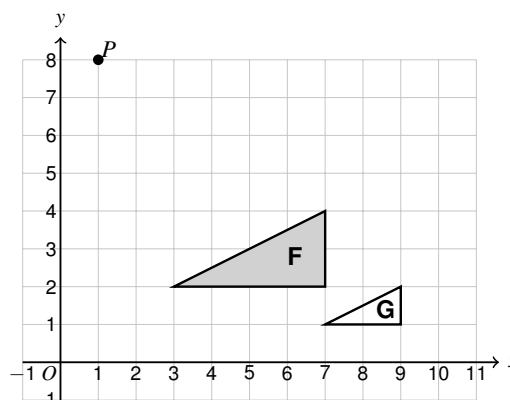


[4 marks]

- B5** The point $(3, -2)$ is transformed. Write down the coordinates of its image after
 (a) a reflection in the x -axis (b) a reflection in the line $y = x$ (c) a rotation of 180° about O

[3 marks]

- B6** (a) Enlarge F by scale factor $\frac{1}{2}$, centre P
 (b) Describe fully the transformation that maps F to G
 (c) Write down the scale factor of the enlargement that maps G to F
 (d) How many times bigger is the area of F than the area of G ?

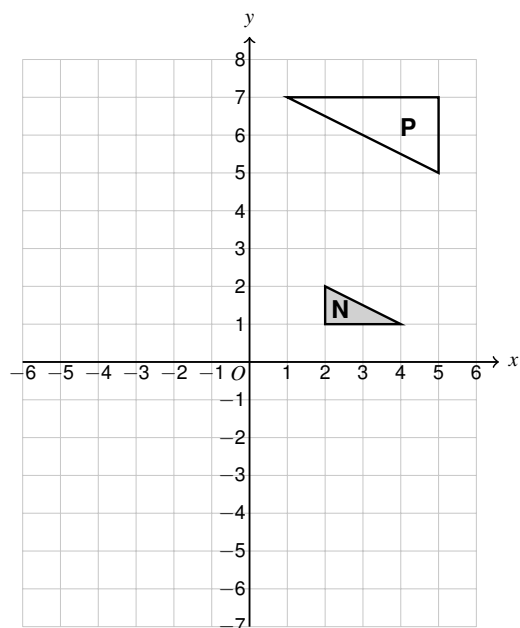


[4 marks]



HIGHER*Higher tier only*

- B7** (a) Enlarge N by scale factor -1 , centre O
(b) Enlarge N by scale factor -2 , centre $(1, -1)$
(c) Describe fully the transformation that maps N to P
(d) Without drawing, find the image of $(4, 2)$ after an enlargement with scale factor -3 , centre $(1, 0)$

**[4 marks]**

- B8** Describe fully the single transformation equivalent to
- (a) a reflection in the x -axis followed by a reflection in the y -axis
(b) a rotation of 90° clockwise about O followed by a reflection in the line $y = x$
(c) a translation by $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$ followed by a reflection in the y -axis
(d) a rotation of 90° anticlockwise about O followed by a rotation of 180° about O

[4 marks]

HIGHER*continued: invariant points and describing harder transformations*

B9 A triangle has vertices $(1, 1)$, $(3, 1)$ and $(1, 3)$. Describe the points of the triangle that are invariant under

(a) a reflection in the line $y = 1$ (b) a rotation of 90° about $(1, 1)$

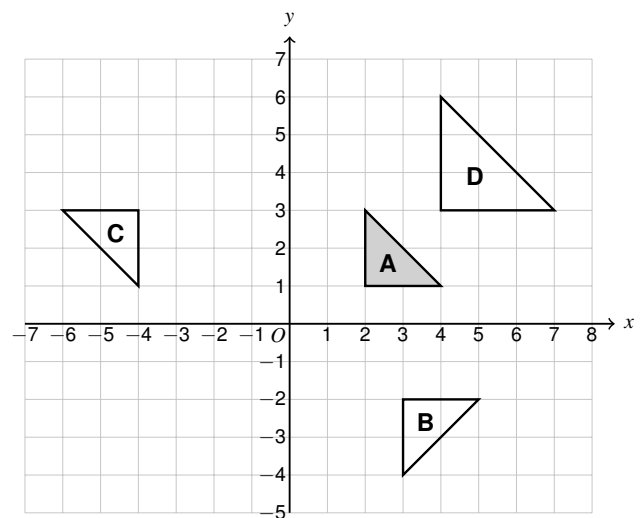
(c) a translation by $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$ (d) an enlargement with scale factor 3, centre $(1, 1)$

[4 marks]

B10 Describe fully the single transformation that maps

(a) A to B (b) A to C

(c) A to D (d) D to A



[4 marks]



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C**Reasoning**

Show your working and explain your thinking. A correct answer without a reason does not score full marks.

FOUNDATION

Everyone starts here

- C1** Tom describes a transformation as “a turn of 90° ”.
Explain what else he must say to describe the rotation fully. [2 marks]
- C2** Sam translates a shape by $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$. He moves it 3 squares down and 2 squares right.
Explain Sam’s mistake. [2 marks]
- C3** A shape is enlarged by scale factor $\frac{1}{2}$
Explain what happens to its side lengths and to its angles. [3 marks]
- C4** Is the image of a shape congruent to the shape after a reflection? After an enlargement with scale factor 2? Explain your answers. [3 marks]



HIGHER*Higher tier only*

- C5** Jo says, "Reflecting in the x -axis then the y -axis gives the same result as reflecting in the y -axis then the x -axis."
Is Jo right? Explain, and name the single transformation. [3 marks]
- C6** Show that a rotation of 180° about O has the same effect as an enlargement with scale factor -1 , centre O [3 marks]
- C7** Explain why a translation by a non-zero vector has no invariant points, but a rotation always has exactly one. [3 marks]
- C8** M is a reflection in the line $y = x$. R is a rotation of 90° anticlockwise about O
- (a) Describe the single transformation equivalent to M followed by R
 - (b) Describe the single transformation equivalent to R followed by M
 - (c) What does this show about the order of transformations? [5 marks]



D**Problem solving**

You decide the method. Read the whole question first, and show every step.

FOUNDATION*Everyone starts here*

D1 A shape is translated by $\begin{pmatrix} 3 \\ -1 \end{pmatrix}$ and then by $\begin{pmatrix} -5 \\ 4 \end{pmatrix}$

(a) Write down the single vector with the same effect.
back to where it started.

(b) Write down the vector that takes the shape
[3 marks]

D2 The point $P(2, 5)$ is reflected in the line $x = a$. Its image is $(8, 5)$

(a) Find a

(b) The image is then reflected in the line $y = 1$. Find the coordinates of the new image.

[4 marks]

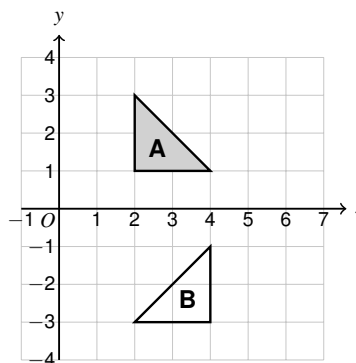
D3 A rectangle measures 3 cm by 2 cm. It is enlarged by scale factor 3

Work out the area of the image, and how many times bigger it is than the area of the rectangle.

[3 marks]

D4 Shape A is rotated to shape B .

Describe the rotation fully. You must give its
centre, angle and direction.



[3 marks]



HIGHER*Higher tier only*

- D5** A triangle has vertices $(2, 1)$, $(5, 1)$ and $(2, 3)$. It is enlarged with scale factor -3 , centre $(1, 0)$
(a) Find the vertices of the image. **(b)** Work out the area of the image. [4 marks]
- D6** The point Q is rotated 90° clockwise about $(1, 1)$. Its image is $(5, -1)$
Find the coordinates of Q [4 marks]
- D7** An enlargement maps $A(1, 2)$ to $(7, 5)$ and $B(3, 1)$ to $(11, 3)$
Find the scale factor and the centre of the enlargement. [4 marks]
- D8** A shape is enlarged with scale factor $-\frac{1}{2}$, centre $(2, -1)$. The image is then enlarged with scale factor -2 , centre $(-2, 3)$
Show that the shape ends up translated, and find the vector of the translation. [5 marks]

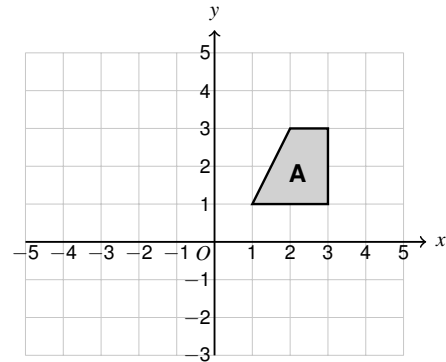


E**Exam practice**

Exam-style questions. Write your answers in the spaces. Aim for about one minute per mark.

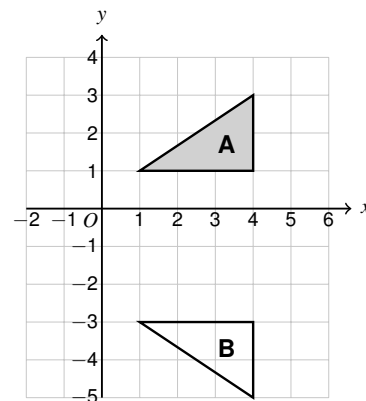
FOUNDATION*Foundation and Higher crossover*

- E1** Translate shape *A* by the vector $\begin{pmatrix} -4 \\ 2 \end{pmatrix}$

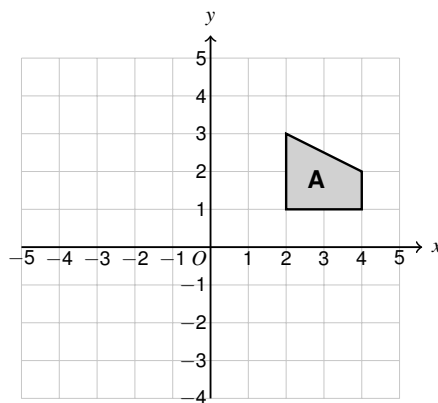
**(Total for Question E1 is 2 marks)**

- E2** Describe fully the single transformation that maps shape *A* onto shape *B*

.....
.....

**(Total for Question E2 is 2 marks)****Join students already acing their exams.**Book your FREE lesson at www.eclassroom.org.uk

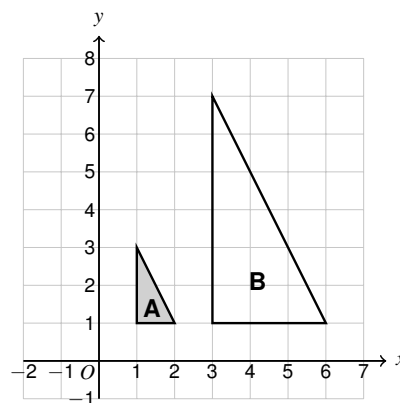
- E3** Rotate shape A 90° anticlockwise about the point $(-1, 0)$



(Total for Question E3 is 2 marks)

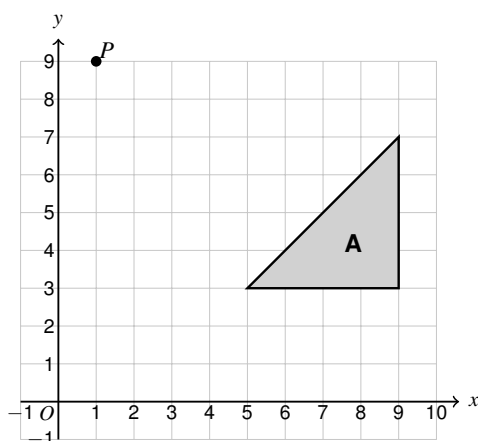
- E4** Describe fully the single transformation that maps shape A onto shape B

.....



(Total for Question E4 is 3 marks)

- E5** Enlarge shape A by scale factor $\frac{1}{2}$, centre P



(Total for Question E5 is 2 marks)



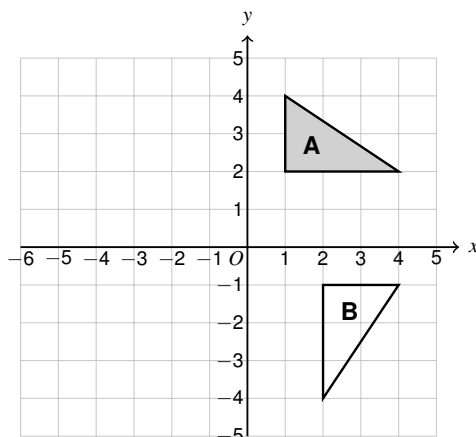
- E6** (a) Reflect shape A in the line $x = -1$

(2)

- (b) Describe fully the single transformation that maps shape A onto shape B

.....

(2)

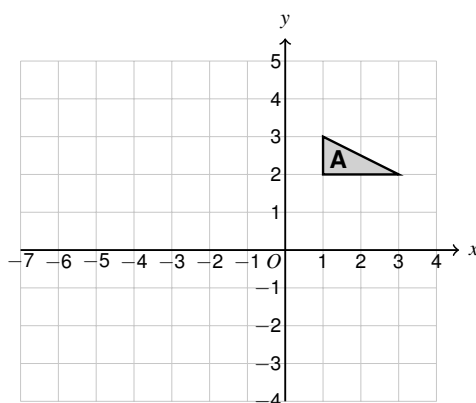


(Total for Question E6 is 4 marks)

HIGHER

Higher tier only

- E7** Enlarge shape A by scale factor -2 , centre $(0, 1)$



(Total for Question E7 is 3 marks)

- E8** Shape P is reflected in the line $x = 1$ to give shape Q . Shape Q is rotated 180° about $(1, 0)$ to give shape R . Describe fully the single transformation that maps P onto R

.....

(Total for Question E8 is 3 marks)



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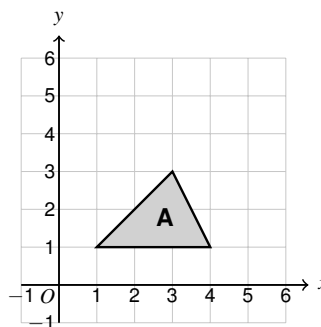
E9 (a) Reflect triangle A in the line $y = x$

(2)

(b) Describe the points of triangle A that are invariant under this reflection.

.....

(2)



(Total for Question E9 is 4 marks)

E10 Shape B is an enlargement of shape A

(a) Find the scale factor and the centre of the enlargement.

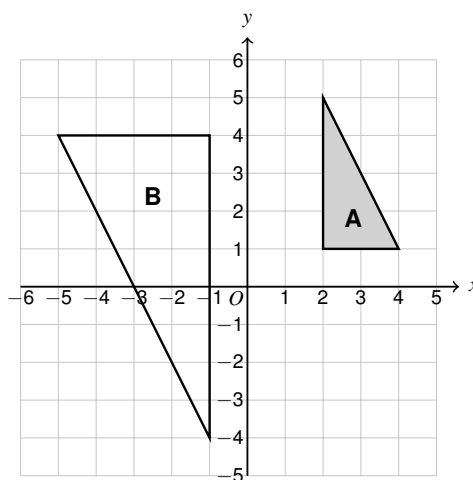
.....

(4)

(b) The same enlargement maps the point $(6, 3)$ to K . Find K

.....

(1)



(Total for Question E10 is 5 marks)

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