Vectors & Matrices – Paper 4 – Mark Scheme

Question 1

2 (a) (i)	$\begin{pmatrix} 15 \\ 8 \end{pmatrix}$	2	**B1** each component
(ii)	17 www 2	2ft	**ft** their 15 and their 8. **M1** for (their 15)^2 + (their 8)^2
(b) (i)	$\frac{1}{2}\mathbf{v} - \frac{1}{2}\mathbf{c}$ or $\frac{1}{2}(\mathbf{v} - \mathbf{c})$ cao	2	**M1** for $\frac{1}{2}\overrightarrow{CV}$ soi
(ii)	$\frac{1}{2}\mathbf{c} + \frac{1}{2}\mathbf{v}$ again allowing brackets cao	2	**M1** for $\overrightarrow{OM}$ e.g. $\overrightarrow{OC} + \overrightarrow{CM}$ or better seen or $\mathbf{v}$ – their **(i)** or $\mathbf{c}$ + their **(i)**
(iii)	$\frac{1}{6}\mathbf{v} - \frac{1}{2}\mathbf{c}$ again allowing brackets cao	2	**M1** for any correct route e.g. $\overrightarrow{MV} + \overrightarrow{VL}$ or their **(i)** – $\frac{1}{3}\mathbf{v}$ or $\frac{2}{3}\mathbf{v}$ – their **(b)(ii)**

Question 2

7			The marks for the reasons are **dependent** on the correct angle or correct ft angle Any incorrect statement in reason loses that mark
	(a) $w = 59$ (angle in) isosceles (triangle)	1 1	
	$x = 31$ (angle in) semicircle (= 90) oe	1ft 1	ft 90 – their w Allow diameter
	$y = 62$ (angles in) same segment or (on) same arc (are =)	1 1	
	$z = 28$ (angles in) triangle (= 180)	1ft 1	ft 180 – their($w + x + y$) or 90 – their y
	(b) (i) $\begin{pmatrix} 2 \\ 3 \end{pmatrix}$	1	
	(ii) $\begin{pmatrix} -2 \\ 4 \end{pmatrix}$	2ft	ft $\begin{pmatrix} 0 \\ 7 \end{pmatrix}$ – their **(i)** **B1** ft for one correct element
	(c) (i) $\frac{1}{3}\mathbf{t}$ final answer	1	
	(ii) $\frac{1}{3}(-\mathbf{t} + \mathbf{r})$ final answer	2	**M1** for correct unsimplified answer or $\overrightarrow{TR} = -\mathbf{t} + \mathbf{r}$ oe or $\overrightarrow{TP} = \frac{1}{3}\overrightarrow{TR}$ oe
	(iii) $\frac{1}{3}\mathbf{r}$ final answer	2	**M1** for correct unsimplified answer or $\overrightarrow{QT} + \overrightarrow{TP}$ oe for any correct path or $\frac{1}{3}\mathbf{t} +$ their **(ii)**
	(iv) $QP = \frac{1}{3}OR$ oe	1dep	**Dependent** on correct answer in **(iii)**
	QP is parallel to OR or $\mathbf{r}$	1dep	**Dependent** on multiple of $\mathbf{r}$ as answer in **(iii)**

Question 3

4	**(a) (i)** $\begin{pmatrix} 25 \\ 43 \end{pmatrix}$	1 1	If 0, 0 then **SC1** for 25 and 43 seen
	(ii) (16)	2	**B1** for 16 without brackets
	(iii) $\frac{1}{-2}\begin{pmatrix} 5 & -3 \\ -4 & 2 \end{pmatrix}$ isw or $\begin{pmatrix} -\frac{5}{2} & \frac{3}{2} \\ 2 & -1 \end{pmatrix}$	2	**B1** for determinant = –2 or **B1** for $k\begin{pmatrix} 5 & -3 \\ -4 & 2 \end{pmatrix}$
	(b) Reflection only	1	If more than one transformation given – no marks available
	x-axis oe	1	independent
	(c) $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$	2	**B1** for one correct column

Question 4

9	(a)	(i)	$\begin{pmatrix} 9 \\ 5 \end{pmatrix}$	1	
		(ii)	$\begin{pmatrix} 4 \\ 7 \end{pmatrix}$	1 1	If 0, **SC1** for $\overrightarrow{CB} = \begin{pmatrix} 5 \\ -2 \end{pmatrix}$ seen
		(iii)	$\overrightarrow{BA}$ or $-\overrightarrow{AB}$	1	BA not indicated as a vector is not enough.
		(iv)	10.3 (10.29 – 10.30)	2	**M1** for (their 9)^2 + (their 5)^2
	(b)	(i)	**2u**	1	
		(ii)	$\frac{1}{2}(\mathbf{t} - \mathbf{u})$ oe	2	**M1** for $\frac{1}{2}$ (their $\overrightarrow{BA} + \overrightarrow{AD} + \overrightarrow{DC}$) or equivalent correct route for $\overrightarrow{BM}$, along obtainable vectors in terms of **t** and **u** or **M1** for correct unsimplified answer
		(iii)	$\frac{3}{2}\mathbf{u} + \frac{1}{2}\mathbf{t}$ oe ft	2ft	ft their **(i)** + their **(ii)** simplified or **t** + **u** – their **(b)(ii)** simplified **M1** for correct (or ft) unsimplified **(i)** + **(ii)** or **t** + **u** – their **(b)(ii)**

Question 5

10 (a)	(i)	(a)	**p** + **q**	1	
		(b)	$\frac{1}{2}\mathbf{p} - \frac{1}{2}\mathbf{q}$ oe	2	M1 for $\overrightarrow{LC} + \overrightarrow{CM}$ o.e. can be written in terms of **p** and/or **q**
		(c)	$\frac{3}{4}\mathbf{p} + \frac{3}{4}\mathbf{q}$ oe cao	2	M1 for $\overrightarrow{AD} + \overrightarrow{DL} + \overrightarrow{LN}$ o.e can be written in terms of **p** and/or **q** ft their **(i)(b)**
	(ii)		$\overrightarrow{AN}$ is a multiple of $\overrightarrow{AC}$ o.e	1	Must be vectors (dependent on answers to **(a)**, **(c)**)
	(b)	(i)	30	2	M1 for $2x + x + 15 + 75 = 180$ or better
		(ii)	135	1ft	ft 165 – their x but only if final answer obtuse

Question 6

11	(a)	(i)	$\begin{pmatrix} 8 \\ 1 \end{pmatrix}$	1	
		(ii)	Point (3, 4) indicated	1	
		(iii)	$\begin{pmatrix} -3 \\ 1 \end{pmatrix}$	1	
	(b)	(i)	$-\frac{5}{12}\mathbf{u} + \frac{2}{3}\mathbf{v}$ oe 2 terms	4	**M1** for any correct route L to K e.g. $LU + UK$ and **B1** for $LU = \mathbf{u}/4$ oe or $OL = \frac{3}{4}\mathbf{u}$ oe and **B1** for $UK = 2/3\ (\mathbf{v} - \mathbf{u})$ oe or $VK = 1/3(\mathbf{u} - \mathbf{v})$ oe all **B**s are soi
		(ii)	$\frac{13}{24}\mathbf{u} + \frac{1}{3}\mathbf{v}$ oe 2 terms	2	**M1** for correct route from O to M e.g. $OL + LM$ (can be in terms of **u**, **v**)

Question 7

7 (a)	$(5, 3)$	1		
(b) (i)	$3\mathbf{a} + \mathbf{c}$	1		
(ii)	$3\mathbf{a} + \frac{1}{2}\mathbf{c}$ or $\frac{1}{2}(6\mathbf{a} + \mathbf{c})$	2	**M1** for $\overrightarrow{OM}$ oe e.g $OA+AM$ or correct unsimplified answer	
(iii)	$\mathbf{a} + \mathbf{c}$	1		
(iv)	$\frac{3}{2}\mathbf{a} + \frac{1}{2}\mathbf{c}$ or $\frac{1}{2}(3\mathbf{a} + \mathbf{c})$	2	**M1** for $-\mathbf{c} + \frac{3}{2}\times$ their (iii) or $\mathbf{a} + \frac{1}{2}\times$ their (iii) or correct unsimplified answer or any correct route e.g. $CE + ED$	
(c)	(CD) parallel (to OB) oe cao	1dep	Part (c) dependent on simplified (i) and (iv) Dep on (i) = $k \times$ (iv)	
	$CD = \frac{1}{2} OB$ oe cao	1dep	Dep on (i) = 2 $\times$ (iv) must be scalars	

Question 8

6	(a) (i)	$\begin{pmatrix} -2 \\ -1 \end{pmatrix}$	1	
	(ii)	7.28 [0] or $\pm\sqrt{53}$ as final answer	2	**M1** for $\sqrt{2^2 + (-7^2)}$ oe
	(iii)	[$m =$] 3.5 oe and [$n =$] -1.5 oe	6	**B1** for $-2m + 2n = -10$ oe and **B1** for $3m - 7n = 21$ oe and **M1** for correct attempt to equate one set of coefficients and **M1dep** for elimination allow 1 arithmetic error overall ft their sim eqns for both m's or **M1** for correct rearrangement (allow 1 slip) and **M1dep** for correct substitution ft their sim eqns for both m's and **A1** for 3.5 or -1.5
	(b) (i)	$-\mathbf{p} + \mathbf{q}$	1	Condone column vector used
	(ii)	$-\frac{3}{5}\mathbf{p} + \frac{3}{5}\mathbf{q}$ oe	1 FT	Correct or ft $\frac{3}{5}$ (their (b)(i)) dep on $a\mathbf{p} + b\mathbf{q}$, [$a \neq 0, b \neq 0$] Condone column vector used
	(iii)	Parallel	1	
		similar	1	Accept enlargement
		9 : 25 oe	1	e.g 1 : 2.77 [7] or 0.36 : 1

Question 9

6	(a)	5.83 or 5.830 to 5.831	2	Allow $\sqrt{34}$ as final answer **M1** for $(3^2 + ([-]5)^2)$
	(b) (i)	Vector drawn from P to Q at $(14, 3)$	1	Must have arrow in correct direction
	(ii)	Points at $(8, 11)$ and $(13, 14)$	1, 1	**SC1** for points at $(8, 5)$ and $(3, 2)$
	(c)	$3\mathbf{a} - 2\mathbf{b}$	2	**M1** for $\mathbf{a} - 3\mathbf{b} + 2\mathbf{a} + \mathbf{b}$ or $\overrightarrow{CD} + \overrightarrow{DE}$ oe Allow mixtures of vector notation.
	(d)	$\begin{pmatrix} 7 \\ -6 \end{pmatrix}$	1 1	
	(e) (i)	$\mathbf{b} - \mathbf{c}$ oe	1	Allow unsimplified

	(ii)	$MX = MB + BX$	**M1**	Any order for the M marks For a correct route
		$\pm \frac{1}{4}$ or $\pm \frac{3}{4}$ used	**M1**	
		$\frac{3}{4}\mathbf{c} - \frac{1}{4}\mathbf{b}$ or $\frac{1}{4}(3\mathbf{c} - \mathbf{b})$ or $\dfrac{3\mathbf{c}}{4} - \dfrac{\mathbf{b}}{4}$	**A2**	**A1** for $\frac{1}{2}\mathbf{b} + \frac{3}{4}(\mathbf{c} - \mathbf{b})$ oe Any correct unsimplified After **0** scored **SC2** for $2/3\mathbf{c} - 1/6\mathbf{b}$

Question 10

7	(a) (i)	$\begin{pmatrix} 15 \\ 21 \end{pmatrix}$	1	
	(ii)	not possible oe	1	
	(iii)	(2) final answer	2	**M1** for $30 - 28$
	(iv)	$\begin{pmatrix} 4 & 13 \\ 0 & 0 \end{pmatrix}$	1	
	(v)	$\begin{pmatrix} -5 & -9 \\ 1 & 0 \end{pmatrix}$	2	**B1** for one correct row or column
	(b)	$\dfrac{1}{2}\begin{pmatrix} 3 & -4 \\ -1 & 2 \end{pmatrix}$ or better isw	2	**B1** for $k\begin{pmatrix} 3 & -4 \\ -1 & 2 \end{pmatrix}$ seen or implied or $\dfrac{1}{2}\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ seen

Question 11

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

Question 12

				Answers	Mark	Part Marks
7	(a)	(i)		$\dfrac{3}{2}$ or 1.5	2	**M1** for $\dfrac{14 - (-4)}{8 - (-4)}$ oe
		(ii)		$y = \dfrac{3}{2}x + 2$ oe	2	**B1** for $y = their\ \dfrac{3}{2}x + c$ o.e. or $y = mx + 2,\ m \neq 0$ **SC1** for $\dfrac{3}{2}x + 2$
		(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)	$\dfrac{1}{5}(6\mathbf{b} - 8\mathbf{a})$ oe simplified	2	**M1** for $\dfrac{1}{5}(12\mathbf{a} + 6\mathbf{b}) - 4\mathbf{a}$ or $AR = AO + OR$
			(c)	$6\mathbf{a} + 3\mathbf{b}$ oe simplified	1	
		(ii)		OR is parallel to OT	1	Dep on $\overrightarrow{OT}$ correct
		(iii)		$\dfrac{9}{4}$ or 2.25	2	**M1** for $\left(\dfrac{3}{2}\right)^2$

Question 13

1	(a)	(i)	$\begin{pmatrix} 6 & 4 \\ -2 & 2 \end{pmatrix}$	1	
		(ii)	Not possible	1	
		(iii)	$\begin{pmatrix} 6 & 4 \\ -2 & 2 \end{pmatrix}$	2	**B1** for one row or column correct
		(iv)	$\dfrac{1}{5}\begin{pmatrix} 1 & -2 \\ 1 & 3 \end{pmatrix}$ oe isw	2	**B1** for $\dfrac{1}{5}\begin{pmatrix} a & c \\ b & d \end{pmatrix}$ seen or $k\begin{pmatrix} 1 & -2 \\ 1 & 3 \end{pmatrix}$ seen
	(b)		1 column in **C** and 2 rows in **D**	1	Any clear indication
	(c)		Enlargement	1	
			[Factor] 2	1	
			[Centre] (0, 0) oe	1	

Question 14

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

Question 15

5	(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**	
			$\overrightarrow{MS} = -\dfrac{2}{3}\mathbf{p} + \dfrac{4}{3}\mathbf{q}$ seen or $\overrightarrow{SM} = \dfrac{2}{3}\mathbf{p} - \dfrac{4}{3}\mathbf{q}$ seen or $\overrightarrow{RM} = \dfrac{2}{3}(-2\mathbf{p} + \mathbf{q})$ soi or $\overrightarrow{MR} = \dfrac{2}{3}(2\mathbf{p} - \mathbf{q})$ soi or $\overrightarrow{MQ} = \dfrac{1}{3}(-2\mathbf{p} + \mathbf{q})$ soi or $\overrightarrow{QM} = \dfrac{1}{3}(2\mathbf{p} - \mathbf{q})$ soi	**B1**	
			$\overrightarrow{PM} = \mathbf{p} + \overrightarrow{RM}$ or $\mathbf{p} - \overrightarrow{MR}$ or $-\mathbf{p} + \mathbf{q} + \overrightarrow{QM}$ or $-\mathbf{p} + \mathbf{q} - \overrightarrow{MQ}$ $[= -\dfrac{1}{3}\mathbf{p} + \dfrac{2}{3}\mathbf{q}]$	**M1**	Any correct route for $\overrightarrow{PM}$ eg $\overrightarrow{PR} + \overrightarrow{RM}$
			$1 : 3$ nfww	**A1**	After 0 scored, **SC1** for $1 : 3$

Question 16

8	(a)		$2\mathbf{c} + 3\mathbf{b}$	2	**M1** for $\overrightarrow{OQ}$ recognised as pos vector.
	(b)	(i)	$3\mathbf{c} - 6\mathbf{a}$ or $3(\mathbf{c} - 2\mathbf{a})$	1	
		(ii)	$2\mathbf{c} - 4\mathbf{a}$ or $2(\mathbf{c} - 2\mathbf{a})$	2	**M1** for any valid route from P to Q e.g. $\quad -(3\mathbf{b} - 2\mathbf{a}) - 6\mathbf{a} + their\,\overrightarrow{OQ}$ $\quad$ or $\overrightarrow{PQ} = \overrightarrow{PA} + \overrightarrow{AO} + \overrightarrow{OQ}$ $\quad$ or $\overrightarrow{PQ} = \overrightarrow{PB} + \overrightarrow{BQ}$
	(c)		$PQ = \dfrac{2}{3}AC$ oe and PQ is parallel to AC	2FT	**STRICT FT** dep on $\overrightarrow{PQ} = k\overrightarrow{AC}$ from **(b)(i)** and **(b)(ii)** **B1FT** for each statement After **0** scored and $\overrightarrow{PQ} = k\overrightarrow{AC}$ in **(b)(i)** and **(ii)**, allow **SC1FT** for correct statement, e.g. PQ is not parallel to AC

Question 17

5	(a)	(i)	$\begin{pmatrix} 0 & -4 \\ 4 & 0 \end{pmatrix}$	1	
		(ii)	$\begin{pmatrix} -1 & 1 \\ 1 & -1 \end{pmatrix}$	1	
		(iii)	$\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$	2	**B1** for three correct elements
		(iv)	$\begin{pmatrix} -13 \\ 5 \end{pmatrix}$	2	**B1** for either correct in this form
	(b)		$\begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}$	3	**M1** for understanding to find the inverse of **Q** and **M1** for det $= 1$ or for $k\begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}$ $k \neq 0$ Alternative $\begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} a & b \\ c & d \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ Leading to $a - 2c = 1$ and $c = 0$ then $a = 1$ and $b - 2d = 1$ and $d = 1$ then $b = 2$ **M2** all four equations, **M1** for a pair of correct equations

Question 18

10	(a)	(i)	$9.43[\ldots]$	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 $\mathbf{a}+\frac{1}{2}AB$ oe, e.g $\mathbf{a}+AM$, $OA+\frac{1}{2}AB$
			(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 $[AN=]-\mathbf{a}+\frac{1}{3}\mathbf{b}$ **A1** for $\frac{1}{4}:\frac{1}{3}$ oe or $AN=\frac{1}{3}(-3\mathbf{a}+\mathbf{b})$ or $3k$ to $4k$ After **0** scored **SC1** for final answer 4 : 3
	(c)	(i)	Triangle drawn at $(-3,-3),(-6,-3),(-6,-4\frac{1}{2})$	3	**B2** for 2 vertices correct in triangle or 3 correct co-ordinates soi in working or **B1** for 1 vertex in triangle correct soi or triangle of correct size and orientation but wrong position or **M1** for correct set up e.g. $\begin{pmatrix} -1.5 & 0 \\ 0 & -1.5 \end{pmatrix}\begin{pmatrix} 2 & 4 & 4 \\ 2 & 2 & 3 \end{pmatrix}$
		(ii)	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	2	**SC1** for 1 correct row or column or for $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$

Question 19

9	(a)	$\begin{pmatrix} 2 & 13 \\ 1 & 14 \end{pmatrix}$	2	**SC1** for one correct column or row
	(b)	$\frac{1}{3}\begin{pmatrix} 3 & -2 \\ 0 & 1 \end{pmatrix}$ oe isw	2	**B1** for $k\begin{pmatrix} 3 & -2 \\ 0 & 1 \end{pmatrix}$ oe for $k \neq 0$ or $\frac{1}{3}\begin{pmatrix} a & c \\ b & d \end{pmatrix}$
	(c)	$[u=]\,3$ $[v=]\,2$	3	**B2** for two of $3=u, 2u+3v=4u, 4=2+v, u+4v=3+4v$ or **B1** for one or **M1** for $\begin{pmatrix} 2 & 3 \\ 1 & 4 \end{pmatrix}\begin{pmatrix} 0 & u \\ 1 & v \end{pmatrix}=\begin{pmatrix} 0 & u \\ 1 & v \end{pmatrix}\begin{pmatrix} 2 & 3 \\ 1 & 4 \end{pmatrix}$ **B1** for $\begin{pmatrix} 3 & 2u+3v \\ 4 & u+4v \end{pmatrix}$ or $\begin{pmatrix} u & 4u \\ 2+v & 3+4v \end{pmatrix}$
	(d)	12 nfww	2	**M1** for $w \times 2 - 8 \times 3\,[=0]$ oe

Question 20

Qu	Answers	Mark	Part Marks
10 (a)	$\mathbf{b} - \mathbf{a}$ or $-\mathbf{a} + \mathbf{b}$	1	
(b)	$\frac{4}{5}\mathbf{b} - \frac{3}{10}\mathbf{a}$ or $\frac{1}{10}(8\mathbf{b} - 3\mathbf{a})$	4	**B3** for correct unsimplified expression in **a** and **b** **or** **M1** for $\overrightarrow{XA} + \overrightarrow{AC} + \overrightarrow{CM}$ or $\overrightarrow{XB} + \overrightarrow{BM}$ or $-\frac{1}{5}$ (*their* (**a**)) $+ \mathbf{b} - \frac{1}{2}\mathbf{a}$ or $\frac{4}{5}$ (*their* (**a**)) $+ \frac{1}{2}\mathbf{a}$ **and M1** indep for $\pm\frac{1}{5}$ oe or $\pm\frac{4}{5}$ oe used After zero scored, **SC2** for answer $\frac{1}{4}(3\mathbf{b} - \mathbf{a})$ or $\frac{3}{4}\mathbf{b} - \frac{1}{4}\mathbf{a}$

Question 21

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

Question 22

7	(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 23

8	(a)	(i)	Not possible	1	
		(ii)	$\begin{pmatrix} 4 & 0 \\ -2 & 10 \\ 6 & -8 \end{pmatrix}$ final answer	1	
		(iii)	$\begin{pmatrix} 14 & 35 \\ -8 & -20 \end{pmatrix}$ final answer	2	**M1** for one correct column or row
		(iv)	(−6) final answer	2	**M1** for 14 − 20
		(v)	$\begin{pmatrix} -2 & 18 \\ -6 & 22 \end{pmatrix}$ final answer	2	**M1** for one correct column or row
	(b)		$\frac{1}{8}\begin{pmatrix} 5 & -3 \\ 1 & 1 \end{pmatrix}$ or better isw	2	**B1** for $k\begin{pmatrix} 5 & -3 \\ 1 & 1 \end{pmatrix}$ seen or implied, $k \neq 0$ or $\frac{1}{8}\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ seen

Question 24

11(a)(i)	$\begin{pmatrix} 1 & -18 \\ 6 & 13 \end{pmatrix}$	2	**M1** for two or three correct elements
11(a)(ii)	$\frac{1}{11}\begin{pmatrix} 4 & 3 \\ -1 & 2 \end{pmatrix}$ or better isw	2	**M1** for det = 11 or $[k]\begin{pmatrix} 4 & 3 \\ -1 & 2 \end{pmatrix}$ isw
11(b)	Reflection	1	
	y-axis oe	1	
11(c)	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	2	**B1** for one correct column or row
11(d)(i)	$\frac{1}{7}(4\mathbf{a} + 3\mathbf{b})$ or $\frac{4}{7}\mathbf{a} + \frac{3}{7}\mathbf{b}$	3	**M2** for correct unsimplified answer seen or $\overrightarrow{AP} = \frac{3}{7}(\mathbf{b} - \mathbf{a})$ oe or $\overrightarrow{BP} = \frac{4}{7}(\mathbf{a} - \mathbf{b})$ oe or **M1** for $\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$ or $\overrightarrow{BA} = \mathbf{a} - \mathbf{b}$ or correct route for $\overrightarrow{OP}$
11(d)(ii)	$[m =] \dfrac{7}{3}$ $[k =] \dfrac{4}{3}$	2	**B1** for each value or **M1** for $\frac{m}{7}(4\mathbf{a} + 3\mathbf{b}) = \mathbf{b} + k\mathbf{a}$ oe

Question 25

11(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 $(their 12)^2 + (their - 4)^2$
11(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 $[\overrightarrow{BA} =]\begin{pmatrix} -8 \\ 7 \end{pmatrix}$
11(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
11(c)(i)	$\begin{pmatrix} 9 & 50 \\ 10 & 69 \end{pmatrix}$	2	**B1** for 2 correct elements
11(c)(ii)	$\frac{1}{11}\begin{pmatrix} 8 & -5 \\ -1 & 2 \end{pmatrix}$ oe isw	2	**B1** for $k\begin{pmatrix} 8 & -5 \\ -1 & 2 \end{pmatrix}$ or $\frac{1}{11}\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ or det = 11 soi

Question 26

2(a)(i)	$\begin{pmatrix} 6 \\ 17 \end{pmatrix}$	2	**B1** for each
2(a)(ii)	6.4[0] or 6.403...	2	**M1** for $4^2 + 5^2$
2(b)	(1, 2)	1	
2(c)	(0, −2)	1	
2(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