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GCSE MATHEMATICS • GEOMETRY

Transformations

Worked Solutions

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

Full worked solutions for the free Transformations worksheet, GCSE and iGCSE Maths



Tap a section to jump straight to it

Full worked solutions for every question on the Transformations worksheet, in the same order and with the same question numbers.

How to mark your work. Tick each step you got right, not just the final answer. In the exam, method marks are given for correct working even when the final answer is wrong. If you lost marks, find the *first* line where your working is different from ours. That is the thing to fix.

In Section E: **M** = method mark, **P** = process mark, **A** = accuracy mark, **B** = independent mark, **C** = communication mark.

Question sheet

Geometry revision engine

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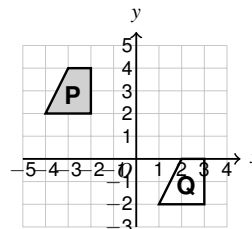
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A**Your turn answers**

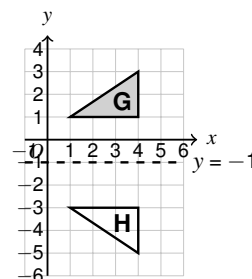
Check your drawing against the grid: every vertex should be in the same place.

FOUNDATION

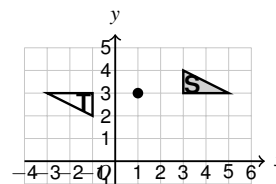
- A1**
- Move every vertex 5 right and 4 down.

shape Q on the grid

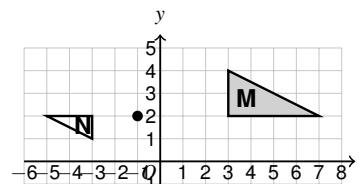
- A2**
- Each vertex the same distance from
- $y = -1$
- , on the other side.

shape H on the grid

- A3**
- Each vertex goes through (1, 3) to the same distance on the other side.

shape T on the grid**HIGHER**

- A4**
- Each point goes through
- $(-1, 2)$
- and half as far on the other side.

shape N on the grid

- A5**
- $(x, y) \rightarrow (y, x) \rightarrow (x, -y)$
- a reflection in the x -axis**

- A6**
- Only the centre of a rotation stays still.
- (1, 3) only**



A7 The vector is $\begin{pmatrix} 1 - (-2) \\ 1 - 6 \end{pmatrix} = \begin{pmatrix} 3 \\ -5 \end{pmatrix}$ $(4 + 3, 0 - 5) = (7, -5)$

Fluency solutions

B

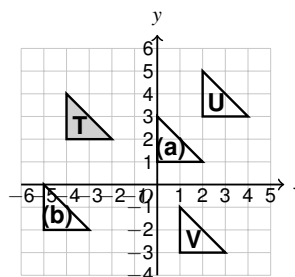
One mark for each correct part. A description needs every detail: the type of transformation and its vector, line, centre, angle, direction or scale factor.

FOUNDATION

B1 (a) (b) **images (a) and (b) on the grid**

(c) $\begin{pmatrix} 6 \\ 1 \end{pmatrix}$ (d) $\begin{pmatrix} 5 \\ -5 \end{pmatrix}$

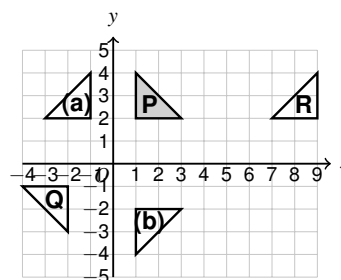
Top number: right (+) or left (−). Bottom: up (+) or down (−).



B2 (a) (b) **images (a) and (b) on the grid**

(c) **reflection in the line $y = -x$**

(d) **reflection in the line $x = 5$**

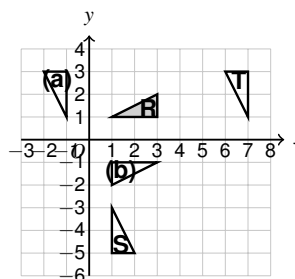


B3 (a) (b) **images (a) and (b) on the grid**

(c) **rotation 90° clockwise about $(-1, -1)$**

(d) **rotation 90° anticlockwise about $(4, 4)$**

A rotation needs its angle, direction and centre.



B4 (a) **enlargement, scale factor 2, centre $(-2, 4)$**

(b) **enlargement, scale factor 3, centre O**

(c) **enlargement, scale factor $\frac{1}{2}$, centre $(-2, 4)$**

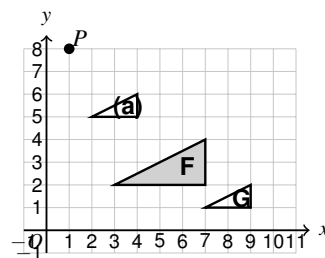
(d) **enlargement, scale factor $\frac{1}{3}$, centre O**

Going back reverses the scale factor: 2 becomes $\frac{1}{2}$. The centre is found by joining matching vertices and extending the lines.



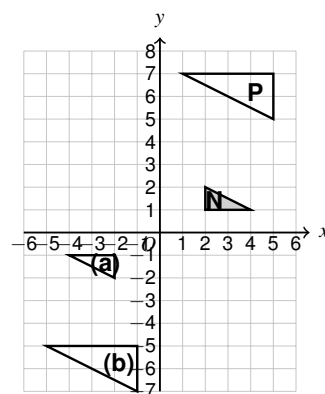
- B5 (a) $(3, 2)$ (b) $(-2, 3)$ (c) $(-3, 2)$

- B6 (a) image (a) on the grid
 (b) enlargement, scale factor $\frac{1}{2}$, centre $(11, 0)$
 (c) 2 (d) lengths $\times 2$, so area $\times 2^2$: 4 times



HIGHER

- B7 (a) (b) images (a) and (b) on the grid
 (c) enlargement, scale factor -2 , centre $(3, 3)$
 (d) $(1, 0) + (-3) \times \begin{pmatrix} 4-1 \\ 2-0 \end{pmatrix} = (1-9, 0-6) = (-8, -6)$



- B8 (a) $(x, y) \rightarrow (x, -y) \rightarrow (-x, -y)$: rotation 180° about O
 (b) $(x, y) \rightarrow (y, -x) \rightarrow (-x, y)$: reflection in the y -axis
 (c) $(x, y) \rightarrow (x+2, y) \rightarrow (-x-2, y)$: reflection in the line $x = -1$
 (d) $90^\circ + 180^\circ = 270^\circ$ anticlockwise: rotation 90° clockwise about O

- B9 (a) every point on the side from $(1, 1)$ to $(3, 1)$ (b) only $(1, 1)$
 (c) none: every point moves 2 to the right (d) only $(1, 1)$, the centre

- B10 (a) rotation 90° clockwise about $(1, -1)$ (b) enlargement, scale factor -1 , centre $(-1, 2)$ (a rotation of 180° about $(-1, 2)$ is also correct)
 (c) enlargement, scale factor $\frac{3}{2}$, centre $(-2, -3)$ (d) enlargement, scale factor $\frac{2}{3}$, centre $(-2, -3)$



C**Reasoning solutions**

Your wording can be different. Check that your reason makes the same point.

FOUNDATION

- C1** He must give the direction (clockwise or anticlockwise) and the centre of the rotation.
- C2** The top number is the horizontal move and the bottom number the vertical move: 3 squares right and 2 squares down.
- C3** Every side length is halved. The angles stay the same, so the image is the same shape, only smaller.
- C4** After a reflection, yes: lengths and angles are unchanged. After an enlargement with scale factor 2, no: the lengths double, so it is similar but not congruent.

HIGHER

- C5** **Yes**. Either order sends (x, y) to $(-x, -y)$: a **rotation of 180° about O** .
- C6** A rotation of 180° about O sends (x, y) to $(-x, -y)$. An enlargement with scale factor -1 , centre O , sends (x, y) to $-1 \times (x, y) = (-x, -y)$. They are the same.
- C7** A translation moves every point by the same non-zero vector, so no point stays still. A rotation turns every point about the centre; only the centre stays where it is.
- C8** (a) $(x, y) \rightarrow (y, x) \rightarrow (-x, y)$: **reflection in the y -axis**
(b) $(x, y) \rightarrow (-y, x) \rightarrow (x, -y)$: **reflection in the x -axis**
(c) The results are different, so the order of transformations matters.



D

Problem solving solutions

There is often more than one correct method. Any complete, correct method scores full marks.

FOUNDATION

D1 (a) $\begin{pmatrix} 3-5 \\ -1+4 \end{pmatrix} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$ (b) $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$

D2 (a) The line is halfway between $x = 2$ and $x = 8$: $a = 5$ (b) $y = 5$ is 4 above $y = 1$, so the image is 4 below: $(8, -3)$

D3 The image is 9 cm by 6 cm: area 54 cm^2 . The original area is 6 cm^2 , so it is 9 times bigger (3^2).

D4 rotation 90° anticlockwise about $(5, 0)$

Check: $(2, 1)$ is 3 left and 1 up from $(5, 0)$; turned 90° anticlockwise it is 1 left and 3 down, at $(4, -3)$, a vertex of B

HIGHER

D5 (a) $(-2, -3)$, $(-11, -3)$ and $(-2, -9)$

(b) The original area is $\frac{1}{2} \times 3 \times 2 = 3$. Lengths $\times 3$, so area $\times 9$: 27

D6 Undo it: rotate $(5, -1)$ 90° anticlockwise about $(1, 1)$. From $(1, 1)$ it is 4 right and 2 down; turned anticlockwise it becomes 2 right and 4 up. $Q = (3, 5)$

D7 $AB = \begin{pmatrix} 2 \\ -1 \end{pmatrix}$ and its image is $\begin{pmatrix} 4 \\ -2 \end{pmatrix}$, so the scale factor is 2

The centre C satisfies $C + 2(A - C) = (7, 5)$, so $C = 2(1, 2) - (7, 5) = (-5, -1)$

D8 First: $P \rightarrow (2, -1) - \frac{1}{2}(P - (2, -1)) = \frac{3}{2}(2, -1) - \frac{1}{2}P$

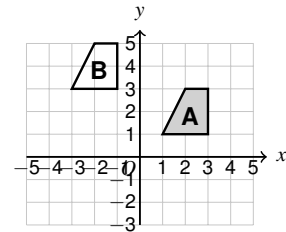
Then: $Q \rightarrow (-2, 3) - 2(Q - (-2, 3)) = 3(-2, 3) - 2Q = 3(-2, 3) - 3(2, -1) + P$

So P moves by $3((-2, 3) - (2, -1)) = 3(-4, 4)$: a translation by $\begin{pmatrix} -12 \\ 12 \end{pmatrix}$



E**Exam practice solutions**

Marks are shown on the right of each line.

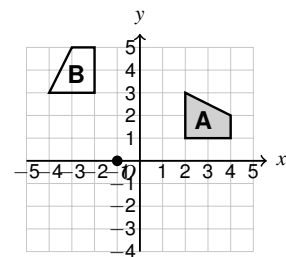
FOUNDATION *Foundation and Higher crossover***E1** **shape B**: 4 left and 2 up

B2

E2 **reflection**in the line $y = -1$

B1

B1

E3 **shape B**, turned 90° anticlockwise about $(-1, 0)$ 

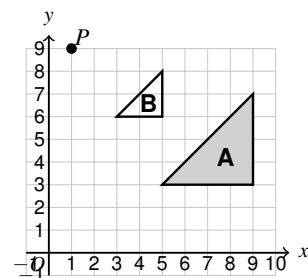
B2

E4 **enlargement****scale factor 3****centre** $(0, 1)$

B1

B1

B1

E5 **shape B**: each vertex halfway from P 

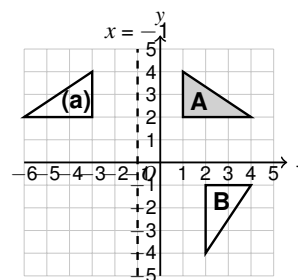
B2



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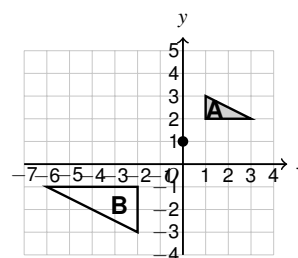
- E6 (a) **image (a)**, reflected in $x = -1$
 (b) **rotation 90° clockwise about O**



B2 B2

HIGHER

- E7 **shape B**: through $(0, 1)$, twice as far on the other side



B3

- E8 $(x, y) \rightarrow (2 - x, y)$
 $\rightarrow (2 - (2 - x), -y) = (x, -y)$

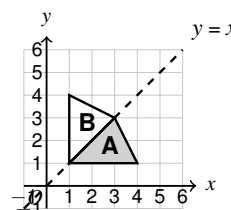
reflection in the x -axis

M1

M1

A1

- E9 (a) **triangle B**
 (b) **every point on the side from $(1, 1)$ to $(3, 3)$** , which lies on $y = x$



B2 B2

- E10 (a) B is upside down and twice as big, so the scale factor is **-2**

B2

The lines joining matching vertices meet at **$(1, 2)$**

B2

(b) $(1, 2) - 2 \times \begin{pmatrix} 6-1 \\ 3-2 \end{pmatrix} = (1-10, 2-2) = \mathbf{(-9, 0)}$

B1

