Extended Mathematics
Topic : Vector-Function-Transformation
Year :May 2013 -May 2024
Paper - 4
Answers

Question 1

(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

Question 2

(a)	$\frac{-1 \pm \sqrt{1^2 - 4\times1\times(-3)}}{2}$	**2**	**B1** for $\sqrt{1^2 - 4\times1\times(-3)}$ or better and if in the form $\frac{p+\sqrt{q}}{r}$ or $\frac{p-\sqrt{q}}{r}$
	–2.30, 1.30 final answer	**2**	then **B1** for $p = -1$ and $r = 2(1)$ or better **B1 B1** **SC1** for –2.30 and 1.30 seen or –2.3 or –2.303 to – 2.302 **and** 1.3 or 1.302 to 1.303 or final answer –1.30 and 2.30
(b)	4, 30, 53	**3**	**M1** for $(2x + 7)^2 + (2x + 7) - 3$ and **B1** for $(2x + 7)^2 = 4x^2 + 14x + 14x + 49$ oe
(c)	$\frac{x-7}{2}$	**2**	**M1** for $y - 7 = 2x$ or $x = 2y + 7$ or –7 **then** ÷ 2 clearly seen in correct order with arrow or better or $\frac{y-7}{2}$
(d)	–2	**1**	
(e)	1.158×10^{77}	**4**	**B3** for 1.16×10^{77} or $1.1579\ldots \times 10^{77}$ or 1.157×10^{77} or **B2** for 2^{256} seen or **B1** for 2^8 seen or 256

Question 3

(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)

Question 4

(a) (i)	$\frac{3}{2}$ or 1.5	**2**	**M1** for $\frac{14-(-4)}{8-(-4)}$ oe
(ii)	$y = \frac{3}{2}x + 2$ oe	**2**	**B1** for $y =$ *their* $\frac{3}{2}x + c$ o.e. or $y = mx + 2,\ m \neq 0$ **SC1** for $\frac{3}{2}x + 2$
(iii)	$\begin{pmatrix}12\\18\end{pmatrix}$	**1**	
(iv)	21.6 or 21.63[…]	**2**	**M1 FT** for *their* $12^2 +$ *their* 18^2 oe

(b) (i)	**(a)** $3\mathbf{b} - 4\mathbf{a}$	**1**	
	(b) $\frac{1}{5}(6\mathbf{b} - 8\mathbf{a})$ oe simplified	**2**	**M1** for $\frac{1}{5}(12\mathbf{a} + 6\mathbf{b}) - 4\mathbf{a}$ or $AR = AO + OR$
	(c) $6\mathbf{a} + 3\mathbf{b}$ oe simplified	**1**	

Question 5

(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

Question 6

(a) **(i)**	–6	**1**	
(ii)	2.75 oe	**2**	**M1** for [g(x) =] 0.5 or 7/14 Or $\left(\frac{7}{x+1}\right)^2 + 5\left(\frac{7}{x+1}\right)$ oe
(b)	$\frac{x-3}{4}$ or $\frac{x}{4} - \frac{3}{4}$ Final answer	**2**	**M1** for $y - 3 = 4x$ or better or $x = 4y + 3$ or better or $\frac{y}{4} = \frac{3}{4} + x$ or flowchart with – 3 then ÷ 4

(c) **(i)** 5	**2**	**M1** for $4x = 23 - 3$ or $x + \frac{3}{4} = \frac{23}{4}$ or better
(ii) $x^2 + 5x - 7 = 0$	**B1**	May be implied by correct values in formula
$\frac{-5 \pm \sqrt{5^2 - 4(1)(-7)}}{2(1)}$ oe	**B1** **B1**	**B1** for $\sqrt{5^2 - 4(1)(-7)}$ or better [53] If in form $\frac{p + \sqrt{q}}{r}$ or $\frac{p - \sqrt{q}}{r}$, **B1** for –5 and 2(1) or better **No** recovery of full line unless **seen**
1.14 and –6.14 final answers	**B1** **B1**	**Or SC1** for 1.1 or 1.140…. and –6.1 or – 6.140 … Or answers –1.14 and 6.14

Question 7

(i) – 15	**2**	**B1** for [h(3) =] 8 seen or **M1** for $1 - 2(x^2 - 1)$ or better
(ii) $\frac{1-x}{2}$ or $\frac{1}{2} - \frac{x}{2}$ oe final answer	**2**	**M1** for $2x = 1 - y$ or $x = 1 - 2y$ or better
(iii) – 2, 2	**3**	**M1** for $x^2 - 1 = 3$ or better **B1** for one answer
(iv) $\frac{1}{8}$ oe nfww	**3**	**M2** for $8x = 1$ or $8x - 1 = 0$ or **M1** for $1 - 2(3x)$ [$= 2x$]

Question 8

(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

(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 9

(a)	$4 - 6x$ final answer	**1**	
(b)	$9x - 8$ final answer	**2**	**M1** for $4 - 3(4 - 3x)$ seen
(c)	$\frac{1}{27}$ final answer	**3**	**M2** for 3^{-3} soi by final answer 0.037037… to 3sf or better **or M1** for [g(− 1) =] 3 soi
(d)	$\frac{4-x}{3}$ oe final answer	**2**	**M1** for a correct first step $3x = 4 - y$ oe or $x = 4 - 3y$ or $\frac{y}{3} = \frac{4}{3} - x$
(e)	$\frac{4}{3}$ or $1\frac{1}{3}$ or 1.33 or better	**3**	**M2** for $3x - 4 = 0$ or better **or M1** for $3^{-(4-3x)}$

Question 10

(a)	$4 - 6x$ final answer	**1**	
(b)	$9x - 8$ final answer	**2**	**M1** for $4 - 3(4 - 3x)$ seen
(c)	$\frac{1}{27}$ final answer	**3**	**M2** for 3^{-3} soi by final answer 0.037037… to 3sf or better **or M1** for [g(− 1) =] 3 soi
(d)	$\frac{4-x}{3}$ oe final answer	**2**	**M1** for a correct first step $3x = 4 - y$ oe or $x = 4 - 3y$ or $\frac{y}{3} = \frac{4}{3} - x$
(e)	$\frac{4}{3}$ or $1\frac{1}{3}$ or 1.33 or better	**3**	**M2** for $3x - 4 = 0$ or better **or M1** for $3^{-(4-3x)}$

Question 11

(a)	**(i)**	$\begin{pmatrix}2\\4\end{pmatrix}$	**1**	
	(ii)	5.83 to 5.831	**2**	**M1** for $3^2 + 5^2$ seen
(b)	**(i)**	$-2\mathbf{p} + \mathbf{q}$ oe	**1**	accept unsimplified
	(ii)	$\overrightarrow{PS} = -\mathbf{p} + 2\mathbf{q}$ or $\overrightarrow{SP} = \mathbf{p} - 2\mathbf{q}$	**B1**	
		$\overrightarrow{MS} = -\frac{2}{3}\mathbf{p} + \frac{4}{3}\mathbf{q}$ seen or $\overrightarrow{SM} = \frac{2}{3}\mathbf{p} - \frac{4}{3}\mathbf{q}$ seen or $\overrightarrow{RM} = \frac{2}{3}(-2\mathbf{p} + \mathbf{q})$ soi or $\overrightarrow{MR} = \frac{2}{3}(2\mathbf{p} - \mathbf{q})$ soi or $\overrightarrow{MQ} = \frac{1}{3}(-2\mathbf{p} + \mathbf{q})$ soi or $\overrightarrow{QM} = \frac{1}{3}(2\mathbf{p} - \mathbf{q})$ soi	**B1**	
		$\overrightarrow{PM} = \mathbf{p} + \overrightarrow{RM}$ or $\mathbf{p} - \overrightarrow{MR}$ or $-\mathbf{p} + \mathbf{q} + \overrightarrow{QM}$ or $-\mathbf{p} + \mathbf{q} - \overrightarrow{MQ}$ $[= -\frac{1}{3}\mathbf{p} + \frac{2}{3}\mathbf{q}]$	**M1**	Any correct route for $\overrightarrow{PM}$ eg $\overrightarrow{PR} + \overrightarrow{RM}$
		1 : 3 nfww	**A1**	After 0 scored, **SC1** for 1 : 3

Question 12

(a)	2	**2**	**B1** for g $\left(\frac{1}{2}\right)=\frac{1}{2}$ soi or [fg=] $\frac{1}{1-x}$
(b)	$1-x$	**1**	Accept equivalents e.g. $-(x-1)$
(c)	x^2-2x+2	**3**	**M1** for $(1-x)^2+1$ **B1** for $(1-x)^2=1-x-x+x^2$ or better
(d)	-6	**1**	
(e)	$\sqrt{(-3)^2-4(1)(1)}$ or better	**B1**	**or** for $\left(x-\frac{3}{2}\right)^2$
	$p=-(-3)$ and $r=2\times1$ oe	**B1**	Must see $\frac{p+\sqrt{q}}{r}$ or $\frac{p-\sqrt{q}}{r}$ or both
			or for $\frac{3}{2}+or-\sqrt{\left(\frac{3}{2}\right)^2-1}$
	0.38, 2.62	**B1B1**	**SC1** for answers 0.4 **and** 2.6 or 0.3819 to 0.3820 **and** 2.618… or 0.38 **and** 2.62 seen in working or for –0.38 and –2.62 as final ans
(f)	f(x) and g(x)	**1**	Accept f and g or $1/x$ and $1-x$

Question 13

(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)

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

Question 14

(a)	**(i)**	$(-5, 7)$	**1**	
	(ii)	5	**2**	**M1** for $\sqrt{(-3)^2 + 4^2}$ or better
(b)	**(i)**	(a) $\frac{3}{5}\mathbf{a} + \frac{2}{5}\mathbf{b}$ or $\frac{1}{5}(3\mathbf{a} + 2\mathbf{b})$ final answer	**2**	**M1** for any correct vector path for $\overrightarrow{ON}$
		(b) $\frac{2}{5}\mathbf{a}$	**2**	**M1** for any correct vector path for $\overrightarrow{NY}$
	(ii)	$NY = \frac{2}{5}BC$ oe	**1dep**	**dep** on **(b)(i)(b)** correct
		$[NY]$ parallel to $[BC]$	**1dep**	**dep** on $\overline{NY} = k\mathbf{a}$, $k \neq 1$

Question 15

(i)	5	**1**	
(ii)	$-2\frac{1}{3}$ oe	**2**	**B1** for [h(– 1) =] $\frac{1}{3}$ soi or **M1** for $2(3^x) - 3$
(iii)	$\frac{x+3}{2}$ or $\frac{x}{2} + 1.5$ as final ans	**2**	**M1** for $y + 3 = 2x$ or $x = 2y - 3$ or $\frac{y}{2} = x - 1.5$ or better or correct reverse flowchart
(iv)	$4x - 9$ as final answer nfww	**2**	**M1** for $2(2x - 3) - 3$
(v)	$(2x - 3)(x + 1) = 1 + 2(x + 1)$	**M1**	$(2x - 5)(x + 1) = 1$ (eliminate fractions)
	$2x^2 - 3x + 2x - 3$ or better seen	**B1**	$2x^2 - 5x + 2x - 5$ or better seen
	$2x^2 - 3x - 6 = 0$	**A1**	No errors or omissions seen

Question 16

(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

Question 17

(a)	**(i)**	8	**1**	
	(ii)	4	**2**	**M1** for [g(17) =] $\frac{7}{14}$ or $2\left(\frac{7}{x-3}\right)^2+7\left(\frac{7}{x-3}\right)$
(b)		4 or – 4	**3**	**M2** for $x^2 = 16$ or $x^2 - 16 = 0$ or **M1** for $7 = (x-3)(x+3)$ or better
(c)		$2x^2 + 7x - 11$ [= 0] soi	**B1**	
		$\frac{-7\pm\sqrt{(7)^2-4(2)(-11)}}{2(2)}$	**B1FT**	**FT** $2x^2 + 7x \pm$ their k [$k \neq 0$] oe
			B1FT	**B1FT** for $\sqrt{7^2-4(2)(-11)}$ or better or $\left(x+\frac{7}{4}\right)^2$ oe If in form $\frac{p+\sqrt{q}}{r}$ or $\frac{p-\sqrt{q}}{r}$, **B1FT** for – 7 and 2(2) or better or $-\frac{7}{4}+$ *or* $-\sqrt{\frac{137}{16}}$ oe
		–4.68, 1.18 **final answers**	**B1B1**	If **B0**, **SC1** for answers –4.7 and 1.2 or –4.676... and 1.176.. seen or for –4.68 and 1.18 seen or for answer 4.68 and –1.18
(d)		$\frac{x+2}{5}$ or $\frac{x}{5}+\frac{2}{5}$	**2**	**M1** for correct first step or better, e.g. $5y = x + 2$ or $x = \frac{y+2}{5}$ or $x = 5y - 2$ or $y + 2 = 5x$ or $\frac{y}{5} = x - \frac{2}{5}$
(e)		– 2	**1**	

Question 18

(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

Question 19

(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

Question 20

(a)	9	**2**	**B1** for [f(3) =] 5 or $2(2x-1)-1$
(b)	$4x^2-2x$ or $2x(2x-1)$ final answer	**3**	**M1** for $(2x-1)^2+(2x-1)$ **B1** for $[(2x-1)^2=]\ 4x^2-2x-2x+1$ or $(2x-1)(2x-1+1)$
(c)	$\frac{x+1}{2}$ oe final answer	**2**	**M1** for $x=2y-1$ or $y+1=2x$ or $\frac{y}{2}=x-\frac{1}{2}$
(d)	$\frac{4x+4}{x(x+2)}$ or $\frac{4x+4}{x^2+2x}$ or $\frac{4(x+1)}{x(x+2)}$ or $\frac{4(x+1)}{x^2+2x}$ final answer	**4**	**B1** for $x(x+2)$ oe isw as common denominator **B2** for $4x+4$ as numerator or **B1** for $2(x+2)+2x$ or better as numerator

Question 21

(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 22

(a)	**(i)**	9.43[…]	**2**	**M1** for $5^2 + ([-]8)^2$ or better
	(ii)	(–3, 5)	**1**	
(b)	**(i)**	**(a)** $\frac{1}{2}(\mathbf{a}+\mathbf{b})$ or $\frac{1}{2}\mathbf{a}+\frac{1}{2}\mathbf{b}$	**2**	**M1** for $\mathbf{a}+\frac{1}{2}\boldsymbol{AB}$ oe, e.g $\mathbf{a}+\boldsymbol{AM}$, $\boldsymbol{OA}+\frac{1}{2}\boldsymbol{AB}$
		(b) $\frac{1}{4}(\mathbf{a}+\mathbf{b})$ or $\frac{1}{4}\mathbf{a}+\frac{1}{4}\mathbf{b}$	**1FT**	**FT** $\frac{1}{2}$ *their* **(b)(i)(a)** <u>in terms of **a** and/or **b**</u> in simplest form
		(c) $\frac{1}{4}(\mathbf{b}-3\mathbf{a})$ or $\frac{1}{4}\mathbf{b}-\frac{3}{4}\mathbf{a}$	**2**	**M1** for $-\mathbf{a}$ + *their* **(b)(i)(b)** or any correct route
	(ii)	3 : 4 final answer	**3**	**M1** for $[\boldsymbol{AN}=]-\mathbf{a}+\frac{1}{3}\mathbf{b}$

Question 23

(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
(b)		enlargement	**B1**	
		[centre] (1, 0)	**B1**	not as column vector
		[scale factor] – 3	**B1**	

Question 24

(a)	8	**1**	
(b)	3	**2**	**B1** for [g(0.5) =] 2 soi or **M1** for $2\left(\frac{1}{x}\right)-1$ or better
(c)	$\frac{x+1}{2}$ final answer	**2**	**M1** for $x=2y-1$ or $y+1=2x$ or better or $\frac{y}{2}=x-\frac{1}{2}$
(d)	$4x-3$	**2**	**M1** for $2(2x-1)-1$
(e)	$4x^2-4x+7$	**2**	**B1** for $\left[(2x-1)^2\right]=4x^2-2x-2x+1$

(f)	x	**1**	
(g)	$g^{-1}(x) = g(x)$	**1**	
(h)	$fh(x)$	**1**	

Question 25

(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**	

Question 26

(a)	**(i)**	11	**1**	
	(ii)	256	**2**	**M1** for [g(3) =] 8 or 2^3 or 2^{2^x}
(b)		$\frac{x-5}{2}$ oe final answer	**2**	**M1** for $x = 2y + 5$ or $2x = y - 5$ or better or $\frac{y}{2} = x + \frac{5}{2}$
(c)		$19 - 6x$ final answer	**2**	**M1** for $2(7 - 3x) + 5$
(d)		– 1, 0, 1, 2	**3**	Additional values count as errors **B2** for one error /omission or **B1** for two errors/omissions or **M2** for $-2 < x \leqslant 2$oe seen or **M1** for $-2 < x$ **or** $x \leqslant 2$ **or** $x = -2$ **and** $x = 2$ **or** $-4 < 2x \leqslant 4$

Question 27

(a)	**(i)**	Rotation	**1**	
		[+]90 or 90 anticlockwise oe	**1**	
		(0 , 2)	**1**	Not as column vector
	(ii)	Reflection	**1**	
		$y = 1$ oe	**1**	
	(iii)	Enlargement	**1**	
		[s f] $-\frac{1}{2}$ oe	**1**	
		Origin oe	**1**	
Image at (4 , 1) (6, 1) (6 , 5) (4 , 3)			**2**	ruled or good freehand **SC1** for translation $\begin{pmatrix} 2 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -3 \end{pmatrix}$ or for 4 correct vertices not joined

Question 28

(a)	**b** – **a** or – **a** + **b**	**1**	
(b)	$\frac{4}{5}$**b** – $\frac{3}{10}$**a** or $\frac{1}{10}$(8**b** – 3**a**)	**4**	**B3** for correct unsimplified expression in **a** and **b**

Question 29

(a)	**(i)**	11	**1**	
	(ii)	$14x + 3$ final answer	**1**	
(b)		$17 - 21x$ final answer	**2**	**M1** for $7(2 - 3x) + 3$ oe
(c)		$-\frac{1}{9}$	**3**	**M1** for $3(2 - 3x) = 7$ oe **M1** for correct first step
(d)		–1.3	**3**	**M1** for $2 - 3(x + 4) - (7x + 3) = 0$ **M1** for $-10x - 13 = 0$ oe If **0** scored, **SC1** for answer -0.7 oe after $2 - 3(x + 4) - 7x + 3 = 0$ shown previously

Question 30

(a)	**(i)**	**y**	**1**	
	(ii)	**x + y**	**1**	
	(iii)	**x + 2y**	**2**	**M1** for a correct unsimplified route or identifying $\overrightarrow{OS}$
(b)		**$-(\frac{1}{2}$ x + y)** oe	**2**	**M1** for a correct unsimplified route or $\overrightarrow{GR} = -\frac{1}{2}$ **x** or $\overrightarrow{RG} = \frac{1}{2}$ **x**
(c)	**(i)**	$\overrightarrow{MG} = 2$**x** + 2**y**	**2**	**M1** for a correct unsimplified route e.g. $2\overrightarrow{PQ}$
	(ii)	$\overrightarrow{MH} =$ **x** + **y** or $\overrightarrow{HG} =$ **x** + **y**	**M1**	Accept $\overrightarrow{HM} =$ **–x – y** or $\overrightarrow{GH} =$ **–x – y**
		$\overrightarrow{MG} = 2\overrightarrow{MH}$ oe	**A1**	Dep on **(c)(i)** correct, arrows essential

Question 31

(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 $y = k$

Question 32

(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**	

Question 33

(a) (i)	–3	**2**	**M1** for [g(1)=] –2 provided not used in a product or for $5\left(\frac{4}{x-3}\right)+7$ or better
(ii)	$\frac{4}{5x+4}$ final answer	**2**	**M1** for $\frac{4}{5x+7-3}$
(iii)	$\frac{4+3x}{x}$ or $\frac{4}{x}+3$ final answer	**3**	**M2** for $xy = 4 + 3x$ or $y - 3 = \frac{4}{x}$ or $x = \frac{4}{y} + 3$ or $x = \frac{4+3y}{y}$ or **M1** for $x = \frac{4}{y-3}$ or $y(x-3) = 4$ or $x - 3 = \frac{4}{y}$ or $x(y-3) = 4$
(iv)	2	**1**	
(b) (i)	$(5x + 7)(x – 3) = 4$	**M1**	
	$5x^2 – 15x + 7x – 21 = 4$ oe $5x^2 – 8x – 25 = 0$	**B1** **A1**	Condone omission of ' = 4' for the B mark Dep on **M1B1** and no errors or omissions at any stage seen
(ii)	$\sqrt{(-8)^2 – 4(5)(-25)}$ or better	**B1**	or for $\left(x-\frac{4}{5}\right)^2$ oe
	$p = –(–8)$ and $r = 5 \times 2$ oe	**B1**	must see $\frac{p+\sqrt{q}}{r}$ or $\frac{p-\sqrt{q}}{r}$ or both or for $\frac{4}{5}+\sqrt{\left(\frac{4}{5}\right)^2+5}$ or $\frac{4}{5}-\sqrt{\left(\frac{4}{5}\right)^2+5}$
	–1.57 and 3.17	**B1B1**	**SC1** for final answers –1.6 or –1.574 to –1.575 **and** 3.2 or 3.174 to 3.175 or –1.57 **and** 3.17 seen in working or for –3.17 **and** 1.57 as final ans

Question 34

(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

Question 35

(a)	2	**2**	**M1** for $2x + 1 = 1 + 4$
(b)	17	**2**	**B1** for [h(3) =] 8 soi or $2\times2^x + 1$ oe
(c)	$\frac{x-1}{2}$ oe final answer	**2**	**M1** for $y-1=2x$ or $\frac{y}{2}=x+\frac{1}{2}$ or $x=2y+1$
(d)	$4x^2+4x+5$ final answer	**3**	**M1** for $(2x+1)^2+4$ and **B1** for $[(2x+1)^2 =] 4x^2+2x+2x+1$ or better
(e)	$\sqrt{2}$ or 1.41 or 1.414....	**1**	
(f)	–1	**1**	

Question 36

(a)	**(i)**	$\frac{1}{2}\mathbf{p}$	**1**	
	(ii)	$\frac{1}{2}\mathbf{p} - \frac{1}{3}\mathbf{r}$	**1**	
	(iii)	$\mathbf{p} + \frac{2}{3}\mathbf{r}$	**1**	
(b)		$\mathbf{r} + \frac{3}{2}\mathbf{p}$	**2**	**M1** for correct unsimplified answer or for correct route or for recognising $\overrightarrow{OU}$ as position vector
(c)		6 nfww	**3**	**B2** for $(2k)^2 + ([-]k)^2 = 180$ oe or **M1** for $(2k)^2 + ([-]k)^2$ oe

Question 37

(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**	

Question 38

(a) (i)	$\begin{pmatrix}12\\-5\end{pmatrix}$	**2**	**M1** for $\begin{pmatrix}12\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-5\end{pmatrix}$
(ii)	13 nfww	**2FT**	**M1FT** for $\sqrt{their\,12^2 + their\,(-5)^2}$ **FT** dep on *their* **(a)** being $\begin{pmatrix}a\\b\end{pmatrix}$ where a, b are both non-zero
(b)(i)(a)	**b** – **a**	**1**	
(i)(b)	$\frac{3}{5}(\mathbf{b}-\mathbf{a})$ or $\frac{3}{5}\mathbf{b}-\frac{3}{5}\mathbf{a}$ final answer	**1FT**	**FT** $\frac{3}{5}$ *their* vector, in terms of **a** and **b**, in **(b)(i)(a)**
(i)(c)	$\frac{1}{5}(2\mathbf{a}+3\mathbf{b})$ or $\frac{2}{5}\mathbf{a}+\frac{3}{5}\mathbf{b}$ final answer	**2**	**M1** for **a** + *their* vector in **(b)(i)(b)** or any correct route
(ii)	$\frac{3}{2}$ oe	**1**	

Question 39

(a)	Triangle drawn at (–4, 3), (–1, 3), (–1, 4)	**2**	**SC1** for correct reflection in $x = k$ or $y = 1$
(b)	Triangle drawn at (1, 7), (1, 6), (4, 6)	**2**	**SC1** for translation by $\begin{pmatrix} -2 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 3 \end{pmatrix}$
(c)	Triangle drawn at (2, 3), (2, 1), (8, 1)	**2**	**M1** for two correct vertices or **SC1** for correct enlargement about the wrong centre
(d)	Rotation 90° clockwise oe (7, 4)	**1** **1** **1**	Accept –90°

Question 40

(a)	**(i)**	1.5 oe	**1**	
	(ii)	$\frac{3}{y-2}$ oe final answer	**3**	**M1** for correct removal of fraction **M1** for collection of terms in x **and** factorises OR **M1** subtracts 2 from both sides **M1** multiplies by x to remove fraction and **M1** for correct division by expression of the form $ay + b$, a and $b \neq 0$
(b)	**(i)**	–3	**1**	
	(ii)	65 536 final answer	**2**	**B1** for h(16) oe e.g. $h(2^4)$
	(iii)	–6	**2**	**M1** for $2 - x = 2^3$ oe
	(iv)	3	**1**	

Question 41

(a)	236	**3**	**B2** for 243 and 7 or **M2** for $3^{2(2)+1} - (2(3^{[1]}) + 1)$ oe **B1** for h(5) or f(3) soi or **M1** for $3^{2x+1} - (2(3^x) + 1)$ or better
(b)	$6x + 1$ final answer	**2**	**M1** for $3(2x + 1) - 2$
(c)	$x < 3$ oe final answer	**2**	**M1** for $1 + 2 > 3x - 2x$ or $2x - 3x > -2 - 1$ oe
(d)	-2	**1**	
(e)	$\frac{x+2}{3}$ oe final answer	**2**	**M1** for $x = 3y - 2$ or $y + 2 = 3x$ or $\frac{y}{3} = x - \frac{2}{3}$
(f)	$\frac{6x^2 - x + 3}{2x + 1}$ final answer	**3**	**M1** for $5 + (2x + 1)(3x - 2)$ or better isw **B1** for common denominator $2x + 1$ isw
(g)	9	**1**	

Question 42

(a) **(i)**	Image at $(-2, -4)$, $(4, -4)$, $(4, 0)$	**2**	**SC1** for translation $\begin{pmatrix} -4 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -8 \end{pmatrix}$
(ii)	8.94 or 8.944…	**2**	**M1** for $\sqrt{(-4)^2 + (-8)^2}$ or $\sqrt{4^2 + 8^2}$
(b) **(i)**	Enlargement [factor] 0.5 oe [centre] (0, 0) oe	**1** **1** **1**	

Question 43

(a)(i)	Translation	**1**	
	$\begin{pmatrix} 3 \\ -13 \end{pmatrix}$ oe	**1**	
(a)(ii)	Enlargement	**1**	
	[sf] $-\frac{1}{2}$ oe	**1**	
	(0, –4)	**1**	

(b)	Image at (0, 0) (0, 6) (−4, 6) (−4, 2)	**2**	**B1** for rotation of 90° anticlockwise about the wrong centre or 90° clockwise about (3, −1) or 4 points correct but not joined.
(c)	Image at (4, 0) (10, 0) (10, −4) (6, −4)	**2**	**B1** for reflection in $y = k$ or in $x = 1$ or 4 points correct but not joined

Question 44

(a)	−11	**1**	
(b)	7	**2**	**M1** for $3x - 2 = 19$ or better
(c)	25	**2**	**M1** for $3 \times 3^x - 2$ oe
(d)	$9x^2 - 8x + 2$ final answer	**3**	**M1** for $(3x-2)^2 + 3x - 2 + x$ oe **B1** for $\left[(3x-2)^2 =\right] 9x^2 - 6x - 6x + 4$ oe
(e)	$\frac{x+2}{3}$ oe final answer	**2**	**M1** for $x = 3y - 2$ or $y + 2 = 3x$ or $\frac{y}{3} = x - \frac{2}{3}$ or better

Question 46

(i)	Image at (8, 1), (10, 5), (8, 5)	**2**	**B1** for translation $\begin{pmatrix} 6 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -5 \end{pmatrix}$ or 3 correct points not joined
(ii)	Image at (4, 10), (4, 8), (8, 8)	**2**	**B1** for rotation 90° anticlockwise but different centre or for rotation 90° clockwise about (4, 10) or 3 correct points not joined
(iii)	Image at (6, 3), (6, 5), (7, 5)	**2**	**B1** for enlargement factor $\frac{1}{2}$ but incorrect centre or 3 correct points not joined

Question 47

(a)(i)	Image at (5, 1), (7, 1), (7, 4)	**2**	**B1** reflection in $y = 4$ or $x = k$
(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)
(a)(iii)	Image at (2, – 4), (4, – 4), (2, – 1)	**2**	**B1** for translation by $\begin{pmatrix}1\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-5\end{pmatrix}$
(b)	Enlargement	**1**	
	[sf] – 0.5 oe	**1**	
	(5, 5)	**1**	

Question 48

(i)	Image at (0, 1), (0, 2), (–3, 1)	**2**	**B1** for reflection in $y = 0$ or $x = k$
(ii)	Image at (0, 0), (0, –2), (6, –2)	**2**	**B1** for correct size and correct orientation wrong position or for 2 correct vertices plotted
iii)	Image at (–5, 4), (–5, 5), (–2, 4)	**2**	**B1** for translation by $\begin{pmatrix}-5\\k\end{pmatrix}$ or $\begin{pmatrix}k\\3\end{pmatrix}$
(b)	Rotation 90° clockwise oe (4, –1)	**3**	**B1** for each

Question 49

(a)	3	**1**	
(b)	$-\frac{2}{5}$ oe	**2**	**M1** for $2(1-2x) = x + 4$
(c)	$-2x - 7$ final answer	**2**	**M1** for $1 - 2(x + 4)$
(d)	26	**2**	**B1** for h(5) soi or **M1** for $\left(x^2+1\right)^2+1$
(e)	$\frac{1-x}{2}$ oe final answer	**2**	**M1** for $x = 1 - 2y$ or $2x = 1 - y$ or $\frac{y}{2} = \frac{1}{2} - x$ or $y - 1 = -2x$

(f)	$[p =] -20$ $[q =] 26$	4	**B3** for $[hgf(x)] = 4x^2 - 20x + 26$ seen and not spoilt by further working or **M1** for $(1 - 2x) + 4$ **M1 dep** for $(their\ (5 - 2x))^2 + 1$ **B1FT dep** for $25 - 10x - 10x + 4x^2$

Question 50

(a)(i)	Correct translation	2	**B1** for translation $\begin{pmatrix} 6 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -2 \end{pmatrix}$
(a)(ii)	Correct rotation	2	**B1** for rotation 180° but other centre
(a)(iii)	Correct reflection	2	**B1** for reflection in $y = -x$
(b)(i)	Enlargement [factor] $\frac{1}{2}$ or 0.5 [centre] (0, 0) oe	3	**B1** for each
(c)	± 2.5	3	**B2** for $25u^2 = 156.25$ or $5u = [\pm]12.5$ or **M1** for $(4u)^2 + (3u)^2$

Question 51

(a)(i)	26	2	**M1** for g(5) or for $\left(x^2 + 1\right)^2 + 1$
(a)(ii)	$x^2 + 4x + 5$	2	**M1** for $(x + 2)^2 + 1$
(a)(iii)	5	2	**M1** for $2x - 3 = 7$
(a)(iv)	$\frac{x+3}{2}$ oe	2	**M1** for $x = 2y - 3$ or $y + 3 = 2x$ or $\frac{y}{2} = x - \frac{3}{2}$ oe
(b)(i)	[0].70 cao	2	**B1** for [0].696 to [0].697
(b)(ii)	4 cao	1	

Question 52

(a)(i)	1	**2**	**M1** for h(0) or for 2^{8-3x}
(a)(ii)	8	**2**	**M1** for g(¼) or for $\frac{10}{2^x+1}$
(a)(iii)	$\frac{10-x}{x}$ or $\frac{10}{x}-1$ final answer	**3**	**M2** for $x = \frac{10-y}{y}$ or better or $xy = 10 - x$ or better or $y + 1 = \frac{10}{x}$ or **M1** for $x(y + 1) = 10$ or $y(x + 1) = 10$ or $x = \frac{10}{y+1}$ or $x + 1 = \frac{10}{y}$
(a)(iv)	5	**1**	
(b)	$\frac{-3x^2+5x+18}{x+1}$ final answer	**3**	**M1** for $\frac{(8-3x)(x+1)+10}{x+1}$ **B1** for $-3x^2 - 3x + 8x + 8$ [+10]

Question 53

(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
(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
(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)
(b)	Rotation 90° [anticlockwise]oe (– 6, – 2)	**3**	**B1** for each

Question 54

(a)(i)	12.6 or 12.64 to 12.65	3	**M2** for $12^2 + (-4)^2$ OR **B1** for $\begin{pmatrix} 12 \\ -4 \end{pmatrix}$ **M1** for $(their 12)^2 + (their - 4)^2$
(a)(ii)	$\begin{pmatrix} -11 \\ 13 \end{pmatrix}$	2	**B1** for $\begin{pmatrix} -11 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 13 \end{pmatrix}$ or for $[\overrightarrow{BA} =] \begin{pmatrix} -8 \\ 7 \end{pmatrix}$
(b)	$\frac{1}{2}(\mathbf{b} - \mathbf{a})$ oe	2	**M1** for correct route or correct unsimplified answer or **B1** for $\overrightarrow{QS} = \mathbf{b} - \mathbf{a}$ oe

Question 55

(a)(i)	Translation $\begin{pmatrix} -8 \\ 2 \end{pmatrix}$ oe	2	**B1** for each
(a)(ii)	Enlargement [sf =] $\frac{1}{2}$ oe $(-4, 0)$	3	**B1** for each
(a)(iii)	Rotation 90° clockwise oe $(1, -1)$	3	**B1** for each
(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 56

(a)(i)	$\begin{pmatrix}-19\\-2\end{pmatrix}$	**2**	**B1** for answer $\begin{pmatrix}-19\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-2\end{pmatrix}$ or for $\begin{pmatrix}-9\\6\end{pmatrix}$ or $\pm\begin{pmatrix}10\\8\end{pmatrix}$ seen
(a)(ii)	3.61 or 3.605 to 3.606	**2**	**M1** for $\sqrt{([-]3)^2+2^2}$ oe
(a)(iii)	$-3m + 5n = 14$ and $2m + 4n = 9$	**B1**	Accept equivalents
	$[m =] -\frac{1}{2}$ or -0.5 and $[n =] 2\frac{1}{2}$ or 2.5 or $\frac{5}{2}$ with evidence of a correct algebraic method	**4**	**M1** for correctly equating one set of coefficients of *their* equations or rearranges one of *their* equations to make m or n the subject e.g. $[m =] \frac{1}{2}(9 - 4n)$ oe **M1** for correct method to eliminate one variable for *their* equations or correctly substitutes *their m* or *their n* into the other equation e.g. $-\frac{3(9-4n)}{2} + 5n = 14$ oe **B1** for one correct answer
(b)(i)(a)	$-\mathbf{a} + 2\mathbf{c}$	**1**	
(b)(i)(b)	$\frac{3}{8}(-\mathbf{a} + 2\mathbf{c})$ or $-\frac{3}{8}\mathbf{a} + \frac{3}{4}\mathbf{c}$ oe	**1**	**FT** $\frac{3}{8}$ (*their* **(b)(i)(a)**) in simplest form
(b)(i)(c)	$\frac{1}{2}(5\mathbf{a} - 2\mathbf{c})$ or $\frac{5}{2}\mathbf{a} - \mathbf{c}$ oe	**1**	
(b)(i)(d)	$\frac{1}{8}(5\mathbf{a} - 2\mathbf{c})$ or $\frac{5}{8}\mathbf{a} - \frac{1}{4}\mathbf{c}$ oe	**2**	**M1** for a correct unsimplified route
1(b)(ii)	4	**1**	

Question 57

(a)	Rotation $90^{[o]}$ clockwise oe Origin oe	**3**	**B1** for each

(b)(i)	Image at (–4, –1) (–4, –4) (–2, –4)	**1**	
(b)(ii)	Image at (3, –1) (5, –1) (3, –4)	**2**	**B1** for translation by $\begin{pmatrix}7\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-5\end{pmatrix}$ or for 3 correct points not joined

Question 58

(a)(i)	Translation $\begin{pmatrix}5\\8\end{pmatrix}$	**2**	**B1** for each Accept 5 right and 8 up
(a)(ii)	Enlargement [sf] 0.5 oe [centre] (0, –7)	**3**	**B1** for each
(a)(iii)	Rotation 90 [anticlockwise] oe Origin oe	**3**	**B1** for each
(b)	Image at (–8, 1) (–8, 5) (–8, 7) (–4, 1)	**2**	**B1** for reflection of flag A in the line $x = -1$ or $y = k$ or for vertices of triangle in correct place but not joined

Question 59

(a)	–3	**1**	
(b)	$\frac{12}{11}$ oe	**2**	**M1** for $\frac{3}{\frac{3}{x+2}+2}$ soi
(c)	$64x-45$ final answer	**2**	**M1** for $8(8x-5)-5$ isw
(d)	$\frac{x+5}{8}$ oe final answer	**2**	**M1** for a correct first step $y+5=8x$, $\frac{y}{8}=x-\frac{5}{8}$ or $x=8y-5$
(e)	$\frac{8x^2+11x-13}{x+2}$ final answer	**3**	**M1** for $(8x-5)(x+2)-3$ oe isw **B1** for common denominator $(x+2)$

(f)(i)	$(8x-5)^2+6 = 19$	**M1**	
	$64x^2-40x-40x+25$	**B1**	
	$64x^2-40x-40x+25+6=19$ oe leading to $16x^2-20x+3=0$	**A1**	with no errors and must show $(8x-5)^2+6 = 19$ with no omissions after this
(f)(ii)	$\frac{[--]20\pm\sqrt{([-]20)^2-4(16)(3)}}{2\times16}$ oe	**2**	**B1** for $\sqrt{([-]20)^2-4(16)(3)}$ or better or **B1** for $\frac{[--]20+\sqrt{q}}{2(16)}$ oe or $\frac{[--]20-\sqrt{q}}{2(16)}$
	0.17 and 1.08 final ans	**2**	**B1** for each If 0 scored, **SC1** for answer 0.2 and 1.1 or answer – 0.17 and –1.08 or 0.174... and 1.075 to 1.076 seen or 0.17 and 1.08 seen in working

Question 60

(a)(i)	Reflection $x = 1.5$	**2**	**B1** for each
(a)(ii)	Rotation (0, –1) 90° [anticlockwise] oe	**3**	**B1** for each
(b)(i)	Image at (5, –1) (6, –1) (6, –3)	**2**	**B1** for correct size and orientation but wrong position If 0 scored, **SC1** for enlargement SF $\frac{1}{2}$ with centre (3, 0)
(b)(ii)	Image at (–6, 3) (–4, 3) (–6, 7)	**2**	**B1** for translation $\begin{pmatrix}-3\\k\end{pmatrix}$ or $\begin{pmatrix}k\\1\end{pmatrix}$

Question 61

!(a)(i)	Reflection $x = 1.5$	**2**	**B1** for each
(a)(ii)	Rotation (0, –1) 90° [anticlockwise] oe	**3**	**B1** for each
!(b)(i)	Image at (5, –1) (6, –1) (6, –3)	**2**	**B1** for correct size and orientation but wrong position If 0 scored, **SC1** for enlargement SF $\frac{1}{2}$ with centre (3, 0)
(b)(ii)	Image at (–6, 3) (–4, 3) (–6, 7)	**2**	**B1** for translation $\begin{pmatrix}-3\\k\end{pmatrix}$ or $\begin{pmatrix}k\\1\end{pmatrix}$

Question 62

(a)	82	**2**	**M1** for $(3^x)^2+1$ soi by $(3^2)^2+1$ or g(9) isw
(b)	$\frac{x+2}{7}$ final answer	**2**	**M1** for $y+2=7x$ or $\frac{y}{7}=x-\frac{2}{7}$ or $x=7y-2$
(c)	[a =] 1, [b =] 2, [c =] 2	**3**	**B2** for $x^4+x^2+x^2+1+1$ or **M1** for $(x^2+1)^2+1$
(d)	$\frac{6}{7}$ oe	**3**	**M2** for $7x-2=4$ or **M1** for $3^x=81$ soi $f(x)=4$ or for $3^{7x-2}=81$ or better

Question 63

(a)(i)	Image at (1, 7), (4, 7), (4, 9), (3, 9)	**2**	**B1** for translation by $\begin{pmatrix}-1\\k\end{pmatrix}$ or $\begin{pmatrix}k\\6\end{pmatrix}$
(a)(ii)	Image at (5, 3), (6, 3), (8, 5), (5, 5)	**2**	**B1** for 180° rotation with wrong centre
(a)(iii)	Rotation 180° (4.5, 6) OR Enlargement, [factor] – 1 (4.5, 6)	**3**	**B1** for rotation **B1** for 180° **B1FT** for centre from *their* (a)(i) **B1** for enlargement **B1** for – 1 **B1FT** for centre from *their* **(a)(i)**
(b)(i)	Image at (1, 2), (1, 5), (3, 5), (3, 4)	**2**	**B1** for $y = x$ drawn or for 3 correct points

Question 64

(a)(i)	5	**1**	
(a)(ii)	1	**2**	**M1** for h(0) or 3^{9-x^2} or better
(a)(iii)	$9 - 4x^2$ final answer	**1**	
(a)(iv)	$15 - 2x^2$ final answer	**2**	**M1** for $2(9 - x^2) - 3$ or better
(b)	$\frac{x+3}{2}$ final answer	**2**	**M1** for $x = 2y - 3$ or $y + 3 = 2x$ or better or $\frac{y}{2} = x - \frac{3}{2}$
(c)	1.8 or $1\frac{4}{5}$ or $\frac{9}{5}$	**2**	**M1** for $10x - 15 = 3$ or $2x - 3 = \frac{3}{5}$
(d)	–1 and 4 nfww	**4**	**M1** for $9 - (2x - 3)^2 = -16$ **A1** for $4x^2 - 12x - 16[= 0]$ oe **M1** (dep on first M1) for correct factors or use of formula or completing the square for their 3-term quadratic

			OR **M1** for $9 - y^2 = -16$ **A1** for $y^2 = 25$ **M1** (dep on first M1) for $2x - 3 = \pm 5$
(e)	$\frac{1}{9}$	**1**	

Question 65

(a)	Reflection $y = -1$	**2**	**B1** for each
(b)(i)	Image at (–6, 5) (–6, 7) (–5, 7) (–4, 5)	**2**	**B1** for translation by $\begin{pmatrix} -3 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 4 \end{pmatrix}$
(b)(ii)	Image at (1, –1) (3, –1) (3, –3) (2, –3)	**2**	**B1** for shape correct size and orientation but wrong position
(b)(iii)	Image at (1, 2) (1, 6) (3, 6) (5, 2)	**2**	**B1** for shape correct size and orientation, wrong position

Question 66

(i)	$\begin{pmatrix} 0 \\ 5 \end{pmatrix}$	**1**	
(ii)	$\begin{pmatrix} -3 \\ -1 \end{pmatrix}$	**1**	

(iii)	3.22 or 3.216... to 3.220...	6	**B3** for [angle AOB =] 36.8 or 36.9 or 36.84 to 36.87 or **M2** for $\tan[AOB] = \frac{3}{4}$ oe or for $[AOB =] 2 \times \sin^{-1}\left(\frac{\sqrt{(5-4)^2+(0--3)^2}}{10}\right)$ oe or for $\cos[AOB =] \frac{5^2+5^2-\left(\sqrt{(5-4)^2+(0--3)^2}\right)^2}{2\times5\times5}$ oe or **M1** for recognition of right-angle with perpendicular from B to OA or x-axis or for $[AB^2 =] (5-4)^2+(0--3)^2$ or better oe or $(their\ AB)^2 = 5^2 + 5^2 - 2 \times 5 \times 5 \times \cos OAB$ oe **M2** for $\frac{their\ \text{angle}\ AOB}{360} \times 2 \times \pi \times 5$ oe or **M1** for radius = 5 soi

Question 67

(a)(i)	13	**1**	
(a)(ii)	3	**2**	**M1** for $h\left(\frac{10}{30}\right)$ oe soi or $27^{\frac{10}{x}}$
(a)(iii)	$\frac{7-x}{2}$ oe final answer	**2**	**M1** for $x = 7 - 2y$ or $y - 7 = -2x$ or $7 - y = 2x$ or $-\frac{y}{2} = -\frac{7}{2} + x$ oe
(b)	0.75 oe final answer	**3**	**M1** for $\frac{10}{2x+1} = 4$ **M1** for $10 = 8x + 4$ or better
(c)	$\frac{70-19x}{x(7-2x)}$ or $\frac{70-19x}{7x-2x^2}$ final answer	**3**	**M1** for $x + 10(7 - 2x)$ or better isw **B1** for common denominator $x(7 - 2x)$ oe isw
(d)	3 final answer	**1**	

Question 68

(a)(i)	(3, 5.5)	**2**	**B1** for either value correct
(a)(ii)	$\frac{5}{4}x+\frac{7}{4}$ final answer	**3**	**B2** for answer $\frac{5}{4}x+c$ oe or for correct equation in different form or **M1** for $\frac{8-3}{5-1}$ oe **and M1** for correct substitution shown of (1, 3) or (5, 8) or *their* (a)(i) into $y = (\textit{their } m)x + c$ oe
(b)(i)	(6, 1) (10, 6)	**2**	**B1** for 2 or 3 values correct
(b)(ii)	(–3, 1) (–8, 5)	**2**	**B1** for 2 or 3 values correct If 0 scored, **SC1** for (3, –1) and (8, –5)
(b)(iii)	(3, 3) (–1, 8)	**2**	**B1** for 2 or 3 values correct but not for (1, 3) and (5, 8)

Question 69

)(a)(i)	$4x-13$ final answer	**1**	
(a)(ii)	$25x^2$ final answer	**1**	
(b)	$\frac{x+1}{4}$ or $\frac{x}{4}+\frac{1}{4}$	**2**	**M1** for correct first step $x=4y-1$ or $y+1=4x$ or $\frac{y}{4}=x-\frac{1}{4}$
(c)	0.6934 final answer	**3**	**B2** for 0.69336… or $3^{-\frac{1}{3}}$ oe or 0.693 or **M1** for $3^{-3^{-x}}$ oe
)(d)(i)	$(3x-2)^2-3^{-(-3)}$	**M1**	
	$9x^2-6x-6x+4-27$ or $9x^2-12x+4-27$ leading to $9x^2-12x-23$	**A1**	with no errors seen

(d)(ii)	$\frac{-(-12)\pm\sqrt{(-12)^2-4(9)(-23)}}{2\times9}$ or better	**B2**	**B1** for $\sqrt{(-12)^2-4(9)(-23)}$ oe or $\frac{-(-12)+\sqrt{q}}{2\times9}$ oe or $\frac{-(-12)-\sqrt{q}}{2\times9}$ oe or both
	– 1.07, 2.40 final answers	**B2**	**B1** for each If **B0, SC1** for answers – 1.1 or –1.06 or –1.065… to – 1.065 **and** 2.4 or 2.39 or 2.398 to 2.398… or – 1.07 **and** 2.40 seen in working or for –2.40 and 1.07 as final answer
(e)	–5 final answer	**2**	**M1** for $243 = 3^{-x}$

Question 70

(a)	4	**1**	
(b)	52	**2**	**M1** for $f(8)$ seen or $7\times\frac{2x}{x-3}-4$
(c)	$7x^2-4$	**1**	
(d)	$\frac{7x^2-21x+12}{2(x-3)}$ or $\frac{7x^2-21x+12}{2x-6}$ final answer	**3**	**M1** for $(7x-4)(x-3)+2\times2x$ **B1** for denominator $2(x-3)$ or $2x-6$
(e)	–3	**2**	**M1** for $7x+14-4=-11$
(f)	$[p=]$ 0 and $[p=]$ 1	**2**	**B1** for each

Question 71

(a)(i)	triangle with vertices at (–2, –1) (–8, –1) (–2, –5)	**2**	**B1** for correct reflection in $y=x$
(a)(ii)	triangle with vertices at (–1, –1) (–1, –7) (3, –7)	**2**	**B1** for translation by $\begin{pmatrix}k\\-9\end{pmatrix}$ or $\begin{pmatrix}-2\\k\end{pmatrix}$
(b)(i)	Enlargement [centre] (–7, 8) [sf] ½	**3**	**B1** for each
(b)(ii)	Rotation [centre] (0, 0) 90° clockwise oe	**3**	**B1** for each

Question 72

5(a)	256	**1**	
5(b)	8	**2**	**M1** for $3(x^2 + 1) + 2$ or for $3(2) + 2$
5(c)	$9x^2 + 12x + 5$	**3**	**M1** for $(3x + 2)^2 + 1$ **B1** for $[(3x + 2)^2 =]\ 9x^2 + 6x + 6x + 4$ oe
5(d)	16	**2**	**M1** for $3x + 2 = 7^2 + 1$ or better
5(e)	$\frac{x-2}{3}$ oe final answer	**2**	**M1** for $x = 3y + 2$ or for $y - 2 = 3x$ or for $\frac{y}{3} = x + \frac{2}{3}$
5(f)	$\frac{4x^2 + 2x + 1}{3x + 2}$ final answer	**3**	**B1** for $x^2 + 1 + x\ (3x + 2)$ or better seen **M1** for common denominator $3x + 2$
5(g)	16	**1**	

Question 73

(a)(i)	$\begin{pmatrix} 6 \\ 17 \end{pmatrix}$	**2**	**B1** for each
(a)(ii)	6.4[0] or 6.403...	**2**	**M1** for $4^2 + 5^2$
(b)	(1, 2)	**1**	
(c)	(0, –2)	**1**	
(d)	$\frac{1}{2}\mathbf{c} + \frac{1}{3}\mathbf{d}$	**3**	**B2** for correct unsimplified answer or **M1** for $\overrightarrow{CT} = -\mathbf{c} + \frac{2}{3}\mathbf{d}$ oe or $\overrightarrow{TC} = \mathbf{c} - \frac{2}{3}\mathbf{d}$ oe or for correct route

Question 74

(a)	Triangle at (–4, –4) (–1, –3) (–4, –3)	**2**	**B1** for correct points not joined or for reflection in any $y = k$ or for reflection in $x = -1$
(b)	Triangle at (1, 1) (1, 4) (2, 4)	**2**	**B1** for correct points not joined or rotation 90 clockwise around any point or rotation 90 anticlockwise around (0, 0)
(c)	Translation $\begin{pmatrix} 5 \\ -6 \end{pmatrix}$	**2**	**B1** for translation or correct vector oe

Question 75

(a)	–23	**2**	**M1** for $4 - 3(3^x)$ oe soi
(b)	$\frac{4-x}{3}$ oe final answer	**2**	**M1** for $x = 4 - 3y$ or $y + 3x = 4$ or $x + 3y = 4$ or $\frac{y}{-3} = \frac{4}{-3} + x$ oe or $\frac{x}{-3} = \frac{4}{-3} + y$ oe
(c)(i)	$1 + 6x$ final answer	**2**	**M1** for $4 - 3(1 - 2x)$
(c)(ii)	$20 - 36x$ or $4(5 - 9x)$ final answer	**4**	**B3** for $20 - 36x$ seen in working then spoiled OR **M1** for $(4 - 3x)^2 + 4 - 3x - 9(x^2 + x)$ or better **B1** for $[(4 - 3x)^2 =] 16 - 12x - 12x + 9x^2$ or better **B1** for answer $20 - kx$ or $k - 36x$ oe or answer $20 - 36x + kx^2$ $k \neq 0$
(d)	$-\frac{1}{2}$ oe	**2**	**M1** for $(3^2)^{kx}$ or $9^{kx} = 9^{-\frac{1}{2}x}$ oe

Question 76

(a)(i)	Triangle at (–3, 2) (–3, 3) (–5, 2)	**2**	**B1** for correct rotation about incorrect point or for rotation 90 clockwise around (0, 0)
(a)(ii)	Triangle at (5, –2) (6, –2) (5, 0)	**2**	**B1** for translation by $\begin{pmatrix} 3 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -5 \end{pmatrix}$
(b)	Enlargement [SF] 3 [Centre] (1, 4)	**3**	**B1** for each

Question 77

(a)(i)	10	**1**	
(a)(ii)	–19	**1**	FT 1 – 2 *their* **(a)(i)**
(b)	$\frac{1-x}{2}$ oe final answer	**2**	**M1** for $x = 1 - 2y$ or $y + 2x = 1$ or $\frac{y}{2} = \frac{1}{2} - x$ or $y - 1 = -2x$ or better
(c)	$\frac{1}{2}$ oe	**1**	
(d)	$4x^2 - 8x + 2$ final answer	**4**	**M1** for $(1 - 2x)(1 - 2x) - (1 - 2(1 - 2x))$ or better **B1** for $1 - 2x - 2x + 4x^2$ **B1** for $-(1 - 2 + 4x)$ or better or [+] $1 - 4x$ or for correct answer seen then spoiled
(e)	x final answer	**1**	
(f)	3125	**1**	
(g)	25	**1**	
(h)	–2	**2**	**B1** for $\frac{1}{25}$ or 0.04

Question 78

(a)	Translation $\begin{pmatrix} 1 \\ -6 \end{pmatrix}$	**2**	**B1** for each
(b)(i)	Image at (0, 1), (–3, 1), (–3, 2)	**2**	**B1** for reflection in $x = k$ or $y = 1$
(b)(ii)	Image at (5, –4), (5, –1), (4, –1)	**2**	**B1** for rotation 90° anticlockwise with other centre or for rotation 90° clockwise about (6, 0)
(b)(iii)	Image at (–1, –2), (–7, –2), (–7, –4)	**2**	**B1** for enlargement, factor –2 with other centre

Question 79

(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
(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
(c)	Enlargement 3 (–5, 5)	**3**	**B1** for each
(d)	Rotation 90° clockwise oe (1, 1)	**3**	**B1** for each

Question 80

(a)(i)	rotation 90 anticlockwise oe (–3, 2)	**3**	**B1** for each
(a)(ii)	enlargement $-\frac{1}{2}$ $(-2,-1)$	**3**	**B1** for each
(b)	Image at (– 3, – 5) (1, – 5) (1, 3)	**2**	**B1** for translation by $\begin{pmatrix}-5\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-10\end{pmatrix}$
(c)	Image at (2, 3) (6, 3) (6, – 5)	**2**	**B1** for reflection in $y = k$ or $x = 4$

Question 81

(a)(i)	4	**1**	
(a)(ii)	3	**1**	
(a)(iii)	13	**1**	**FT** 5 × *their* **(a)(i)** – 7

(b)	$\frac{x+2}{3}$ final answer	**2**	**M1** for $y + 2 = 3x$ or for $\frac{y}{3} = x - \frac{2}{3}$ or for $x = 3y - 2$
(c)	$9x^2 - 9x + 2$ final answer	**3**	**M1** for $(3x-2)^2 + 3x - 2$ **B1** for $(3x-2)^2 = 9x^2 - 6x - 6x + 4$
(d)	$2x + 1$	**1**	
(e)(i)	81	**1**	
(e)(ii)	x	**1**	Not $y = x$

Question 82

(i)	$\begin{pmatrix} 0 \\ 2 \end{pmatrix}$	**2**	**B1** for $\begin{pmatrix} 0 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 2 \end{pmatrix}$
(ii)	$\begin{pmatrix} -2 \\ 9 \end{pmatrix}$	**2**	**FT** *their* $\overrightarrow{PQ}$ **B1FT** for $\begin{pmatrix} 0 \\ 6 \end{pmatrix}$

Question 83

(i)	$\frac{2}{3}\mathbf{t} + \frac{1}{3}\mathbf{u}$ or $\frac{1}{3}(2\mathbf{t} + \mathbf{u})$ final answer	**2**	**M1** for $\overrightarrow{UY} = \frac{2}{3}(\mathbf{t} - \mathbf{u})$ oe or $\overrightarrow{TY} = \frac{1}{3}(\mathbf{u} - \mathbf{t})$ oe or correct route soi
(ii)	$\frac{2}{3}\mathbf{t}$ cao	**1**	

Question 84

(a)(i)	Triangle at (4, 0) (4, 3) (6, 3)	**2**	**B1** for translation by $\begin{pmatrix}2\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-1\end{pmatrix}$ If 0 scored **SC1** for triangle at (3, 0.5) (3, 3.5) (5, 3.5)
(a)(ii)	Triangle at (1, –2) (4, –4) (4, –2)	**2**	**B1** for rotation 90 clockwise wrong centre or for rotation 90 anticlockwise about the origin
(a)(iii)	Triangle at (–4, 4) (–4, 2.5) (–5, 2.5)	**2**	**B1** for enlargement SF $-\frac{1}{2}$ with wrong centre or for enlargement SF $\frac{1}{2}$ with centre (–2, 3)
(b)	Reflection $y = -x$ oe	**2**	**B1** for each

Question 85

(a)(i)(a)	$\begin{pmatrix}5\\-13\end{pmatrix}$ final answer	**1**	
(a)(i)(b)	$\begin{pmatrix}-4\\11\end{pmatrix}$ final answer	**2**	**B1** for answer $\begin{pmatrix}-4\\k\end{pmatrix}$ or $\begin{pmatrix}k\\11\end{pmatrix}$ or $\begin{pmatrix}-6\\16\end{pmatrix}$ seen
(a)(i)(c)	5.39 or 5.385…	**2**	**M1** for $2^2 + ([-]5)^2$
(a)(ii)	$[k =]$ 8 $[m =] -32$	**3**	**B2** for $k = 8$ or $m = -32$ or **M1** for $-3 + 2k = 13$ oe or for $m = -5 \times$ *their* $k + 8$ correctly evaluated
(b)(i)(a)	$\mathbf{p} + \mathbf{q}$ final answer	**1**	
(b)(i)(b)	$\frac{1}{2}\mathbf{p} - \frac{1}{2}\mathbf{q}$ **or** $\frac{1}{2}(\mathbf{p} - \mathbf{q})$ or $\frac{\mathbf{p}-\mathbf{q}}{2}$ final answer	**2**	**M1** for unsimplified answer or any correct vector route for $\overrightarrow{CM}$, e.g. $-\mathbf{q} + \frac{1}{2}$ *their* **(b)(i)(a)**
(b)(i)(c)	$\frac{1}{2}\mathbf{p} + \frac{1}{10}\mathbf{q}$ or $\frac{5\mathbf{p}+\mathbf{q}}{10}$ final answer	**2**	**M1** for unsimplified answer or any correct vector route for $\overrightarrow{MN}$

Question 86

(a)	13	**1**	
(b)	$4x - 3$ final answer	**2**	**M1** for $3-2(3-2x)$
(c)	-7 5	**4**	**M1** for $x^2+2x-35$ [= 0] or $x^2+2x=35$ **M2** for $(x+7)(x-5)$ or $x(x-5)+7(x-5)$ or $x(x+7)-5(x+7)$ or **M1** for $(x+a)(x+b)$ where a, b are integers with $ab = -35$ or $a + b = 2$
(d)	$\frac{3-x}{2}$ oe final answer	**2**	**M1** for a correct first step: $x=3-2y$ or $y-3=-2x$, $2x = 3 - y$ or $\frac{y}{2}=\frac{3}{2}-x$
(e)	$32-54x+37x^2-8x^3$ final answer	**5**	**B4** for $27-36x-18x+24x^2+12x^2-8x^3+x^2+5$ oe OR **B1** for $(3-2x)^3+x^2+5$ and **B2** for expansion of the 3 brackets, allow one error or **B1** for correct expansion of 2 of the brackets with at least 3 terms correct

Question 87

(a)(i)	64	**1**	
(a)(ii)	127	**1**	**FT** $2 \times$ *their* **(a)(i)** $- 1$
(b)	$\pm\frac{1}{2}$ oe nfww	**4**	**M1** for $(2x-1)^2 + 2(2x-1)$ **B1** for $4x^2 - 2x - 2x + 1$ or $(2x-1)(2x-1+2)$ **B1** for $4x^2 - 1$ [= 0] or $(2x-1)(2x+1)$ [= 0] OR **M1** for $x(x + 2) = 0$ (solving $g(x) = 0$) **A1** for $x = 0$ or -2 **B1** for $2x - 1 = 0$ or $2x - 1 = -2$
(c)	$\frac{x+1}{2}$ oe final answer	**2**	**M1** for $y+1=2x$ or $\frac{y}{2}=x-\frac{1}{2}$ or $x=2y-1$
(d)	$-\frac{1}{6}$ oe nfww	**3**	**B2** for $3x=-\frac{1}{2}$ oe OR **M1** for $2^{2x}\times 2^{x}$ oe or $4^{\frac{1}{2}x}\times 4^{x}$ oe or 8^{x} oe **M1** for $2^{-\frac{1}{2}}$ or $4^{-\frac{1}{4}}$ or $8^{-\frac{1}{6}}$ soi

Question 88

(a)	Rotation 90° clockwise oe [centre] (5, 2)	**3**	**B1** for each
(b)(i)	Translation $\begin{pmatrix}-1\\4\end{pmatrix}$	**2**	**B1** for each
(b)(ii)	4.12 or 4.123...	**2**	**M1** for (*their* $(-1))^2$ + (*their* $4)^2$

Question 89

(a)(i)	(3, 1)	**1**	
(a)(ii)	$\begin{pmatrix}-10\\15\end{pmatrix}$	**1**	
(a)(iii)	3.61 or 3.605 to 3.606	**2**	**M1** for $(-2)^2 + 3^2$ oe
(b)(i)(a)	$\frac{1}{2}\mathbf{c}$	**1**	
(b)(i)(b)	$\mathbf{a} + \frac{1}{2}\mathbf{c}$ oe	**1**	FT $\mathbf{a}$ + *their* (b)(i)(a)
(b)(ii)(a)	$\overrightarrow{OP} = \frac{1}{3}(2\mathbf{a} + \mathbf{c})$ oe and $\overrightarrow{OQ} = \frac{1}{2}(2\mathbf{a} + \mathbf{c})$ oe OR $\overrightarrow{OP} = \frac{2}{3}(\mathbf{a} + \frac{1}{2}\mathbf{c})$ OR $\overrightarrow{PQ} = \frac{1}{3}(\mathbf{a} + \frac{1}{2}\mathbf{c})$ **and** correct comment e.g. have the same base vector or that they are multiples of one another **and** they share a common point OR e.g. $\overrightarrow{OQ} = 1.5\overrightarrow{OP}$, $2\overrightarrow{PQ} = \overrightarrow{OP}$	**2**	**B1** for $\overrightarrow{OP}$ or $\overrightarrow{PQ}$ factorised or for correct multiplicative statement on relationship without factorised vectors e.g. $\overrightarrow{OQ} = 1.5\overrightarrow{OP}$, $\frac{2}{3}\overrightarrow{OQ} = \overrightarrow{OP}$, $2\overrightarrow{PQ} = \overrightarrow{OP}$, $1.5\left(\frac{2}{3}\mathbf{a} + \frac{1}{3}\mathbf{c}\right) = \mathbf{a} + \frac{1}{2}\mathbf{c}$
(b)(ii)(b)	1.5 oe	**1**	

Question 90

(a)(i)	Image at (–5, 6) (–5, 8) (–6, 7)	**2**	**B1** for translation by $\begin{pmatrix}-4\\k\end{pmatrix}$ or $\begin{pmatrix}k\\5\end{pmatrix}$
(a)(ii)	Image at (3, 1) (3, 3) (4, 2)	**2**	**B1** for reflection in $y = 1$ or $x = k$
(a)(iii)	Image at (3, 4) (3, 8) (1, 6)	**2**	**B1** for enlargement, sf 2, in wrong position
(b)	Rotation 90° [anticlockwise] oe (–3, 0)	**3**	**B1** for each

Question 91

(i)	1.6 oe	**2**	**M1** for $3 - 5x = -5$
(ii)	$\frac{3-x}{5}$ oe final answer	**2**	**M1** for $x = 3 - 5y$ or $\frac{y}{5} = \frac{3}{5} - x$ or better, or $y - 3 = -5x$ oe

Question 92

(a)(i)(a)	Shape at (–2, 1) (–4, 1) (–4, 7) (0, 7)	**2**	**B1** for 3 correct points or for enlargement SF2 from any centre
(a)(i)(b)	Shape at (2, –2) (2, –3) (5, –1) (5, –3)	**3**	**B2** for correct orientation but wrong position or for 3 correct points or **B1** for $y = x - 1$ drawn
(a)(ii)	Rotation 90 [anticlockwise] oe (0, 0) oe	**3**	**B1** for each
(b)	$\frac{3}{4}\mathbf{p} + \frac{1}{2}\mathbf{q}$ or $\frac{1}{4}(3\mathbf{p} + 2\mathbf{q})$ or $\frac{3\boldsymbol{p} + 2\boldsymbol{q}}{4}$ final answer	**3**	**M2** for $AM = \overrightarrow{AM} = \frac{1}{2}\left(-\mathbf{p} + \mathbf{q} + \frac{1}{2}\mathbf{p}\right)$ oe or **M1** for correct route for $\overrightarrow{AB}$ oe soi by $-\frac{1}{2}\mathbf{p} + \mathbf{q}$ or for $\overrightarrow{OM}$ soi

Question 93

(a)(i)	169	**2**	**M1** for g(13) or $(1+4x)^2$ or better
(a)(ii)	$1+4x^2$ final answer	**1**	
(a)(iii)	x	**1**	
(b)	3.5 or $\frac{7}{2}$	**2**	**M1** for $1+4x=15$

Question 94

(a)(i)	Triangle drawn at (2, – 1), (2, – 4), (3, – 4)	**2**	**B1** for two correct points If 0 scored, **SC1** for reflection of triangle T in $y=-x$
(a)(ii)	Triangle drawn at (– 5, 6), (– 2, 5), (– 5, 5)	**2**	**B1** for translation by $\begin{pmatrix}-1\\k\end{pmatrix}$ or by $\begin{pmatrix}k\\3\end{pmatrix}$ If 0 scored **SC1** for triangle drawn at (–4.5, 3.5), (–4.5, 4.5) and (–1.5, 3.5)
(a)(iii)	Enlargement [SF] – 1.5 oe [centre] (0, 3)	**3**	**B1** for each
(b)	28.8, $28\frac{8}{10}$, $28\frac{4}{5}$	**2**	**M1** for 1.2^2 oe

Question 95

(a)	Correct lines drawn	**2**	**B1** for one correct with no incorrect lines
(b)(i)(a)	Translation or translate $\begin{pmatrix}-1\\4\end{pmatrix}$ oe	**2**	**B1** for each
(b)(i)(b)	Rotation or rotate 90 [anticlockwise] oe [centre] (2, 1)	**3**	**B1** for each
(b)(ii)(a)	Triangle at (– 5, 6) (– 2, 6) (– 2, 5)	**2**	**B1** for reflection in $y=k$
(b)(ii)(b)	Triangle at (1, 5) (1, 7) (7, 7)	**2**	**B1** for correct size and orientation, wrong position

Question 96

(a)(i)	3	1	
(a)(ii)	7	1	**FT** *their* (i) 3×*their* (i) –2
(b)	$\frac{x+2}{3}$ oe final answer	2	**M1** for $y + 2 = 3x$ or $\frac{y}{3} = x - \frac{2}{3}$ or $x = 3y - 2$
(c)	25	2	**M1** for $\frac{1}{x} = 5^{-2}$ oe
(d)	$\frac{2x^2 - x - 1}{x}$ final answer	2	**M1** for $2x - 1 - \frac{1}{x}$
(e)	2.98×10^{17} or $2.980... \times 10^{17}$	1	
(f)	625	2	**M1** for $x = $ j(4)

Question 97

(a)	Triangle drawn at (1, – 5), (1, – 7), (5, – 5)	2	**B1** for reflection in any horizontal line If 0 scored, **SC1** for reflection in $x = -2$
(b)	Triangle drawn at (– 2, 0), (– 2, – 1), (0, – 1)	2	**B1** for correct size and orientation but wrong position
(c)	Rotation 90 [anticlockwise] oe [centre] (– 1, 0)	3	**B1** for each

Question 98

(a)(i)	**2a** drawn correctly with direction arrow	1	
(a)(ii)	**a** – **b** drawn correctly with direction arrow	2	**B1** for $\begin{pmatrix} 4 \\ -3 \end{pmatrix}$ seen or implied or **M1** for correctly drawing *their* **a** – **b** with an arrow
(b)(i)(a)	$\mathbf{q} + \frac{3}{4}\mathbf{p}$ final answer	1	
(b)(i)(b)	$\mathbf{q} - \frac{1}{4}\mathbf{p}$ final answer	2	**M1** for a correct route
(b)(i)(c)	$\frac{13}{24}\mathbf{p} - \frac{2}{3}\mathbf{q}$ final answer	3	**M2** for $\frac{3}{8}\mathbf{p} - \frac{2}{3}$ (*their* **(b)(i)(b)**) oe or for $-\frac{3}{8}\mathbf{p} - \mathbf{q} + \mathbf{p} + \frac{1}{3}$ (*their* **(b)(i)(b)**) oe or **M1** for a correct route or for $[\overrightarrow{BN} =] -\frac{2}{3}$ (*their* **(b)(i)(b)**) or $[\overrightarrow{AN} =] \frac{1}{3}$ (*their* **(b)(i)(b)**) or final answer $k\mathbf{p} - \frac{2}{3}\mathbf{q}$ oe or $\frac{13}{24}\mathbf{p} - k\mathbf{q}$ oe
(b)(ii)	$\frac{19}{16}\mathbf{p}$ oe final answer	2	**M1** for $\overrightarrow{AG} = \frac{3}{8}\mathbf{p} \div 2$ soi or for answer $k\mathbf{p}$ oe

Question 99

(a)	2.5 and – 2.5 oe	3	**M2** for $1681m^2 = \frac{42025}{4}$ oe or **M1** for $(9m)^2 + (40m)^2$ oe
(b)(i)(a)	**c** – **a** final answer	1	
(b)(i)(b)	$\frac{3}{4}$ **a** final answer	1	
(b)(i)(c)	**c** + $\frac{3}{4}$ **a** final answer	1	**FT c** + *their* **(b)(i)(b)**, must be a vector in terms of **a** and/or **c** in its simplest form
1(b)(ii)	**a** + $\frac{4}{3}$ **c** oe	2	**B1** for $[\overrightarrow{BQ} =]\ \frac{1}{3}$ **c** or $[\overrightarrow{AQ} =]\ \frac{4}{3}$ **c** or **M1** for a correct route or for answer **a** + k**c** oe, where $k > 1$

Question 100

(a)(i)	Translation $\begin{pmatrix} 7 \\ -8 \end{pmatrix}$ oe	2	**B1** for each
(a)(ii)	Rotation 90° [anticlockwise] oe (0, 8)	3	**B1** for each
a)(iii)	Enlargement [sf] $\frac{1}{2}$ oe [centre] (–1, –4)	3	**B1** for each
(b)	Image at (–4, 4) (–3, 4) (–2, 5) (–2, 3) (–4, 3)	2	**B1** for the line $y = x + 8$ drawn soi long enough to be fit for purpose or correct size and orientation but wrong position

Question 101

'(a)(i)	4	**1**	
(a)(ii)	16	**1**	**FT** $2^{\text{their } 4}$
'(b)	3	**1**	
'(c)	$\frac{1}{4}$ oe	**2**	**M1** for $\frac{2}{x}=2^3$ or better
'(d)	$\frac{5-x}{2}$ oe final answer	**2**	**M1** for $x = 5 - 2y$ or $y + 2x = 5$ oe or $\frac{y}{2}=\frac{5}{2}-x$ oe
'(e)	$\frac{11x-x^2+2}{x}$ final answer	**3**	**B2** for $\frac{x(10-x)+2+x}{x}$ oe single fraction or **B1** for $x(10-x)+2+x$ oe or **M1** for $10-x+\frac{2}{x}+1$
'(f)	$[a=]$ 1 $[b=]$ –21 $[c=]$ 100	**4**	**B3** for $x^2-21x+100$ OR **M1** for $(10-x)^2-(10-(10-x))$ oe or better **B2** for $[(10-x)^2]=100-10x-10x+x^2$ or **B1** for three out of four terms of $[(10-x)^2]=100-10x-10x+x^2$ correct
'(g)	1024	**2**	**M1** for $[x=]$ h(10) oe or better

Question 102

(a)(i)	$\begin{pmatrix} -3 \\ 3 \end{pmatrix}$	**1**	
(a)(ii)	$\begin{pmatrix} 3 \\ 2 \end{pmatrix}$	**1**	
(a)(iii)	3.61 or 3.605 to 3.606	**2**	**M1** for $2^2 + 3^2$ oe
(b)	(6, 1)	**2**	**B1** for each
(c)	$\frac{2}{7}\mathbf{g} + \frac{3}{14}\mathbf{h}$	**4**	**B3** for correct unsimplified expression for $\overrightarrow{MK}$ or **B2** for $[\overrightarrow{MK} =] \frac{2}{7}\mathbf{g} + k\mathbf{h}$ or $[\overrightarrow{MK} =] k\mathbf{g} + \frac{3}{14}\mathbf{h}$ or $\overrightarrow{HK} = \frac{2}{7}(\mathbf{g} - \mathbf{h})$ oe or $\overrightarrow{GK} = \frac{5}{7}(\mathbf{h} - \mathbf{g})$ oe or **M1** for correct route for $\overrightarrow{MK}$

Question 103

(a)	1	**1**	
(b)	$-\frac{1}{5}$ or -0.2	**2**	**M1** for $2x - 1 + 3x + 2 = 0$ oe isw
(c)	$9x + 8$ final answer	**2**	**M1** for $3(3x + 2) + 2$
(d)	$\frac{4x^2 + 5x - 3}{x(2x-1)}$ final answer	**4**	**M1** for $\frac{1}{2x-1}$ and $3\left(\frac{1}{x}\right) + 2$ oe **B1** for $x + 3(2x-1) + 2x(2x-1)$ oe or better isw **B1** for common denominator = $x(2x - 1)$ isw If 0 scored, **SC1** for answer $\frac{4x^2 + 9x + 3}{x(2x+1)}$
(e)	h(x) indicated	**1**	

Question 104

(a)(i)	Triangle at (3, –1), (9, –1), (9, 2)	2	**B1** for correct shape, size and orientation or for correct plots but no triangle
(a)(ii)(a)	Triangle at (3, 3), (4, 3), (3, 5)	2	**B1** for correct shape size and orientation or for rotation about (4, 2) 90° anticlockwise or for correct plots but no triangle
(a)(ii)(b)	Triangle at (4, 3), (5, 3), (5, 5)	3	**B2** for correct shape size and orientation or for correct plots but no triangle or **M1** for $x + y = 6$ drawn
(a)(ii)(c)	Reflection $x = 4$	2	**B1** for each
(b)	$\frac{5}{7}\mathbf{a} + \frac{2}{7}\mathbf{b}$ final answer	3	**B2** for correct unsimplified answer OR **M2** for $\overrightarrow{HZ} = \frac{2}{7}(\mathbf{b} - \mathbf{a})$ or $\overrightarrow{KZ} = \frac{5}{7}(\mathbf{a} - \mathbf{b})$ oe or **M1** for $\overrightarrow{HK} = -\mathbf{a} + \mathbf{b}$ or $\overrightarrow{KH} = -\mathbf{b} + \mathbf{a}$ or for a correct route

Question 105

)(a)(i)	-7	1	
)(a)(ii)	$\frac{x-5}{2}$ oe final answer	2	**M1** for correct first step e.g. $x = 2y + 5$ or $2x = y - 5$ or $\frac{y}{2} = x + \frac{5}{2}$
(a)(iii)	$2x^3 - 11x^2 - 8x + 80$ final answer	4	**M1** for $(x-4)(2x+5)(x-4)$ oe **B2** for $2x^3 - 8x^2 - 8x^2 + 5x^2 - 20x - 20x + 32x + 80$ or for simplified 4 term expression of the correct form with 3 terms correct in final answer or **B1** for 3 terms correct out of 4 from $x^2 - 4x - 4x + 16$ or $2x^2 - 8x + 5x - 20$
)(b)	0	2	**M1** for g(– 2) or $2(x - 4) + 5$ oe or $3^x = 1$ or $g(f(2)) = 1$

Question 106

(a)(i)	7	**1**	
(a)(ii)	$\frac{1}{8}$ oe	**2**	**M1** for g(–0.5) or for $64^{5(x)-3}$ or better
(b)	$\frac{2-x}{x}$ or $\frac{2}{x}-1$ final answer	**3**	**M1** for $y(x+1)=2$ or $x=\frac{2}{y+1}$ or better **M1** for $\frac{2-y}{y}$ or $xy=2-x$ oe
6c	$-\frac{5}{6}$ –0.833 or better	**2**	**M1** for $[64^x=]\ 2^{6x}$ or $(2^6)^x$ or $6x=-5$
(d)	$\frac{7-9x}{(5x-3)(x+1)}$ or $\frac{7-9x}{5x^2+2x-3}$ or $-\frac{9x-7}{5x^2+2x-3}$ final answer	**4**	**B1** for $\frac{1}{5x-3}-\frac{2}{x+1}$ **M1** for $x+1-2(5x-3)$ seen isw **M1** for $(5x-3)(x+1)$ seen isw

Question 107

(a)	Rotation 90° [anticlockwise] oe (2, 7)	**3**	**B1** for each
(b)(i)	Image at (–4, –1), (–3, –1), (–4, –4)	**2**	**B1** for reflection in $y=k$ or $x=1$
(b)(ii)	Image at (2, –4), (1, –4), (1, –1)	**2**	**B1** for translation by $\begin{pmatrix}5\\k\end{pmatrix}$ or $\begin{pmatrix}k\\-7\end{pmatrix}$
(b)(iii)	Image at (–4, 7), (–4, 1), (–2, 1)	**2**	**B1** for enlargement, factor 2 with other centre

Question 108

(i)	$\begin{pmatrix}2\\5\end{pmatrix}$	**1**	
(ii)	$\begin{pmatrix}-6\\4\end{pmatrix}$	**1**	

Question 109

(a)	4	**1**	
(b)	$7 - 3x$ final answer	**2**	**M1** for $1 - 3(x - 2)$
(c)	$\frac{1-x}{3}$ oe final answer	**2**	**M1** for $x = 1 - 3y$ or $y - 1 = -3x$ or $1 - y = 3x$ or $\frac{y}{3} = \frac{1}{3} - x$
(d)	$a = 2$, $b = 5$, $c = -1$	**5**	**B4** for two correct values only after correct substitution seen i.e. $(1 - 3x - 1)^2 - (x - 1)^2(1 - 3x)$ or for correct unsimplified expansion or a correct simplified expansion. OR **M1** for $(1 - 3x - 1)^2 - (x - 1)^2(1 - 3x)$ **B2** for correct expansion of $[-](x - 1)^2(1 - 3x)$ $[-](x^2 - x - x + 1 - 3x^3 + 3x^2 + 3x^2 - 3x)$ or better or **B1** for expansion of one pair of brackets $[(x-1)^2 =]x^2 - x - x + 1$ or better or $[(x - 1)(1 - 3x) =] - 3x^2 + x + 3x - 1$
(e)	$\frac{3 - x + 3x^2}{x}$ final answer	**3**	**B1** for $3 - x(1 - 3x)$ or better **B1** for common denominator x isw
(f)	-7	**1**	

Question 110

(a)(i)	Image at (–5, 3), (–1, 3), (–1, 5)	**2**	**B1** for translation $\begin{pmatrix} -7 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 1 \end{pmatrix}$
(a)(ii)	Translation $\begin{pmatrix} 7 \\ -1 \end{pmatrix}$ cao	**1**	
(b)	Image at (6, 4), (6, 6), (2, 6)	**2**	**B1** for reflection in line $x = 4$ or for reflection in line $y = k$
(c)	Image at (2, –2), (2, –6), (4, –6)	**2**	**B1** for correct size and orientation or for rotation 90° anticlockwise about (0, 0)
(d)(i)	Image at (–1, –1), (–3, –1), (–3, –2)	**2**	**B1** for correct size and orientation or for enlargement SF $\frac{1}{2}$, centre (0, 0)
(d)(ii)	Enlargement and [centre] (0, 0) [factor] –2	**2**	**B1** for Enlargement **and** [centre] (0, 0) **B1** for [factor] –2

Question 111

)(a)(i)	(15, 6)	**2**	**B1** for each
(a)(ii)	$\begin{pmatrix} 3 \\ 24 \end{pmatrix}$	**1**	
(a)(iii)	13.6 or 13.60…	**2**	**M1** for $(-11)^2 + 8^2$ oe
)(b)(i)	$\mathbf{a} + \frac{3}{5}(\mathbf{b} - \mathbf{a})$ or $\mathbf{b} + \frac{2}{5}(\mathbf{a} - \mathbf{b})$ leading to $\frac{2}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}$ with no errors	**M3**	**M2** for $[\overrightarrow{MR} =] \frac{3}{5}(\mathbf{b} - \mathbf{a})$ oe or $[\overrightarrow{NR} =] \frac{2}{5}(\mathbf{a} - \mathbf{b})$ oe or **M1** for $\overrightarrow{MN} = \mathbf{b} - \mathbf{a}$ or $\overrightarrow{NM} = \mathbf{a} - \mathbf{b}$ or a correct route for $\overrightarrow{OR}$
)(b)(ii)(a)	$k = 5$, $c = 10$	**4**	**B2** for $c = 10$ or **M1** for $c(\frac{2}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}) = \mathbf{b} + 4\mathbf{a} + k\mathbf{b}$ oe or for $\frac{2}{5}c = 4$ and **M1** for $\frac{3}{5} \times$ *their* $c = k + 1$
)(b)(ii)(b)	$3\mathbf{a} + 6\mathbf{b}$ final answer	**1**	**FT** $3\boldsymbol{a} + (\textit{their}\, k + 1)\boldsymbol{b}$

Question 112

(a)(i)	–20	**1**	
(a)(ii)	$\frac{x+3}{2}$ oe final answer	**2**	**M1** for $x = 2y - 3$ or better or $y + 3 = 2x$ or better or $\frac{y}{2} = x - \frac{3}{2}$ or better
(a)(iii)	125	**2**	**M1** for g(64) or $2(4^{2x-1}) - 3$
(b)	2.5 oe	**2**	**M1** for $2(2x) - 3 = 7$ or better
(c)	$2x^2 + 4x - 11$ final answer	**3**	**B2** for $2x^2$ and either $+4x$ or -11 in final 3 term answer or for correct answer seen then spoiled or **M1** for $2x^2 - 3 + 2(2x - 3) - 3$ [+ 1]
(d)	1.5 oe	**2**	**M1** for $4^{2x-1} = 4^2$ or better
(e)	$a = 3$ $b = 4$ $c = -59$ $d = -20$	**3**	**B2** for 3 correct values or for correct unsimplified expanded expression or for simplified four-term expression of correct form with 3 terms correct or **B1** for 2 correct values or for correct expansion of one pair of brackets with at least 3 out of 4 terms correct.

Question 113

(a)(i)	Translation $\begin{pmatrix} -7 \\ -1 \end{pmatrix}$ oe	**2**	**B1** for each
(a)(ii)	Rotation 90° clockwise oe (5, 1)	**3**	**B1** for each
(b)(i)	Image at (2, 6) (3, 6) (3, 8)	**2**	**B1** for reflection in $y = k$, $k \neq 2$ or for reflection in $x = 2$
(b)(ii)	Image at (–4, 4) (–6, 4) (–6, 8)	**2**	**B1** for an enlargement, sf –2 in the wrong position

Question 114

(a)(i)	-3.5 oe	**2**	**M1** for $g\left(\frac{1}{2}\right)$ seen or $3\left(\frac{1}{x}\right)-5$ or better
(a)(ii)	$\frac{x+5}{3}$ oe final answer	**2**	**M1** for correct first step $y+5=3x$, $\frac{y}{3}=x-\frac{5}{3}$ or $x=3y-5$
(b)	$3x-11$ final answer	**2**	**M1** for $3(x-2)-5$
(c)(i)	5	**2**	**M1** for $\frac{1}{3x-5}[=0.1]$
(c)(ii)	4 nfww	**2**	**M1** for $2^x-(3\times 7-5)[=0]$ or better

Question 115

(a)(i)	$\begin{pmatrix}-12\\15\end{pmatrix}$	**1**	
(a)(ii)(a)	$\begin{pmatrix}12\\-10\end{pmatrix}$	**1**	
(a)(ii)(b)	15.6 or 15.62…	**2**	**M1dep** for *their* $12^2+(\textit{their}[-]10)^2$ oe, dep *their* $12\neq 0$ and *their* $-10\neq 0$
(b)	$\frac{3}{8}\mathbf{a}+\frac{5}{8}\mathbf{b}$ final answer	**3**	**B2** for an unsimplified correct answer or $MS=\frac{5}{8}(\mathbf{b}-\mathbf{a})$ soi or $NS=\frac{3}{8}(-\mathbf{b}+\mathbf{a})$ soi or **B1** for correct route for $\overrightarrow{OS}$ or for $MN=\mathbf{b}-\mathbf{a}$ or $NM=\mathbf{a}-\mathbf{b}$

Question 116

)(i)	$\frac{1}{15}$ oe	**1**	
)(ii)	19 683	**2**	**B1** for g(9), 3^9 or 3^{3^x} seen
(iii)	–3	**2**	**M1** for $3^k = \frac{1}{27}$ or $3^k = 3^{-3}$ or answer g(–3)

Question 117

)(a)(i)	13	**1**	
(a)(ii)	–20	**1**	**FT** 6 – 2(*their* **(a)(i)**)
)(b)	$\frac{6-x}{2}$ oe final answer	**2**	**M1** for correct first step $x = 6 - 2y$, $y - 6 = -2x$, $\frac{y}{2} = 3 - x$
)(c)	2.375 oe	**4**	**B1** for $6 - 2(2x - 7)$ oe **B1** for $4x + 1 = 6 - 4x + 14$ **M1** for $8x = 19$ FT *their* linear equation rearranged correctly from $ax + b = cx + d$ to form $ex = f$
)(d)	$\frac{1}{3}$ or 0.333…	**2**	**M1** for h(1) or 3^(3^{x-2} – 2) or 3^(3^{2-2} – 2) or better
)(e)	6561	**2**	**M1** for 3^{10-2} or x = h(10)

Question 118

(a)(i)	$\begin{pmatrix} 4 \\ -12 \end{pmatrix}$	**2**	**B1** for each
(a)(ii)	$1^2 + 7^2$	**M1**	
	$5^2 + ([-]5)^2$	**M1**	
	Both $\sqrt{50}$ oe	**A1**	With no errors seen If M0M0A0 scored SC1 for $\sqrt{50}$ oe for each
(a)(iii)	44.4 or 44.42[8…] to 44.435	**2**	FT *their* **(a)(ii)** correct to 3sf or better **M1** for $2 \times \pi \times$ *their* $\sqrt{50}$ oe
(a)(iv)	(3, 1)	**2**	**B1** for each
(a)(v)	$[y =] \frac{1}{3}x$	**4**	**B3** for a correct equation in the wrong form as final answer Or **B2** for 1/3 stated or used as perpendicular gradient OR **M1** for [grad PQ] = $\frac{7 - -5}{1 - 5}$ oe **M1** for $\frac{-1}{\textit{their}\ \text{grad}\ PQ}$ **M1dep** for substituting *their***(a)(iv)** or (0,0) into $y =$ *their* $mx + c$ oe dep on the 2nd M1 or B2

(b)	$\frac{3}{5}\mathbf{a} + \frac{2}{5}\mathbf{b}$ final answer	**4**	**B3** for an unsimplified correct answer or **B2** for $AM = \frac{2}{5}(\boldsymbol{b} - \boldsymbol{a})$ soi or $BM = \frac{3}{5}(\boldsymbol{a} - \boldsymbol{b})$ soi or **B1** for $AB = \mathbf{b} - \mathbf{a}$ or $BA = \mathbf{a} - \mathbf{b}$ or for a correct route for OM or for correct diagram

Question 119

(a)(i)	Triangle at (2, 1) (1, 3) (5, 3)	**1**	
(a)(ii)	Triangle at (–4, –5) (–3, –3) (0, –5)	**2**	**B1** for translation by $\begin{pmatrix} -5 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ -2 \end{pmatrix}$
(a)(iii)	Triangle at (–2.5, 2) (–4, 3) (–2, 3)	**2**	**B1** for enlargement by sf $-\frac{1}{2}$ with any centre
(b)	14.4	**3**	**M2** for [10 ×] $3^2 \times \left(\frac{2}{5}\right)^2$ oe or **M1** for 3^2 or $\left(\frac{2}{5}\right)^2$ soi