Transformations – Paper 4 – Mark Scheme

Question 1

3 (a)	Triangle drawn with co-ords at (1, 4), (4, 2), (4, 4)	2	**SC1** for 2 correct vertices or an enlargement sf $\frac{1}{2}$ with wrong centre
(b) (i)	$\begin{pmatrix} -8 & -8 & -2 \\ 4 & 8 & 8 \end{pmatrix}$	2	**B1** each row
(ii)	Triangle drawn at (–8, 4), (–8, 8), (–2, 8) ft **(i)**	2**ft**	**SC1** for 2 correct ft vertices. Can also be correct regardless of **(i)**
(iii)	Reflection cao		**B1** Independent of **(i)** or **(ii)** Extra transformations lose all marks
	$y-$axis or $x=0$ cao	2	**B1** Independent of **(i)** or **(ii)**
(c) (i)	Translation		**B1** Extra transformations lose all marks
	$\begin{pmatrix} -10 \\ -10 \end{pmatrix}$ o.e.	2	**B1**
(ii)	Rotation (0, 0) 90° clockwise oe	3	**B1** Extra transformations lose all marks **B1** Allow word origin for (0, 0) **B1** Allow – 90° or 270° (anti-clockwise)
(d)	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	2	**B1** each column

Question 2

4 (a) (i)	Triangle with vertices (–4, 4), (–1, 4), (–1, 6)	2	**SC1** for translation $\begin{pmatrix} -7 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 3 \end{pmatrix}$
(ii)	Triangle with vertices (1, –3), (1, –6), (3, –6)	2	**SC1** two correct vertices or 90° anticlockwise about (0, 0)
(b) (i)	Reflection only $y=-x$ oe	1 1	Marks independent but must be single transformation to score any marks
(ii)	Stretch only x-axis oe invariant (factor) 3	1 1 1	Marks independent but must be single transformation to score any marks
(c) (i)	$\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$	2	**B1** each column
(ii)	$\begin{pmatrix} 1 & 0 \\ 0 & 3 \end{pmatrix}$ ft	2**ft**	**ft** factor in **(b)(ii) only** if stretch and can recover to correct matrix **SC1ft** for right-hand column
(iii)	$\begin{pmatrix} 1 & 0 \\ 0 & \frac{1}{3} \end{pmatrix}$ ft	1**ft**	ft $\begin{pmatrix} 1 & 0 \\ 0 & n \end{pmatrix}$ to $\begin{pmatrix} 1 & 0 \\ 0 & \frac{1}{n} \end{pmatrix}$ or $\begin{pmatrix} n & 0 \\ 0 & 1 \end{pmatrix}$ to $\begin{pmatrix} \frac{1}{n} & 0 \\ 0 & 1 \end{pmatrix}$ $n \neq 0, \pm 1$ for $\frac{1}{3}$, allow 0.33 or better

Question 3

4 (a)	Triangle drawn , vertices (6, 10), (10, 10), (10, 8)	2	**SC1** reflects correctly in $x = 6$
(b)	Triangle drawn , vertices (2, 8), (6, 8), (6, 10)	2	**SC1** for translation $\begin{pmatrix} -4 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 6 \end{pmatrix}$
(c)	Translation $\begin{pmatrix} 4 \\ -6 \end{pmatrix}$ o.e.	2	**B1 All part marks** spoiled if extra transformation **B1** Indep. Allow other clear forms or words
(d) (i)	Enlargement (centre) (4, 6) (factor) 0.5	3	**B1 All part marks** spoiled if extra transformation **B1** Indep. **B1** Indep.
(ii)	$\frac{1}{4}$ or 0.25 oe	1	
(e) (i)	Stretch y-axis o.e invariant (factor) 0.5	3	**B1 All part marks** spoiled if extra transformation **B1** Indep **B1** Indep
(ii)	$\begin{pmatrix} 0.5 & 0 \\ 0 & 1 \end{pmatrix}$ ft	**2ft**	**ft** their factor in **(e)(i)** only if stretch **SC1** (also **ft**) for left-hand column

Question 4

2	**(a) (i)** Correct reflection (1, –1) (4, –1) (4, –3)	2	**SC1** for reflection in y-axis or vertices only of correct triangle
	(ii) Correct rotation (–1, 1) (–1, 4) (–3, 4)	2	**SC1** for rotation 90 clockwise about O or vertices only of correct triangle
	(iii) Reflection only	1dep	Two transformations scores 0 Dependent on at least **SC1** scored in **both (i)** and **(ii)**
	$y = x$ oe **or** $y = -x$ oe	1	Only from **2 and 2** or **SC1 and SC1** scored Only from **2 and SC1** or **SC1 and 2** scored
	(b) (i) $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$ oe	2	**B1** for either column correct or determinant = 1
	(ii) Rotation, 90° clockwise, origin oe	2	**B1** for rotation **and** origin **B1** for 90° clockwise oe

Question 5

8	**(a) (i)** Correct translation to (3, –5), (5, –6) and (4, –4)	2	**SC1** for translation of $\begin{pmatrix}3\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-7\end{pmatrix}$ or vertices only
	(ii) Correct reflection to (4, 1), (5, 3) and (6, 2)	2	**SC1** for reflection in $y = 3$ or vertices only
	(iii) Correct rotation to (–2, 0), (–1, 2) and (–3, 1)	2	**SC1** for rotation 90 clockwise around (0, 0) or vertices only
	(iv) Correct enlargement to (0, –3), (–8, 1) and (–4, –7)	2	**SC1** for two correct points or vertices only
	(b) 16 cao	1	
	(c) (i) Correct transformation to (–4, 0), (5, 3) and (–2, 0)	3	**B2** for 3 correct points shown in working but not plotted **or B1** for incorrect shear drawn with x-axis invariant **or** two correct points shown
	(ii) Shear only	1	If more than one transformation given – no marks available
	x-axis oe invariant (factor) 3	1 1	Accept fixed, constant oe for invariant
	(iii) $\begin{pmatrix}1 & -3\\0 & 1\end{pmatrix}$ oe	2	**B1** for determinant = 1 **or** $k\begin{pmatrix}1 & -3\\0 & 1\end{pmatrix}$ oe

Question 6

5 (a)	**(i)** Correct translation (see diagram)	2	SC1 for translation by $\begin{pmatrix}-3\\k\end{pmatrix}$ or by $\begin{pmatrix}k\\-2\end{pmatrix}$
	(ii) Correct reflection (see diagram)	2	SC1 for reflection in $y = -1$
(b)	**(i)** Stretch, (factor) 3, y-axis or $x = 0$ invariant	1 1 1	
	(ii) Rotation 90° clockwise (1, – 1)	1 1 1	Accept –90°
(c)	**(i)** $\begin{pmatrix}3 & 0\\0 & 1\end{pmatrix}$ ft from **(b)(i)**	2 **ft**	SC1 for $\begin{pmatrix}1 & 0\\0 & 3\end{pmatrix}$ (ft from **(b)(i)**) or $\begin{pmatrix}k & 0\\0 & 1\end{pmatrix}$ with k algebraic or numeric but $\neq 1$ or 0
	(ii) Rotation, 180° Origin	1 1 1	Accept O or (0,0)

Question 7

8 (a)	Correct enlargement	2	B1 for any enlargement of 2 in correct orientation
(b)	**(i)** Stretch only *y*- axis oe invariant (factor) 4	1 1 1	
	(ii) $\begin{pmatrix} 4 & 0 \\ 0 & 1 \end{pmatrix}$	2**ft**	Ft their factor 4 SC1 for $\begin{pmatrix} k & 0 \\ 0 & 1 \end{pmatrix}$ $k \neq 0, \neq 1$ or $\begin{pmatrix} 1 & 0 \\ 0 & 4 \end{pmatrix}$ ft their factor 4
(c)	Shear only *x*-axis oe invariant (factor) 2	1 1 1	

Question 8

2 (a)	**(i)** Image at (4, –4), (6, –4), (6, –6), (2, –6)	2	SC1 for reflection in *y*-axis
	(ii) Image at (–4, –4), (–4, –6), (–6, –6), (–6, –2)	2 **ft**	SC1 ft if rotated 90° anti-clockwise about (0, 0)
	(iii) Reflection $y = -x$	1 **ft** 1 **ft**	ft their *Z* (name of transformation) independent (full details)
(b)	**(i)** Image at (2, 2), (3, 2), (3, 3), (1, 3)	2	SC1 for enlargement s.f. 0.5 with correct orientation, different centre or sf – 0.5, centre (0, 0)
	(ii) $\begin{pmatrix} 0.5 & 0 \\ 0 & 0.5 \end{pmatrix}$ cao	2	B1 B1 each column
(c)	**(i)** Image at (0, 4), (2, 4), (0, 6), (–4, 6)	2	SC1 if 3 vertices correct
	(ii) $\begin{pmatrix} 1 & -1 \\ 0 & 1 \end{pmatrix}$	2	SC1 for $\begin{pmatrix} 1 & k \\ 0 & 1 \end{pmatrix}$, $k \neq 0$ but can be algebraic or numeric or for $\begin{pmatrix} 1 & 0 \\ -1 & 1 \end{pmatrix}$

Question 9

7 (a)	**(a) (i)** Reflection only	**B1**	Spoilt if extras
	$y = -2$	**B1**	
	(ii) Enlargement only	**B1**	Spoilt if extras
	$\frac{1}{2}$	**B1**	
	(1, 4)	**B1**	
	(iii) Rotation only	**B1**	Spoilt if extras
	90° clockwise oe	**B1**	Accept –90° or (+)270°
	Around (1, –3)	**B1**	
	(b) (i) Triangle at (–4, 4), (–1, 4), (–1, 5)	**2**	**B1** for translation of $\begin{pmatrix} -5 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 2 \end{pmatrix}$ After **B0**, **SC1** for translation of 5 small squares to the left and 2 small squares up
	(ii) Triangle at (4, 4), (1, 4), (4, 6)	**3**	**B1** for each of (4, 4) or (4, 6) plotted If no/wrong plots allow **SC2** for 3 correct coordinates shown in working or **SC1** for any 2 correct coordinates shown or **M1** for $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}\begin{pmatrix} 1 & 4 & 4 \\ 2 & 2 & 3 \end{pmatrix}$ shown
	(c) Stretch only	**B1**	Spoilt if extras
	(Factor) 2	**B1**	
	x-axis oe invariant	**B1**	

Question 10

3	**(a)** Reflection only	**B1**	Two transformations scores 0
	$x = -1$ oe only	**B1**	
	(b) (i) Triangle (–1, 2) (–1, 6) (–3, 6)	**B2**	**B1** for vertices plotted only or for clockwise rotation about (0,0)
	(ii) Triangle (–1, –2) (–1, –6) (–3, –6)	**B2**	**B1** for vertices plotted only or for reflection in $x = y$
	(iii) Triangle (1, –1) (7, –1) (7, 2)	**B2**	**B1** for vertices plotted only or for enlargement by 1.5 with correct orientation
	(c) (i) Triangle drawn at (2, 3) (6, 7) (6, 9)	**3**	**B2** for 2 correct vertices plotted or **SC2** for 3 correct coordinates shown in working or **SC1** for any 2 correct coordinates or **M1** for $\begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}\begin{pmatrix} 2 & 6 & 6 \\ 1 & 1 & 3 \end{pmatrix}$
	(ii) Shear (only)	**B1**	Two transformations scores 0
	y axis invariant	**B1**	or $x = 0$ invariant
	(factor) 1	**B1**	
	(d) $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	**B2**	**B1** for either column or row correct

Question 11

4	**(a)** Image (1, –1), (1, –2), (4, –2), (3, –1)	**2**	**B1** if vertices plotted only or reflects in $y = -x$
	(b) Image (–3, 2), (–4, 2), (–4, 5), (–3, 4)	**2**	**B1** for translation by $\begin{pmatrix} -2 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 1 \end{pmatrix}$
	(c) **(i)** Rotation only,	**1**	Spoilt if extras
	90 clockwise oe,	**1**	
	(Centre) (0, 0) oe	**1**	
	(ii) $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	**2**	**B1** for one row or one column correct
	(d) Stretch only,	**1**	Spoilt if extras
	(Factor) 2,	**1**	
	x-axis oe invariant	**1**	

Question 12

7	**In any part of part (a) all marks are independent but mention of a second transformation scores 0 out of 3**		
(a) (i)	Rotation	**1**	accept R
	(centre/about) origin (O) (0,0)	**1**	
	180°	**1**	**SC3** for all of enlargement, sf – 1, (0, 0)
(ii)	Enlargement	**1**	accept E
	(centre/about) (0,– 3)	**1**	
	SF – 3	**1**	
(iii)	Enlargement	**1**	accept E
	(centre/about) (0, 6)	**1**	
	SF $\frac{1}{3}$	**1**	
(b) (i)	image at (–4, –2) (–2, –2) and (–1, 0)	**2**	**SC1** for translation by $\begin{pmatrix} -4 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -5 \end{pmatrix}$, $k \neq 0$
(ii)	image at (– 2, 3) (– 4, 3) and (– 5, 5)	**2**	**SC1** for reflection in $y = -1$
(c) (i)	image at (0, 3) (4, 3) and (6, 5)	**2**	**SC1** for stretch sf 2 with x-axis invariant ie at (0,6) (2,6) (3,10)
(ii)	$\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$ ft	**2 ft**	ft their stretch factor only **SC1** for correct left hand column ft or $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$ ft

Question 13

3 **(a)**	Triangle with vertices (6, 4), (9, 4), (9, 6)	**2**	Ignore labels and condone good freehand in parts (a), (b) and (d)(i) **SC1** for translation $\begin{pmatrix}5\\k\end{pmatrix}$ or $\begin{pmatrix}k\\3\end{pmatrix}$
(b)	Triangle with vertices (11, 1), (8, 1), (8, 3)	**2**	**SC1** for reflection in $y = 6$
(c) (i)	Rotation 90° [anticlockwise] oe [centre] (0, 0) oe	**1** **1** **1**	If other transformations in addition, then 0, 0, 0 e.g. O, origin
(ii)	$\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}$	**2**	**B1** each column
(d) (i)	Triangle with vertices (1, 3), (4, 3), (4, 9)	**2**	**SC1** for (1, 3) and (4, 3), or (4, 9)
(ii)	$\begin{pmatrix}1 & 0\\0 & 3\end{pmatrix}$	**2**	**B1** right-hand column or $\begin{pmatrix}3 & 0\\0 & 1\end{pmatrix}$

Question 14

2	**(a) (i)** Image at (– 3, 1), (– 7, 7), (– 3, 7)	**2**	**SC1** for translation $\begin{pmatrix}-11\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-1\end{pmatrix}$
	(ii) Image at (– 4, – 1), (– 4, – 4), (– 2, – 4)	**2**	**SC1** for enlargement factor 0.5 and correct orientation **In each part of (b) must be one transformation only – if more then lose all marks for that part**
	(b) (i) Reflection, $y = 1$	**2**	**B1 B1** independent
	(ii) Rotation, (3, 2), 180 oe or enlargement, (3, 2), (factor) – 1	**3**	**B1 B1 B1** independent
	(iii) Stretch, (factor) 0.5, Invariant line y-axis or $x = 0$	**3**	**B1 B1 B1** independent – must be clear on **invariant** line
	(c) $\begin{pmatrix}0.5 & 0\\0 & 1\end{pmatrix}$	**2 ft**	**ft** *their* factor in **(b)(iii) only** if stretch not 0 or 1 **SC1** for $\begin{pmatrix}k & 0\\0 & 1\end{pmatrix}$ $[k \neq 0 \text{ or } 1]$ **or** $\begin{pmatrix}1 & 0\\0 & 0.5\end{pmatrix}$ **ft** *their* factor **only** if stretch in **(b)(iii)**

Question 15

4	**(a)**	Enlargement	**1**	
		[centre] (–3, 4)	**1**	Do not allow column vector for coordinates
		[scale factor] 3	**1**	
	(b) (i)	Image at (1 5), (4, 5), (4, 6), (1, 7)	**2**	**SC1** for translation by $\begin{pmatrix}5\\k\end{pmatrix}$ or $\begin{pmatrix}k\\4\end{pmatrix}$
	(ii)	Image at (5, 1), (8, 1), (8, 3), (5, 2)	**2**	**SC1** for reflection in $y = 2$
	(iii)	Image at (– 4, 3), (– 1, 3), (– 1, 6), (– 4, 9)	**2**	**SC1** for three correct vertices or shape with vertices at (–4, 1) and (–1, 1), (–1, 4) and (–4, 7)
	(iv)	$\begin{pmatrix}1 & 0\\0 & 3\end{pmatrix}$	**2**	**SC1** for $\begin{pmatrix}1 & 0\\0 & k\end{pmatrix}$, $k \neq \pm 1$ or $\begin{pmatrix}3 & 0\\0 & 1\end{pmatrix}$
	(c)	Reflection $y = x$ oe	**2**	**B1 B1** independent

Question 16

2	**(a) (i)**	Translation, $\begin{pmatrix}-5\\8\end{pmatrix}$ oe	**1,1**	Brackets needed for vector Not (–5, 8), (–5 8)
	(ii)	correct trapezium at (2, 2) (4 , 3) (4 , 5) (2, 5)	**2**	**SC1** for reflection in $x = -1$ or vertices only
	(iii)	correct trapezium at (4, 2) (5, 4) (7, 4) (7, 2)	**3**	**M2** for 4 correct vertices on grid or in working or **M1** for $\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}\begin{pmatrix}2 & 2 & 4 & 4\\-4 & -7 & -7 & -5\end{pmatrix}$ **or SC1** for 3 vertices correct **or** complete shape in correct orientation but wrong position
	(b) (i)	Shear	**1**	
		x –axis (oe) invariant	**1**	
		2	**1**	
	(ii)	rectangle at (–3, 2) (1, 2) (1, 8) (–3, 8)	**2**	**SC1** for all vertices only **or** correct orientation and size, wrong position

Question 17

7	**(a)** **(i)**	Triangle at (1, 3) (1, 9) (3, 3)	2	**SC1** for correct vertices not joined or triangle(1, 1) (3, 1) (1, 7)
	(ii)	$\begin{pmatrix}1 & 0\\0 & 3\end{pmatrix}$	2	**SC1** for $\begin{pmatrix}1 & 0\\0 & k\end{pmatrix}$, $k \neq \pm 1$ or 0 or $\begin{pmatrix}3 & 0\\0 & 1\end{pmatrix}$
	(b) **(i)**	Shear x-axis oe invariant [factor] 2	1 1 1	
	(ii)	$\begin{pmatrix}1 & 2\\0 & 1\end{pmatrix}$	2FT	**FT** from *their* 2 in (b)(i) **SC1** for $\begin{pmatrix}1 & k\\0 & 1\end{pmatrix}$, $k \neq 0$ or $\begin{pmatrix}1 & 0\\2\text{FT} & 1\end{pmatrix}$

Question 18

5	**(a)** **(i)**	Correct reflection to (4, 8) (2, 9) (4, 9)	**2**	**SC1** for reflection in line $x = 5$ or reflection in $y = k$ Ignore additional triangles
	(ii)	Correct rotation to (4, 2), (4, 3) (6, 3)	**2**	**SC1** for rotation 180° with incorrect centre Ignore additional triangles
	(iii)	Shear, x-axis oe invariant, [factor] 2	**3**	**B1** each (independent)
	(iv)	$\begin{pmatrix}1 & 2\\0 & 1\end{pmatrix}$	**2FT**	**FT** *their* shear factor **B1FT** for one correct column or row in 2 by 2 matrix but not identity matrix or **SC1FT** for $\begin{pmatrix}1 & 0\\2 & 1\end{pmatrix}$
	(b) **(i)**	$\mathbf{p} + 2\mathbf{s}$ final answer	**2**	**M1** for recognising $\overrightarrow{OQ}$ as position vector soi
	(ii)	$\mathbf{s} + \frac{1}{2}\mathbf{p}$ final answer	**2**	**B1** for $\mathbf{s} + k\mathbf{p}$ or $k\mathbf{s} + \frac{1}{2}\mathbf{p}$ or correct route ($k \neq 0$)
	(c)	parallel **and** $OQ = 2SR$ oe	**1**	

Question 19

9	**(a) (i)** Reflection $x = -2$ oe	**2**	**B1** for either
	(ii) Translation $\begin{pmatrix} -7 \\ 2 \end{pmatrix}$ oe	**2**	**B1** for either
	(iii) Stretch x-axis oe invariant [factor] 3	**3**	**B1** for each
	(b) (i) Triangle with coords at (8, 2) (7, 3) and (7, 5)	**2**	**B1** for rotation about (6, 0) but 90° anticlockwise Or for rotation 90° clockwise around any point
	(ii) Triangle with coords at (–2, –5) (–6, –5) and (–8, –7)	**2**	**B1** for 2 correct points or for enlargement of SF –2 any centre
	(iii) Triangle with coords at (1, –1) (4, –6) and (3, –5)	**2**	**B1** for 2 correct points or coordinates of 2 points shown
	(c) $\begin{pmatrix} 1 & 0 \\ -2 & 1 \end{pmatrix}$	**2**	**B1** for one row or one column correct but not identity matrix. **Or SC1** for $\begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}$

Question 20

7	**(a) (i)**	Image: (–4, –3), (–4, –1), (–3, –1)	**2**	**SC1** for translation $\begin{pmatrix} -5 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -4 \end{pmatrix}$
	(ii)	Image: (1, –1), (3, –1), (3, –2)	**2**	**SC1** for rotation about the origin but 90° anticlockwise
	(b) (i)	Image: (2, 1), (2, 3), (4, 3)	**3**	**B2** for 2 correct vertices plotted **or** **SC2** for 3 vertices shown in working **or** **SC1** for 2 vertices shown in working **or** **M1** $\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix} \times \begin{pmatrix} 1 & 1 & 2 \\ 1 & 3 & 3 \end{pmatrix}$
	(ii)	Stretch [factor] 2 Invariant line y-axis oe	**1** **1** **1**	 Accept $x = 0$, stays the same

Question 21

4	**(a)**	Image at (–3, 2), (–5, 2), (–5, 4), (–3, 3)	**2**	**SC1** reflection in $y = -1$ or $x = k$ **or** 4 correct points not joined
	(b) (i)	Image at (–2, –4), (–6, –4), (–6, –8), (–2, –6)	**2**	**SC1** other enlargement of scale factor -2, correct size and correct orientation **or** 4 correct points not joined
	(ii)	$\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}$	**2**	**SC1** for $\begin{pmatrix} k & 0 \\ 0 & k \end{pmatrix}$, k may be algebraic or numeric but not 0 or 1
	(c) (i)	Image at (1, 4), (3, 4), (3, 8), (1, 6)	**2**	**SC1** for trapezium with vertices at (1, 6) and (3, 8) or correct stretch with y-axis invariant **or** 4 correct points not joined
	(ii)	$\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$	**2**	**SC1** for $\begin{pmatrix} 1 & 0 \\ 0 & k \end{pmatrix}$ k may be algebraic or numeric but not 0 or 1 **or** for $\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$
	(iii)	$\frac{1}{2}\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$ oe isw	**2FT**	FT inverse of their (c)(ii) (algebraic or numeric) **B1FT** *their* (c)(ii) for $\frac{1}{2}\begin{pmatrix} a & c \\ b & d \end{pmatrix}$ or $p\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$ ie **FT** *their* correct fraction or *their* transposed matrix **FT** for **2** and **1** mark dependent on det $\neq 0$
	(iv)	Stretch, [factor] $\frac{1}{2}$, invariant [line] x-axis oe	**3**	**B1 B1 B1** each independent cao

Question 22

3	**(a)**	Correct reflection (0, 1) (3, 1) (3, 3)	**1**	
	(b)	Correct rotation (–5, 1) (–7, 1) (–5, 4)	**2**	**SC1** for rotation of 90° anticlockwise about the wrong centre or 90° clockwise about (–4, 0) or for 3 correct points plotted but not joined
	(c) (i)	Enlargement [scale factor] 2 [centre] (–7, 7)	**3**	**B1** for each
	(ii)	1 : 4 or 3 : 12 or ¼ : 1	**2**	**M1** for $1 : 2^2$ oe, e.g. $(3 \times 2)/2 : (6 \times 4)/2$ or **SC1** for 4 : 1 or 12 : 3 or 1 : ¼
	(d)	$\begin{pmatrix} 4 & 0 \\ 0 & 1 \end{pmatrix}$	**2**	**B1** for $\begin{pmatrix} k & 0 \\ 0 & 1 \end{pmatrix}$, k may be algebraic or numeric but $\neq 0$ or 1 or **SC1** for $\begin{pmatrix} 1 & 0 \\ 0 & 4 \end{pmatrix}$
	(e) (i)	Correct shear drawn (0, 1) (–3, –5) (–3, –3)	**3**	**B2** for two correct points plotted or if not plotted correctly shown in working or **B1** for $\begin{pmatrix} 1 & 0 \\ 2 & 1 \end{pmatrix}\begin{pmatrix} -3 \\ 3 \end{pmatrix}$ or $\begin{pmatrix} 1 & 0 \\ 2 & 1 \end{pmatrix}\begin{pmatrix} -3 \\ 1 \end{pmatrix}$ or $\begin{pmatrix} 1 & 0 \\ 2 & 1 \end{pmatrix}\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ or better
	(ii)	Shear y-axis or $x = 0$ invariant [factor] 2	**3**	**B1** for each
	(iii)	$\begin{pmatrix} 1 & 0 \\ -2 & 1 \end{pmatrix}$ oe	**2**	**B1** for [determinant =] 1 shown or stated or $k\begin{pmatrix} 1 & 0 \\ -2 & 1 \end{pmatrix}$ soi, $k \neq 0$

Question 23

4	(a)	Enlargement [SF] – ½ oe [centre] (2, 5)	3	**B1** for each
	(b) (i)	Image at (–2, 6), (–8, 3), (–4, 3)	2	**SC1** for reflection in any vertical line or for 3 correct points not joined
	(ii)	Image at (3, –2), (3, 2), (6, 4)	2	**SC1** for rotation 90° [anti clockwise] around origin at (–3, 2) (–3, –2) (–6, –4) or for 3 correct points not joined
	(iii)	Image at (–5, 1), (–3, –2), (1, –2)	2	**SC1** for translation by $\begin{pmatrix}-1\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-5\end{pmatrix}$ or for 3 correct points not joined
	(c) (i)	$\begin{pmatrix}0 & 1\\-1 & 0\end{pmatrix}$	2	**B1** for a correct row or column
	(ii)	Rotation, 90° [anticlockwise] oe origin oe	2	**B1** for two elements correct

Question 24

3	(a) (i)	image at (1, 4) (1, 5) (2, 5) (4, 4)	2	**SC1** for translation by $\begin{pmatrix}-1\\k\end{pmatrix}$ or $\begin{pmatrix}k\\3\end{pmatrix}$ or 4 correct vertices plotted but not joined
	(ii)	image at (–2, –1) (–5, –1) (–2, –2) (–3, –2)	2	**SC1** for correct size and orientation, wrong position or 4 correct vertices plotted but not joined
	(iii)	image at (2, –1) (2, –2) (3 ,–2) (5, –1)	3	**B2** for 3 correct vertices plotted or if no / wrong plots allow **SC2** for 4 correct coordinates in column matrix or shown in working or **SC1** for any 3 correct coordinates or **M1** for $\begin{pmatrix}1 & 0\\0 & -1\end{pmatrix}\begin{pmatrix}2 & 2 & 3 & 5\\1 & 2 & 2 & 1\end{pmatrix}$ oe
	(b)	enlargement	B1	
		[centre] (1, 0)	B1	not as column vector
		[scale factor] – 3	B1	
	(c)	$\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}$	2	**B1** for one correct row or column or $\begin{pmatrix}0 & 1\\-1 & 0\end{pmatrix}$

Question 25

1	(a) (i)	Triangle at (–3, 1), (–3, 3), (–4, 3)	2	**SC1** for reflection in line $y = -1$ at (1, –3), (1, –5), (2, –5) or reflection in any vertical line or three correct points not joined
	(ii)	Triangle at (–1, –1), (–2, –3), (–1, –3)	2	**SC1** for rotation 180° but other centre or three correct points not joined
	(b) (i)	Translation	1	
		$\begin{pmatrix} -2 \\ 2 \end{pmatrix}$ oe	1	
	(ii)	Enlargement	1	
		(0, 3)	1	
		[factor] 3	1	

Question 26

2	(a) (i)	Image at (–2, 5), (1, 5), (1, 7)	2	**SC1** for translation $\begin{pmatrix} -4 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 4 \end{pmatrix}$ or 3 correct vertices plotted but not joined
	(ii)	Image at (2, –3), (5, –3), (5, –5)	2	**SC1** for a reflection in a horizontal line or in the line $x = -1$ or 3 correct vertices plotted but not joined
	(b)	Rotation	1	Alt Enlargement SF –1 (–1, 0)
		180 oe	1	
		(–1, 0)	1	Not as column vector
	(c) (i)	Reflection	1	
		$y = -x$ oe	1	
	(ii)	$\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$	2	**SC1** for a correct row or column

Question 27

7	(a) (i)	Rotation [centre] (0, 0) or origin 90° [anticlockwise] oe	1 1 1	

(ii)	Enlargement [centre] (–2, 1) [s.f.] – 2	**1** **1** **1**	
(b)	vertices at (–3, 4) (–3, 5) (–3, 6) (–2, 6)	**2**	**SC1** for translation by $\begin{pmatrix}2\\k\end{pmatrix}$ or $\begin{pmatrix}k\\1\end{pmatrix}$
(c)	vertices at (7, 3) (7, 4) (7, 5) (6, 5)	**2**	**SC1** for reflection in $y = 1$ or reflection in any vertical line
(d)	reflection x-axis oe	**1** **1**	

Question 28

6 (a) (i)	Rotation	**1**	
	90° [anticlockwise] oe	**1**	
	(4 , 4)	**1**	
(ii)	Enlargement	**1**	
	[centre] (5 , 1)	**1**	
	[scale factor] 2	**1**	
(b) (i)	Image at (–2, 5) (–2, 7) (–1, 7)	**2**	**B1** for translation by $\begin{pmatrix}-5\\k\end{pmatrix}$ or $\begin{pmatrix}k\\3\end{pmatrix}$
(ii)	Image at (–2, 1) (–2, –1) (–1, –1)	**2FT**	**FT** *their* triangle P reflected in line $y = 3$ **B1** for reflection of **triangle *P*** in the line $x = 3$ or $y = k$
(c)	Image at (–2, 3) (–4, 3) (–4, 4)	**3**	**B2** for 2 vertices correct in triangle or 3 correct co-ordinates soi in working or **B1** for 1 vertex in triangle correct soi or **M1** for $\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}\begin{pmatrix}3 & 3 & 4\\2 & 4 & 4\end{pmatrix}$ shown or statement rotation 90° [anticlockwise] about (0, 0)

Question 29

2 (a) (i)	Triangle drawn, vertices (2, – 4), (2, – 5), (4, – 4)	**2**	**SC1** for translation $\begin{pmatrix}5\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-2\end{pmatrix}$ or correct points not joined
(ii)	Triangle drawn, vertices (– 3, 4), (– 3, 5), (– 1, 4)	**2**	**SC1** for reflection in line $y = k$ or line $x = 1$ or correct points not joined
(iii)	Enlargement	**1**	
	[factor] 3	**1**	
	[centre] (– 6, – 5)	**1**	
(b) (i)	$\begin{pmatrix}2 & 5\\3 & 10\end{pmatrix}$	**1**	

(ii)	$\begin{pmatrix}10 & 14\\18 & 24\end{pmatrix}$ final answer	**2**	**SC1** for one row or one column correct
(iii)	$\frac{1}{4}$ oe	**3**	**M2** for $1\times4-2\times3=4\times k-3\times1$ or better or **B1** for $1\times4-2\times3$ or $4\times k-3\times1$ seen
(c) (i)	Rotation	**1**	
	90° [anti-clockwise] oe	**1**	
	(0, 0) oe	**1**	
(ii)	$\begin{pmatrix}0 & 1\\1 & 0\end{pmatrix}$	**2**	**SC1** for one correct row or column

Question 30

3 (a) (i)	Image at (3, 1), (5, 1), (5, 4), (4, 4), (4, 2), (3, 2)	**2**	**SC1** reflection in $y = 1$ or $x = k$ or 6 correct points not joined
(ii)	Image at (2, 1), (6, 1), (6, – 5), (4, – 5), (4, – 1), (2, – 1)	**2**	**SC1** for other enlargement of scale factor –2, correct size and correct orientation **or** 6 correct points but not joined
(iii)	Image at (– 1, – 1), (– 2, – 1), (– 2, – 2), (– 4, – 2), (– 4, – 3), (– 1, – 3)	**3**	**M2** for 6 correct points shown in working or plotted correctly but not joined or **M1** for $\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}\begin{pmatrix}-1 & -1 & -2 & -2 & -3 & -3\\1 & 2 & 2 & 4 & 4 & 1\end{pmatrix}$ or for rotation 90° [anticlockwise] centre (0, 0) stated
(b)	Enlargement [sf] 3 origin oe	**3**	**B1** for each

Question 31

6 (a) (i)	Correct image (2, –5) (4, –5) (4, –1)	**2**	**SC1** for reflection in $y = 0$ or 3 correct points not joined
(ii)	Correct image (–2, 1) (–6, 1) (–6, –1)	**2**	**SC1** for rotation 90 clockwise any centre or 3 correct points not joined
(iii)	Translation by $\begin{pmatrix}1\\9\end{pmatrix}$	**2**	**B1** for each
(iv)	Enlargement [SF] – ½ oe [Centre] (2, 1)	**1** **1** **1**	
(b) (i)	$\begin{pmatrix}-1 & 0\\0 & 1\end{pmatrix}$	**2**	**B1** for one correct row or column but not the identity matrix
(ii)	Reflection $x = 0$ oe	**1** **1**	

Question 32

3(a)(i)	Image at (5, 1), (7, 1), (7, 4)	**2**	**B1** reflection in $y = 4$ or $x = k$
3(a)(ii)	Image at (–1, 1), (–4, 1), (–1, 3)	**2**	**B1** correct size and correct orientation wrong position or for rotation 90° clockwise around (0, 0)
3(a)(iii)	Image at (2, – 4), (4, – 4), (2, – 1)	**2**	**B1** for translation by $\begin{pmatrix}1\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-5\end{pmatrix}$
3(b)	Enlargement	**1**	
	[sf] – 0.5 oe	**1**	
	(5, 5)	**1**	
3(c)	$\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}$	**2**	**B1** for one correct column or row
3(d)(i)	(4, 2)	**2**	**M1** for $\begin{pmatrix}1 & 0\\0 & 2\end{pmatrix}\begin{pmatrix}4\\1\end{pmatrix}$ oe
3(d)(ii)	(– 4, 2)	**3**	**M2** for $\begin{pmatrix}-1 & 0\\0 & 2\end{pmatrix}$ or $\begin{pmatrix}1 & 0\\0 & 2\end{pmatrix}\begin{pmatrix}-4\\1\end{pmatrix}$ or **M1** for $\begin{pmatrix}1 & 0\\0 & 2\end{pmatrix}\begin{pmatrix}-1 & 0\\0 & 1\end{pmatrix}\left[\begin{pmatrix}4\\1\end{pmatrix}\right]$ or $\begin{pmatrix}-4\\1\end{pmatrix}$
3(d)(iii)	$\frac{1}{2}\begin{pmatrix}2 & 0\\0 & 1\end{pmatrix}$ oe isw	**3**	**M2** for det = 2 soi or $k\begin{pmatrix}2 & 0\\0 & 1\end{pmatrix}$ soi or **M1** for recognition that **Q** is inverse matrix of **G** or **GQ = I** or **QG = I**

Question 33

4(a)(i)	Translation $\begin{pmatrix}-8\\2\end{pmatrix}$ oe	**2**	**B1** for each
4(a)(ii)	Enlargement [sf =] $\frac{1}{2}$ oe $(-4, 0)$	**3**	**B1** for each
4(a)(iii)	Rotation 90° clockwise oe $(1, -1)$	**3**	**B1** for each
4(b)	Triangle with (1, –1), (5, –1), (1,7)	**2**	**B1** for correct size and orientation in wrong position or for 3 correct points not joined

Question 34

3(a)(i)	Image at (3, – 3), (7, – 3), (7, – 5)	**2**	**B1** for reflection in any $x = k$ or if 3 correct points not joined
3(a)(ii)	Image at (– 5, 1), (– 1, 1), (– 5, – 1)	**2**	**B1** for translation by $\begin{pmatrix}-2\\k\end{pmatrix}$ or $\begin{pmatrix}k\\4\end{pmatrix}$ or if 3 correct points not joined
3(a)(iii)	Image at (6, 3), (6, 4), (4, 3)	**3**	**B2** for correct size and orientation but wrong position or if 3 correct points not joined **B1** for enlargement SF ½ with centre (3, 1)
3(b)	Rotation 90° [anticlockwise]oe (– 6, – 2)	**3**	**B1** for each
3(c)	Reflection $y = -x$ oe	**2**	**B1** for each

Question 35

1(a)	Image at (4, –1) (4, –4) (5, –4)	**2**	**B1** for translation by $\begin{pmatrix}8\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-6\end{pmatrix}$or for correct vertices not joined
1(b)	Image at (–4, –4) (–4, –7) (–3, –4)	**2**	**B1** for reflection in $x = -1$ or $y = k$ or for correct vertices not joined
1(c)	Enlargement 3 (–5, 5)	**3**	**B1** for each
1(d)	Rotation 90º clockwise oe (1, 1)	**3**	**B1** for each