Vectors
Difficulty: Medium

Question Paper 1

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Medium
Booklet	Question Paper 1

Time allowed: **82 minutes**

Score: **/71**

Percentage: **/100**

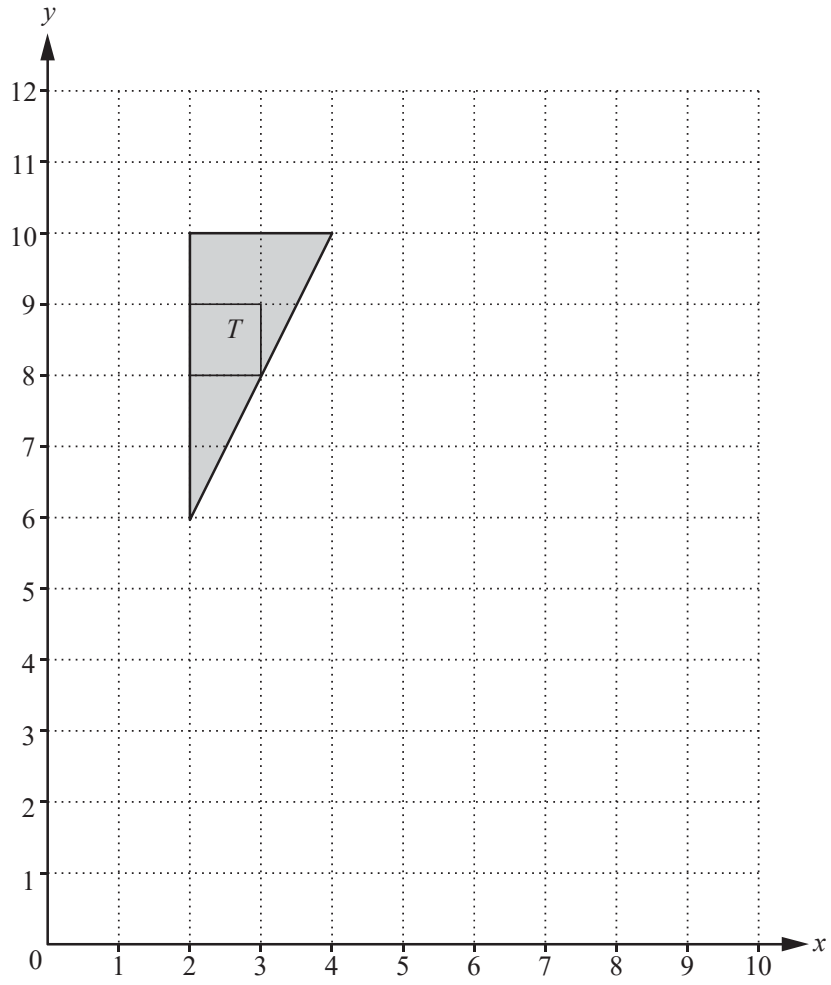
Grade Boundaries:

CIE IGCSE Maths (0580)

A*	A	B	C	D
>83%	67%	51%	41%	31%

CIE IGCSE Maths (0980) ~~Assembled by A/S~~

9	8	7	6	5	4
>95%	87%	80%	69%	58%	46%

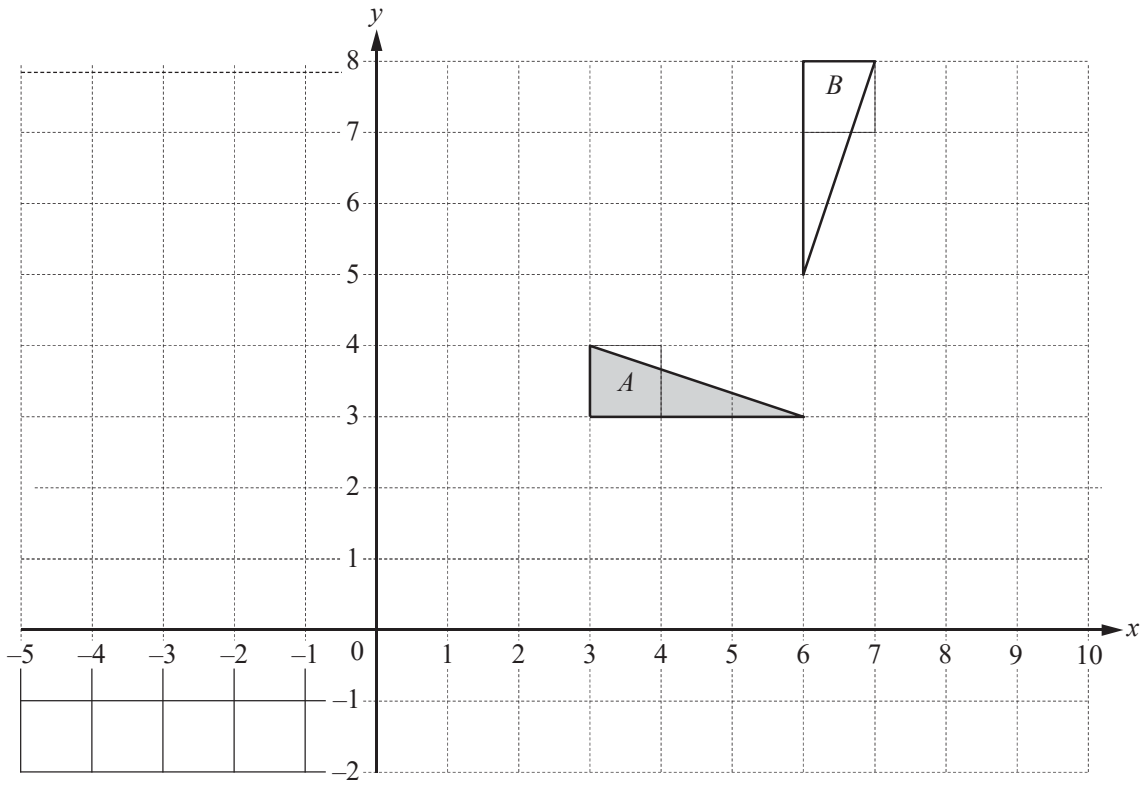


On the grid, draw the image of $\begin{pmatrix} 6 \\ -5 \end{pmatrix}$,

(i) triangle T after translation by the vector [2]

(ii) triangle T after rotation through 90° anticlockwise with centre $(4, 10)$, [2]

(iii) triangle T after enlargement with scale factor $\frac{1}{2}$, centre $(10, 0)$. [2]



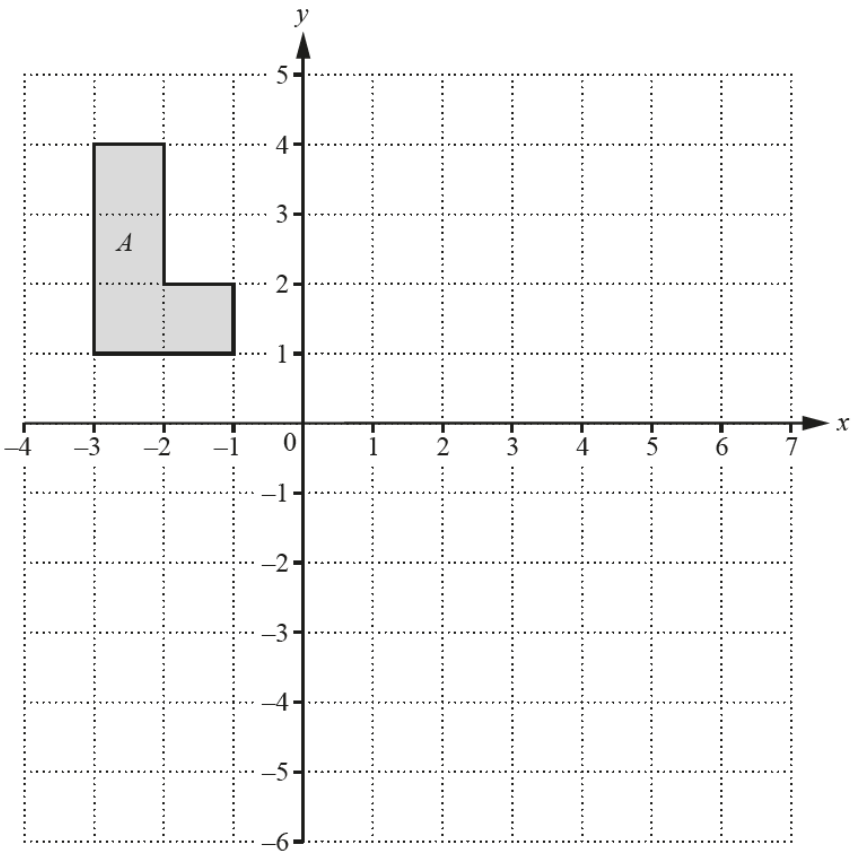
(a) Draw the image when triangle A is reflected in the line $x = 1$. [2]

(b) Draw the image when triangle A is translated by the vector $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$. [2]

(c) Draw the image when triangle A is enlarged by scale factor 2 with centre (4, 5). [2]

(d) Describe fully the **single** transformation that maps triangle A onto triangle B. [3]

(a)



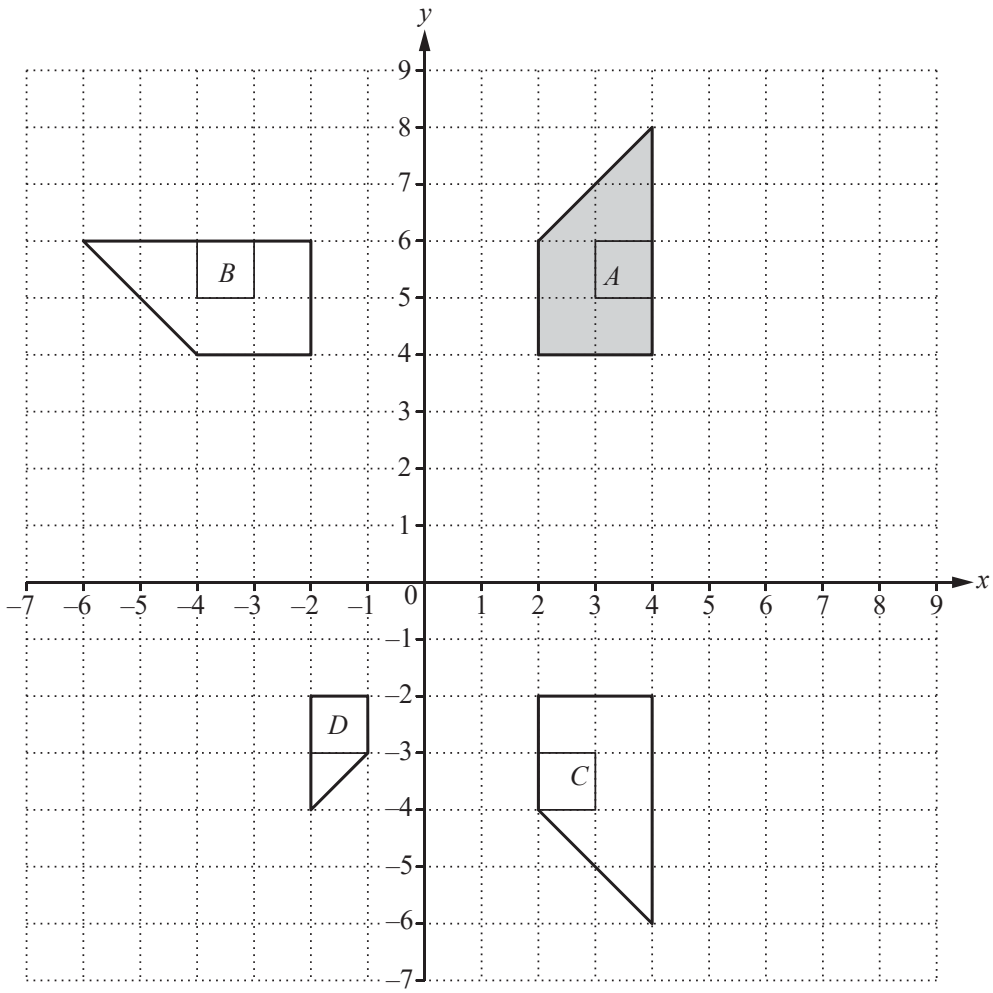
On the grid, draw the image of

(i) shape A after a reflection in the line $x = 1$, [2]

(ii) shape A after an enlargement with scale factor -2, centre $(0, 1)$, [2]

(iii) shape A after the transformation represented by the matrix $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. [3]

(b) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 3 & 0 \\ 0 & 3 \end{pmatrix}$. [3]



(a) Describe fully the **single** transformation that maps

(i) shape A onto shape B,

[3]

(ii) shape A onto shape C, [2]

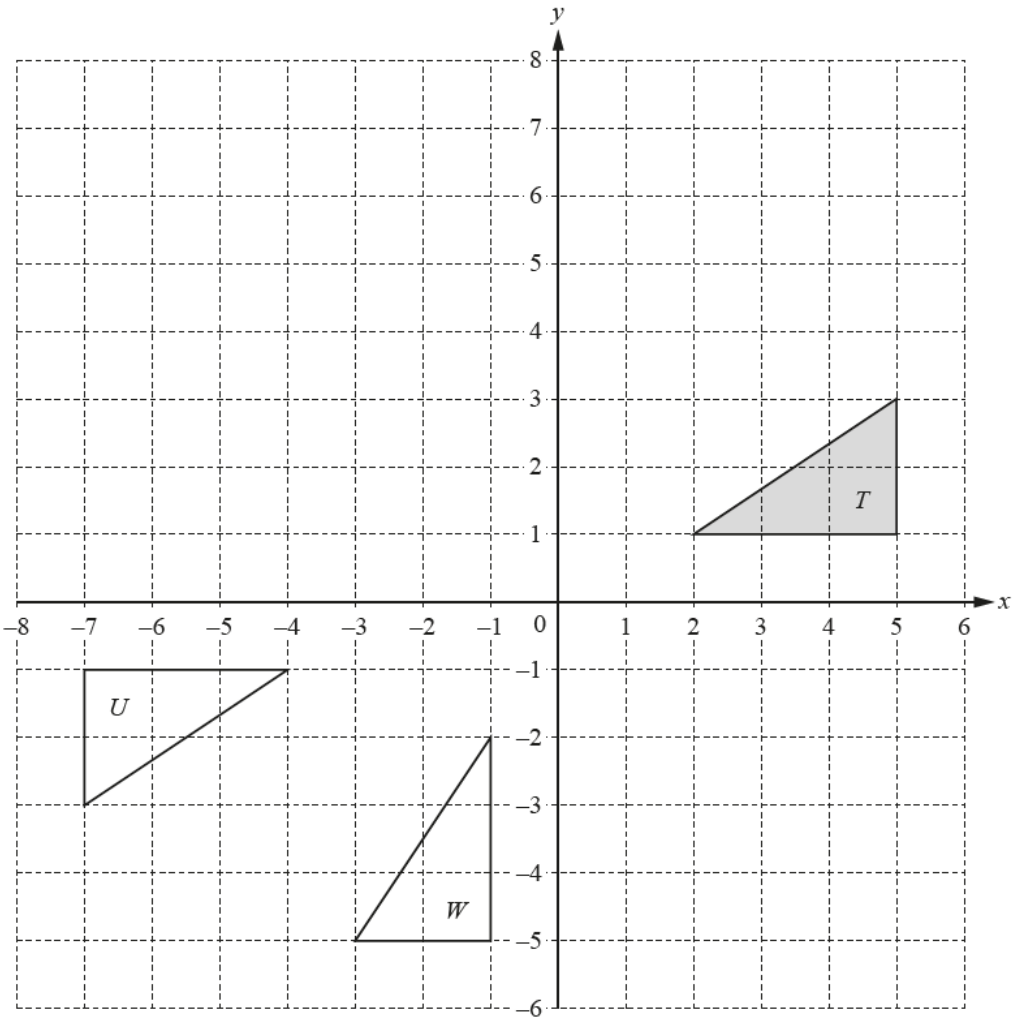
(iii) shape A onto shape D. [3]

(b) Find the 2 × 2 matrix that represents the transformation in **part (a)(iii)**. [2]

(c) On the grid, draw the image of shape A after a translation by the vector $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$. [2]

$\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$.

(d) Describe fully the **single** transformation represented by the matrix [2]



(a) On the grid, draw the image of

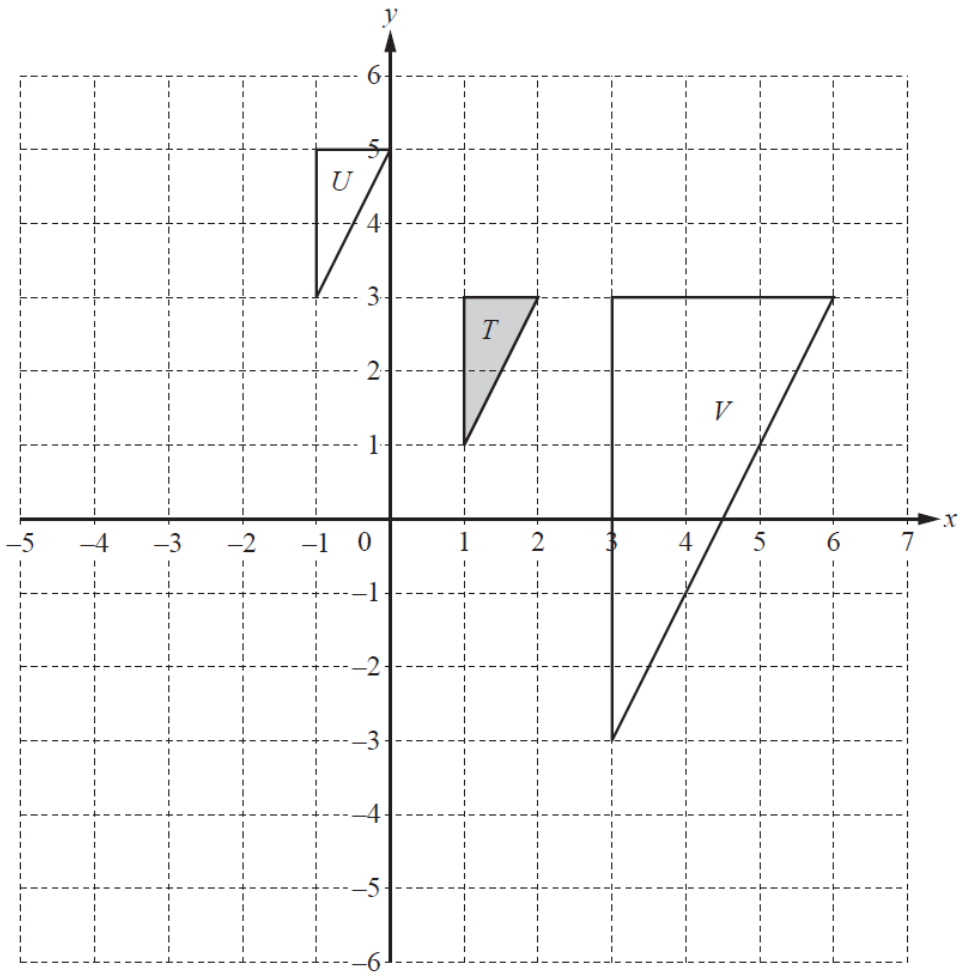
(i) triangle T after a translation by the vector $\begin{pmatrix} -4 \\ 4 \end{pmatrix}$, [2]

(ii) triangle T after a reflection in the line $y = -1$. [2]

(b) Describe fully the **single** transformation that maps triangle T onto triangle U. [3]

(c) (i) Describe fully the **single** transformation that maps triangle T onto triangle W. [2]

(ii) Find the 2×2 matrix that represents the transformation in **part (c)(i)**. [2]



(a) On the grid, draw the image of

(i) triangle T after a reflection in the line $x = -1$, [2]

(ii) triangle T after a rotation through 180° about $(0, 0)$. [2]

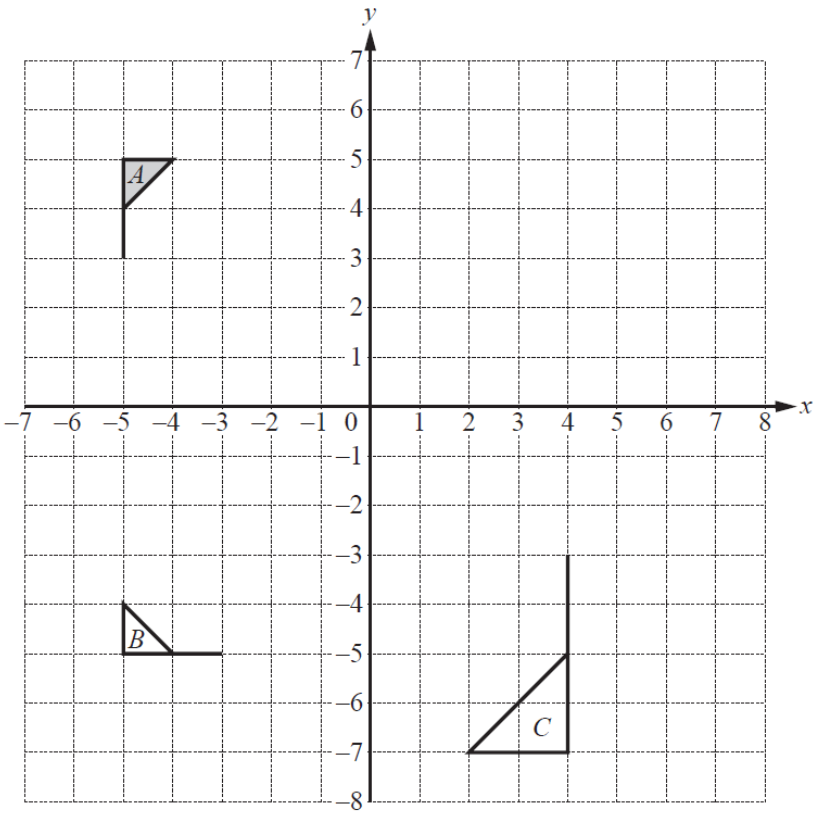
(b) Describe fully the **single** transformation that maps

(i) triangle T onto triangle U,

[2]

(ii) triangle T onto triangle V.

[3]



(a) Describe fully the **single** transformation that maps

(i) flag A onto flag B, [3]

(ii) flag A onto flag C. [3]

(b) Draw the image of flag A after a translation by the vector $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$. [2]

(c) Draw the image of flag A after a reflection in the line $x = 1$. [2]

(d) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$. [2]

Vectors
Difficulty: Medium

Question Paper 2

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Medium
Booklet	Question Paper 2

Time allowed: **109 minutes**

Score: **/95**

Percentage: **/100**

Grade Boundaries:

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A*	A	B	C	D
>83%	67%	51%	41%	31%

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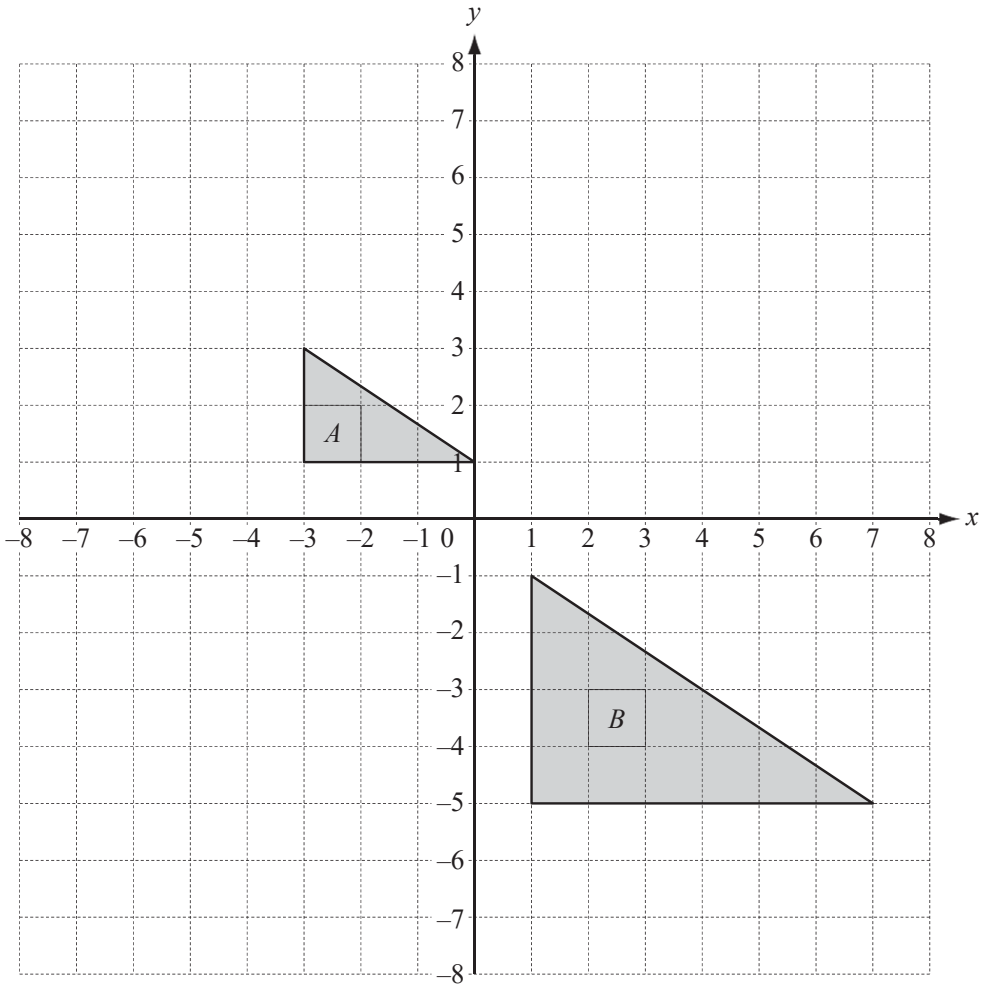


(a) Draw the image when triangle A is reflected in the line $x = 0$. [1]

(b) Draw the image when triangle A is rotated through 90° anticlockwise about $(-4, 0)$. [2]

(c) (i) Describe fully the **single** transformation that maps triangle A onto triangle B. [3]

(ii) Complete the following statement.

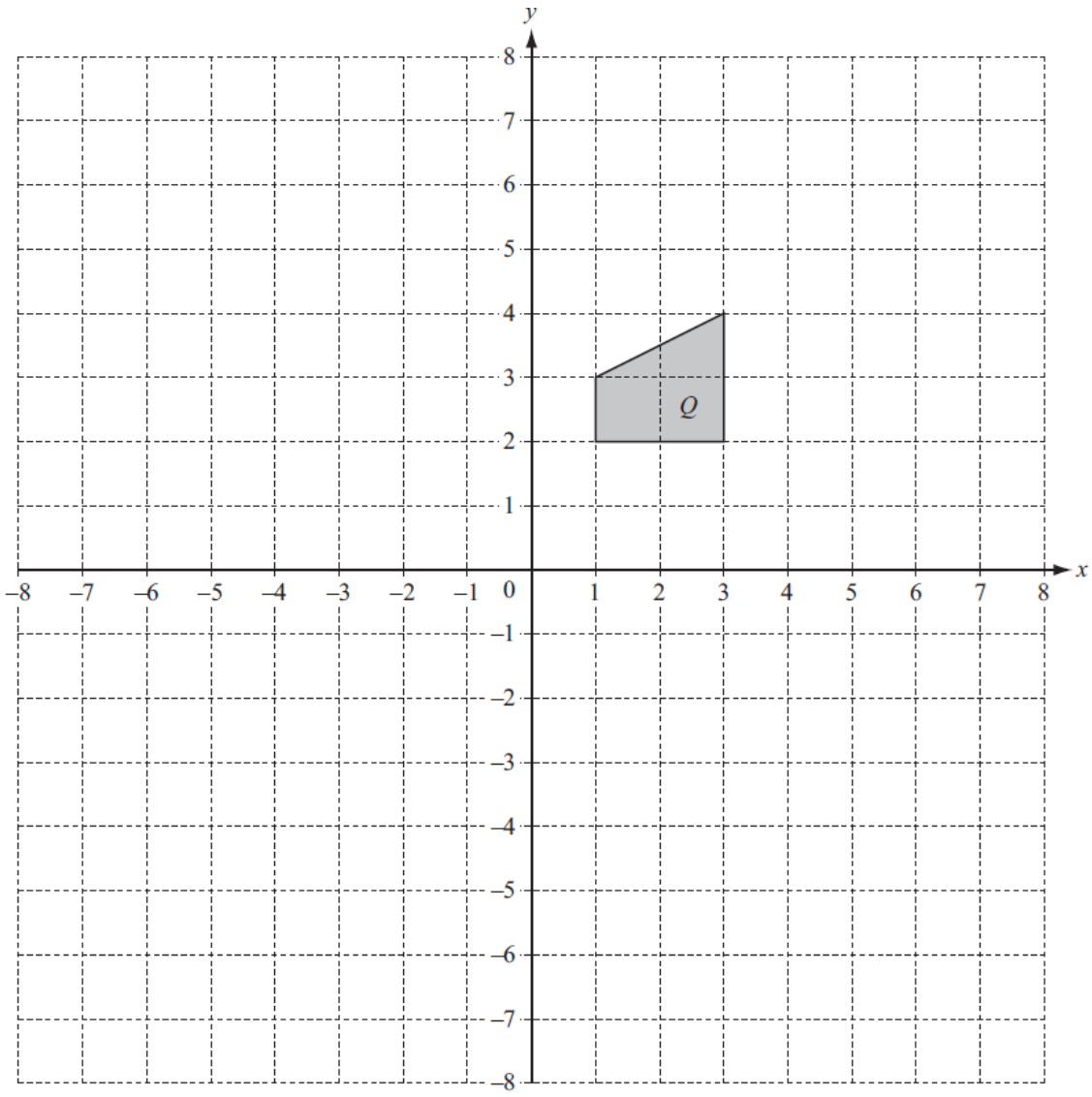
Area of triangle A : Area of triangle B = ... : ..... [2]

(d) Write down the matrix that represents a stretch, factor 4 with the y-axis invariant. [2]

(e) (i) On the grid, draw the image of triangle A after the transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 2 & 1 \end{pmatrix}$. [3]

(ii) Describe fully this **single** transformation. [3]

(iii) Find the inverse of the matrix $\begin{pmatrix} 1 & 0 \\ 2 & 1 \end{pmatrix}$. [2]



(a) Draw the reflection of shape Q in the line $x = -1$. [2]

(b) (i) Draw the enlargement of shape Q, centre (0, 0), scale factor -2 . [2]

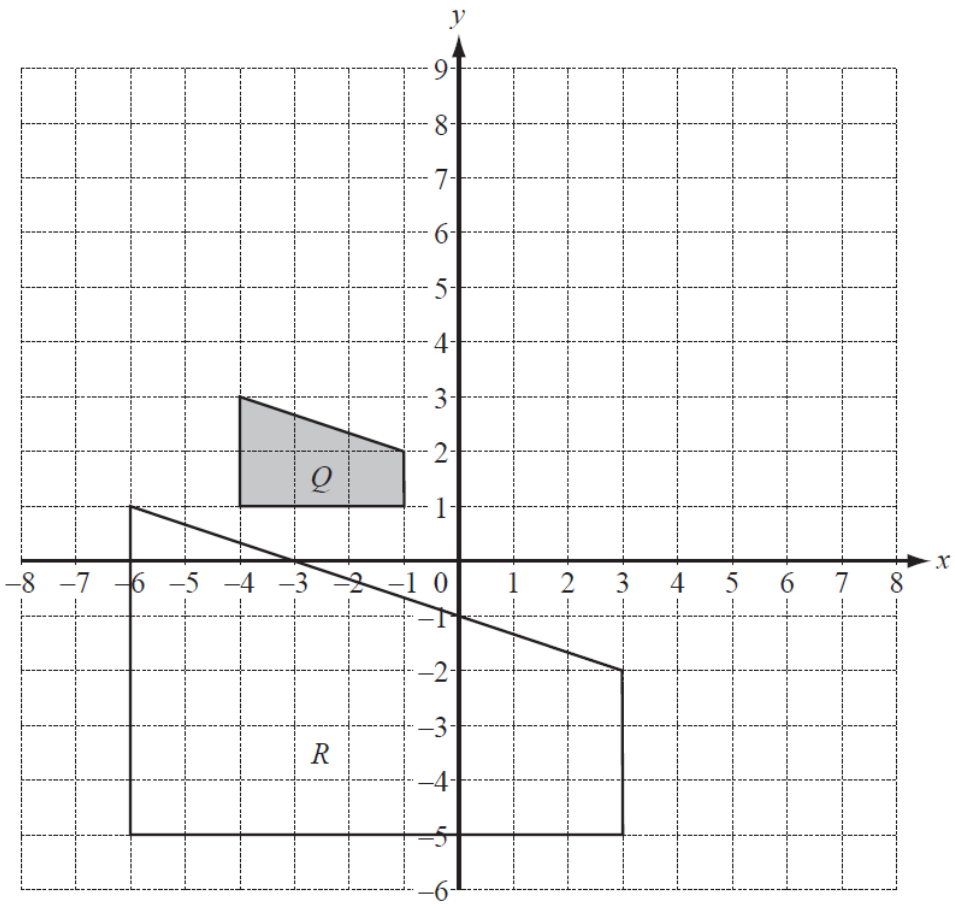
(ii) Find the 2×2 matrix that represents an enlargement, centre (0, 0), scale factor -2 . [2]

(c) **(i)** Draw the stretch of shape Q, factor 2, x-axis invariant. [2]

(ii) Find the 2×2 matrix that represents a stretch, factor 2, x-axis invariant. [2]

(iii) Find the inverse of the matrix in **part (c)(ii)**. [2]

(iv) Describe fully the **single** transformation represented by the matrix in **part (c)(iii)**. [3]



(a) Describe fully the **single** transformation that maps shape Q onto shape R. [3]

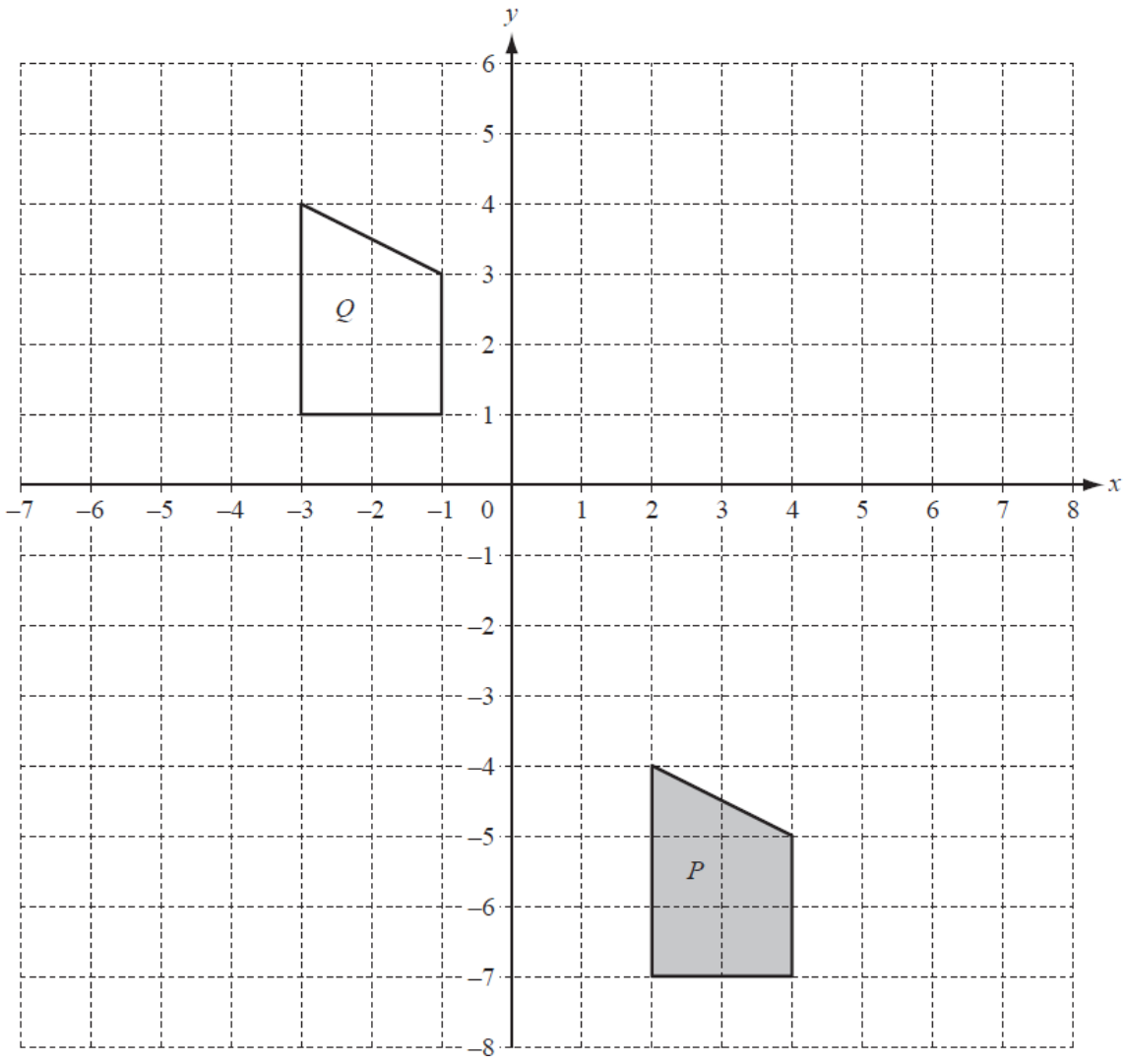
(b) (i) Draw the image when shape Q is translated by the vector $\begin{pmatrix} 5 \\ 4 \end{pmatrix}$. [2]

(ii) Draw the image when shape Q is reflected in the line $x = 2$. [2]

(iii) Draw the image when shape Q is stretched, factor 3, x-axis invariant. [2]

(iv) Find the 2×2 matrix that represents a stretch of factor 3, x-axis invariant. [2]

(c) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$. [2]

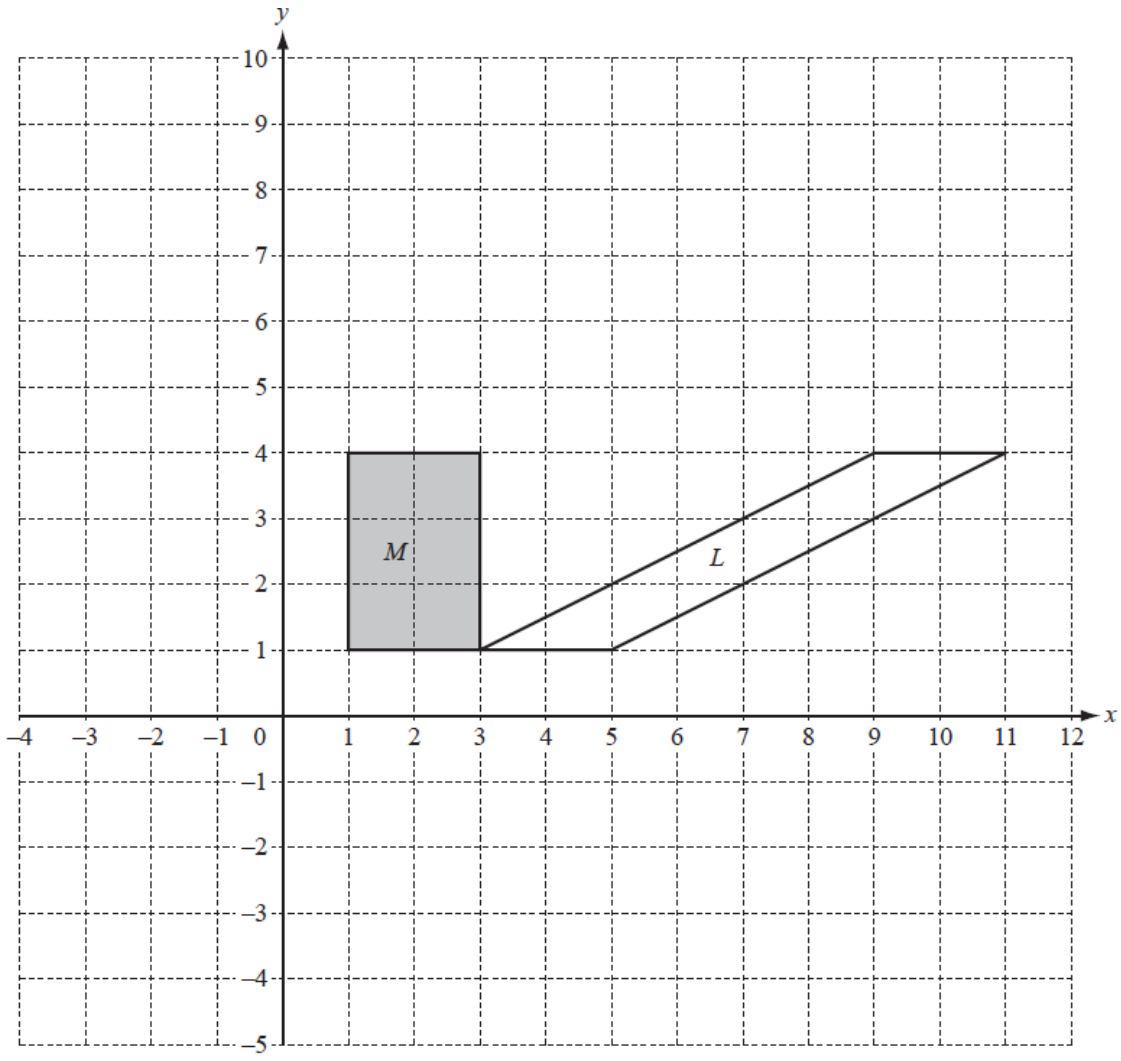


(i) Describe fully the **single** transformation which maps shape P onto shape Q. [2]

(ii) On the grid above, draw the image of shape P after reflection in the line $y = -1$. [2]

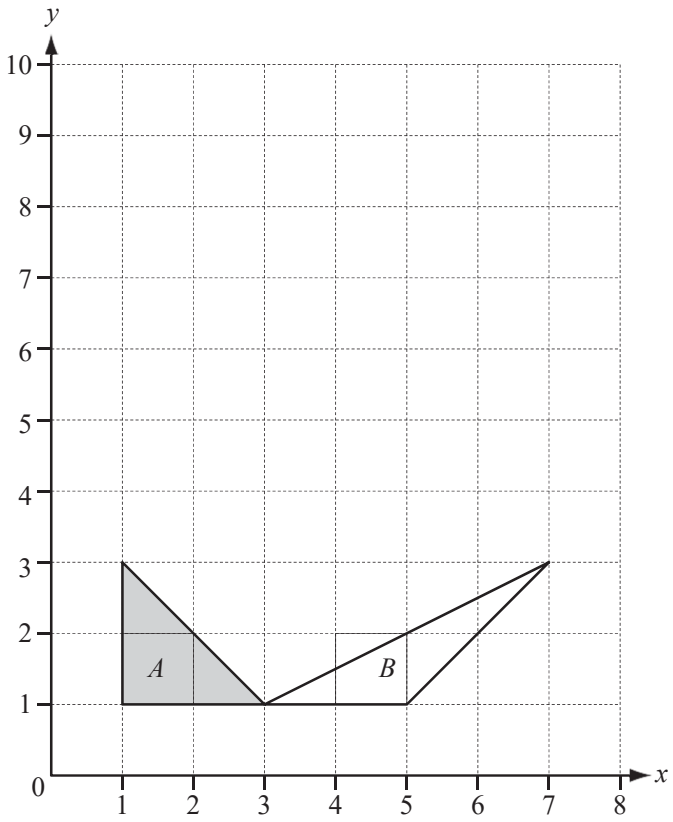
(iii) On the grid above, draw the image of shape P under the transformation represented by the matrix $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. [3]

(b)



(i) Describe fully the **single** transformation which maps shape M onto shape L. [3]

(ii) On the grid above, draw the image of shape M after enlargement by scale factor 2, centre (5, 0). [2]



(a) (i) Draw the image of shape A after a stretch, factor 3, x-axis invariant. [2]

(ii) Write down the matrix representing a stretch, factor 3, x-axis invariant. [2]

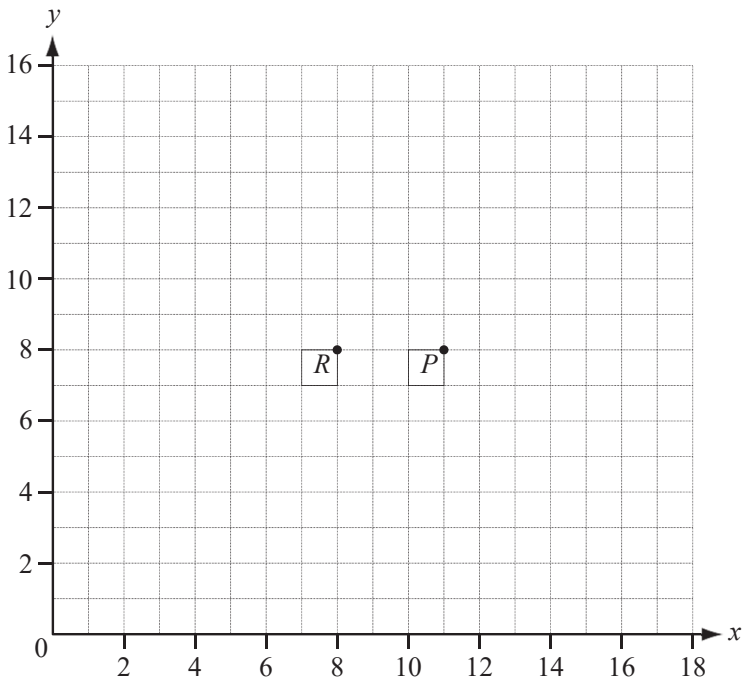
(b) (i) Describe fully the **single** transformation which maps shape A onto shape B. [3]

(ii) Write down the matrix representing the transformation which maps shape A onto shape B.

[2]

(a) Calculate the magnitude of the vector $\begin{pmatrix} 3 \\ -5 \end{pmatrix}$. [2]

(b)



(i) The points P and R are marked on the grid above.

$\overrightarrow{PQ} = \begin{pmatrix} 3 \\ -5 \end{pmatrix}$. Draw the vector $\overrightarrow{PQ}$ on the grid above. [1]

(ii) Draw the image of vector $\overrightarrow{PQ}$ after rotation by 90° anticlockwise about R. [2]

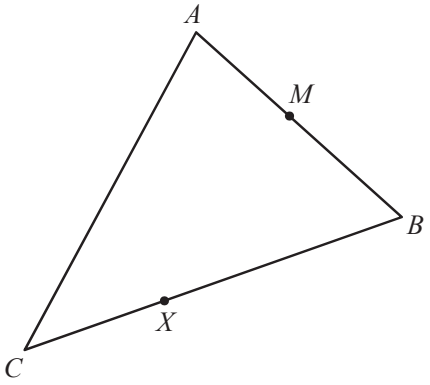
(c) $\overrightarrow{DE} = 2\mathbf{a} + \mathbf{b}$ and $\overrightarrow{DC} = 3\mathbf{b} - \mathbf{a}$.

Find $\overrightarrow{CE}$ in terms of $\mathbf{a}$ and $\mathbf{b}$. Write your answer in its simplest form. [2]

(d) $\overrightarrow{OT} = \begin{pmatrix} -2 \\ 5 \end{pmatrix}$ and $\overrightarrow{OV} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$.

Write $\overrightarrow{TV}$ as a column vector. [2]

(e)



NOT TO SCALE

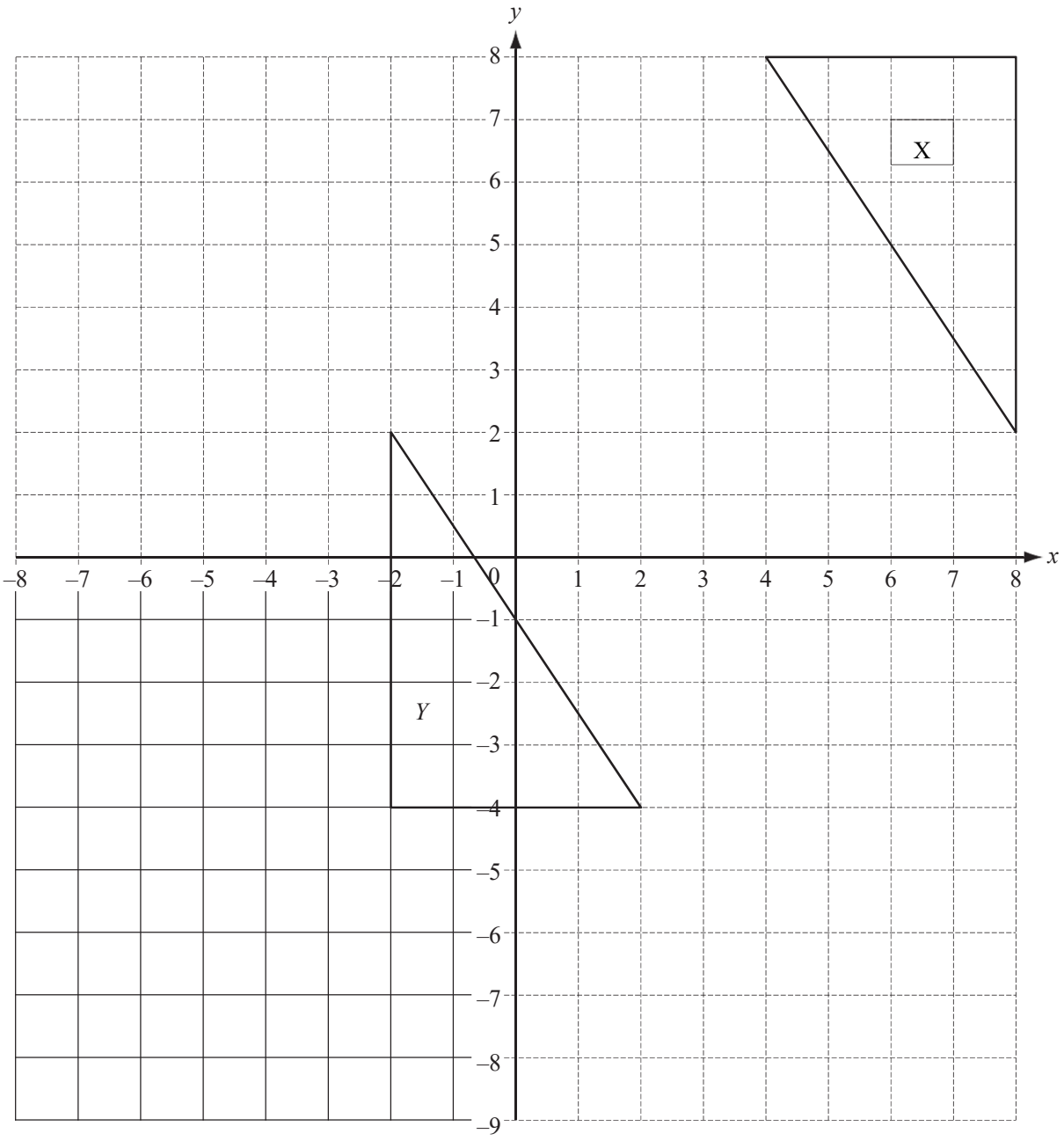
$\overrightarrow{AB} = \mathbf{b}$ and $\overrightarrow{AC} = \mathbf{c}$.

(i) Find $\overrightarrow{CB}$ in terms of $\mathbf{b}$ and $\mathbf{c}$. [1]

(ii) X divides CB in the ratio $1:3$.
M is the midpoint of AB.

Find $\overrightarrow{MX}$ in terms of $\mathbf{b}$ and $\mathbf{c}$.
Show all your working and write your answer in its simplest form. [4]

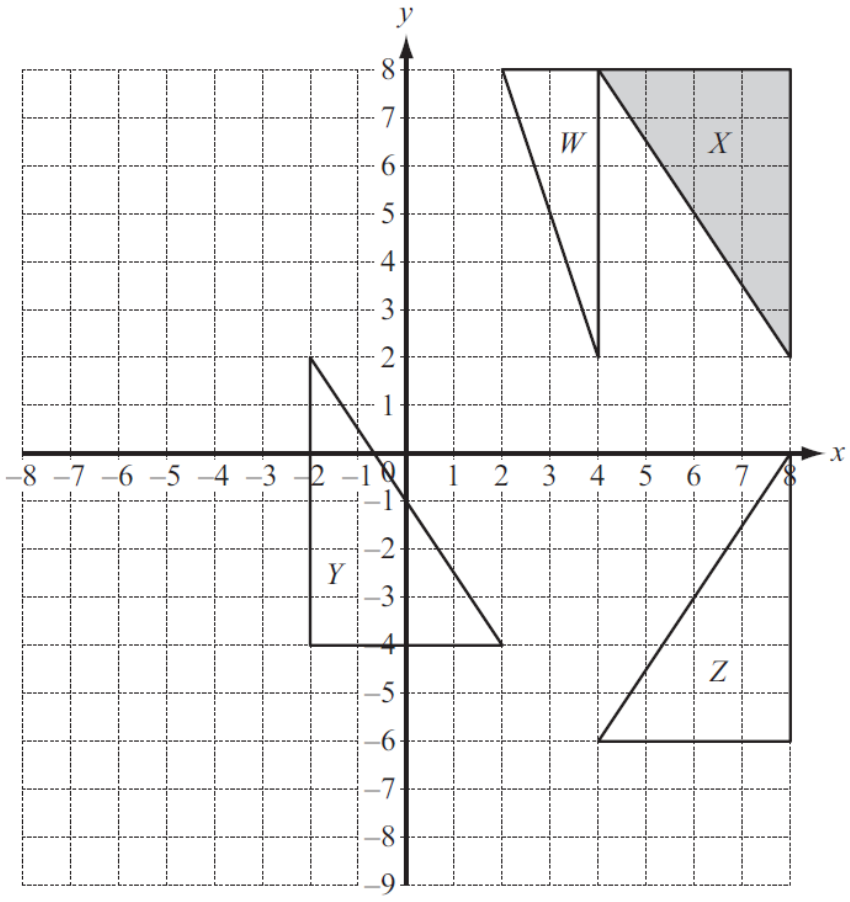
(a)



(i) Draw the translation of triangle X by the vector $\begin{pmatrix} -11 \\ -1 \end{pmatrix}$. [2]

(ii) Draw the enlargement of triangle Y with centre (–6, – 4) and scale factor $\frac{1}{2}$. [2]

(b)



Describe fully the **single** transformation that maps

(i) triangle X onto triangle Z, [2]

(ii) triangle X onto triangle Y, [3]

(iii) triangle X onto triangle W. [3]

(c) Find the matrix that represents the transformation in part (b)(iii). [2]

Vectors
Difficulty: Medium

Question Paper 3

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Medium
Booklet	Question Paper 3

Time allowed: **110 minutes**

Score: **/96**

Percentage: **/100**

Grade Boundaries:

CIE IGCSE Maths (0580)

A*	A	B	C	D
>83%	67%	51%	41%	31%

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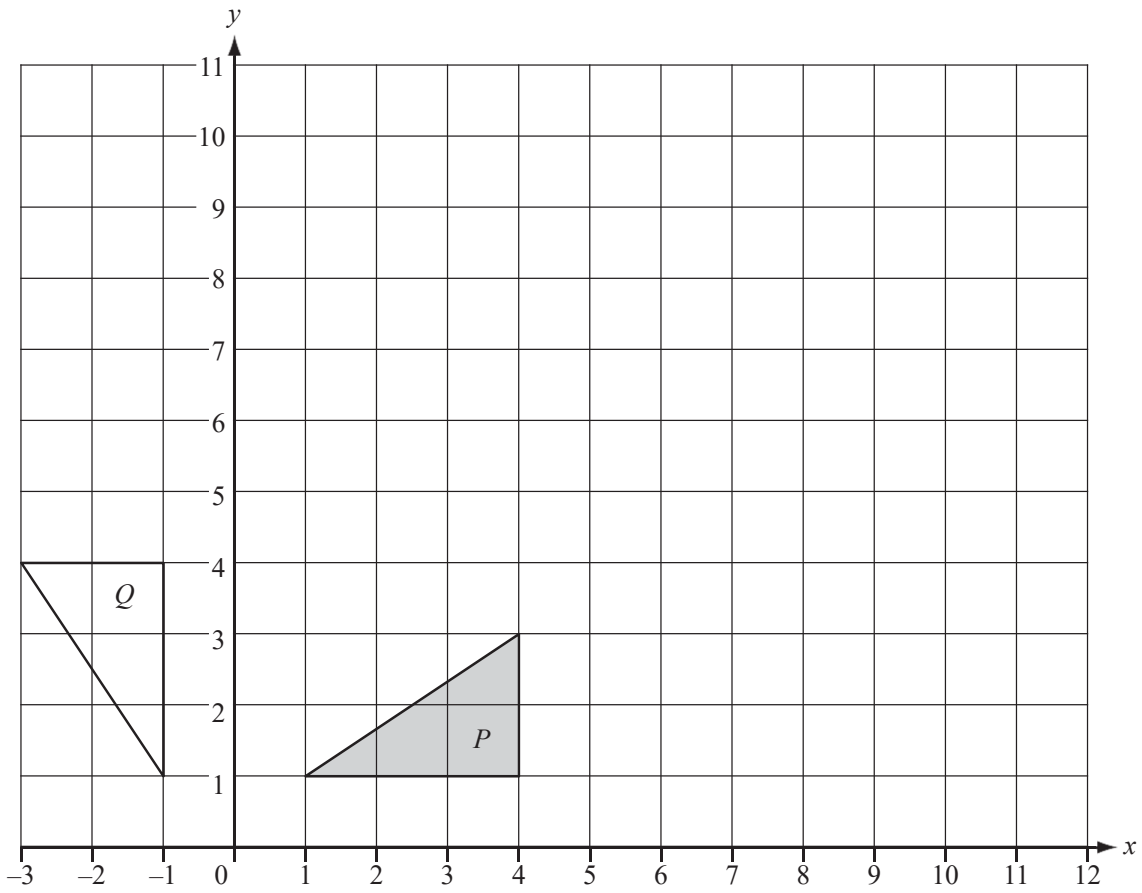


(a) Draw the translation of triangle P by $\begin{pmatrix} 5 \\ 3 \end{pmatrix}$. [2]

(b) Draw the reflection of triangle P in the line $x = 6$. [2]

(c) (i) Describe fully the **single** transformation that maps triangle P onto triangle Q.

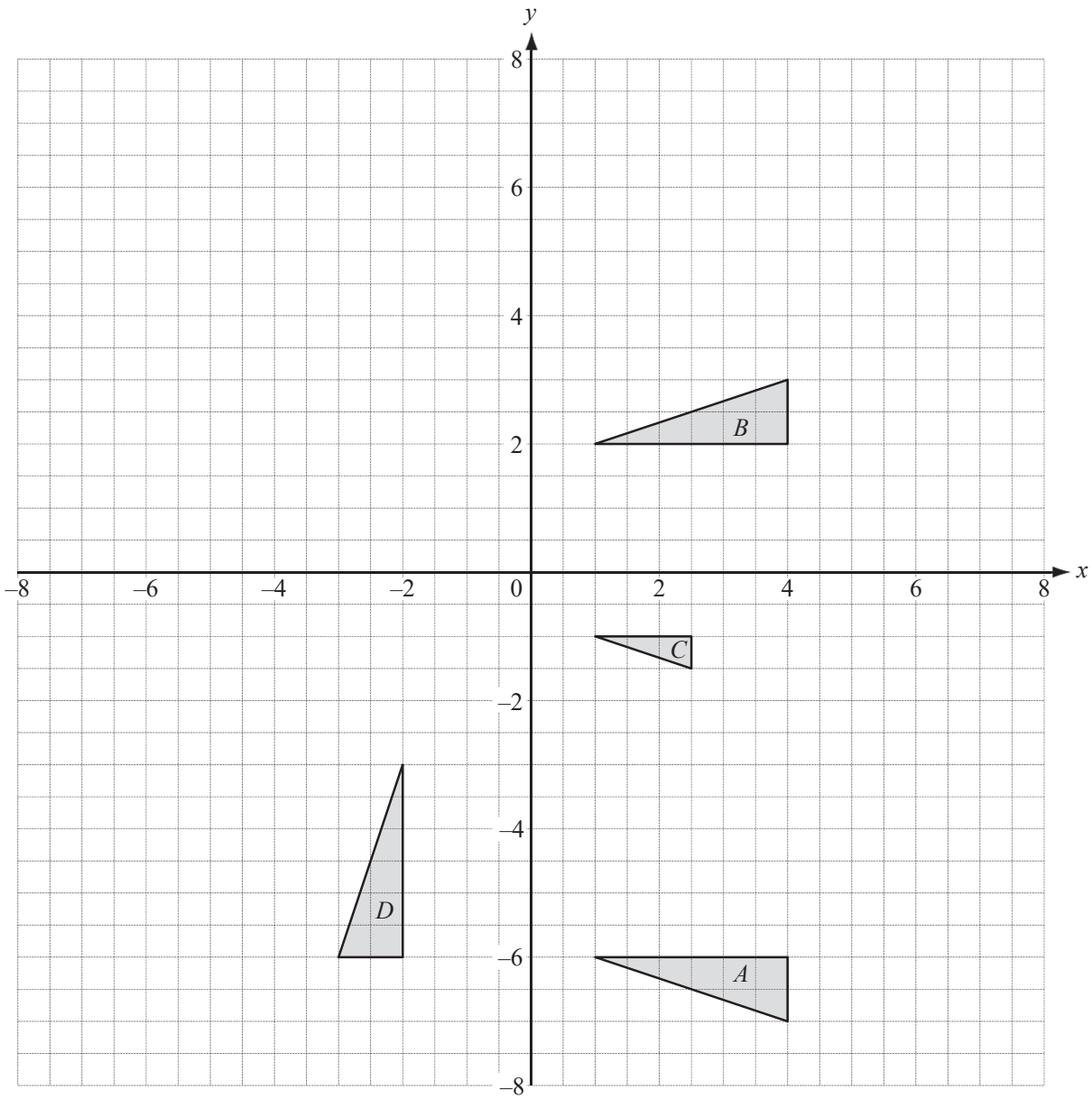
[3]

(ii) Find the 2 by 2 matrix which represents the transformation in **part(c)(i).**

[2]

(d) (i) Draw the stretch of triangle P with scale factor 3 and the x-axis as the invariant line. [2]

(ii) Find the 2 by 2 matrix which represents a stretch, scale factor 3 and x-axis invariant. [2]



(a) Describe fully the **single** transformation which maps

(i) triangle A onto triangle B, [2]

(ii) triangle A onto triangle C, [3]

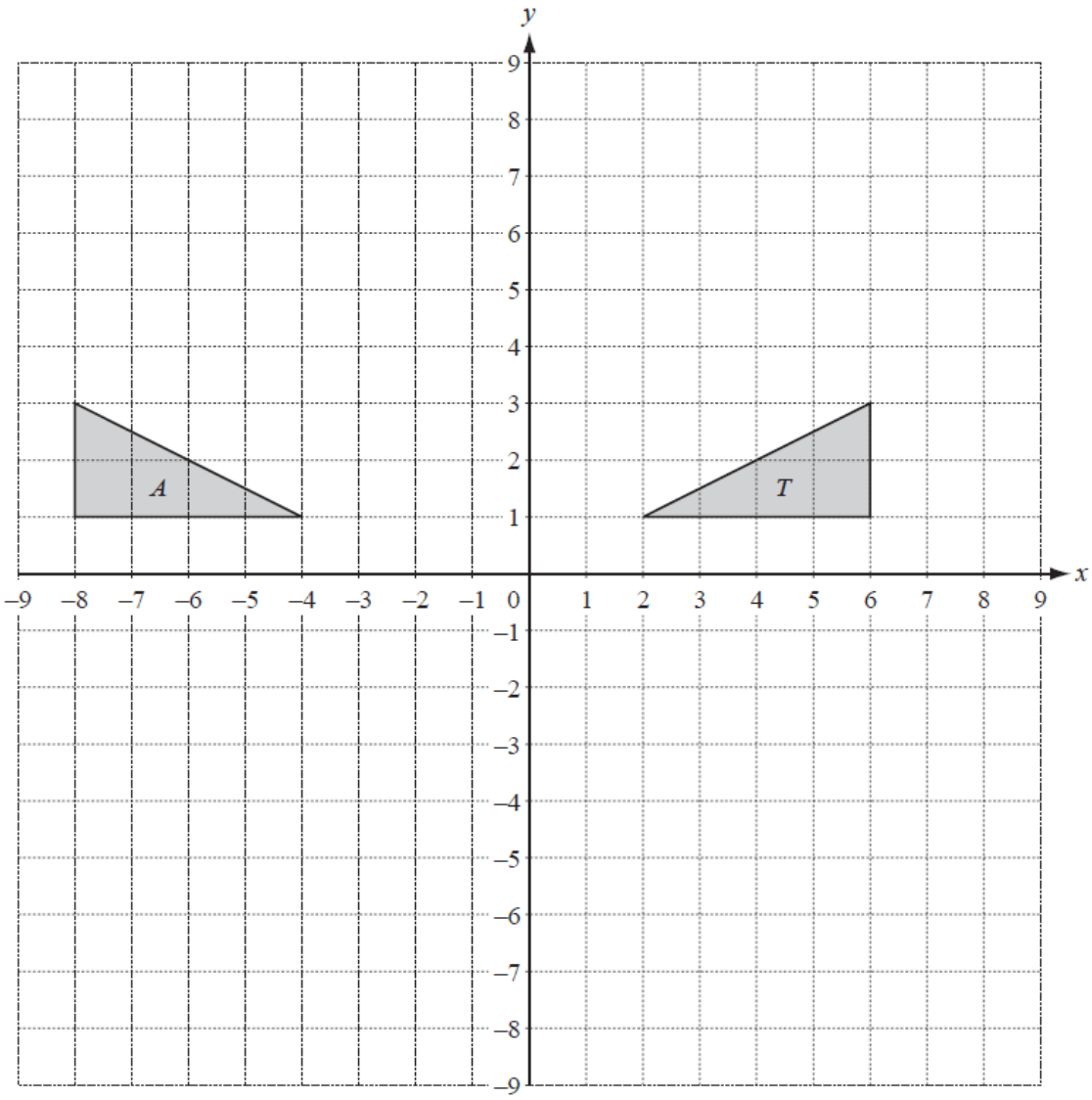
(iii) triangle A onto triangle D. [3]

(b) Draw the image of

(i) triangle B after a translation of $\begin{pmatrix} -5 \\ 2 \end{pmatrix}$, [2]

(ii) triangle B after a transformation by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$. [3]

(c) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$. [3]



Triangles T and A are drawn on the grid above.

(a) Describe fully the single transformation that maps triangle T onto triangle A. [2]

(b) (i) Draw the image of triangle T after a rotation of 90° anticlockwise about the point (0,0).

Label the image B. [2]

(ii) Draw the image of triangle T after a reflection in the line $x + y = 0$.

Label the image C. [2]

(iii) Draw the image of triangle T after an enlargement with centre (4, 5) and scale factor 1.5.

Label the image D. [2]

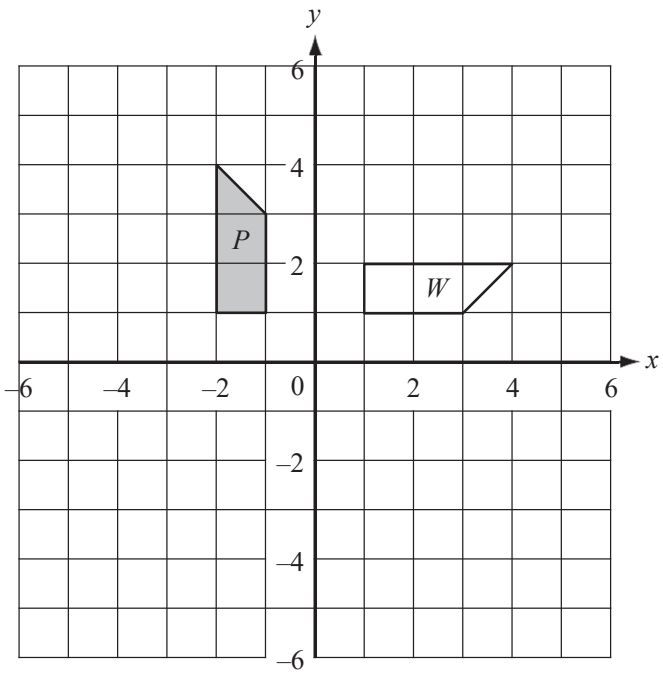
(c) (i) Triangle T has its vertices at co-ordinates (2, 1), (6, 1) and (6, 3).

Transform triangle T by the matrix $\begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$.

Draw this image on the grid and label it E. [3]

(ii) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$. [3]

(d) Write down the matrix that transforms triangle B onto triangle T. [2]



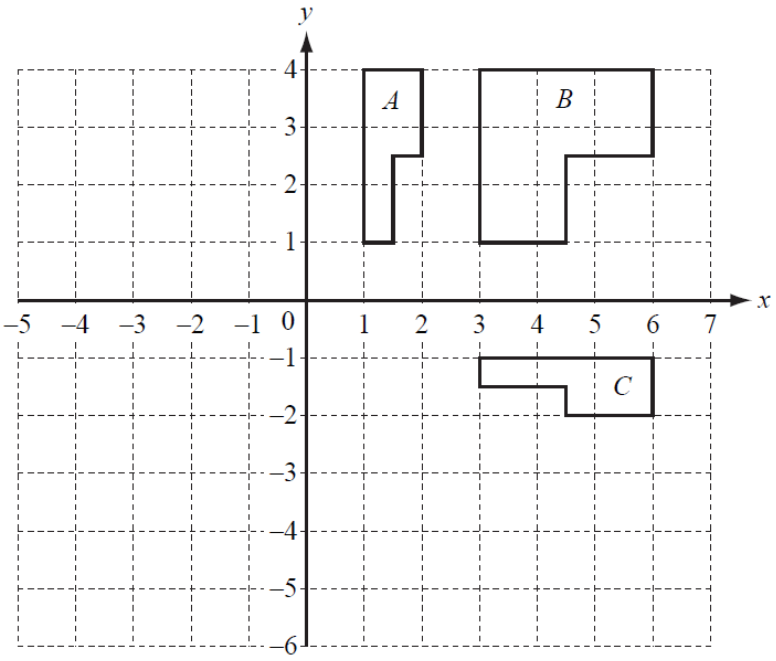
(a) Draw the reflection of shape P in the line $y = x$. [2]

(b) Draw the translation of shape P by the vector $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$. [2]

(c) (i) Describe fully the **single** transformation that maps shape P onto shape W. [3]

(ii) Find the 2 by 2 matrix which represents this transformation. [2]

(d) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$. [3]



(a) On the grid above, draw the image of

(i) shape A after translation by the vector $\begin{pmatrix} -3 \\ -2 \end{pmatrix}$, [2]

(ii) shape A after reflection in the line $x = -1$. [2]

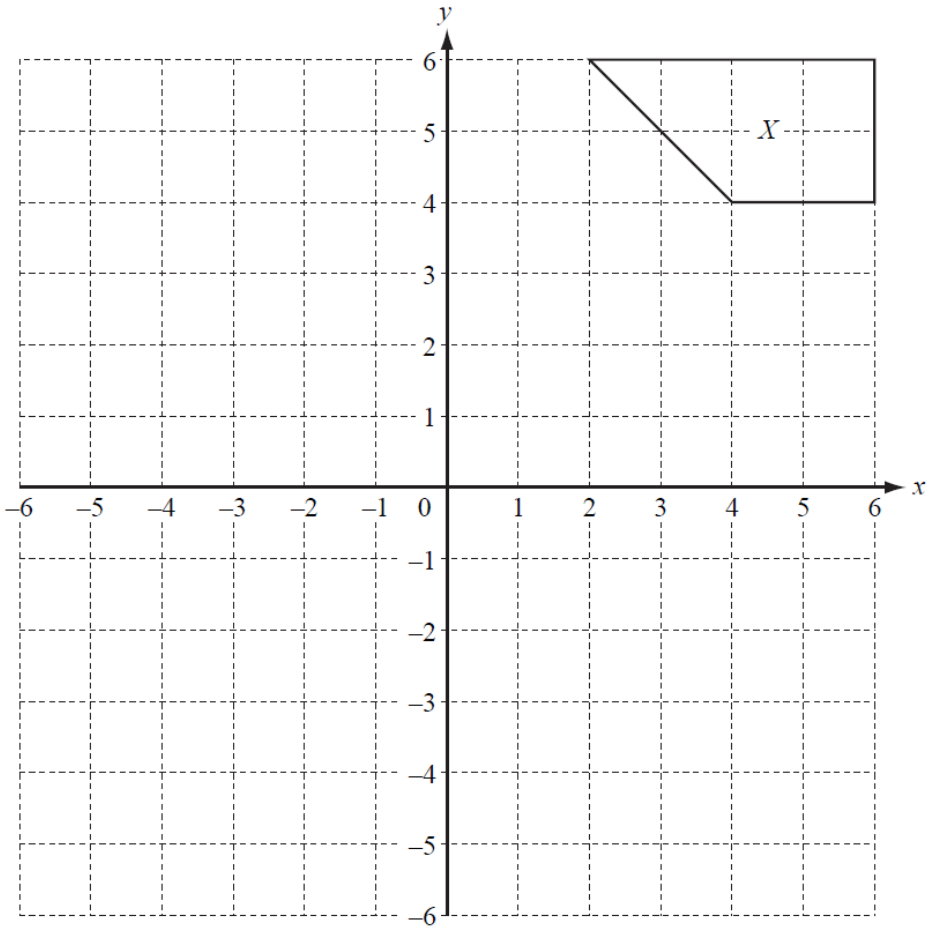
(b) Describe fully the **single** transformation which maps

(i) shape A onto shape B, [3]

(ii) shape A onto shape C. [3]

(c) Find the matrix representing the transformation which maps shape A onto shape B. [2]

(d) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$. [3]



(a) (i) Draw the reflection of shape X in the x-axis. Label the image Y. [2]

(ii) Draw the rotation of **shape *Y***, 90° clockwise about (0, 0). Label the image Z. [2]

(iii) Describe fully the **single** transformation that maps shape Z onto shape X. [2]

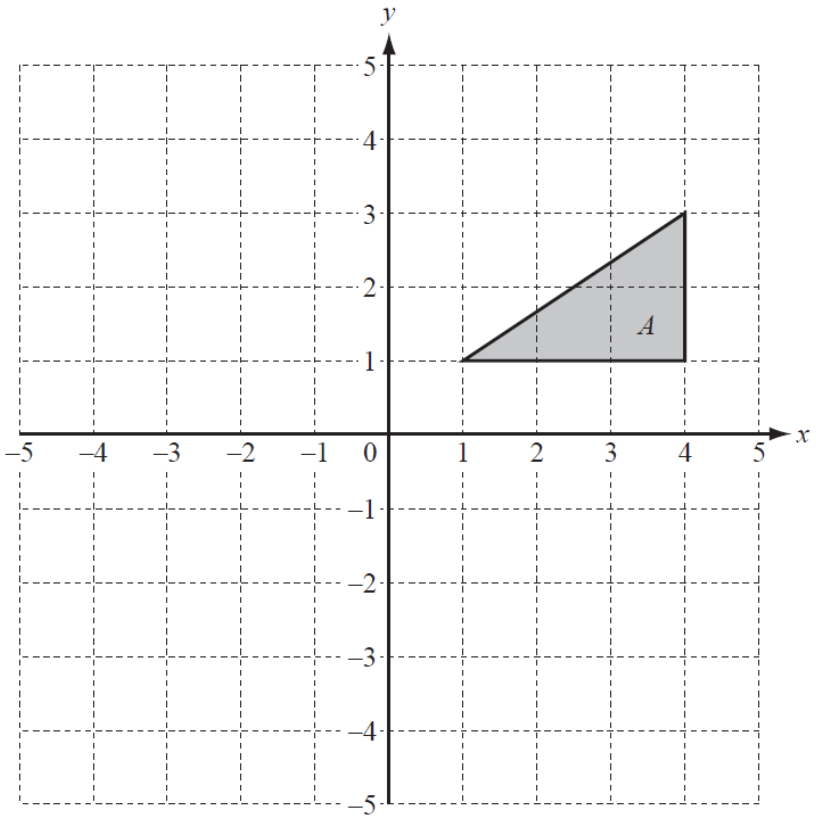
(b) (i) Draw the enlargement of shape X, centre (0, 0), scale factor $\frac{1}{2}$. [2]

(ii) Find the matrix which represents an enlargement, centre (0, 0), scale factor $\frac{1}{2}$. [2]

(c) (i) Draw the shear of **shape *X*** with the x-axis invariant and shear factor –1. [2]

(ii) Find the matrix which represents a shear with the x-axis invariant and shear factor –1. [2]

(a)



(i) Draw the image when triangle A is reflected in the line $y = 0$.
Label the image B. [2]

(ii) Draw the image when triangle A is rotated through 90 anticlockwise about the origin.
Label the image C. [2]

(iii) Describe fully the **single** transformation which maps triangle B onto triangle C.

[2]

(b) Rotation through $90°$ anticlockwise about the origin is represented by the matrix $\mathbf{M} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.

(i) Find $\mathbf{M}^{-1}$, the inverse of matrix $\mathbf{M}$. [2]

(ii) Describe fully the **single** transformation represented by the matrix $\mathbf{M}^{-1}$. [2]

Vectors
Difficulty: Medium

Question Paper 4

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Medium
Booklet	Question Paper 4

Time allowed: **92 minutes**

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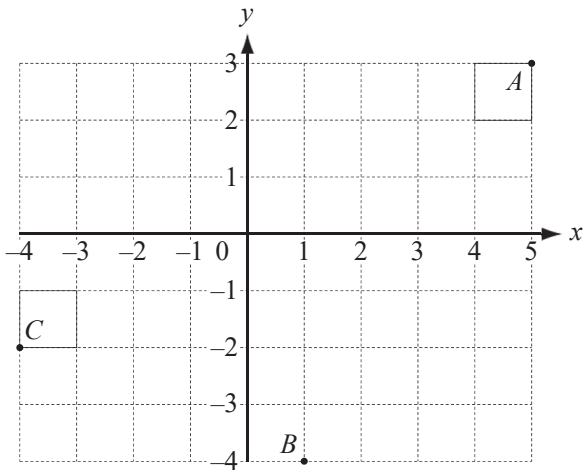
>95%	87%	80%	69%	58%	46%

(a)



The points A (5, 3), B (1, –4) and C (–4, –2) are shown in the diagram.

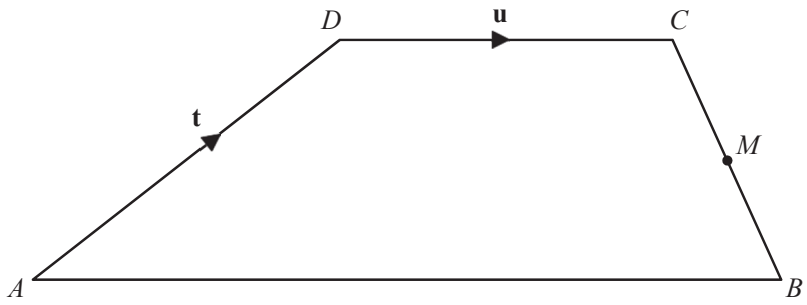
(i) Write $\overrightarrow{CA}$ as a column vector. [1]

(ii) Find $\overrightarrow{CA} - \overrightarrow{CB}$ as a single column vector. [2]

(iii) Complete the following statement. [1]

(iv) Calculate $|\overrightarrow{CA}|$. [2]

(b)



NOT TO SCALE

ABCD is a trapezium with *DC* parallel to *AB* and $DC = \frac{1}{2}AB$.

M is the midpoint of *BC*.

$\overrightarrow{AD} = \mathbf{t}$ and $\overrightarrow{DC} = \mathbf{u}$.

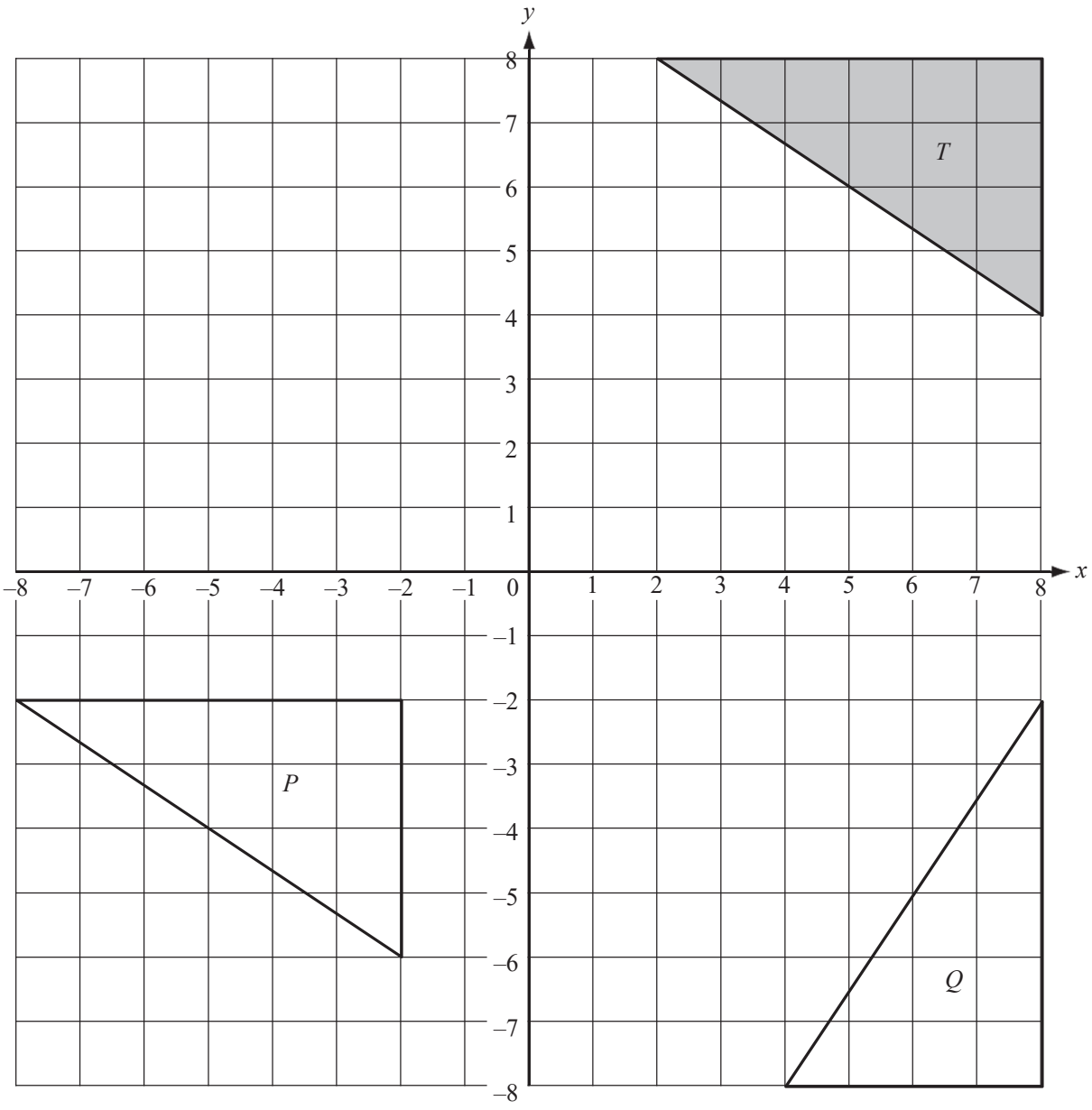
Find the following vectors in terms of **t** and / or **u**.

Give each answer in its simplest form.

(i) $\overrightarrow{AB}$ [1]

(ii) $\overrightarrow{BM}$ [2]

(iii) $\overrightarrow{AM}$ [2]



(a) On the grid, draw the enlargement of the triangle T, centre (0, 0), scale factor $\frac{1}{2}$. [2]

(b) The matrix $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$ represents a transformation.

(i) Calculate the matrix product $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 8 & 8 & 2 \\ 4 & 8 & 8 \end{pmatrix}$. [2]

(ii) On the grid, draw the image of the triangle T under this transformation. [2]

(iii) Describe fully this **single** transformation. [2]

(c) Describe fully the **single** transformation which maps

(i) triangle T onto triangle P, [2]

(ii) triangle T onto triangle Q. [3]

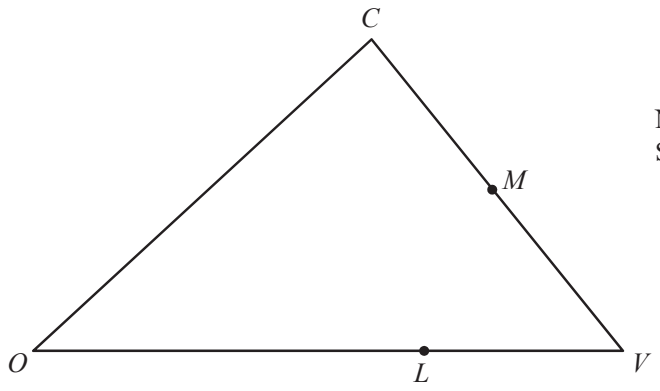
(d) Find the 2 by 2 matrix which represents the transformation in **part (c)(ii).** [2]

(a) $\mathbf{p} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$ and $\mathbf{q} = \begin{pmatrix} 6 \\ 3 \end{pmatrix}$.

(i) Find, as a single column vector, $\mathbf{p} + 2\mathbf{q}$. [2]

(ii) Calculate the value of $|\mathbf{p} + 2\mathbf{q}|$. [2]

(b)



NOT TO SCALE

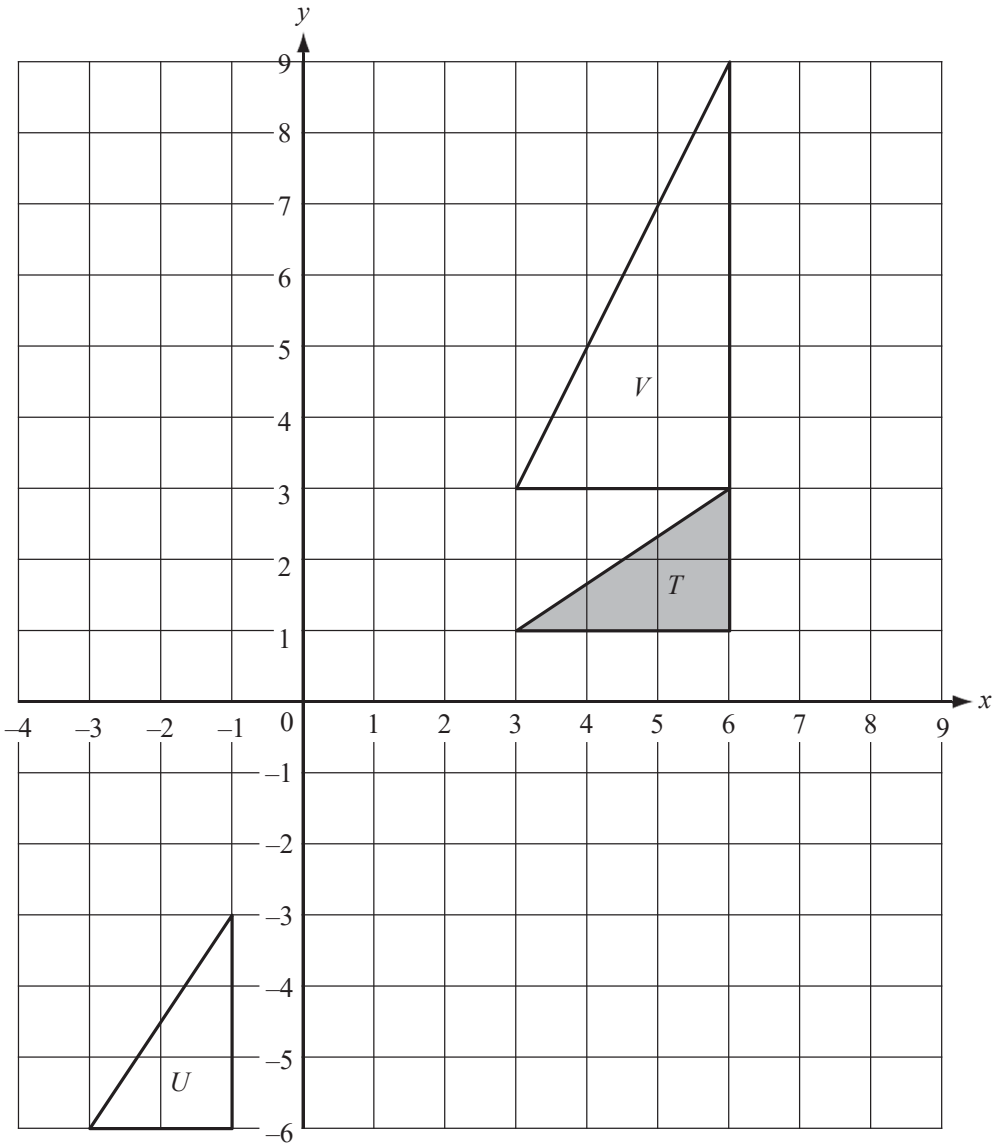
In the diagram, $CM = MV$ and $OL = 2LV$.
O is the origin. $\overrightarrow{OC} = \mathbf{c}$ and $\overrightarrow{OV} = \mathbf{v}$.

Find, in terms of c and v, in their simplest forms

(i) $\overrightarrow{CM}$, [2]

(ii) the position vector of M, [2]

(iii) $\overrightarrow{ML}$. [2]



(a) On the grid, draw

(i) the translation of triangle T by the vector $\begin{pmatrix} -7 \\ 3 \end{pmatrix}$, [2]

(ii) the rotation of triangle T about (0, 0), through 90° clockwise. [2]

(b) Describe fully the **single** transformation that maps

(i) triangle T onto triangle U, [2]

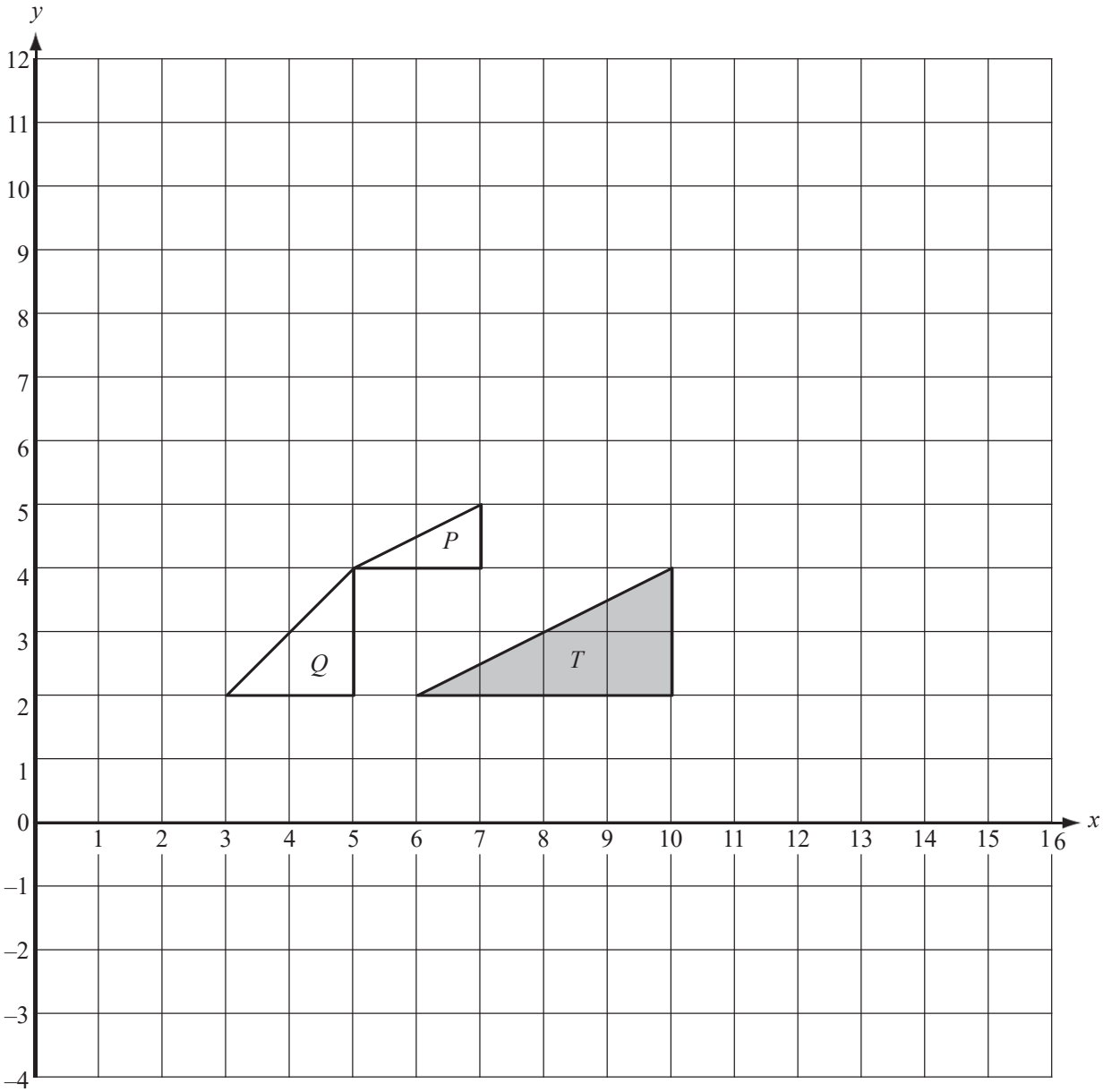
(ii) triangle T onto triangle V. [3]

(c) Find the 2 by 2 matrix which represents the transformation that maps

(i) triangle T onto triangle U, [2]

(ii) triangle T onto triangle V, [2]

(iii) triangle V onto triangle T. [1]



(a) Draw the reflection of triangle T in the line $y = 6$.

Label the image A. [2]

(b) Draw the translation of triangle T by the vector $\begin{pmatrix} -4 \\ 6 \end{pmatrix}$.

Label the image B. [2]

(c) Describe fully the **single** transformation which maps triangle B onto triangle T. [2]

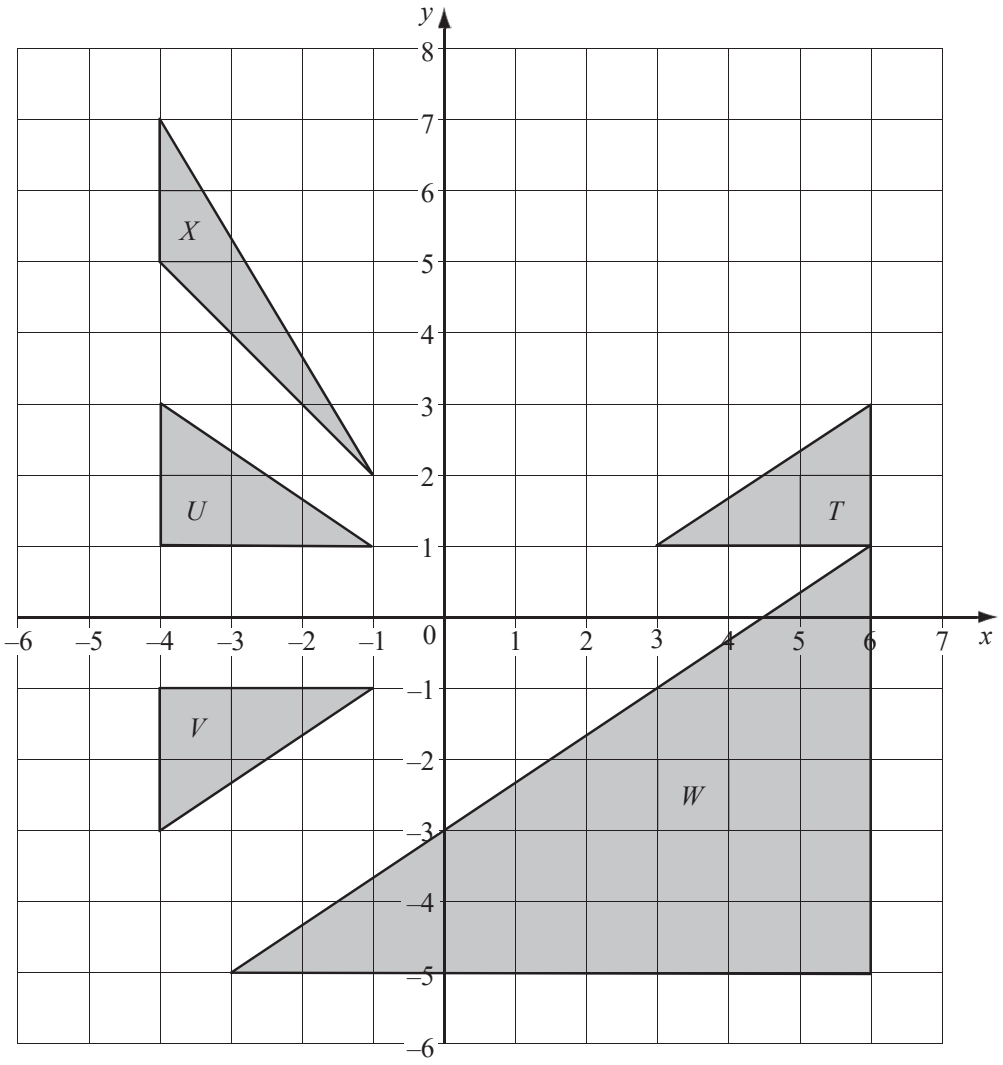
(d) (i) Describe fully the **single** transformation which maps triangle T onto triangle P. [3]

(ii) Complete the following statement. [1]

(e) (i) Describe fully the **single** transformation which maps triangle T onto triangle Q. [3]

(ii) Find the 2 by 2 matrix which represents the transformation mapping triangle T onto triangle Q.

[2]



(a) Describe fully the **single** transformation which maps

(i) triangle T onto triangle U, [2]

(ii) triangle T onto triangle V, [3]

(iii) triangle T onto triangle W, [3]

(iv) triangle U onto triangle X. [3]

(b) Find the matrix representing the transformation which maps

(i) triangle U onto triangle V, [2]

(ii) triangle U onto triangle X. [2]

Vectors
Difficulty: Medium

Question Paper 5

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Medium
Booklet	Question Paper 5

Time allowed: **85 minutes**

Score: **/74**

Percentage: **/100**

Grade Boundaries:

CIE IGCSE Maths (0580)

A*	A	B	C	D
>83%	67%	51%	41%	31%

CIE IGCSE Maths (0980)

9	8	7	6	5	4
>95%	87%	80%	69%	58%	46%

Answer the whole of this question on a sheet of graph paper.

(a) Draw x and y axes from 0 to 12 using a scale of 1 cm to 1 unit on each axis. [1]

(b) Draw and label triangle T with vertices (8, 6), (6, 10) and (10, 12). [1]

(c) Triangle T is reflected in the line $y = x$.

(i) Draw the image of triangle T. Label this image P. [2]

(ii) Write down the matrix which represents this reflection. [2]

(d) A transformation is represented by the matrix $\begin{pmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{2} \end{pmatrix}$

(i) Draw the image of triangle T under this transformation. Label this image Q. [2]

(ii) Describe fully this single transformation. [3]

1

(e) Triangle T is stretched with the y-axis invariant and a stretch factor of $\frac{1}{2}$.

Draw the image of triangle T. Label this image R. [2]

(a) Draw and label x and y axes from -6 to 6, using a scale of 1 cm to 1 unit. [1]

(b) Draw triangle ABC with A (2,1), B (3,3) and C (5,1). [1]

(c) Draw the reflection of triangle ABC in the line $y = x$. Label this $A_1B_1C_1$. [2]

(d) Rotate **triangle $A_1B_1C_1$** about (0,0) through 90° anti-clockwise. Label this $A_2B_2C_2$. [2]

(e) Describe fully the single transformation which maps triangle ABC onto triangle $A_2B_2C_2$. [2]

(f) A transformation is represented by the matrix $\begin{pmatrix} 1 & 0 \\ -1 & 1 \end{pmatrix}$.

(i) Draw the image of triangle ABC under this transformation. Label this $A_3B_3C_3$. [3]

(ii) Describe fully the single transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ -1 & 1 \end{pmatrix}$. [2]

(iii) Find the matrix which represents the transformation that maps triangle $A_3B_3C_3$ onto triangle ABC. [2]

Transformation T is translation by the vector $\begin{pmatrix} 3 \\ 2 \end{pmatrix}$.

Transformation M is reflection in the line $y = x$.

(a) The point A has co-ordinates (2, 1).

Find the co-ordinates of

(i) T(A), [1]

(ii) MT(A). [2]

(b) Find the 2 by 2 matrix $\mathbf{M}$, which represents the transformation M. [2]

(c) Show that, for any value of k, the point Q $(k - 2, k - 3)$ maps onto a point on the line $y = x$ following the transformation TM(Q). [3]

(d) Find $\mathbf{M}^{-1}$, the inverse of the matrix $\mathbf{M}$. [2]

(e) $\mathbf{N}$ is the matrix such that $\mathbf{N} + \begin{pmatrix} 0 & 3 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 4 \\ 0 & 0 \end{pmatrix}$.

(i) Write down the matrix $\mathbf{N}$. [2]

(ii) Describe completely the **single** transformation represented by N. [3]

Answer the whole of this question on one sheet of graph paper.

(a) Draw and label x and y axes from –8 to +8, using a scale of 1 cm to 1 unit on each axis. [1]

(b) Draw and label triangle ABC with A (2, 2), B (5, 2) and C (5, 4). [1]

(c) On your grid:

(i) translate **triangle *ABC*** by the vector $\begin{pmatrix} 3 \\ -9 \end{pmatrix}$ and label this image $A_1B_1C_1$; [2]

(ii) reflect **triangle *ABC*** in the line $x = -1$ and label this image $A_2B_2C_2$; [2]

(iii) rotate **triangle *ABC*** by 180° about (0, 0) and label this image $A_3B_3C_3$. [2]

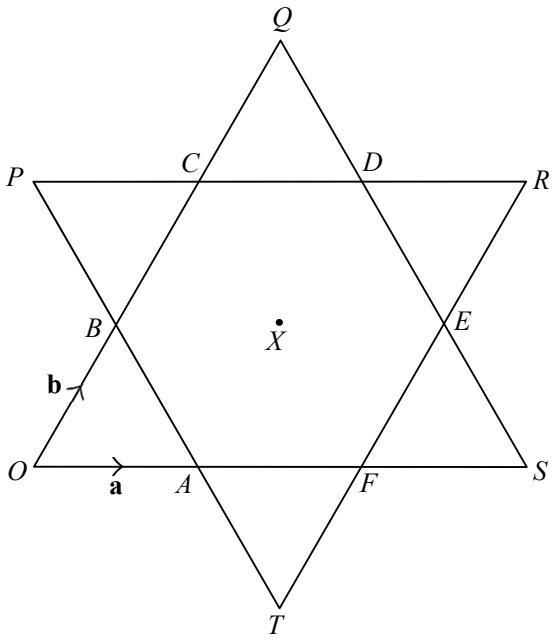
(d) A stretch is represented by the matrix $\begin{pmatrix} 1.5 & 0 \\ 0 & 1 \end{pmatrix}$.

(i) Draw the image of **triangle *ABC*** under this transformation. Label this image $A_4B_4C_4$. [3]

(ii) Work out the inverse of the matrix $\begin{pmatrix} 1.5 & 0 \\ 0 & 1 \end{pmatrix}$. [2]

(iii) Describe **fully** the single transformation represented by this inverse. [3]

5



A star is made up of a regular hexagon, centre X, surrounded by 6 equilateral triangles.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.

(a) Write the following vectors in terms of **a** and/or **b**, giving your answers in their simplest form.

(i) $\overrightarrow{OS}$, [1]

(ii) $\overrightarrow{AB}$, [1]

(iii) $\overrightarrow{CD}$, [1]

(iv) $\overrightarrow{OR}$, [2]

(v) $\overrightarrow{CF}$. [2]

(b) When $|\mathbf{a}| = 5$, write down the value of

(i) $|\mathbf{b}|$, [1]

(ii) $|\mathbf{a} - \mathbf{b}|$. [1]

(c) Describe fully a single transformation which maps

(i) triangle OBA onto triangle OQS, [2]

(ii) triangle OBA onto triangle RDE, with O mapped onto R and B mapped onto D. [2]

(d) (i) How many lines of symmetry does the star have? [1]

(ii) When triangle OQS is rotated clockwise about X, it lies on triangle PRT, with O on P. Write down the angle of rotation. [1]

Vectors
Difficulty: Hard

Question Paper 1

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Hard
Booklet	Question Paper 1

Time allowed: **69 minutes**

Score: **/60**

Percentage: **/100**

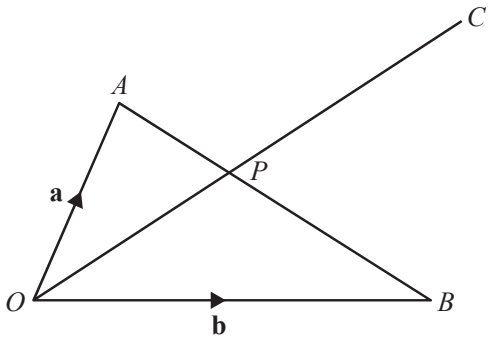
Grade Boundaries:

CIE IGCSE Maths (0580)

A*	A	B	C	D
>83%	67%	51%	41%	31%

CIE IGCSE Maths (0980)

9	8	7	6	5	4
>95%	87%	80%	69%	58%	46%



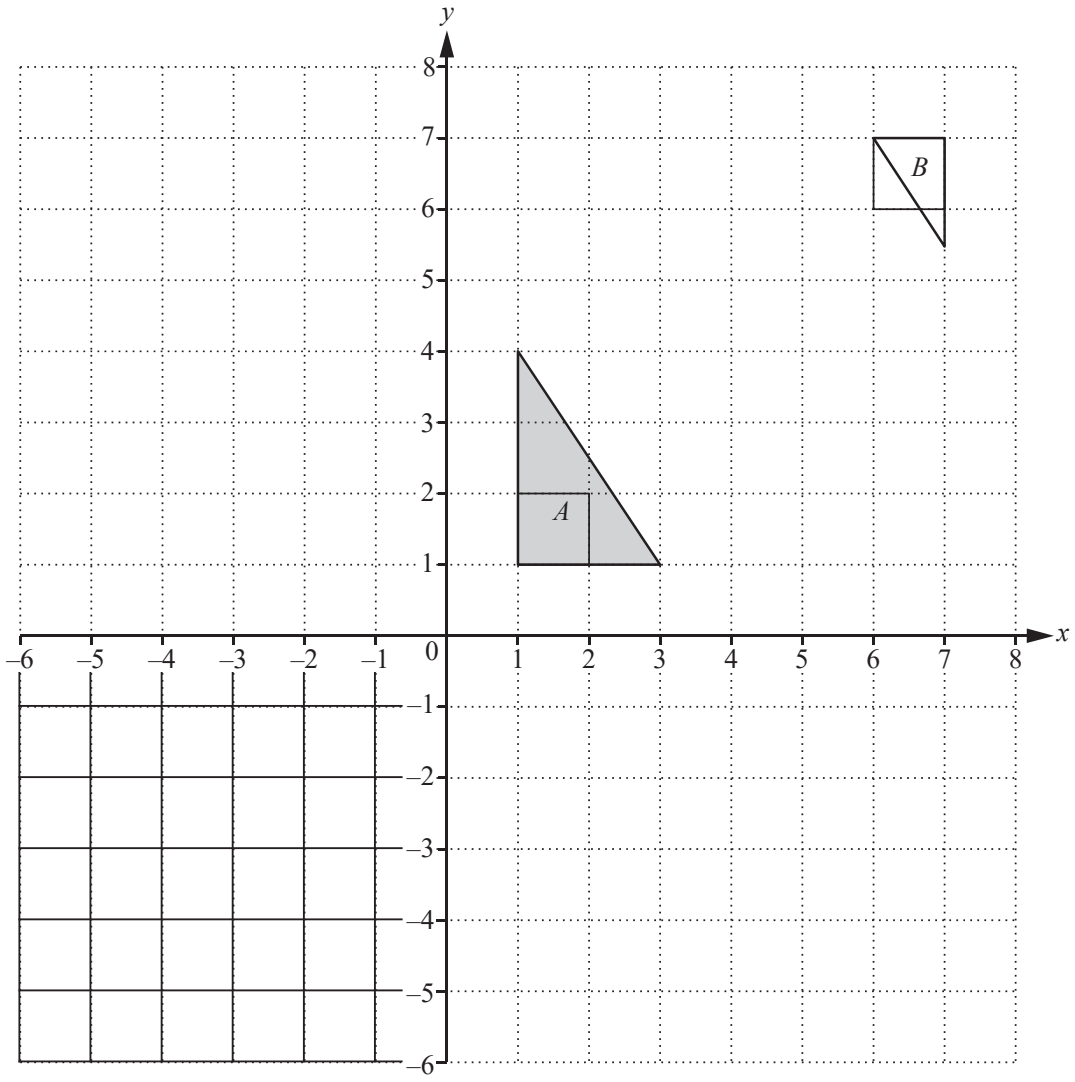
NOT TO SCALE

In the diagram, O is the origin and P lies on AB such that $AP : PB = 3 : 4$.
$\overrightarrow{OA} =$ **a** and $\overrightarrow{OB} =$ **b**.

(i) Find $\overrightarrow{OP}$, in terms of **a** and **b**, in its simplest form. [3]

(ii) The line OP is extended to C such that $\overrightarrow{OC} = mOP$ and $BC = k$**a**.

Find the value of m and the value of k. [2]

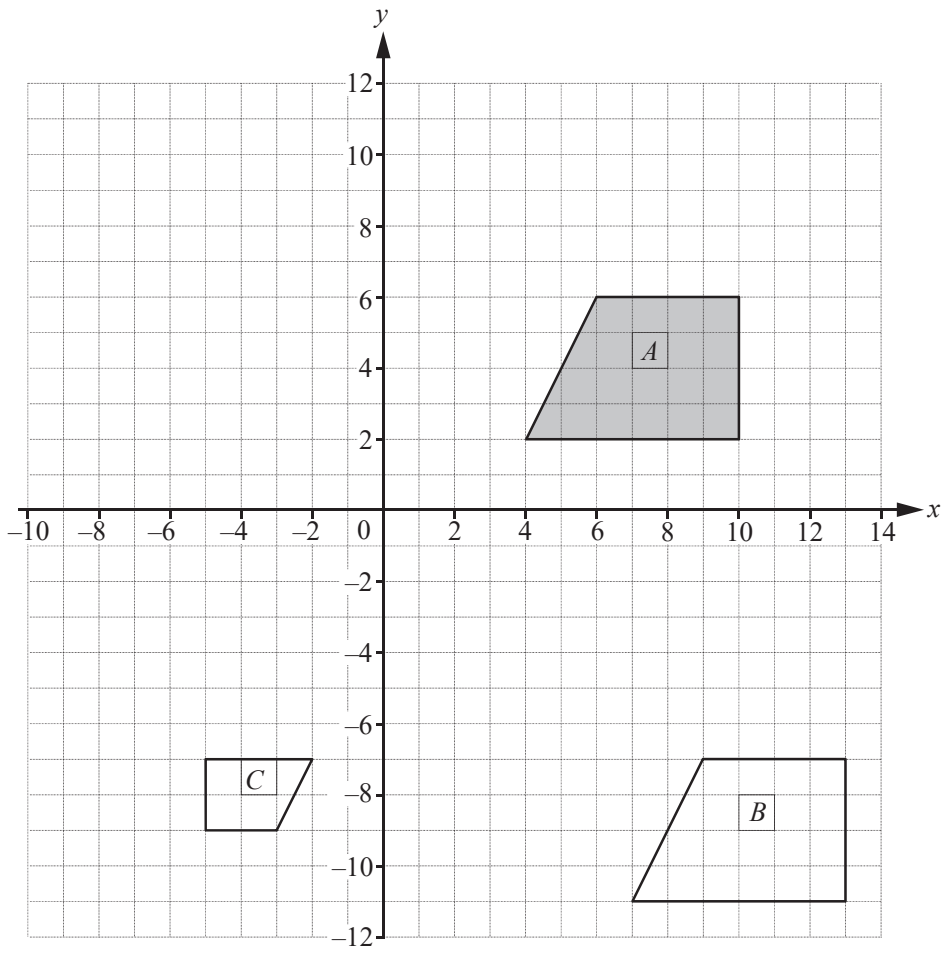


(a) (i) Draw the image of triangle A after reflection in the line $x = 4$. [2]

(ii) Draw the image of triangle A after rotation of 90° anticlockwise about $(0, 0)$. [2]

(iii) Draw the image of triangle A after translation by the vector $\begin{pmatrix} 1 \\ -5 \end{pmatrix}$. [2]

(b) Describe fully the **single** transformation that maps triangle A onto triangle B. [3]



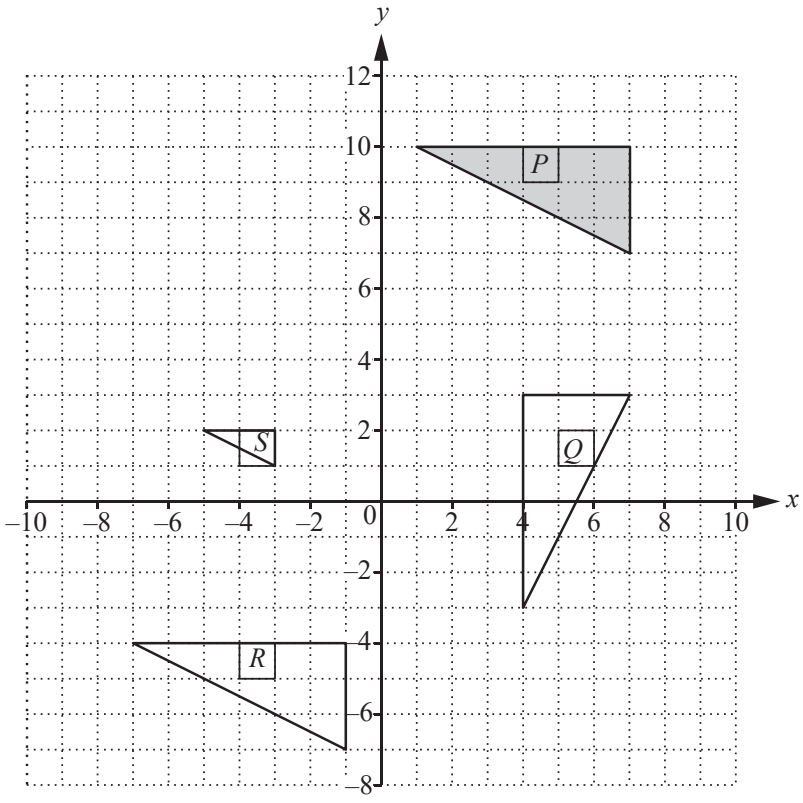
(a) Describe fully the **single** transformation that maps shape A onto

(i) shape B, [2]

(ii) shape C. [3]

(b) Draw the image of shape A after rotation through 90° anticlockwise about the point (3, - 1). [2]

(c) Draw the image of shape A after reflection in $y = 1$. [2]



(a) Describe fully the **single** transformation that maps

(i) shape P onto shape Q, [3]

(ii) shape P onto shape R, [2]

(iii) shape P onto shape S. [3]

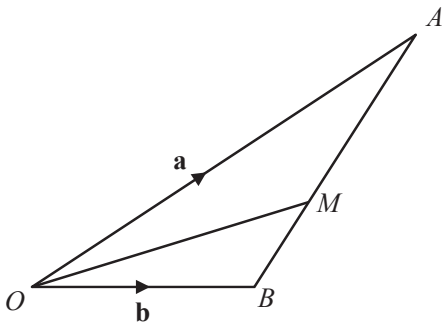
(b) (i) Draw the reflection of **shape *S*** in the line $y = x$. [2]

(a) $\mathbf{m} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$ $\mathbf{n} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$

(i) Work out $2\mathbf{m} - 3\mathbf{n}$. [2]

(ii) Calculate $|2\mathbf{m} - 3\mathbf{n}|$. [2]

(b) (i)



NOT TO SCALE

In the diagram, O is the origin, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
The point M lies on AB such that $AM : MB = 3 : 2$.

Find, in terms of **a** and **b**, in its simplest form

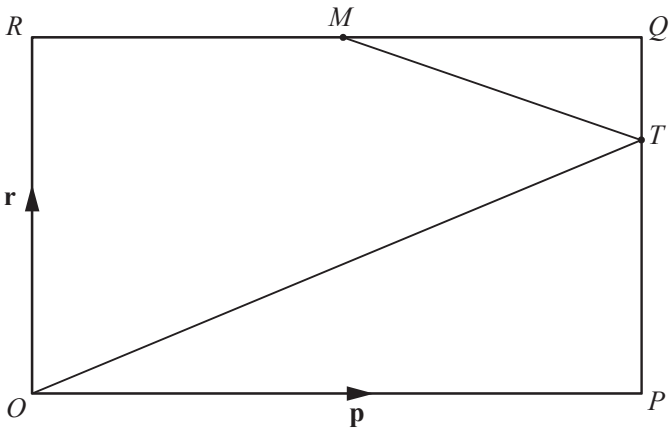
(a) $\overrightarrow{AB}$, [1]

(b) $\overrightarrow{AM}$, [1]

(c) the position vector of M. [2]

(ii) OM is extended to the point C.
The position vector of C is $\mathbf{a} + k\mathbf{b}$.

Find the value of k. [1]



NOT TO SCALE

$OPQR$ is a rectangle and O is the origin.
M is the midpoint of RQ and $PT : TQ = 2 : 1$.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.

(a) Find, in terms of **p** and/or **r**, in its simplest form

(i) $\overrightarrow{MQ}$, [1]

(ii) MT, [1]

$\longrightarrow$

[1]

(iii) $\overrightarrow{OT}$.

$\longrightarrow$

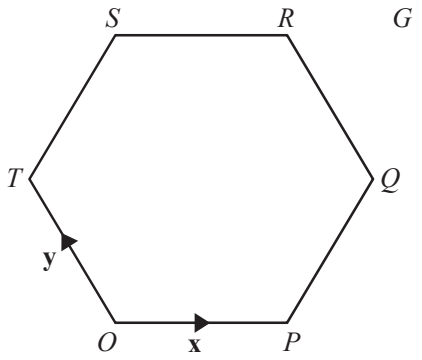
(b) RQ and OT are extended to meet at U.

Find the position vector of U in terms of **p** and **r**.
Give your answer in its simplest form. [2]

(c) $\overrightarrow{MT} = \begin{pmatrix} 2k \\ -k \end{pmatrix}$ and $|\overrightarrow{MT}| = \sqrt{180}$.

Find the positive value of k.

[3]



NOT TO SCALE

O is the origin and $OPQRST$ is a regular hexagon.

$\overrightarrow{OP} = \mathbf{x}$ and $\overrightarrow{OT} = \mathbf{y}$.

(a) Write down, in terms of **x** and/or **y**, in its simplest form,

(i) $\overrightarrow{QR}$, [1]

(ii) $\overrightarrow{PQ}$, [1]

(iii) the position vector of S. [2]

(b) The line SR is extended to G so that $SR : RG = 2 : 1$.

Find $\overrightarrow{GQ}$, in terms of **x** and **y**, in its simplest form. [2]

(c) M is the midpoint of OP.

(i) Find $\overrightarrow{MG}$, in terms of **x** and **y**, in its simplest form. [2]

(ii) H is a point on TQ such that $TH : HQ = 3 : 1$.

Use vectors to show that H lies on MG. [2]

Vectors
Difficulty: Hard

Question Paper 2

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Hard
Booklet	Question Paper 2

Time allowed: **74 minutes**

Score: **/64**

Percentage: **/100**

Grade Boundaries:

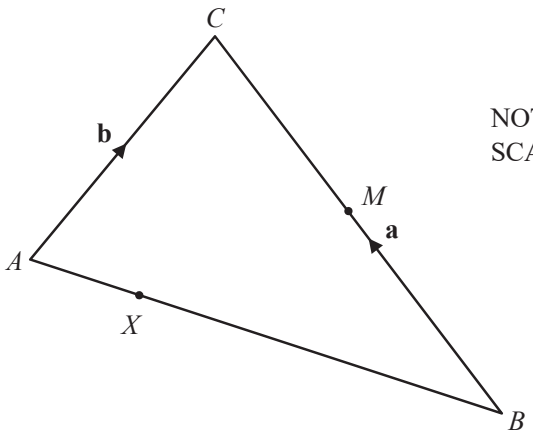
CIE IGCSE Maths (0580)

A*	A	B	C	D
>83%	67%	51%	41%	31%

CIE IGCSE Maths (0980)

9	8	7	6	5	4
>95%	87%	80%	69%	58%	46%

Question 1



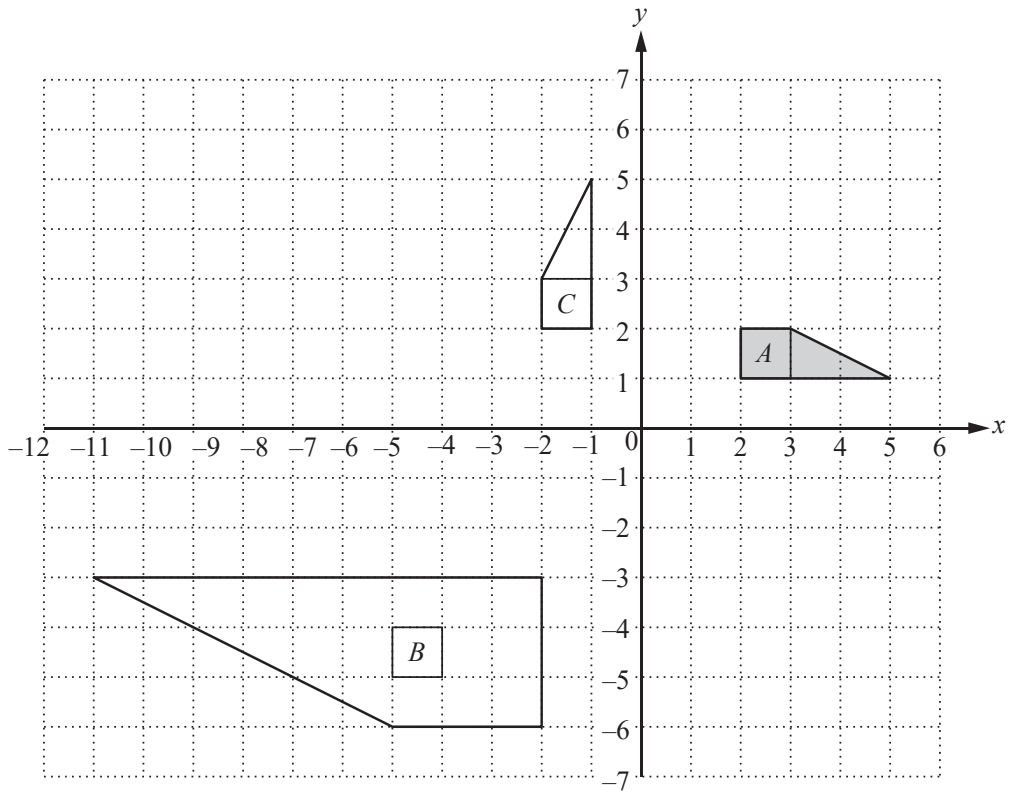
NOT TO SCALE

$\overrightarrow{BC} = \mathbf{a}$ and $\overrightarrow{AC} = \mathbf{b}$.

(a) Find $\overrightarrow{AB}$ in terms of **a** and **b**. [1]

(b) M is the midpoint of BC.
X divides AB in the ratio $1:4$.

Find $\overrightarrow{XM}$ in terms of **a** and **b**.
Show all your working and write your answer in its simplest form. [4]



(a) Draw the image of

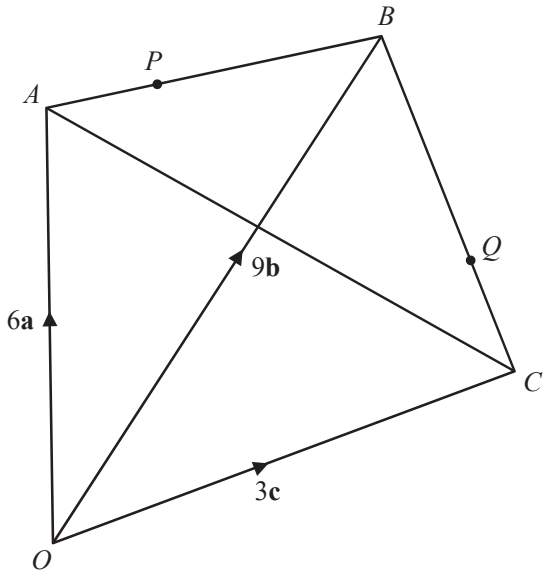
(i) shape A after a translation by $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$, [2]

(ii) shape A after a rotation through 180° about the point (0, 0), [2]

(iii) shape A after the transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$. [3]

(b) Describe fully the **single** transformation that maps shape A onto shape B. [3]

(c) Find the matrix which represents the transformation that maps shape A onto shape C. [2]



NOT TO SCALE

In the diagram, O is the origin and $\overrightarrow{OA} = 6\mathbf{a}$, $\overrightarrow{OB} = 9\mathbf{b}$ and $\overrightarrow{OC} = 3\mathbf{c}$.
The point P lies on AB such that $\overrightarrow{AP} = 3\mathbf{b} - 2\mathbf{a}$.
The point Q lies on BC such that $\overrightarrow{BQ} = 2\mathbf{c} - 6\mathbf{b}$.

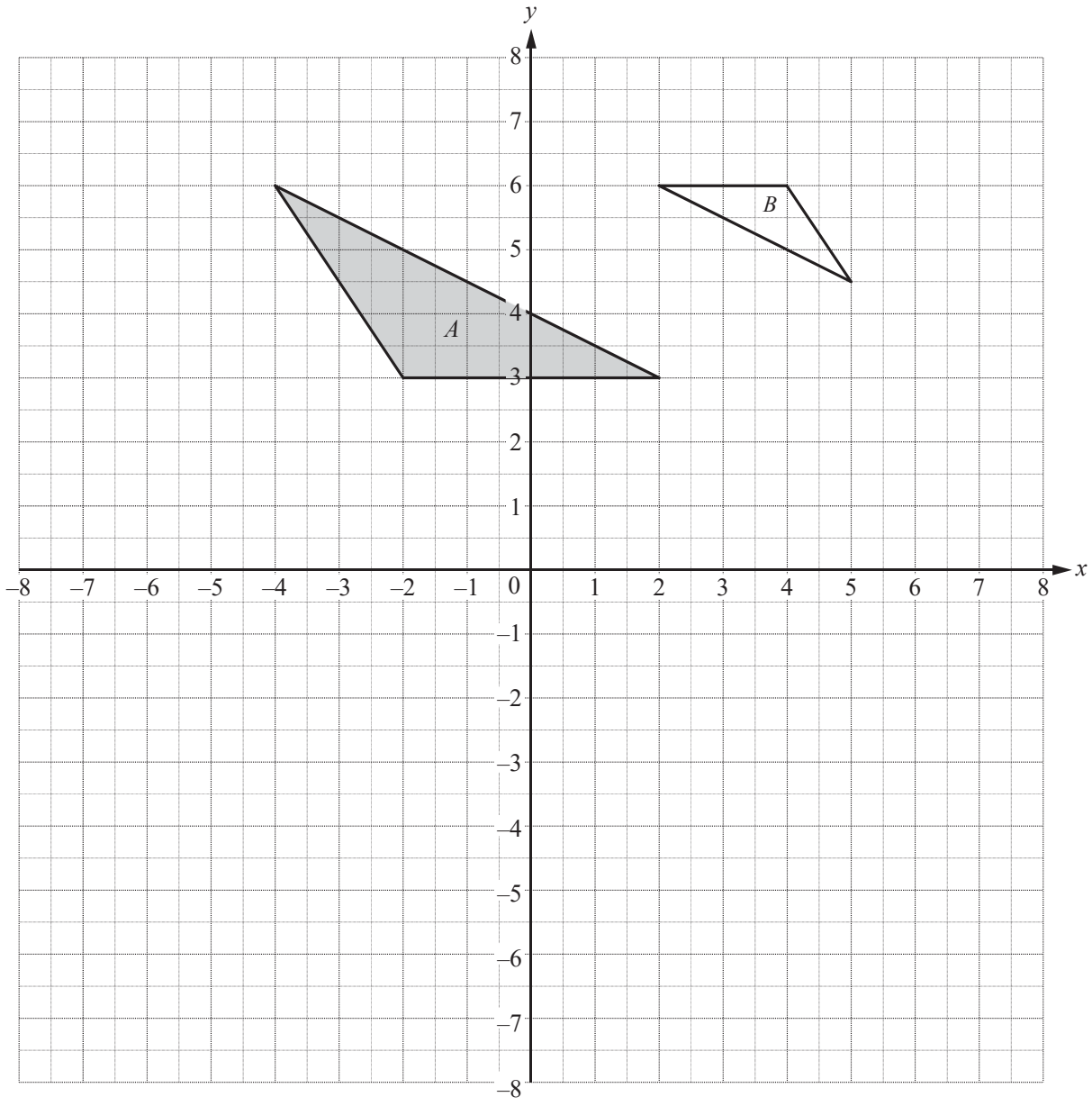
(a) Find, in terms of **b** and **c**, the position vector of Q.
Give your answer in its simplest form. [2]

(b) Find, in terms of **a** and **c**, in its simplest form

(i) $\overrightarrow{AC}$, [1]

(ii) $\overrightarrow{PQ}$. [2]

(c) Explain what your answers in **part (b)** tell you about PQ and AC. [2]



(a) Describe fully the **single** transformation that maps triangle A onto triangle B. [3]

(b) On the grid, draw the image of

(i) triangle A after a reflection in the line $x = -3$, [2]

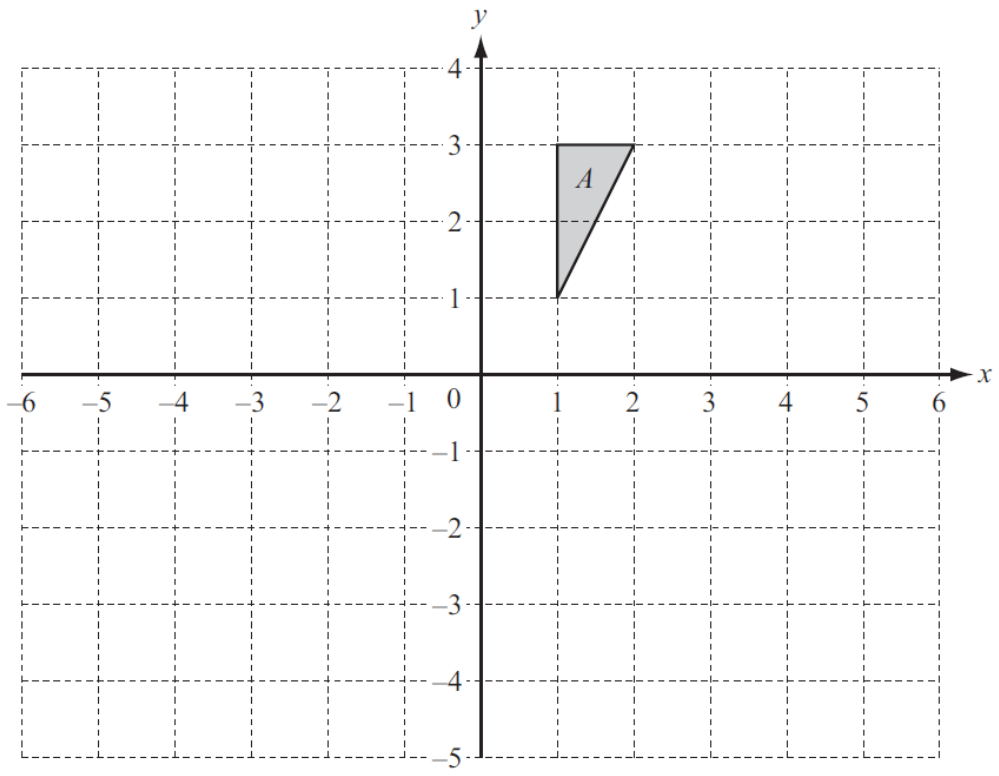
(ii) triangle A after a rotation about the origin through 270° anticlockwise, [2]

(iii) triangle A after a translation by the vector $\begin{pmatrix} -1 \\ -5 \end{pmatrix}$. [2]

(c) **M** is the matrix that represents the transformation in **part (b)(ii)**.

(i) Find **M**. [2]

(ii) Describe fully the **single** transformation represented by $\mathbf{M}^{-1}$, the inverse of **M**. [2]



(a) On the grid,

(i) draw the image of shape A after a translation by the vector $\begin{pmatrix} -5 \\ -4 \end{pmatrix}$, [2]

(ii) draw the image of shape A after a rotation through 90° clockwise about the origin. [2]

(b) (i) On the grid, draw the image of shape A after the transformation represented by the matrix $\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$.

[3]

(ii) Describe fully the **single** transformation represented by the matrix $\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$. [3]

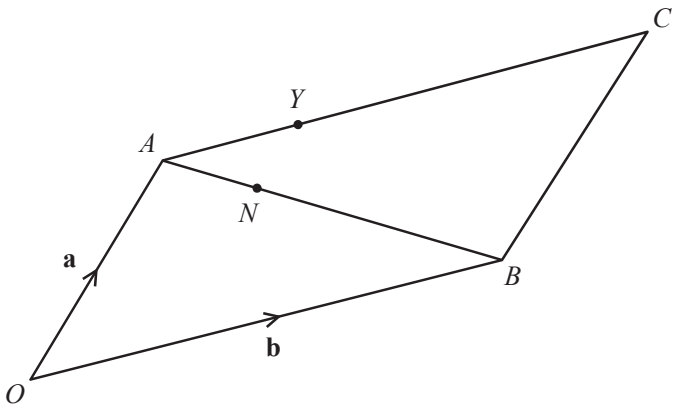
(a) $\overrightarrow{PQ} = \begin{pmatrix} -3 \\ 4 \end{pmatrix}$

(i) P is the point (–2, 3).

Work out the co-ordinates of Q. [1]

(ii) Work out $|\overrightarrow{PQ}|$, the magnitude of $\overrightarrow{PQ}$. [2]

(b)



NOT TO SCALE

$OACB$ is a parallelogram.
$\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
$AN : NB = 2 : 3$ and $AY = \frac{2}{5}AC$.

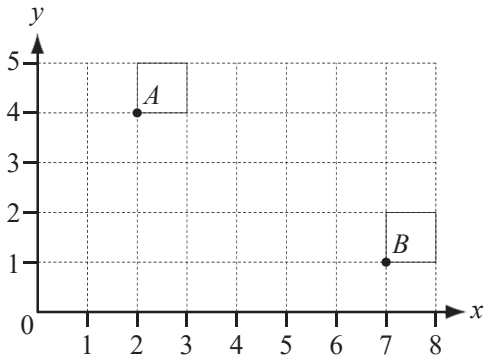
(i) Write each of the following in terms of **a** and/or **b**.
Give your answers in their simplest form.

(a) $\overrightarrow{ON}$ [2]

(b) $\overrightarrow{NY}$ [2]

(ii) Write down two conclusions you can make about the line segments NY and BC. [2]

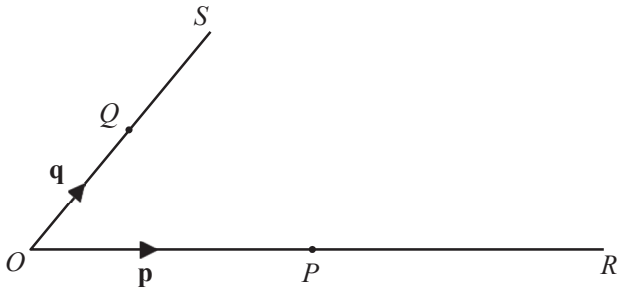
(a)



(i) Write down the position vector of A. [1]

(ii) Find $|\overrightarrow{AB}|$, the magnitude of $\overrightarrow{AB}$. [2]

(b)



NOT TO SCALE

O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
OP is extended to R so that $OP = PR$.
OQ is extended to S so that $OQ = QS$.

(i) Write down $\overrightarrow{RQ}$ in terms of $\mathbf{p}$ and $\mathbf{q}$. [1]

(ii) PS and RQ intersect at M and $RM = 2MQ$.

Use vectors to find the ratio $PM : PS$, showing all your working. [4]

Vectors
Difficulty: Hard

Question Paper 3

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Hard
Booklet	Question Paper 3

Time allowed: **106 minutes**

Score: **/92**

Percentage: **/100**

Grade Boundaries:

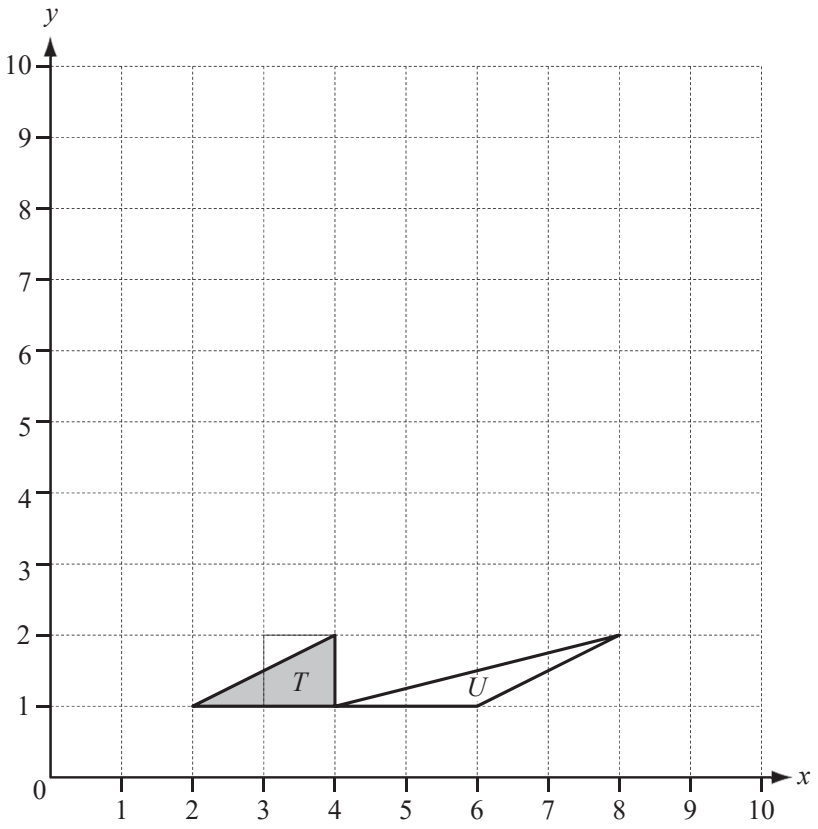
CIE IGCSE Maths (0580)

A*	A	B	C	D
>83%	67%	51%	41%	31%

CIE IGCSE Maths (0980)

9	8	7	6	5	4
>95%	87%	80%	69%	58%	46%

(a)



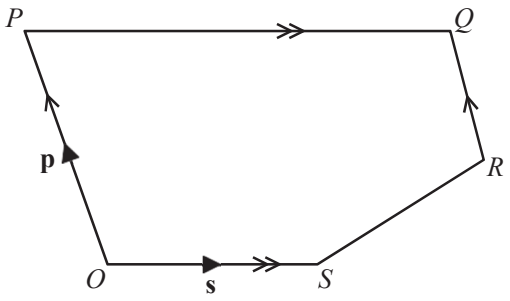
(i) Draw the reflection of triangle T in the line $y = 5$. [2]

(ii) Draw the rotation of triangle T about the point (4, 2) through 180°. [2]

(iii) Describe fully the **single** transformation that maps triangle T onto triangle U. [3]

(iv) Find the 2×2 matrix which represents the transformation in **part (a)(iii)**. [2]

(b)



NOT TO SCALE

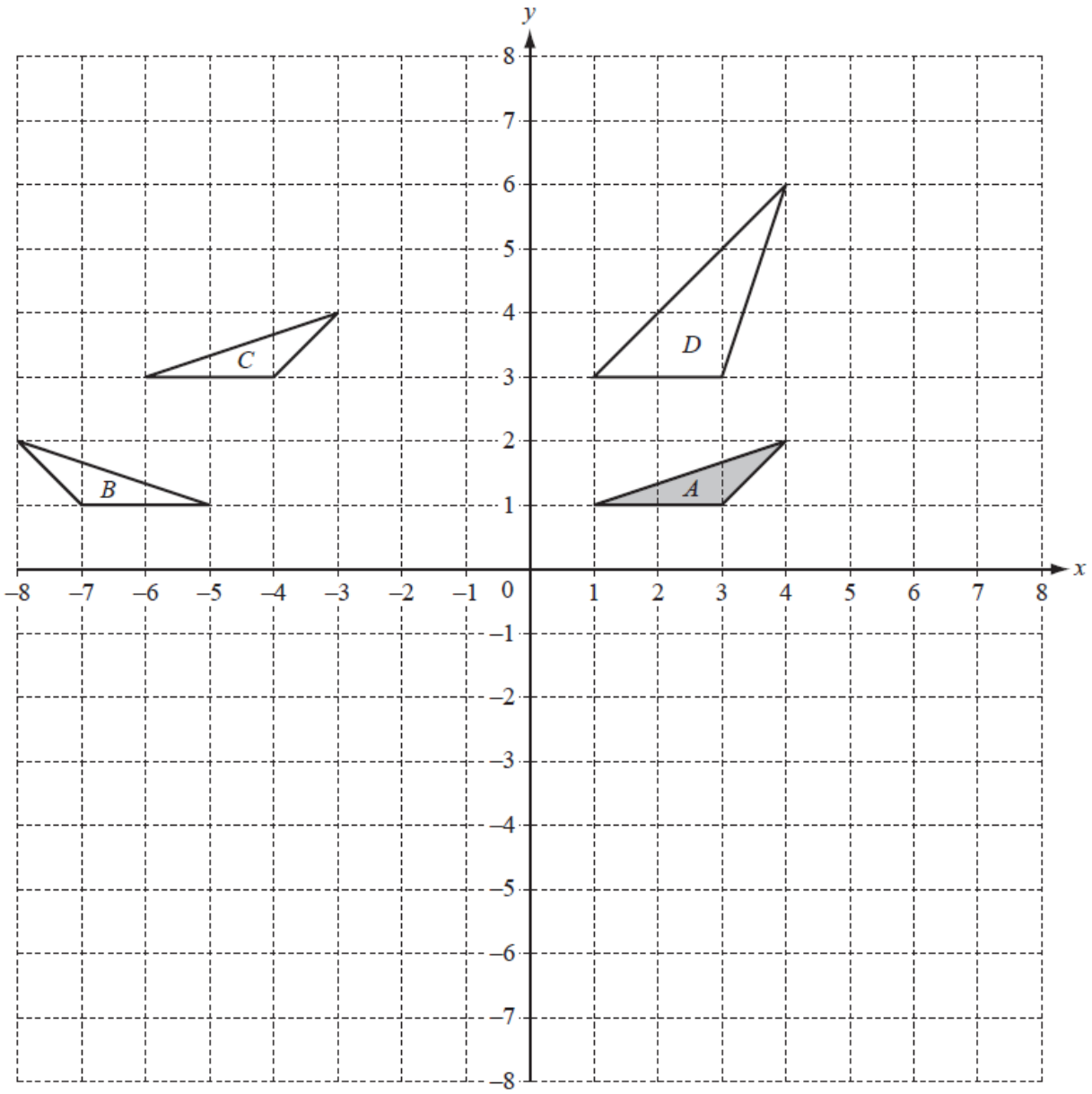
In the pentagon $OPQRS$, OP is parallel to RQ and OS is parallel to PQ.
$PQ = 2OS$ and $OP = 2RQ$.
O is the origin, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OS} = \mathbf{s}$.

Find, in terms of **p** and **s**, in their simplest form,

(i) the position vector of Q, [2]

(ii) $\overrightarrow{SR}$. [2]

(c) Explain what your answers in **part (b)** tell you about the lines OQ and SR. [1]



(a) Describe fully the **single** transformation that maps triangle *A* onto

(i) triangle *B*, [2]

(ii) triangle *C*, [2]

(iii) triangle *D*. [3]

(b) On the grid, draw

(i) the rotation of triangle A about (6, 0) through 90° clockwise, [2]

(ii) the enlargement of triangle A by scale factor –2 with centre (0, –1), [2]

(iii) the shear of triangle A by shear factor –2 with the y-axis invariant. [2]

(c) Find the matrix that represents the transformation in **part (b)(iii)**. [2]

(a) The co-ordinates of P are $(-4, -4)$ and the co-ordinates of Q are $(8, 14)$.

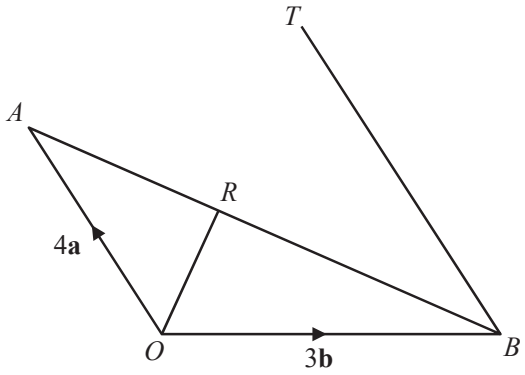
(i) Find the gradient of the line PQ. [2]

(ii) Find the equation of the line PQ. [2]

(iii) Write $\overrightarrow{PQ}$ as a column vector. [1]

(iv) Find the magnitude of $\overrightarrow{PQ}$. [2]

(b)



NOT TO SCALE

In the diagram, $\overrightarrow{OA} = 4\mathbf{a}$ and $\overrightarrow{OB} = 3\mathbf{b}$.

R lies on AB such that $\overrightarrow{OR} = \frac{1}{5}(12\mathbf{a} + 6\mathbf{b})$.

T is the point such that $\overrightarrow{BT} = \frac{3}{2}\overrightarrow{OA}$.

(i) Find the following in terms of **a** and **b**, giving each answer in its simplest form.

(a) $\overrightarrow{AB}$ [1]

(b) $\overrightarrow{AR}$ [2]

(c) $\overrightarrow{OT}$ [1]

(ii) Complete the following statement. [1]

The points O, R and T are in a straight line because .....

(iii) Triangle OAR and triangle TBR are similar.

Find the value of $\dfrac{\text{area of triangle } TBR}{\text{area of triangle } OAR}$. [2]

(a) $\mathbf{a} = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} 2 \\ -7 \end{pmatrix}$ $\mathbf{c} = \begin{pmatrix} -10 \\ 21 \end{pmatrix}$

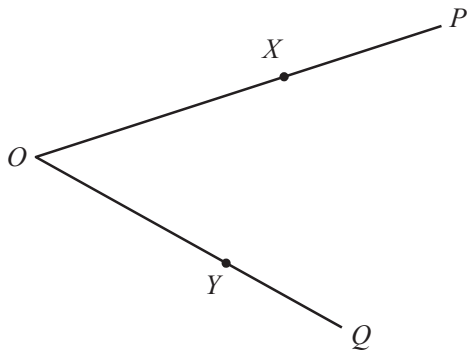
(i) Find $2\mathbf{a} + \mathbf{b}$. [1]

(ii) Find $|\mathbf{b}|$. [2]

(iii) $m\mathbf{a} + n\mathbf{b} = \mathbf{c}$

Find the values of m and n.
Show all your working. [6]

(b)



NOT TO SCALE

In the diagram, $OX:XP = 3:2$ and $OY:YQ = 3:2$.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.

(i) Write $\overrightarrow{PQ}$ in terms of $\mathbf{p}$ and $\mathbf{q}$. [1]

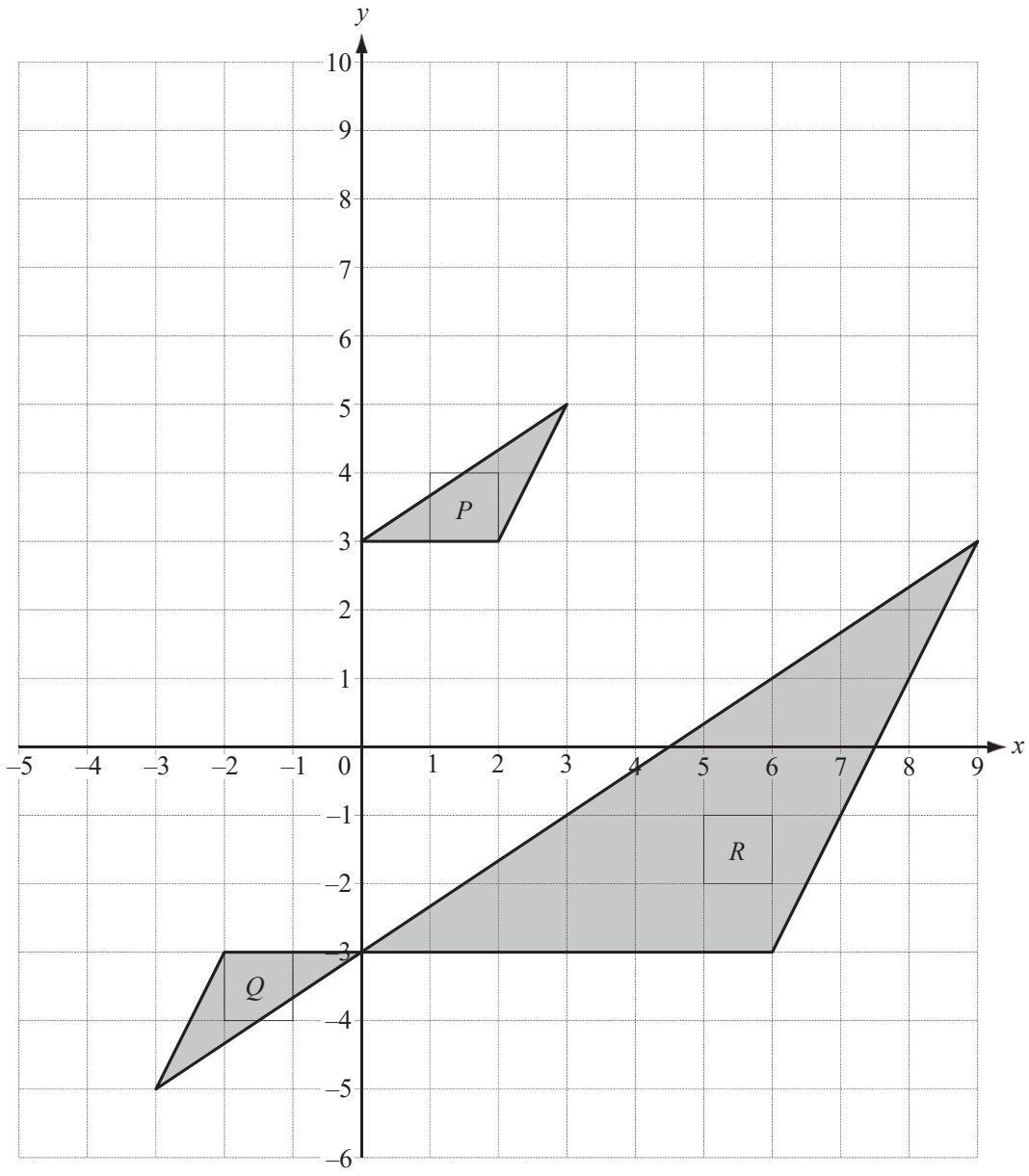
(ii) Write $\overrightarrow{XY}$ in terms of $\mathbf{p}$ and $\mathbf{q}$. [1]

(iii) Complete the following sentences. [3]

The lines XY and PQ are

The triangles OXY and OPQ are

The ratio of the area of triangle OXY to the area of triangle OPQ is



(a) Describe fully

(i) the **single** transformation which maps triangle P onto triangle Q, [3]

(ii) the **single** transformation which maps triangle Q onto triangle R, [3]

(iii) the **single** transformation which maps triangle R onto triangle P. [3]

(b) On the grid, draw the image of

(i) **triangle *P*** after translation by $\begin{pmatrix} -4 \\ -5 \end{pmatrix}$, [2]

(ii) **triangle *P*** after reflection in the line $x = -1$. [2]

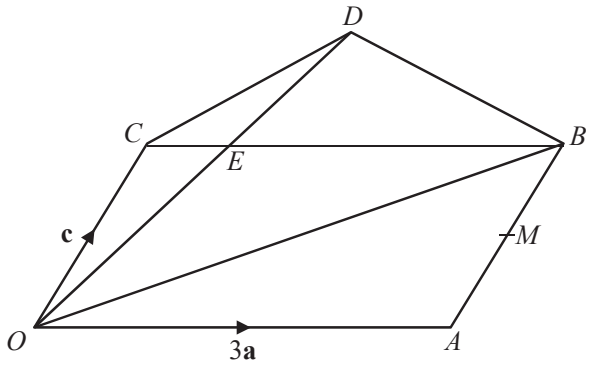
(c) (i) On the grid, draw the image of **triangle *P*** after a stretch, scale factor 2 and the y-axis as the invariant line. [2]

(ii) Find the matrix which represents this stretch. [2]

(a) P is the point (2, 5) and $\overrightarrow{PQ} = \begin{pmatrix} 3 \\ -2 \end{pmatrix}$.

Write down the co-ordinates of Q. [1]

(b)



NOT TO SCALE

O is the origin and $OABC$ is a parallelogram.
M is the midpoint of AB.
$\overrightarrow{OC} = \mathbf{c}$, $\overrightarrow{OA} = 3\mathbf{a}$ and $CE = \frac{1}{3}CB$.

OED is a straight line with $OE : ED = 2 : 1$.

Find in terms of **a** and **c**, in their simplest forms

(i) $\overrightarrow{OB}$, [1]

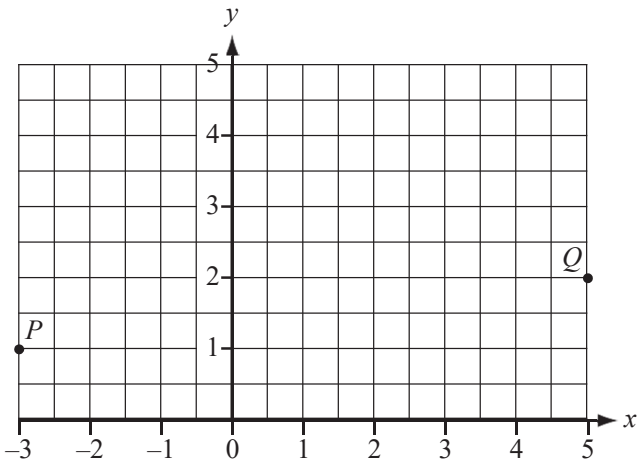
(ii) the position vector of M, [2]

(iii) $\overrightarrow{OE}$, [1]

(iv) $\overrightarrow{CD}$. [2]

(c) Write down two facts about the lines CD and OB. [2]

(a)



The points P and Q have co-ordinates (–3, 1) and (5, 2).

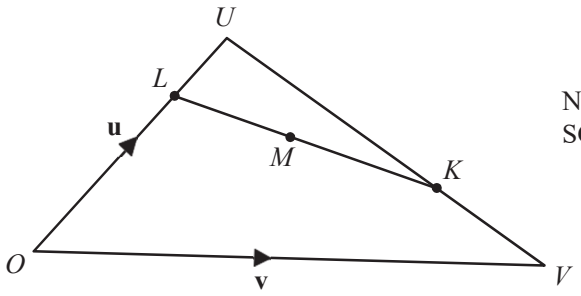
(i) Write $\overrightarrow{PQ}$ as a column vector. [1]

(ii) $\overrightarrow{QR} = 2\begin{pmatrix} -1 \\ 1 \end{pmatrix}$

Mark the point R on the grid. [1]

(iii) Write down the position vector of the point P. [1]

(b)



NOT TO SCALE

In the diagram, $\overrightarrow{OU} = \mathbf{u}$ and $\overrightarrow{OV} = \mathbf{v}$.

K is on UV so that $\overrightarrow{UK} = \frac{2}{3}\overrightarrow{UV}$ and L is on OU so that $\overrightarrow{OL} = \frac{3}{4}\overrightarrow{OU}$.

M is the midpoint of KL.

Find the following in terms of **u** and **v**, giving your answers in their simplest form.

(i) $\overrightarrow{LK}$ [4]

(ii) $\overrightarrow{OM}$ [2]

Vectors
Difficulty: Hard

Question Paper 4

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Hard
Booklet	Question Paper 4

Time allowed: **87 minutes**

Score: **/76**

Percentage: **/100**

Grade Boundaries:

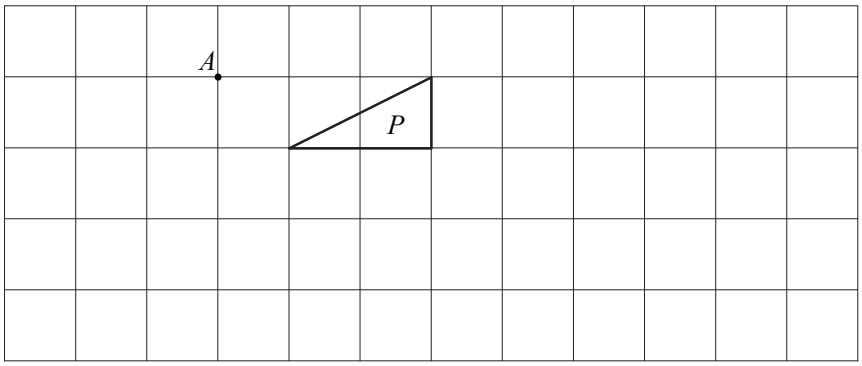
CIE IGCSE Maths (0580)

A*	A	B	C	D
>83%	67%	51%	41%	31%

CIE IGCSE Maths (0980)

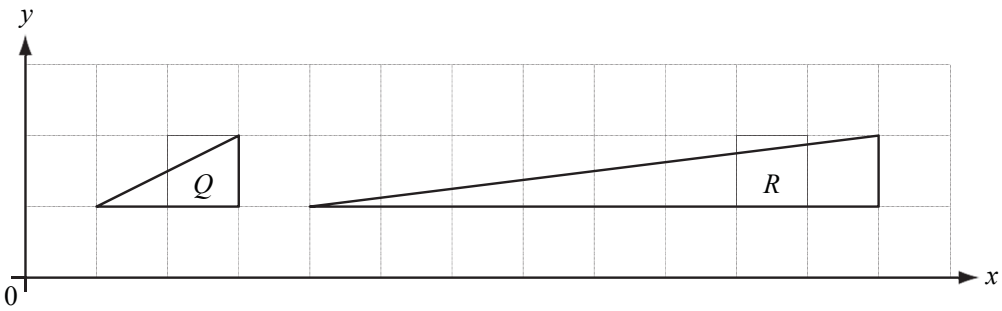
9	8	7	6	5	4
>95%	87%	80%	69%	58%	46%

(a)



Draw the enlargement of triangle P with centre A and scale factor 2. [2]

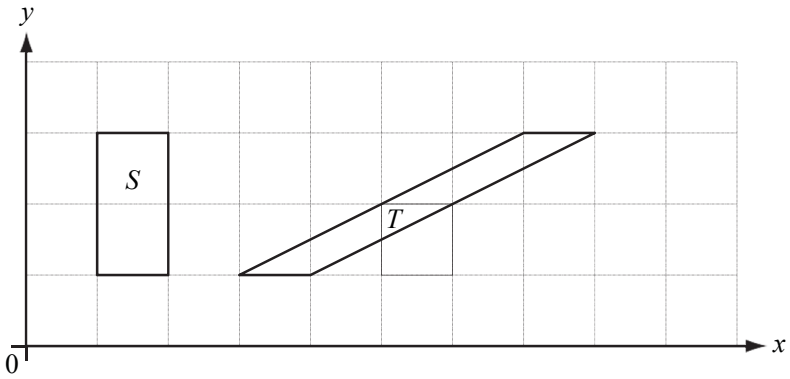
(b)



(i) Describe fully the **single** transformation which maps shape Q onto shape R. [3]

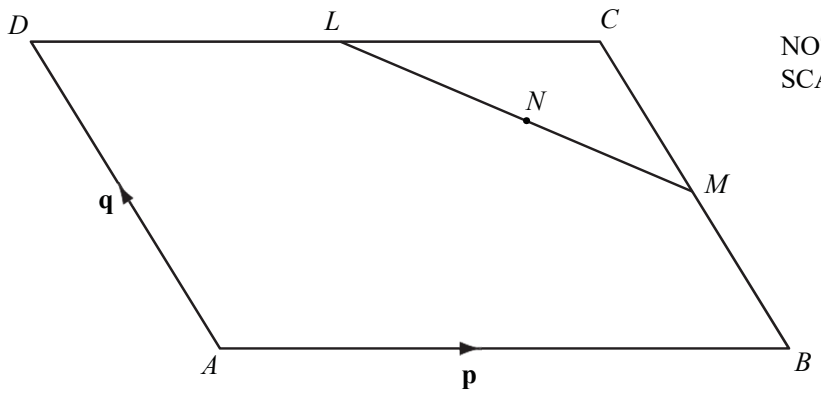
(ii) Find the matrix which represents this transformation. [2]

(c)



Describe fully the **single** transformation which maps shape S onto shape T. [3]

(a)



NOT TO SCALE

$ABCD$ is a parallelogram.
L is the midpoint of DC, M is the midpoint of BC and N is the midpoint of LM.
$\overrightarrow{AB} = \mathbf{p}$ and $\overrightarrow{AD} = \mathbf{q}$.

(i) Find the following in terms of $\mathbf{p}$ and $\mathbf{q}$, in their simplest form.

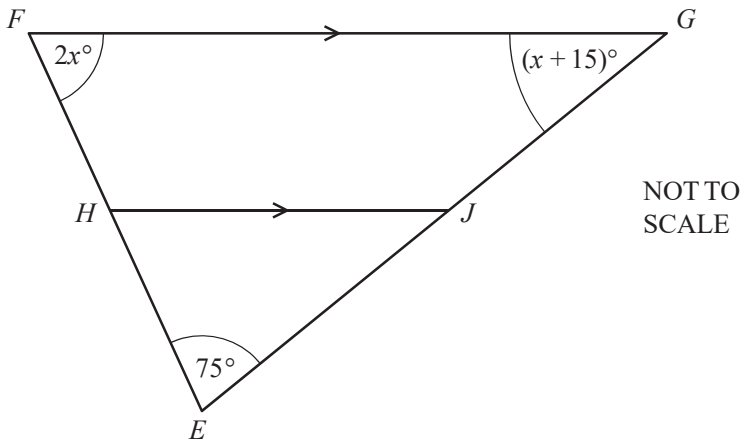
(a) $\overrightarrow{AC}$ [1]

(b) $\overrightarrow{LM}$ [2]

(c) $\overrightarrow{AN}$ [2]

(ii) Explain why your answer for $\overrightarrow{AN}$ shows that the point N lies on the line AC. [1]

(b)

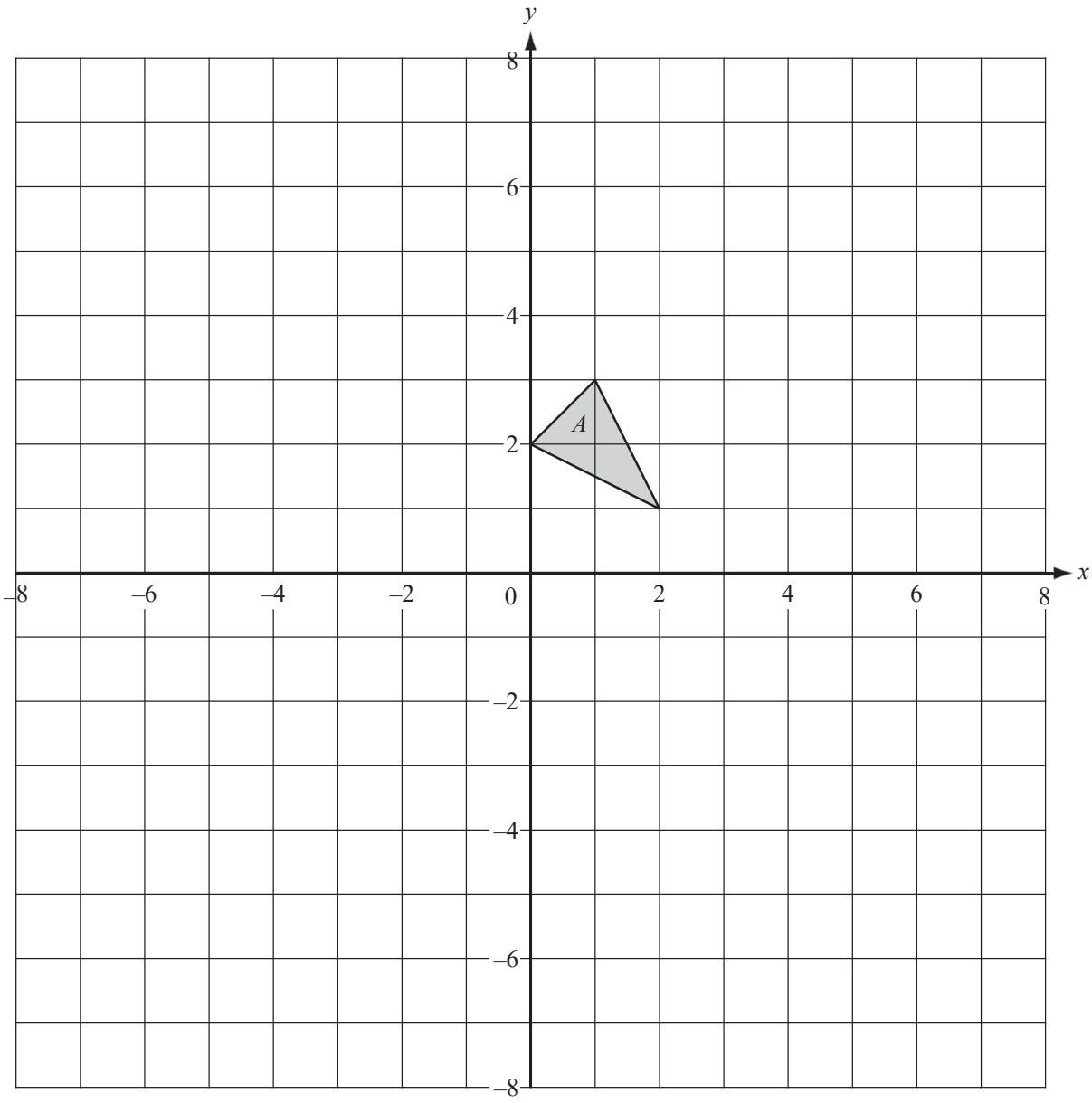


EFG is a triangle.
HJ is parallel to *FG*.
Angle *FEG* = 75°.
Angle *EFG* = 2*x*° and angle *FGE* = (*x* + 15)°.

(i) Find the value of *x*. [2]

(ii) Find angle *HJG*. [1]

(a)



Draw the images of the following transformations on the grid above.

(i) Translation of triangle A by the vector $\begin{pmatrix} 3 \\ -7 \end{pmatrix}$. Label the image B. [2]

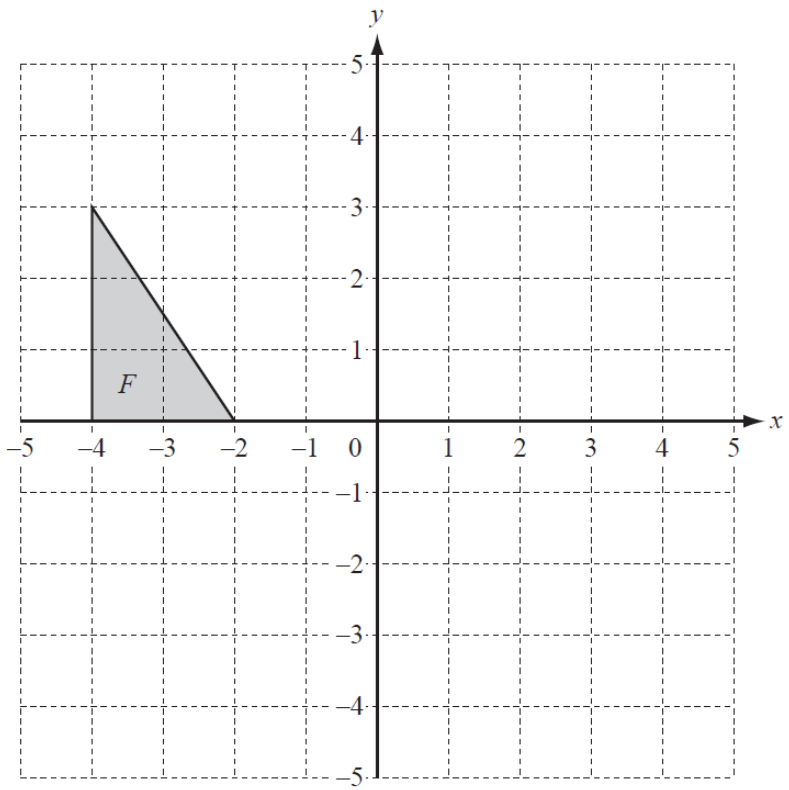
(ii) Reflection of triangle A in the line $x = 3$. Label the image C. [2]

(iii) Rotation of triangle A through 90° anticlockwise around the point (0, 0). Label the image D. [2]

(iv) Enlargement of triangle A by scale factor –4, with centre (0, 1). Label the image E. [2]

(b) The area of triangle E is $k \times$ area of triangle A.
Write down the value of k. [1]

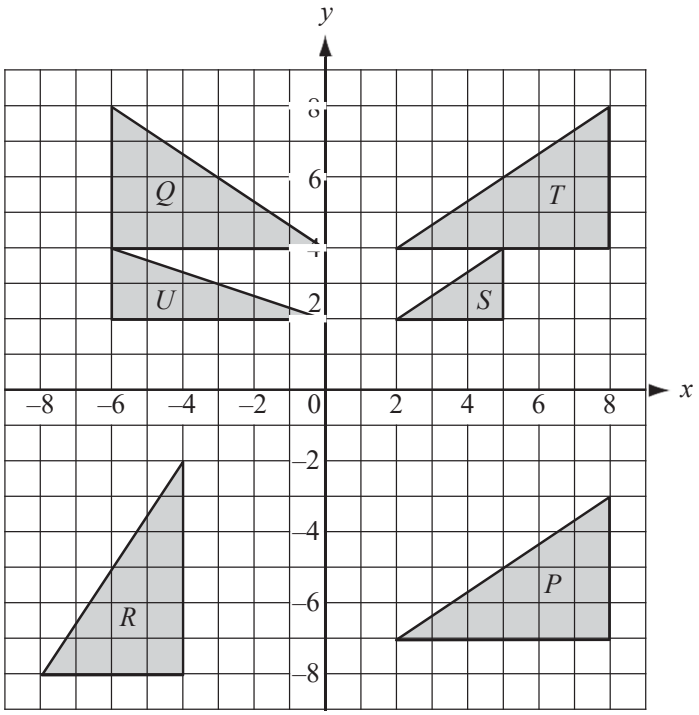
(c)



(i) Draw the image of triangle F under the transformation represented by the matrix $\mathbf{M} = \begin{pmatrix} 1 & 3 \\ 0 & 1 \end{pmatrix}$. [3]

(ii) Describe fully this single transformation. [3]

(iii) Find $\mathbf{M}^{-1}$, the inverse of the matrix $\mathbf{M}$. [2]



The diagram shows triangles P, Q, R, S, T and U.

(a) Describe fully the **single** transformation which maps triangle

(i) T onto P, [2]

(ii) Q onto T, [2]

(iii) T onto R, [2]

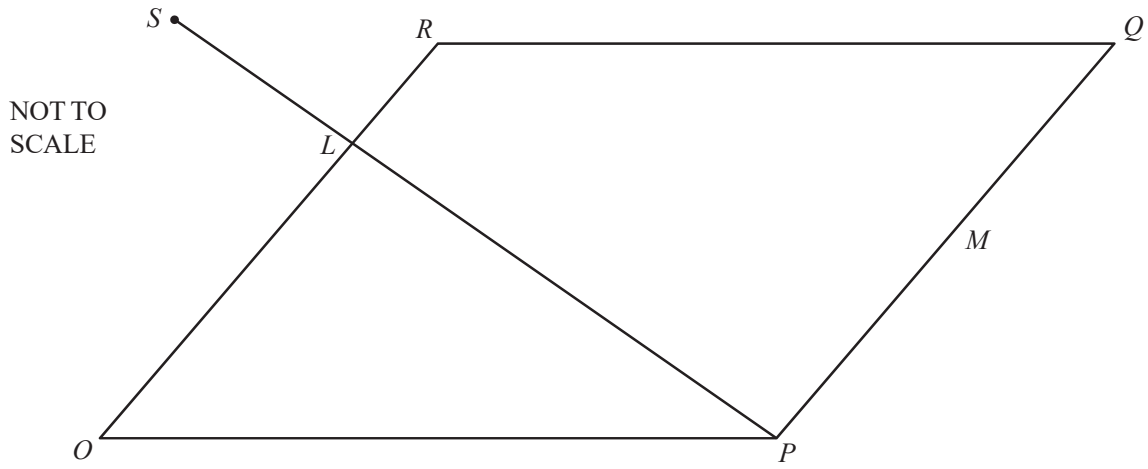
(iv) T onto S, [3]

(v) U onto Q. [3]

(b) Find the 2 by 2 matrix representing the transformation which maps triangle

(i) T onto R, [2]

(ii) U onto Q. [2]



$OPQR$ is a parallelogram.
O is the origin.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.
M is the mid-point of PQ and L is on OR such that $OL : LR = 2 : 1$.
The line PL is extended to the point S.

(a) Find, in terms of $\mathbf{p}$ and $\mathbf{r}$, in their simplest forms,

(i) $\overrightarrow{OQ}$, [1]

(ii) $\overrightarrow{PR}$, [1]

(iii) $\overrightarrow{PL}$, [1]

(iv) the position vector of M. [1]

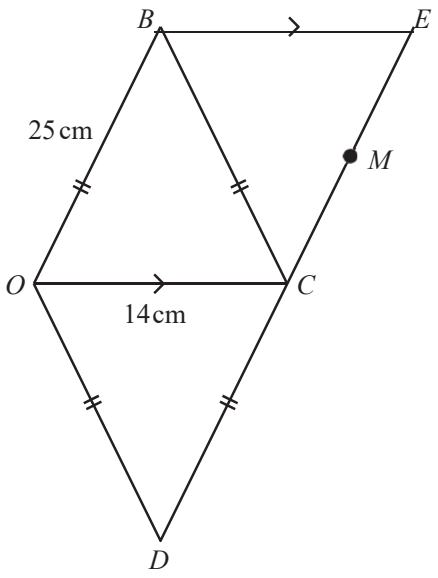
(b) PLS is a straight line and $PS = \frac{3}{2}PL$.

Find, in terms of $\mathbf{p}$ and/or $\mathbf{r}$, in their simplest forms,

(i) $\overrightarrow{PS}$, [1]

(ii) $\overrightarrow{QS}$. [2]

(c) What can you say about the points Q, R and S? [1]



NOT TO SCALE

OBCD is a rhombus with sides of 25 cm. The length of the diagonal *OC* is 14 cm.

(a) Show, **by calculation**, that the length of the diagonal *BD* is 48 cm. [3]

(b) Calculate, correct to the nearest degree,

(i) angle *BCD*, [2]

(ii) angle *OBC*. [1]

(c) $\overrightarrow{DB} = 2\mathbf{p}$ and $\overrightarrow{OC} = 2\mathbf{q}$.
Find, in terms of $\mathbf{p}$ and $\mathbf{q}$,

(i) $\overrightarrow{OB}$, [1]

(ii) $\overrightarrow{OD}$. [1]

(d) *BE* is parallel to *OC* and *DCE* is a straight line.
Find, in its simplest form, $\overrightarrow{OE}$ in terms of $\mathbf{p}$ and $\mathbf{q}$. [2]

(e) *M* is the mid-point of *CE*.
Find, in its simplest form, $\overrightarrow{OM}$ in terms of $\mathbf{p}$ and $\mathbf{q}$. [2]

(f) *O* is the origin of a co-ordinate grid. *OC* lies along the *x*-axis and $\mathbf{q} = \begin{pmatrix} 7 \\ 0 \end{pmatrix}$.
($\overrightarrow{DB}$ is vertical and $|\overrightarrow{DB}| = 48$.)
Write down as column vectors

(i) $\mathbf{p}$, [1]

(ii) $\overrightarrow{BC}$. [2]

(g) Write down the value of $|\overrightarrow{DE}|$. [1]

Vectors
Difficulty: Hard

Question Paper 5

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Vectors
Paper	Paper 4
Difficulty	Hard
Booklet	Question Paper 5

Time allowed: **90 minutes**

Score: **/78**

Percentage: **/100**

Grade Boundaries:

CIE IGCSE Maths (0580)

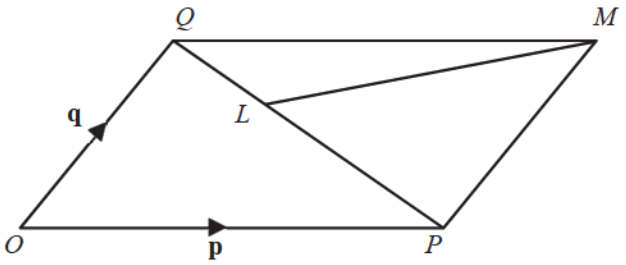
A*	A	B	C	D
>83%	67%	51%	41%	31%

CIE IGCSE Maths (0980)

9	8	7	6	5	4
>95%	87%	80%	69%	58%	46%

(a)

NOT TO SCALE



$OPMQ$ is a parallelogram and O is the origin.
$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$.
L is on PQ so that $PL : LQ = 2:1$.

Find the following vectors in terms of **p** and **q**. Write your answers in their simplest form.

(i) $\overrightarrow{PQ}$, [1]
(ii) $\overrightarrow{PL}$, [1]
(iii) $\overrightarrow{ML}$, [2]
(iv) the position vector of L. [2]

(b) R is the point (1,2). It is translated onto the point S by the vector $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$.

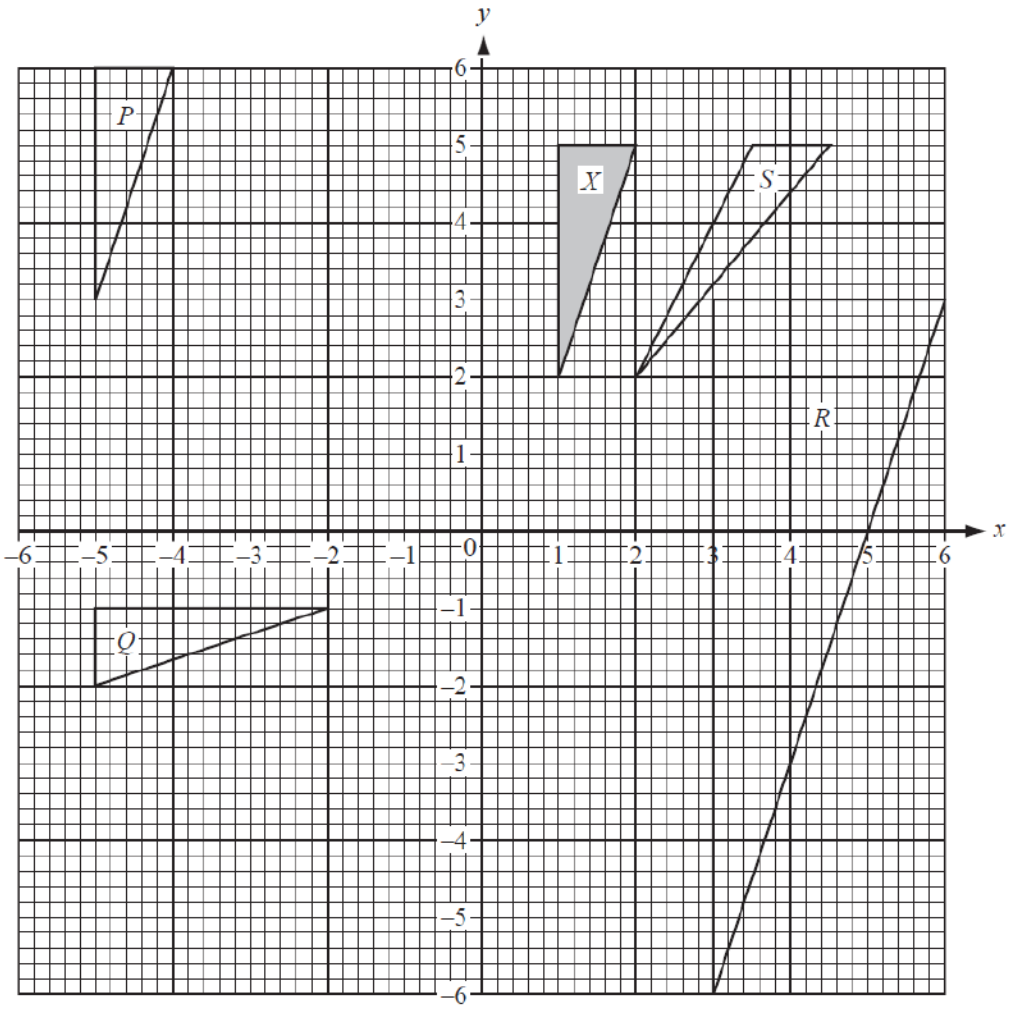
(i) Write down the co-ordinates of S. [1]
(ii) Write down the vector which translates S onto R. [1]

(c) The matrix $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ represents a **single** transformation.

(i) Describe fully this transformation. [3]

(ii) Find the co-ordinates of the image of the point (5, 3) after this transformation. [1]

(d) Find the matrix which represents a reflection in the line $y = x$. [2]



(a) Describe fully the single transformation which maps

(i) triangle X onto triangle P, [2]

(ii) triangle X onto triangle Q, [2]

(iii) triangle X onto triangle R, [3]

(iv) triangle X onto triangle S. [3]

(b) Find the 2 by 2 matrix which represents the transformation that maps

(i) triangle X onto triangle Q, [2]

(ii) triangle X onto triangle S. [2]

Answer the whole of this question on a sheet of graph paper.

(a) Draw x- and y-axes from –8 to 8 using a scale of 1cm to 1 unit.
Draw triangle ABC with A (2, 2), B (5, 2) and C (5, 4). [2]

(b) Draw the image of triangle ABC under a translation of $\begin{pmatrix} -9 \\ 3 \end{pmatrix}$.
Label it $A_1B_1C_1$. [2]

(c) Draw the image of triangle ABC under a reflection in the line $y = -1$.
Label it $A_2B_2C_2$. [2]

(d) Draw the image of triangle ABC under an enlargement, scale factor 2, centre (6,0).
Label it $A_3B_3C_3$. [2]

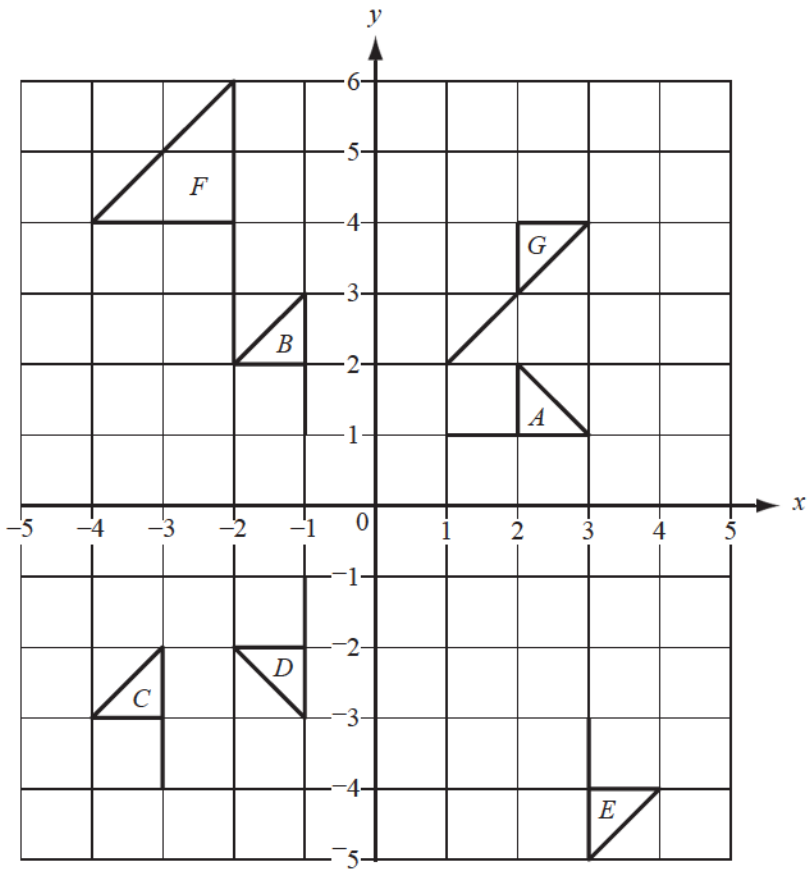
(e) The matrix $\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$ represents a transformation.

(i) Draw the image of triangle ABC under this transformation. Label it $A_4B_4C_4$. [2]

(ii) Describe fully this single transformation. [2]

(f) (i) Draw the image of triangle ABC under a stretch, factor 1.5, with the y-axis invariant.
Label it $A_5B_5C_5$. [2]

(ii) Find the 2 by 2 matrix which represents this transformation. [2]



(a) Describe fully the **single** transformation which maps

(i) shape A onto shape B, [2]

(ii) shape B onto shape C, [2]

(iii) shape A onto shape D, [2]

(iv) shape B onto shape E, [2]

(v) shape B onto shape F, [2]

(vi) shape A onto shape G. [2]

(b) A transformation is represented by the matrix $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.

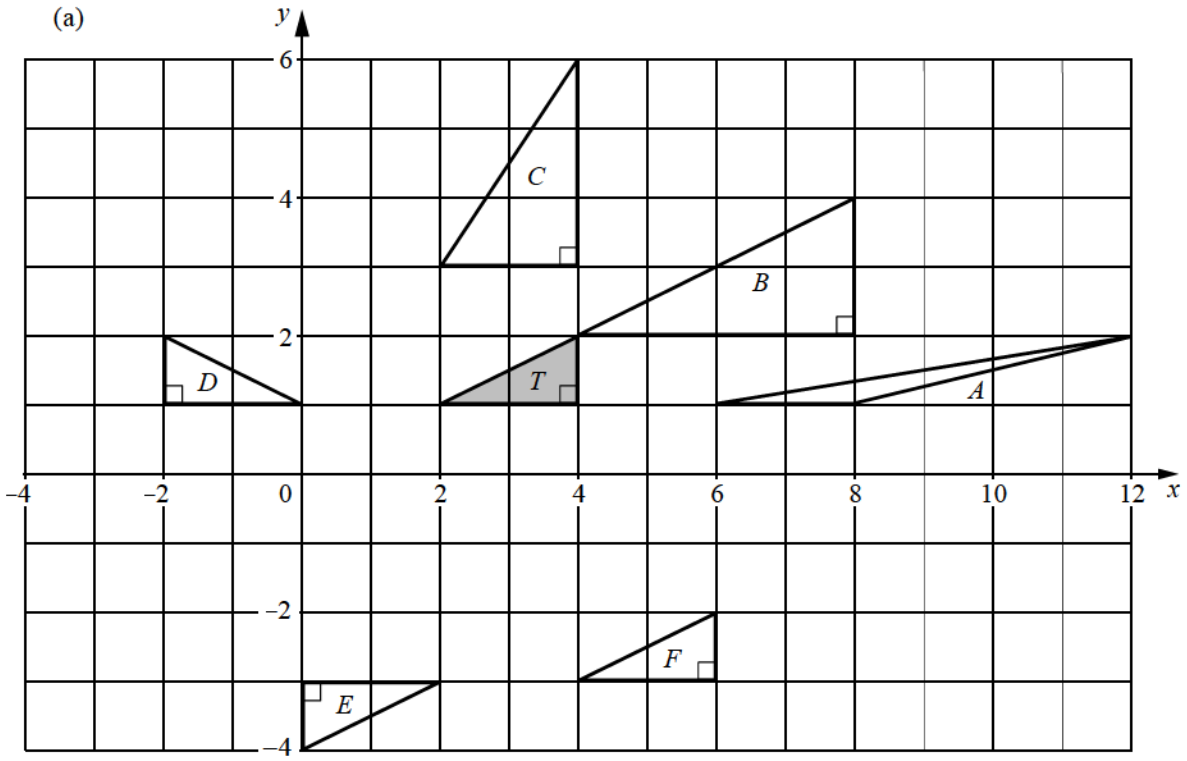
Which shape above is the image of shape A after this transformation? [2]

(c) Find the 2 by 2 matrix representing the transformation which maps

(i) shape B onto shape D, [2]

(ii) shape A onto shape G. [2]

(a)



Use one of the letters A, B, C, D, E or F to answer the following questions.

(i) Which triangle is T mapped onto by a **translation**? Write down the translation vector. [2]

(ii) Which triangle is T mapped onto by a **reflection**? Write down the equation of the mirror line. [2]

(iii) Which triangle is T mapped onto by a **rotation**? Write down the coordinates of the centre of rotation. [2]

(iv) Which triangle is T mapped onto by a **stretch** with the x-axis invariant? Write down the scale factor of the stretch. [2]

(v) $\mathbf{M} = \begin{pmatrix} 1 & 4 \\ 0 & 1 \end{pmatrix}$ Which triangle is T mapped onto by **M**?

Write down the name of this transformation. [2]

(b) $\mathbf{P} = \begin{pmatrix} 1 & 3 \\ 5 & 7 \end{pmatrix}$ $\mathbf{Q} = (-1 \quad -2)$, $\mathbf{R} = (1 \quad 2 \quad 3)$, $\mathbf{S} = \begin{pmatrix} -1 \\ 2 \\ 3 \end{pmatrix}$.

Only some of the following matrix operations are possible with matrices **P**, **Q**, **R** and **S** above.

PQ, **QP**, **P + Q**, **PR**, **RS**

Write down and calculate each matrix operation that is possible. [6]