Extended Mathematics
Topic : Vector-Function-Transformation
Year :May 2013 -May 2024
Paper - 2
Answers

Question 1

(a)	hexagon	1	
(b) (i)	$-\mathbf{b} + \mathbf{c}$	1	
(ii)	$\mathbf{b} - \frac{1}{2}\mathbf{c}$	2	**B1** for **OB** + **BA** or any correct route
(iii)	$-\mathbf{b} + \mathbf{c}$	1FT	= *their* (b)(i)

Question 2

(a)	1.5	2	**B1** for [g(18) =] 4
(b)	$2(x + 5)$ or $2x + 10$	2	**M1** for correct first step e.g. $x = \frac{y}{5} - 5$ or $\frac{x}{2} = y + 5$ or $2y = x - 10$

Question 3

(a)	4.5 oe	2	**B1** for [g(5)=] 0.1 oe
(b)	x	2	**M1** for $\frac{1}{2\left(\frac{1}{2x}\right)}$ seen oe
(c)	$\frac{x - 4}{5}$ oe	2	**M1** for a correct first step e.g. $y - 4 = 5x$ or $\frac{y}{5} = x + \frac{4}{5}$ or $x = 5y + 4$
(d)	-3	2	**M1** for $\left(\frac{1}{2}\right)^{-3} = 8$ or $\left(\frac{1}{2}\right)^{x} = \left(\frac{1}{2}\right)^{-3}$ or $2^{x} = \frac{1}{8}$ oe or $2^{-x} = 2^{3}$

Question 4

(a) (i)	$\mathbf{p} + \frac{1}{2}\mathbf{r}$	1	
(ii)	$2\mathbf{p} + \mathbf{r}$	1ft	$2 \times$ *their* (i)
(b)	Midpoint of RQ	1	

Question 5

(a) 75 | 2 | **B1** for [g(6) =] 36

(b) 3.5 −6.5 | 3 | **M1** for $(2x + 3)^2 = 100$
M1 for $2x + 3 = [\pm]10$

If 0 scored, **SC1** for one correct value as answer

(c) $\dfrac{x-3}{2}$ oe final answer | 2 | **M1** for $x = 2y + 3$ or $y - 3 = 2x$ or $\dfrac{y}{2} = x + \dfrac{3}{2}$
or better

(d) 5 | 1

Question 6

(a) −2**a** − 2**c** oe | 2 | **M1** for **BO** = −**a** − **c** or for any correct route or correct unsimplified expression

(b) 2**a** + **c** | 2 | **M1** for any correct route or correct unsimplified expression

(c) −**a** − **c** oe | 2FT | FT *their* **(a)** or correct answer
Or **M1** for a correct non direct route from O to E or for correct unsimplified expression or for correct FT unsimplified

Question 7

(a) | Triangle at (2,−1) (2,1) (1,−2) | 2 | **B1** for translation by $\begin{pmatrix} k \\ -4 \end{pmatrix}$ or $\begin{pmatrix} 3 \\ k \end{pmatrix}$

(b) | Rotation | 1 | **OR** | enlargement
| [centre] (1 , 0) | 1 | | [centre] (1 , 0)
| 180° or half turn | 1 | | [scale factor] −1

Question 8

(a) | **p** + **r** | 1

(b) | $\frac{3}{2}$ **p** + $\frac{1}{2}$ **r** | 2 | **M1** for correct route from *O* to *M*

or

M1 for **p** + ½*their*(a)

Question 9

(a) $\frac{1}{2}\mathbf{b} - \frac{1}{2}\mathbf{a}$ oe   2

M1 for $\frac{1}{2}(\overrightarrow{AO} + \overrightarrow{OB})$ oe or correct unsimplified
route e.g. $\overrightarrow{AO} + \overrightarrow{OB} + \overrightarrow{BP}$
or $-\mathbf{a} + \mathbf{b} + \frac{1}{2}\,\overrightarrow{BA} = -\mathbf{a} + \mathbf{b} + \frac{1}{2}(\mathbf{a} - \mathbf{b})$

(b) $\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}$ oe   2

M1 for $\overrightarrow{OA} + \overrightarrow{AQ}$ oe or correct unsimplified route

Question 10

(a) (i) $\mathbf{c} - \mathbf{a}$ 1

(ii) $-\frac{1}{3}\,\mathbf{a} + \frac{1}{3}\,\mathbf{c}$ 3

M2 for $-\mathbf{a} + \frac{1}{3}(\mathbf{c} + 2\mathbf{a})$ oe

e.g. $-\mathbf{a} + \mathbf{c} + 2\mathbf{a} - \frac{2}{3}(\mathbf{c} + 2\mathbf{a})$

Or **M1** for a correct route from A to X

(b) $\overrightarrow{AC}$ is a multiple of $\overrightarrow{AX}$
and   1   oe
they share a common point [A]   1   oe

Question 11

(a) 17   2   **M1** for [g(−2) =] 4 seen or for $5x^2 - 3$

(b) $25x^2 - 30x + 9$ or $(5x - 3)^2$ as final
answer   2   **M1** for $g(5x - 3)$

(c) $\frac{x + 3}{5}$ 2   **M1** for $5x = y + 3$ or $x = 5y - 3$ or
$\frac{y}{5} = x - \frac{3}{5}$

Question 12

(a) $\mathbf{b} - \mathbf{a}$ 2   **M1** if unsimplified or correct route in terms
of P, Q, R, S

(b) $\frac{5}{8}\mathbf{x} + \frac{3}{8}\mathbf{y}$ 2   **M1** for a correct route e.g. $OX + XM$
or
for $\frac{3}{8}\overrightarrow{XY}$ or $\frac{5}{8}\overrightarrow{YX}$

Question 13

(a)	**(i)**	$-\mathbf{b} + \mathbf{a}$	1	
	(ii)	$\mathbf{b} + \dfrac{1}{2}\mathbf{a}$	1	
(b)		$[\overrightarrow{OX} =]\ \mathbf{b} + \dfrac{1}{3}(-\mathbf{b} + \mathbf{a})$ oe	**M1**	
		$\dfrac{1}{3}\mathbf{a} + \dfrac{2}{3}\mathbf{b}$ oe	**A1**	
		2 statements from: $\overrightarrow{OM} = \mathbf{b} + \dfrac{1}{2}\mathbf{a}$ oe or $[\overrightarrow{OX} =]\ \dfrac{2}{3}\left(\mathbf{b} + \dfrac{1}{2}\mathbf{a}\right)$ oe or $\overrightarrow{OX} = \dfrac{2}{3}\overrightarrow{OM}$ oe	**B2**	**B1** for any one of these statements

Question 14

(a)	$9x^2$	1	
(b)	$\dfrac{x-5}{3}$	2	**M1** for correct first algebraic step e.g. $y - 5 = 3x$ or $\dfrac{y}{3} = x + \dfrac{5}{3}$ or better or for interchanging x and y, e.g. $x = 3y + 5$, this does not need to be the first step
(c)	$9x + 20$ cao final answer	2	**M1** for $3(3x + 5) + 5$

Question 15

(a)	-13	1	
(b)	$-3x - 1$ or $5 - 3(x + 2)$	1	
(c)	$9x - 10$ cao	2	**M1** for $5 - 3(5 - 3x)$
(d)	$\dfrac{5-x}{3}$ final answer oe	2	**M1** for correct first step e.g.

Question 16

(a)	$a + 2b - a$ or $a - (a - 2b)$ oe	1	
(b)	Parallelogram	1	
	PM **equal** and parallel to *QR*	1	**SC1** for answer trapezium with reason *PM* parallel to *QR*
	or		
	PM or *PS* parallel to *QR* **and** *MR* found = **a** so 2 pairs of parallel sides		

Question 17

(a)	$\frac{1}{3}(-a + b)$ oe	2	**M1** for any correct route eg $AO+OB+\frac{2}{3}BA$ or **B1** for $\overrightarrow{AB} = -a + b$ oe
(b)	$\frac{2}{3}a + \frac{1}{3}b$ oe simplified	2FT	FT *their* **(a)** + **a** simplified only if in terms of **a** and **b**. **M1** for identifying $\overrightarrow{OC}$ as position vector or correct route in any form or for correct unsimplified answer

Question 18

(a)	512	2	**B1** for $[f(2) =] 8$ or **M1** for $(x^3)^3$ or better
(b)	$6x - 2$ or $2(3x - 1)$ final answer	2	**B1** for $3(2x + 1) - 5$ or better
(c)	$\frac{1}{2}(x-1)$ oe	2	**M1** for correct first step eg $y - 1 = 2x$ or $\frac{y}{2} = x + \frac{1}{2}$ or $x = 2y + 1$ or better

Question 19

Enlargement	1	
$\frac{1}{2}$	1	
origin oe	1	

Question 20

Triangle $(3, -2)$, $(4, -2)$, $(4, -1)$	2	**B1** for movement 2 right or 3 down

Question 21

$\frac{1}{4}\mathbf{a} - \frac{1}{4}\mathbf{b} - \frac{1}{4}\mathbf{c}$ oe	2	**B1** for $\overrightarrow{GK} = \mathbf{a} - \mathbf{b} - \mathbf{c}$ oe soi or $\overrightarrow{GL} = \frac{1}{4}(\overrightarrow{GK})$ or for any correct route

Question 22

(a)	$\mathbf{a} + \mathbf{b} - \mathbf{c}$	1	
(b)	$\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b} + \frac{1}{2}\mathbf{c}$	2	**M1** for $\mathbf{c} + \frac{1}{2}$ (*their* (a)) or for a correct route e.g. $\overrightarrow{OC} + \frac{1}{2}\overrightarrow{CB}$, $\overrightarrow{OQ}$
(c)	$\frac{1}{2}\mathbf{c} - \frac{1}{2}\mathbf{a} - \frac{1}{6}\mathbf{b}$	2	**M1** for $\frac{1}{3}\mathbf{b} - \frac{1}{2}$ (*their* (a)) or other correct route e.g. $-\frac{2}{3}\mathbf{b} - \mathbf{a} +$ *their* (b), $\overrightarrow{PO} + \overrightarrow{OQ}$

Question 23

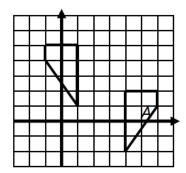|			
(a)	$\begin{pmatrix} -7 \\ 3 \end{pmatrix}$	2	**M1** for $\overrightarrow{CB} = \begin{pmatrix} -2 \\ -3 \end{pmatrix}$ or for correct route allow e.g. $BA - BC$, $CB + BA$
(b)	7.81 or 7.810….	2	**M1** for $\sqrt{(-5)^2 + 6^2}$

Question 24

(a)	10	2	**M1** for $\frac{x}{4} - 3 = -0.5$
(b)	$\frac{x+7}{6}$ final answer	2	**M1** for $y + 7 = 6x$ or $\frac{y}{6} = x - \frac{7}{6}$ or $x = 6y - 7$
(c)	−2	2	**M1** for $[\mathrm{f}(13) =] \frac{1}{4}$

Question 25

3

B2 for correct translation of A seen

or **B1** for translation of A by $\begin{pmatrix} -1 \\ k \end{pmatrix}$ or $\begin{pmatrix} k \\ 3 \end{pmatrix}$ seen

and **B1** for correct reflection of their translation in $x = 2$ seen

If 0 scored
SC2 for correct TM(A)
or **SC1** for reflection in $x = 2$ seen or a correct translation of $\begin{pmatrix} -1 \\ 3 \end{pmatrix}$ seen

Question 26

Enlargement **1**

[s.f.] $\dfrac{1}{2}$ **1**

[centre] $(-1, 3)$ **1**

Question 27

$\dfrac{2}{7}\mathbf{p} + \dfrac{5}{7}\mathbf{q}$

3

M1 for $PZ = \dfrac{5}{7}(\mathbf{q} - \mathbf{p})$ oe or $QZ = \dfrac{2}{7}(\mathbf{p} - \mathbf{q})$ oe

M1 for correct route from O to Z or identifying OZ

Question 28

(a)	$3 + 12x$ final answer	**1**
(b)	$24x + 31$ final answer	**2** **M1** for $3 + 4(6x + 7)$

Question 29

(a)(i)	$\begin{pmatrix} 30 \\ -20 \end{pmatrix}$	**1**
(a)(ii)	$\begin{pmatrix} -6 \\ 4 \end{pmatrix}$	**1**
(b)	-4	**1**

Question 30

(a)	$2\mathbf{a} + \mathbf{b}$	1	
(b)	D	1	
(c)	$\overrightarrow{CF}$ and $\overrightarrow{BG}$	2	**B1** for each

Question 31

$\frac{1}{3}\mathbf{a} + \frac{2}{3}\mathbf{b}$ oe simplified	3	**B2** for correct unsimplified vector for $\overrightarrow{OK}$ in terms of $\mathbf{a}$ and $\mathbf{b}$ or **M1** for a correct route for $\overrightarrow{OK}$ or $\overrightarrow{AB} = -\mathbf{a} + \mathbf{b}$ or $\overrightarrow{BA} = -\mathbf{b} + \mathbf{a}$ or recognition of $\overrightarrow{OK}$ as a position vector

Question 32

Enlargement	1	
$\frac{1}{3}$	1	
(2, 1)	1	

Question 33

(a)	2	2	**M1** for f(5) or $7 - (7 - x)$ or better
(b)	$30 - 4x$ final answer	2	**M1** for $4(7 - x) + 2$ or better or for correct answer then spoilt
(c)	$15 - 4x^2$ final answer	2	**M1** for $15 - (2x)^2$ or better or for correct answer then spoilt

Question 34

(a)	Rotation [centre] origin oe 90°[anti-clockwise] oe	3	**B1** for each
(b)	Enlargement [centre] (0, 3) [sf] – 2	3	**B1** for each

Question 35

$2\mathbf{q} + \mathbf{p}$		2	**B1** for $CF = 2(\mathbf{q} + \mathbf{p})$ or $BA = \mathbf{q} + \mathbf{p}$ or $DE = \mathbf{q} + \mathbf{p}$ or $DA = 2\mathbf{q}$ or for correct route

Question 36

(a)	Enlargement [scale factor] 2 [centre] (7, 0)	3	**B1** for each
(b)	Image at (6, 4), (7, 4), (6, 8)	3	**B2** for rotation through 90° clockwise but about other point or **B1** for rotation through 90° anticlockwise about any point or for triangle at (6, 4), (7, 4), (6, k)

Question 37

$\dfrac{2}{3}\mathbf{p} + \dfrac{1}{3}\mathbf{q}$	2	**M1** for correct route e.g. $\overrightarrow{OT}$ or $\overrightarrow{OQ} + \overrightarrow{QT}$ or for $\overrightarrow{QT} = \dfrac{2}{3}(-\mathbf{q} + \mathbf{p})$ oe or for $\overrightarrow{PT} = \dfrac{1}{3}(-\mathbf{p} + \mathbf{q})$ oe

Question 38

(a)	$6\mathbf{a} - 2\mathbf{b}$ or $2(3\mathbf{a} - \mathbf{b})$	2	**M1** for $4\mathbf{a} + \mathbf{b} - (-2\mathbf{a} + 3\mathbf{b})$ or better
(b)	$5\mathbf{a} - \mathbf{b}$	2	**M1** for a correct route e.g. $\overrightarrow{OD} + \overrightarrow{DE}$, $4\mathbf{a} + \mathbf{b} + \mathbf{a} - 2\mathbf{b}$, $\overrightarrow{OE}$

Question 39

(a)	-17	2	**M1** for $f(11)$ seen or $5 - 2(5 - 2x)$ or better
(b)(i)	$4x^2 + 8$ oe	1	
(b)(ii)	$\dfrac{5 - x}{2}$ oe final answer	2	**M1** for $x = 5 - 2y$ or $2x = 5 - y$ or $y - 5 = -2x$ or $\dfrac{y}{2} = \dfrac{5}{2} - x$

Question 40

(a)	$\mathbf{c} + \dfrac{2}{3}\mathbf{a}$	2	**M1** for correct unsimplified form or correct route e.g. $\overrightarrow{OC} + \overrightarrow{CP}$

(b)(i)	$\dfrac{2}{5}\mathbf{a} + \dfrac{3}{5}\mathbf{c}$		2	**M1** for correct unsimplified form or correct route e.g. $\overrightarrow{OC} + \overrightarrow{CX}$
(b)(ii)	3 : 2 oe		2	**B1** for $\overrightarrow{OX} = \dfrac{3}{5}\overrightarrow{OP}$ oe or $\overrightarrow{XP} = \dfrac{2}{5}\mathbf{c} + \dfrac{4}{15}\mathbf{a}$

Question 41

(a)(i)	$5x^3 + 2$ final answer		1	
(a)(ii)	$\dfrac{x-2}{5}$ final answer		2	**M1** for correct first step e.g. $y - 2 = 5x$, $x = 5y + 2$, $\dfrac{y}{5} = x + \dfrac{2}{5}$
(b)	5		2	**M1** for $a \times (-2)^2 + 1 = 21$

Question 42

(a)	27		2	**M1** for 3^{3x} seen
(b)	3		2	**M1** for $7 + 3x = 2^4$
(c)	$\dfrac{x-7}{3}$ oe final answer		2	**M1** for $x = 7 + 3y$ or $y - 7 = 3x$ or $-3x = 7 - y$ or $\dfrac{y}{3} = \dfrac{7}{3} + x$

Question 43

x + 7y			2	**M1** for a correct route

Question 44

(a)	$-\mathbf{s} + \mathbf{t}$		1	
(b)	$-\dfrac{4}{5}\mathbf{s} - \dfrac{1}{5}\mathbf{t}$ oe simplified		3	**M2** for correct unsimplified e.g. $-\mathbf{t} + \dfrac{4}{5}(-\mathbf{s}+\mathbf{t})$ or $-\mathbf{s} - \dfrac{1}{5}(-\mathbf{s}+\mathbf{t})$ or **M1** for a correct route e.g. $\overrightarrow{CB} + \overrightarrow{BN}$ or $[\overrightarrow{BN} =] \dfrac{4}{5}(-\mathbf{s}+\mathbf{t})$ or $[\overrightarrow{DN} =] -\dfrac{1}{5}(-\mathbf{s}+\mathbf{t})$

Question 45

(a)	Rotation 90° clockwise oe (1, 0)		3	**B1** for each
(b)	Enlargement − 2 (0, 2)		3	**B1** for each

Question 46

(a)	$\frac{5}{3}\mathbf{p} - 2\mathbf{q}$ oe simplified		2	**M1** for correct unsimplified answer or $c\mathbf{p} - 2\mathbf{q}$ or $\frac{5}{3}\mathbf{p} + c\mathbf{q}$ $c \neq 0$ or for a correct route
(b)	$\frac{5}{6}$		2	**B2FT** for $\frac{\textit{their } c}{2}$ if *their* **(a)** is $c\mathbf{p} - 2\mathbf{q}$ oe **M1** for $\overrightarrow{MX} = \frac{5}{6}\mathbf{p} - \mathbf{q}$ or $\overrightarrow{MX} = \frac{1}{2}$ *their* **(a)** or $\overrightarrow{BX} = \frac{1}{2}\overrightarrow{AN}$ or $\mathbf{q} + \frac{1}{2}$ *their* **(a)** or $\mathbf{q} + \overrightarrow{MX} - k\mathbf{p} = 0$ oe

Question 47

(a)	$\frac{1}{3}\mathbf{p} - \frac{1}{2}\mathbf{q}$ oe simplified		2	**M1** for a correct unsimplified answer or a correct route
(b)	$\frac{5}{6}\mathbf{p} + \frac{3}{4}\mathbf{q}$ oe simplified		2	**M1** for a correct unsimplified answer or a correct route

Question 48

(a)	$-\frac{1}{3}\mathbf{q} + \frac{1}{2}\mathbf{p}$ oe		2	**M1** for correct unsimplified answer or correct route
(b)	$\frac{1}{2}\mathbf{p} + \frac{1}{2}\mathbf{q}$ oe		2	**M1** for correct unsimplified answer or correct route

Question 49

(a)	19		2	**M1** for $3(2^x) - 5$ soi or for f(8)
(b)	$\dfrac{x+5}{3}$ oe final answer		2	**M1** for correct first step $y + 5 = 3x$ or $\dfrac{y}{3} = x - \dfrac{5}{3}$ or $x = 3y - 5$

Question 50

X, Y and Z are collinear oe	1	Allow in a straight line
X is the midpoint of ZY oe	1	Allow e.g. $ZY = 2XY$, $ZX = XY$ oe

Question 51

(a)	Rotation 90° clockwise oe (0, 2)	3	**B1** for each
(b)	Reflection $y = x$	2	**B1** for each
(c)	Enlargement [sf] $\dfrac{1}{2}$ (4, 6)	3	**B1** for each

Question 52

(a)(i)	$\mathbf{a} - \mathbf{b}$ or $-\mathbf{b} + \mathbf{a}$	2	**B1** for a correct route or identifying $\overrightarrow{OT}$
(a)(ii)	$\dfrac{1}{2}\mathbf{a} - \mathbf{b}$ or $-\mathbf{b} + \dfrac{1}{2}\mathbf{a}$	1	
(b)	$\overrightarrow{PT} = \mathbf{a} - 2\mathbf{b}$ oe	**M1**	
	$\overrightarrow{PT} = 2\overrightarrow{RV}$ oe	**A1**	Dep on correct vector RV Accept in words

Question 53

Enlargement [scale factor] $-\dfrac{1}{2}$ [centre] (3, 4)	3	**B1** for each

Question 54

(a)(i)	$\begin{pmatrix} 15 \\ 21 \end{pmatrix}$	1	
(a)(ii)	26	2	**M1** for $10^2 + (-24)^2$ or better
(b)	$\mathbf{p} + \dfrac{3}{4}\mathbf{q}$	2	**M1** for a correct route or for $\overrightarrow{AE} = \dfrac{3}{4}\mathbf{q}$

Question 55

(a)	$[p =\,] -13$	2	**M1** for $4(5x - 4) + 3$ or better
(b)	$\dfrac{3x+1}{5}$	3	**M2** for $x = \dfrac{3y+1}{5}$, $5y = 3x + 1$ or $y - \dfrac{1}{5} = \dfrac{3x}{5}$ **M1** for $x = \dfrac{5y-1}{3}$, $3y = 5x - 1$ or $y + \dfrac{1}{3} = \dfrac{5x}{3}$

Question 56

(a)	$-\mathbf{a} + \mathbf{b}$	1	
(b)	$2\mathbf{a} - \dfrac{1}{2}\mathbf{b}$	3	**B2** for answer $2\mathbf{a} + p\mathbf{b}$ or $q\mathbf{a} - \dfrac{1}{2}\mathbf{b}\ q \neq \dfrac{1}{2}$ or correct unsimplified answer in terms of **a** and **b** or **M1** for $\overrightarrow{AC} = \dfrac{3}{2}\mathbf{a}$ or $\overrightarrow{OC} = \dfrac{5}{2}\mathbf{a}$ or correct route If 0 scored **SC1** for answer $\mathbf{a} + \dfrac{1}{2}\mathbf{b}$

Question 57

(a)	$\dfrac{5}{6}\,\mathbf{m} - \dfrac{1}{3}\,\mathbf{n}$	3	**B2** for correct unsimplified answer in terms of $\mathbf{m}$ and $\mathbf{n}$ e.g. $\dfrac{1}{3}(\mathbf{m} - \mathbf{n}) + \dfrac{1}{2}\,\mathbf{m}$ or **M1** for a correct route or for $\overrightarrow{FC} = \mathbf{m} - \mathbf{n}$ or $\overrightarrow{CF} = \mathbf{n} - \mathbf{m}$ or better e.g. $\overrightarrow{AC} = \dfrac{1}{3}(\mathbf{m} - \mathbf{n})$
(b)	$\overrightarrow{GH} = 3\overrightarrow{JK}$ oe or $\overrightarrow{GH}$ has a greater magnitude $\overrightarrow{GH}$ and $\overrightarrow{JK}$ are parallel	2	**B1** for each

Question 58

(a)	$[a =]\ 7$	2	**M1** for $3(-2)^2 + a = 19$ or better
'(b)(i)	$6x - 9$ or $3(2x - 3)$ final answer	2	**M1** for $2(3x - 8) + 7$ or better
(b)(ii)	$\dfrac{x - 7}{2}$ final answer	2	**M1** for a correct first step $x = 2y + 7$ or $y - 7 = 2x$ or $\dfrac{y}{2} = x + \dfrac{7}{2}$

Question 59

$\sqrt{2^2 + (-3)^2}$	1	

Question 60

$[\pm]\ 21$	3	**M2** for $29^2 - 20^2$ oe or better or **M1** for $20^2 + k^2 = 29^2$ oe

Question 61

(a)	Translation $\begin{pmatrix} -1 \\ -8 \end{pmatrix}$	2	**B1** for each
(b)	Image at $(-1, -1), (-4, -1), (-1, -2)$	2	**B1** for image correct scale factor and orientation but wrong position or for enlargement scale factor $\dfrac{1}{2}$ centre $(0, 0)$

Question 62

$[x =]$ –2.1 oe		**4**	**M3** for $x^2 + 10x = x^2 - 21$ or better OR

M3 for $x^2 + 10x = x^2 - 21$ or better
OR
M1 for $(x + 1 + 4)^2 - 25$ or better
M1 for $x^2 - 25 + 4$ or better

If 0 scored **SC1** for answer $-\dfrac{11}{6}$ oe

Question 63

$\dfrac{5}{9}\mathbf{a} + \dfrac{4}{9}\mathbf{b}$

2   **M1** for $\dfrac{4}{9}(\mathbf{b} - \mathbf{a})$ or $\dfrac{5}{9}(\mathbf{a} - \mathbf{b})$ or a correct route

Question 64

(a)(i)	Rotation	**3**	**B1** for each
	90° anticlockwise oe		
	(0, − 1)		
(a)(ii)	enlargement	**3**	**B1** for each
	[s.f.] $\dfrac{1}{3}$		
	(6, 6)		
10(b)	triangle at (− 4, 7) (− 4, 1) (− 1, 1)	**2**	**B1** for translation by $\begin{pmatrix} k \\ 10 \end{pmatrix}$ or $\begin{pmatrix} 2 \\ k \end{pmatrix}$

Question 65

$\dfrac{3}{5}\mathbf{r} + \dfrac{2}{5}\mathbf{t}$ or $\dfrac{1}{5}(3\mathbf{r} + 2\mathbf{t})$

3   **M2** for $\mathbf{r} + \dfrac{2}{5}(-\mathbf{r} + \mathbf{t})$ oe or $\mathbf{t} + \dfrac{3}{5}(\mathbf{r} - \mathbf{t})$ oe
or
M1 for $\overrightarrow{RT} = -\mathbf{r} + \mathbf{t}$ oe or $\overrightarrow{TR} = \mathbf{r} - \mathbf{t}$

M1 for $\overrightarrow{OR} + \overrightarrow{RX}$ or $\overrightarrow{OT} + \overrightarrow{TX}$ any other correct route.

Question 66

(a)	32	**2**	**M1** for f(6) = 8 or $\mathrm{ff}(x) = 2^{\left(2^{x-3}\right)-3}$ oe
(b)	$x + 21$	**1**	
(c)	-1	**2**	**M1** for $\dfrac{1}{16}$ oe or 2^{-4} oe

Question 67

(a)	$\mathbf{a} - \dfrac{2}{5}\mathbf{b}$ oe simplified	**2**	**M1** for $-\mathbf{b} + \mathbf{a} + \dfrac{3}{5}\mathbf{b}$ or a correct route
(b)	$\dfrac{5}{2}\mathbf{a}$ oe	**2**	**B1** for $k\mathbf{a}$ where $k > 1$ or $\dfrac{5}{2}\overrightarrow{OR}$

Question 68

(a)(i)	triangle at (− 1, 1) (− 4, 2) (− 3, 5)	**1**	
(a)(ii)	triangle at (− 2, −3) (1, − 2) (0, 1)	**2**	**B1** for translation by $\begin{pmatrix} -3 \\ k \end{pmatrix}$ or by $\begin{pmatrix} k \\ -4 \end{pmatrix}$
(b)	enlargement [sf] $\dfrac{1}{2}$ [centre] (9, − 1)	**3**	**B1** for each

Question 69

(a)	3	**2**	**M1** for $k(-5k)^2 = 675$ or better
(b)	$\dfrac{5}{7x-2}$ final answer	**1**	
(c)	$\dfrac{1}{2}$ or 0.5	**4**	**B3** for answer $\dfrac{7}{14}$ OR **B2** for $\dfrac{5x+2}{7}$ or **M1** for correct first step for $h^{-1}(x)$ e.g. $x = \dfrac{7y-2}{5}$ $\quad 5y = 7x-2$ $y + \dfrac{2}{5} = \dfrac{7x}{5}$ **M1FT** for $\dfrac{2(5x+2)}{14} + \dfrac{3-10x}{14}$ oe with common denominator

Question 70

(a)	$\dfrac{x+8}{7}$ final answer	**2**	**M1** for $x = 7y - 8$ or $y + 8 = 7x$ or $\dfrac{y}{7} = x - \dfrac{8}{7}$
(b)	4	**2**	**M1** for $4 \div \dfrac{1}{3} + 5$ oe or better

Question 71

(a)(i)	$\begin{pmatrix} 3 \\ 4 \end{pmatrix}$	**1**	
(a)(ii)	$\begin{pmatrix} 12 \\ 48 \end{pmatrix}$	**1**	
(b)	5	**2**	**M1** for $(their3)^2 + (their4)^2$ or better

Question 72

$\dfrac{5}{3}\mathbf{a} + \dfrac{1}{3}\mathbf{b}$ final answer	**4**	**M1** for $\overrightarrow{AK} = -\dfrac{1}{3}\mathbf{a} + \dfrac{1}{3}\mathbf{b}$ or $\overrightarrow{BK} = \dfrac{2}{3}\mathbf{a} - \dfrac{2}{3}\mathbf{b}$ **M1** for $\overrightarrow{AL}$ (or $\overrightarrow{OK}$) = $\mathbf{a}$ + *their* $\overrightarrow{AK}$ oe soi or $\overrightarrow{OK}$ (or $\overrightarrow{AL}$) = $\mathbf{b}$ + *their* $\overrightarrow{AK}$ oe soi or $\overrightarrow{BL}$ = $\mathbf{a}$ + *their* $\overrightarrow{AK}$ oe soi **M1** for a correct route e.g. $\overrightarrow{OL}$, $\mathbf{a}$ + $\overrightarrow{AL}$, $\mathbf{b}$ + $\overrightarrow{BL}$

Question 73

Enlargement [sf] $-\dfrac{1}{2}$ [centre] (4, 4)	**3**	**B1** for each

Question 74

(a)	$\dfrac{2}{x-1}$ final answer	**2**	**M1** for $\dfrac{10}{5x - 3 - 2}$ or better
(b)	$\dfrac{10}{x} + 2$ or $\dfrac{10 + 2x}{x}$ final answer	**3**	**M2** for $y - 2 = \dfrac{10}{x}$ or $x = \dfrac{10 + 2y}{y}$ oe or $yx = 10 + 2x$ oe or **M1** for $x = \dfrac{10}{y - 2}$ or $y(x - 2) = 10$ oe or better
(c)	$x - 1$	**1**	

Question 75

(a)	9	**1**	
(b)	$2x - 5$ final answer	**2**	**M1** for correct first step e.g. $x = \dfrac{y + 5}{2}$ or $2y = x + 5$ or $y - \dfrac{5}{2} = \dfrac{x}{2}$ or better

(c) | 11 | 3 | **M1** for $\dfrac{x^2+5}{2}$
| | | **M1** for $hh^{-1}(63) = 63$ soi

Question 76

Rotation
(5, 3)
90° clockwise   oe
| 3 | **B1** for each

Question 77

$\sqrt[3]{x-1}$ or $(x-1)^{\frac{1}{3}}$ | 2 | **M1** for $x = y^3 + 1$ or for $y - 1 = x^3$
or better

Question 78

(a) | $\begin{pmatrix} -3 \\ -2 \end{pmatrix}$ | 1

(b) | $\begin{pmatrix} -2 \\ 6 \end{pmatrix}$ | 1

Question 79

(a) | $6x + 5$ cao final answer | 2 | **M1** for $6(x+2) - 7$ oe

(b) | $\dfrac{x+7}{6}$ or $\dfrac{x}{6} + \dfrac{7}{6}$ final answer | 2 | **M1** for $x = 6y - 7$ or $y + 7 = 6x$ or $\dfrac{y}{6} = x - \dfrac{7}{6}$

(c) | $\dfrac{1}{5}$ or 0.2 | 2 | **M1** for $x^{-3} = 6 \times 22 - 7$ or better

Question 80

$\sqrt{1^2 + (-5)^2}$ | **M2** | **M1** for $\begin{pmatrix} 1 \\ -5 \end{pmatrix}$

or $(5-4)^2 + (3-8)^2$

or $\sqrt{e^2 + f^2}$ from *their* $\overrightarrow{OB} = \begin{pmatrix} e \\ f \end{pmatrix}$

or *their* $B = (e, f)$
or only $\sqrt{1 + 25}$

Correct working leading to 5.09[9..] | **A1** | **Dep.** on **M2** or **M1** for only $\sqrt{1 + 25}$

Question 81

Rotation		**3**	**B1** for each
(0,0) oe			
90° clockwise oe			

Question 82

$\dfrac{x-2}{5}$ oe final answer	**2**	**M1** for a correct first step $x = 5y + 2$ or $y - 2 = 5x$ or $\dfrac{y}{5} = x + \dfrac{2}{5}$

Question 83

(a)	Reflection $y = 2$	**2**	**B1** for each
(b)	Shape at $(-2, -2), (-6, -5), (-6, -3), (-4, -2)$	**2**	**B1** for correct size and orientation but wrong position or for rotation of 90° anticlockwise about $(-1, 2)$ or for three correct vertices
(c)	Shape at $(0, -2), (0, 2), (-2, 6), (-6, 6)$	**2**	**B1** for correct size and orientation but wrong position or for three correct vertices

Question 84

(a)	$\begin{pmatrix} 24 \\ -9 \end{pmatrix}$	**1**	
(b)	$\begin{pmatrix} -4 \\ 32 \end{pmatrix}$	**1**	
(c)	$(9, -7)$	**1**	
(d)	37	**2**	**M1** for $(-12)^2 + 35^2$ oe

Question 85

(a)	6.4[0] or 6.403...	**2**	**M1** for $(-4)^2 + 5^2$ oe
(b)	$2\mathbf{x} - \mathbf{y}$	**1**	

Question 86

(a)	Enlargement [sf] 2 (0, 7)	3	**B1** for each
(b)	Rotation (3, 1) 90° clockwise oe	3	**B1** for each

Question 87

(a)	$\begin{pmatrix} 21 \\ -9 \end{pmatrix}$	1	
(b)	7.62 or 7.615 to 7.616	2	**M1** for $(7)^2 + (-3)^2$ oe If 0 scored **SC1** for 22.8 or 22.84 to 22.85

Question 88

$\mathbf{b} + \dfrac{4}{3}\mathbf{a}$	3	**B2** for correct unsimplified answer or $\overrightarrow{QX} = \dfrac{1}{3}\mathbf{a}$ seen or **B1** for a correct route for $\overrightarrow{OX}$ or answer $\mathbf{b} + k\mathbf{a}$ where $k > 1$ or $\overrightarrow{OK} = \mathbf{a} + \dfrac{3}{4}\mathbf{b}$ seen or $\overrightarrow{QX} = \dfrac{1}{3}\overrightarrow{OP}$ or $\overrightarrow{OX} = \dfrac{4}{3} \times \overrightarrow{OK}$

Question 89

(a)(i)	reflection $x = -2$	2	**B1** for each
(a)(ii)	enlargement [sf] $\frac{1}{2}$ $(-3, -4)$	3	**B1** for each

Question 90

$\begin{pmatrix} -10 \\ 3 \end{pmatrix}$ final answer	1	

Question 91

$\frac{4}{3}\mathbf{p} + \frac{2}{3}\mathbf{q}$ oe	4	**B3** for correct unsimplified answer or for $\overrightarrow{OR} = \mathbf{p} + \frac{1}{3}\mathbf{q} - \frac{1}{3}\mathbf{p}$ oe or **M2** for $\overrightarrow{PR} = \frac{1}{3}(-\mathbf{p} + \mathbf{q})$ oe or $\overrightarrow{QR} = \frac{2}{3}(-\mathbf{q} + \mathbf{p})$ oe or **M1** for $\overrightarrow{PQ} = -\mathbf{p} + \mathbf{q}$ oe or $\overrightarrow{QP} = -\mathbf{q} + \mathbf{p}$ oe or a correct route from O to S.

Question 92

(a)	5	2	**M1** for $3^x + 2 = 245$
(b)	2189	2	**M1** for $x = f(7)$ or $3^7 + 2$

Question 93

(a)	Rotation 90° clockwise oe $(0, -2)$	3	**B1** for each
(b)	Triangle at $(-5, -1), (-5, -7), (-7, -7)$	2	**B1** for enlargement s.f. –2 in wrong position

Question 94

(a)	$\dfrac{1}{2}\mathbf{b} - \dfrac{2}{3}\mathbf{a}$	2	**B1** for answer $\dfrac{1}{2}\mathbf{b} + k\mathbf{a}$ or $j\mathbf{b} - \dfrac{2}{3}\mathbf{a}$ or correct unsimplified in terms of **a** and **b**
(b)	$\dfrac{5}{4}\mathbf{b}$	3	**M2** for $\overrightarrow{RS} = \dfrac{1}{4}\mathbf{b}$ oe or $\overrightarrow{MS} = \dfrac{3}{2}\left(\dfrac{1}{2}\mathbf{b} - \dfrac{2}{3}\mathbf{a}\right)$ oe or $\overrightarrow{NS} = \dfrac{1}{2}\left(\dfrac{1}{2}\mathbf{b} - \dfrac{2}{3}\mathbf{a}\right)$ oe or **M1** for a correct route in terms of vertices and/or **a** and/or **b** or **B1** for answer $j\mathbf{b}$ where $j > 1$ or $\overrightarrow{RS} = \dfrac{1}{2}\overrightarrow{MQ}$, $\overrightarrow{RS} = \dfrac{1}{4}\overrightarrow{OR}$, oe $\overrightarrow{NS} = \dfrac{1}{2}\overrightarrow{MN}$, $\overrightarrow{MS} = \dfrac{3}{2}\overrightarrow{MN}$ $\overrightarrow{NS} = \dfrac{1}{3}\overrightarrow{MS}$

Question 95

(a)	Enlargement [s f] 2 [centre] $(1,-1)$	3	**B1** for each
(b)	image at $(-1, 4)(-1, 5)(1, 4)$	2	**B1** for translation by $\begin{pmatrix} -4 \\ k \end{pmatrix}$ **or** $\begin{pmatrix} k \\ 3 \end{pmatrix}$