

Extended Mathematics
Topic: Vector-Function-Transformation
Year: May 2013 - May 2023

Paper-2

Question 1

		Answers	
(a)	hexagon	1	
(b) (i)	$-b + c$	1	
(ii)	$b - \frac{1}{2}c$	2	B1 for OB + BA or any correct route
(iii)	$-b + c$	1FT	= <i>their</i> (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 $\frac{1}{2(\frac{1}{2x})}$ 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 $(\frac{1}{2})^{-3} = 8$ or $(\frac{1}{2})^x = (\frac{1}{2})^{-3}$ or $2^x = \frac{1}{8}$ oe or $2^{-x} = 2^3$

Question 4

(a) (i)	$p + \frac{1}{2}r$	1	
(ii)	$2p + r$	1ft	$2 \times$ <i>their</i> (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 $2x + 3 = [\pm]10$
(c) $\frac{x-3}{2}$ oe final answer	2	If 0 scored, SC1 for one correct value as answer M1 for $x = 2y + 3$ or $y - 3 = 2x$ or $\frac{y}{2} = x + \frac{3}{2}$ or better
(d) 5	1	

Question 6

(a) $-2a - 2c$ oe	2	M1 for BO = $-a - c$ or for any correct route or correct unsimplified expression
(b) $2a + c$	2	M1 for any correct route or correct unsimplified expression
(c) $-a - c$ oe	2FT	FT <i>their</i> (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 [centre] (1, 0) 180° or half turn	1 1 1	OR enlargement [centre] (1, 0) [scale factor] -1

Question 8

(a) $\mathbf{p} + \mathbf{r}$	1	
(b) $\frac{3}{2} \mathbf{p} + \frac{1}{2} \mathbf{r}$	2	M1 for correct route from O to M or M1 for $\mathbf{p} + \frac{1}{2}\mathbf{r}$ <i>their</i> (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 they share a common point $[A]$	1 1	oe 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)	$\mathbf{b} + \frac{1}{2}\mathbf{a}$	1	
(b)	$[\overrightarrow{OX} =] \mathbf{b} + \frac{1}{3}(-\mathbf{b} + \mathbf{a})$ oe	M1	
	$\frac{1}{3}\mathbf{a} + \frac{2}{3}\mathbf{b}$ oe	A1	
	2 statements from: $\overrightarrow{OM} = \mathbf{b} + \frac{1}{2}\mathbf{a}$ oe	B2	B1 for any one of these statements
	or $[\overrightarrow{OX} =] \frac{2}{3}(\mathbf{b} + \frac{1}{2}\mathbf{a})$ oe		
	or $\overrightarrow{OX} = \frac{2}{3}\overrightarrow{OM}$ oe		

Question 14

(a)	$9x^2$	1	
(b)	$\frac{x-5}{3}$	2	M1 for correct first algebraic step e.g. $y-5=3x$ or $\frac{y}{3}=x+\frac{5}{3}$ 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)	$\frac{5-x}{3}$ final answer oe	2	M1 for correct first step e.g.

Question 16

(a)	$\mathbf{a} + 2\mathbf{b} - \mathbf{a}$ or $\mathbf{a} - (\mathbf{a} - 2\mathbf{b})$ 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 = \mathbf{a} so 2 pairs of parallel sides		

Question 17

(a)	$\frac{1}{3}(-\mathbf{a} + \mathbf{b})$ oe	2	M1 for any correct route eg $AO+OB+\frac{2}{3}BA$ or B1 for $\overrightarrow{AB} = -\mathbf{a} + \mathbf{b}$ oe
(b)	$\frac{2}{3}\mathbf{a} + \frac{1}{3}\mathbf{b}$ oe simplified	2FT	FT <i>their</i> $(\mathbf{a}) + \mathbf{a}$ simplified only if in terms of \mathbf{a} and \mathbf{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

$$\frac{1}{4}\mathbf{a} - \frac{1}{4}\mathbf{b} - \frac{1}{4}\mathbf{c} \text{ oe}$$

2

B1 for $\overline{GK} = \mathbf{a} - \mathbf{b} - \mathbf{c}$ oe soi or $\overline{GL} = \frac{1}{4}(\overline{GK})$
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. $\overline{OC} + \frac{1}{2}\overline{CB}$, \overline{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), $\overline{PO} + \overline{OQ}$

Question 23

(a) $\begin{pmatrix} -7 \\ 3 \end{pmatrix}$

2

M1 for $\overline{CB} = \begin{pmatrix} -2 \\ -3 \end{pmatrix}$

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

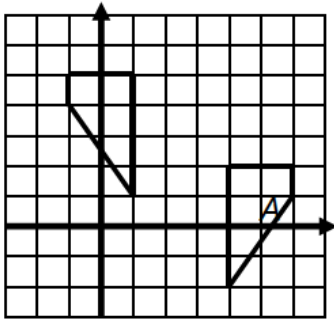
M1 for $y + 7 = 6x$ or $\frac{y}{6} = x - \frac{7}{6}$ or
 $x = 6y - 7$

(c) -2

2

M1 for $[f(13) =] \frac{1}{4}$

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

[s.f.] $\frac{1}{2}$

[centre] $(-1, 3)$

1

1

1

Question 27

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

3

M1 for $PZ = \frac{5}{7}(\mathbf{q} - \mathbf{p})$ oe or $QZ = \frac{2}{7}(\mathbf{p} - \mathbf{q})$ 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)	\overline{CF} and \overline{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 \overline{OK} in terms of \mathbf{a} and \mathbf{b} or M1 for a correct route for \overline{OK} or $\overline{AB} = -\mathbf{a} + \mathbf{b}$ or $\overline{BA} = -\mathbf{b} + \mathbf{a}$ or recognition of \overline{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

i(a) | Enlargement
 [scale factor] 2
 [centre] (7, 0)

3 | **B1** for each

i(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

$\frac{2}{3}\mathbf{p} + \frac{1}{3}\mathbf{q}$

2 | **M1** for correct route e.g. \overrightarrow{OT} or $\overrightarrow{OQ} + \overrightarrow{QT}$
 or for $\overrightarrow{QT} = \frac{2}{3}(-\mathbf{q} + \mathbf{p})$ oe or for $\overrightarrow{PT} = \frac{1}{3}(-\mathbf{p} + \mathbf{q})$ 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) | $\frac{5-x}{2}$ oe final answer

2 | **M1** for $x = 5 - 2y$ or $2x = 5 - y$ or
 $y - 5 = -2x$ or $\frac{y}{2} = \frac{5}{2} - x$

Question 40

(a) | $\mathbf{c} + \frac{2}{3}\mathbf{a}$

2 | **M1** for correct unsimplified form or correct route e.g. $\overrightarrow{OC} + \overrightarrow{CP}$

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

Question 41

(a)(i)	$5x^3 + 2$ final answer	1	
(a)(ii)	$\frac{x-2}{5}$ final answer	2	M1 for correct first step e.g. $y - 2 = 5x$, $x = 5y + 2$, $\frac{y}{5} = x + \frac{2}{5}$
(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)	$\frac{x-7}{3}$ oe final answer	2	M1 for $x = 7 + 3y$ or $y - 7 = 3x$ or $-3x = 7 - y$ or $\frac{y}{3} = \frac{7}{3} + x$

Question 43

$\mathbf{x} + 7\mathbf{y}$

2 | M1 for a correct route

Question 44

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

Question 45

i(a)	Rotation 90° clockwise oe (1, 0)	3	B1 for each
i(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 $\frac{\text{their } c}{2}$ if their (a) is $c\mathbf{p} - 2\mathbf{q}$ oe M1 for $\overrightarrow{MX} = \frac{5}{6}\mathbf{p} - \mathbf{q}$ or $\overrightarrow{MX} = \frac{1}{2}\text{their (a)}$ or $\overrightarrow{BX} = \frac{1}{2}\overrightarrow{AN}$ or $\mathbf{q} + \frac{1}{2}\text{their (a)}$ 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

i(a)	$-\frac{1}{3}\mathbf{q} + \frac{1}{2}\mathbf{p}$ oe	2	M1 for correct unsimplified answer or correct route
i(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)	$\frac{x+5}{3}$ oe final answer	2	M1 for correct first step $y+5=3x$ or $\frac{y}{3}=x-\frac{5}{3}$ 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] $\frac{1}{2}$ (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 \overline{OT}
(a)(ii)	$\frac{1}{2}\mathbf{a} - \mathbf{b}$ or $-\mathbf{b} + \frac{1}{2}\mathbf{a}$	1	
(b)	$\overline{PT} = \mathbf{a} - 2\mathbf{b}$ oe	M1	
	$\overline{PT} = 2\overline{RV}$ oe	A1	Dep on correct vector RV Accept in words

Question 53

Enlargement [scale factor] $-\frac{1}{2}$ [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)	$\mathbf{p} + \frac{3}{4} \mathbf{q}$	2	M1 for a correct route or for $\overline{AE} = \frac{3}{4} \mathbf{q}$

Question 55

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

Question 56

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

Question 57

(a)	$\frac{5}{6} \mathbf{m} - \frac{1}{3} \mathbf{n}$	3	B2 for correct unsimplified answer in terms of m and n e.g. $\frac{1}{3} (\mathbf{m} - \mathbf{n}) + \frac{1}{2} \mathbf{m}$ or M1 for a correct route or for $\overline{FC} = \mathbf{m} - \mathbf{n}$ or $\overline{CF} = \mathbf{n} - \mathbf{m}$ or better e.g. $\overline{AC} = \frac{1}{3} (\mathbf{m} - \mathbf{n})$
(b)	$\overline{GH} = 3 \overline{JK}$ oe or \overline{GH} has a greater magnitude \overline{GH} and \overline{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)	$\frac{x-7}{2}$ final answer	2	M1 for a correct first step $x = 2y + 7$ or $y - 7 = 2x$ or $\frac{y}{2} = x + \frac{7}{2}$

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 $\frac{1}{2}$ centre $(0, 0)$

Question 62

$$[x =] -2.1 \text{ oe}$$

4 **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 $-\frac{11}{6}$ oe

Question 63

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

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

Question 64

(a)(i) | Rotation
 | 90° anticlockwise oe
 | (0, -1)

3 **B1** for each

(a)(ii) | enlargement
 | [s.f.] $\frac{1}{3}$
 | (6, 6)

3 **B1** for each

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

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

3 **M2** for $\mathbf{r} + \frac{2}{5}(-\mathbf{r} + \mathbf{t})$ oe or $\mathbf{t} + \frac{3}{5}(\mathbf{r} - \mathbf{t})$
 oe
 or
M1 for $\overline{RT} = -\mathbf{r} + \mathbf{t}$ oe or $\overline{TR} = \mathbf{r} - \mathbf{t}$
M1 for $\overline{OR} + \overline{RX}$ or $\overline{OT} + \overline{TX}$ any other correct route.

Question 66

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

Question 67

(a)	$a - \frac{2}{5}b$ oe simplified	2	M1 for $-b + a + \frac{3}{5}b$ or a correct route
(b)	$\frac{5}{2}a$ oe	2	B1 for ka where $k > 1$ or $\frac{5}{2}\overline{\text{OR}}$

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] $\frac{1}{2}$ [centre] $(9, -1)$	3	B1 for each

Question 69

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

Question 70

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

$$\frac{5}{3}\mathbf{a} + \frac{1}{3}\mathbf{b} \text{ final answer}$$

4 **M1** for $\overrightarrow{AK} = -\frac{1}{3}\mathbf{a} + \frac{1}{3}\mathbf{b}$ or $\overrightarrow{BK} = \frac{2}{3}\mathbf{a} - \frac{2}{3}\mathbf{b}$

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] $-\frac{1}{2}$

[centre] (4, 4)

3 **B1** for each

Question 74

(a)	$\frac{2}{x-1}$ final answer	2	M1 for $\frac{10}{5x-3-2}$ or better
(b)	$\frac{10}{x} + 2$ or $\frac{10+2x}{x}$ final answer	3	M2 for $y-2 = \frac{10}{x}$ or $x = \frac{10+2y}{y}$ oe or $yx = 10 + 2x$ oe or M1 for $x = \frac{10}{y-2}$ 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. $x = \frac{y+5}{2}$ or $2y = x+5$ or $y - \frac{5}{2} = \frac{x}{2}$ or better
(c)	11	3	M1 for $\frac{x^2+5}{2}$ 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) $\frac{x+7}{6}$ or $\frac{x}{6} + \frac{7}{6}$ final answer

2 | M1 for $x = 6y - 7$ or $y + 7 = 6x$ or $\frac{y}{6} = x - \frac{7}{6}$

(c) $\frac{1}{5}$ 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 $\overline{OB} = \begin{pmatrix} e \\ f \end{pmatrix}$

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

$$\frac{x-2}{5} \text{ oe final answer}$$

2 | **M1** for a correct first step

$$x = 5y + 2 \text{ or } y - 2 = 5x \text{ or } \frac{y}{5} = x + \frac{2}{5}$$

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)	$2x - y$	1	

Question 86

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

