Jan 2009 Q7

Question Number	Scheme	Marks
7 (a)	The determinant is a - 2	M1
	$\mathbf{X}^{-1} = \frac{1}{a-2}\begin{pmatrix} -1 & -a \\ 1 & 2 \end{pmatrix}$	M1 A1 (3)
(b)	$\mathbf{I} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	B1
	Attempt to solve $2 - \frac{1}{a-2} = 1$, or $a - \frac{a}{a-2} = 0$, or $-1 + \frac{1}{a-2} = 0$, or $-1 + \frac{2}{a-2} = 1$	M1
	To obtain a =3 only	A1 cso (3) [6]
	Alternatives for (b) If they use $\mathbf{X}^2 + \mathbf{I} = \mathbf{X}$ they need to identify **I** for B1, then attempt to solve suitable equation for M1 and obtain $a = 3$ for A1 If they use $\mathbf{X}^2 + \mathbf{X}^{-1} = \mathbf{O}$, they can score the B1then marks for solving If they use $\mathbf{X}^3 + \mathbf{I} = \mathbf{O}$ they need to identify **I** for B1, then attempt to solve suitable equation for M1 and obtain $a = 3$ for A1	

Notes:

(a) Attempt *ad-bc* for first M1

$\frac{1}{\det}\begin{pmatrix} -1 & -a \\ 1 & 2 \end{pmatrix}$ for second M1

(b) Final A1 for correct solution only

Jan 2009 Q10

Question Number	Scheme	Marks
10 (a)	**A** represents an enlargement scale factor $3\sqrt{2}$ (centre O)	M1 A1
	B represents reflection in the line $y = x$	B1
	C represents a rotation of $\frac{\pi}{4}$, i.e.45° (anticlockwise) (about O)	B1 (4)
(b)	$\begin{pmatrix} 3 & -3 \\ 3 & 3 \end{pmatrix}$	M1 A1 (2)
(c)	$\begin{pmatrix} 3 & -3 \\ 3 & 3 \end{pmatrix}\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} -3 & 3 \\ 3 & 3 \end{pmatrix}$	B1 (1)
(d)	$\begin{pmatrix} -3 & 3 \\ 3 & 3 \end{pmatrix}\begin{pmatrix} 0 & -15 & 4 \\ 0 & 15 & 21 \end{pmatrix} = \begin{pmatrix} 0 & 90 & 51 \\ 0 & 0 & 75 \end{pmatrix}$ so (0, 0), (90 , 0) and (51 , 75)	M1A1A1A1 (4)
(e)	Area of $\Delta\, OR'S'$ is $\frac{1}{2} \times 90 \times 75 = 3375$	B1
	Determinant of **E** is –18 or use area scale factor of enlargement So area of $\Delta\, ORS$ is $3375 \div 18 = 187.5$	M1A1 (3) [14]

Notes:

(a) Enlargement for M1
$3\sqrt{2}$ for A1

(b) Answer incorrect, require **CD** for M1

(c) Answer given so require **DB** as shown for B1

(d) Coordinates as shown or written as $\begin{pmatrix} 0 \\ 0 \end{pmatrix}$, $\begin{pmatrix} 90 \\ 0 \end{pmatrix}$, $\begin{pmatrix} 51 \\ 75 \end{pmatrix}$ for each A1

(e) 3375 B1
Divide by theirs for M1

June 2009 Q7

Question Number	Scheme	Marks
Q5 (a)	$\mathbf{R}^2 = \begin{pmatrix} a^2+2a & 2a+2b \\ a^2+ab & 2a+b^2 \end{pmatrix}$	M1 A1 A1 (3)
(b)	Puts their $a^2+2a=15$ or their $2a+b^2=15$ or their $(a^2+2a)(2a+b^2)-(a^2+ab)(2a+2b)=225$ (or to 15) ,	M1,
	Puts their $a^2+ab=0$ or their $2a+2b=0$	M1
	Solve to find either a or b	M1
	$a=3,\ \ b=-3$	A1, A1 (5) [8]
Alternative for (b)	Uses $\mathbf{R}^2\times$ column vector $=15\times$ column vector, and equates rows to give two equations in a and b only Solves to find either a or b as above method	M1, M1 M1 A1 A1
Notes	(a) 1 term correct: M1 A0 A0 2 or 3 terms correct: M1 A1 A0 (b) M1 M1 as described in scheme (In the alternative scheme column vector can be general or specific for first M1 but must be specific for 2nd M1) M1 requires solving equations to find a and/or b (though checking that correct answer satisfies the equations will earn this mark) This mark can be given independently of the first two method marks. So solving $\mathbf{M}^2=15\mathbf{M}$ for example gives M0M0M1A0A0 in part (b) Also putting leading diagonal = 0 and other diagonal = 15 is M0M0M1A0A0 (No possible solutions as $a>0$) A1 A1 for correct answers only **Any Extra answers given**, e.g. $a=-5$ and $b=5$ or wrong answers – **deduct last A1 awarded** So the two sets of answers would be A1 A0 Just the answer . $a=-5$ and $b=5$ is A0 A0 Stopping at two values for a or for b – no attempt at other is A0A0 Answer with no working at all is 0 marks	

June 2009 Q7

Question Number	Scheme	Marks
Q7 (a)	Use $4a-(-2\times -1)=0 \quad \Rightarrow \quad a,=\frac{1}{2}$	M1, A1 (2)
(b)	Determinant: $(3\times 4)-(-2\times -1)=10 \quad (\Delta)$	M1
	$\mathbf{B}^{-1}=\frac{1}{10}\begin{pmatrix}4 & 2\\ 1 & 3\end{pmatrix}$	M1 A1cso (3)
(c)	$\frac{1}{10}\begin{pmatrix}4 & 2\\ 1 & 3\end{pmatrix}\begin{pmatrix}k-6\\ 3k+12\end{pmatrix}, \quad =\frac{1}{10}\begin{pmatrix}4(k-6)+2(3k+12)\\ (k-6)+3(3k+12)\end{pmatrix}$	M1, A1ft
	$\begin{pmatrix}k\\ k+3\end{pmatrix}$ Lies on $y=x+3$	A1 (3) [8]
	Alternatives: (c) $\begin{pmatrix}3 & -2\\ -1 & 4\end{pmatrix}\begin{pmatrix}x\\ x+3\end{pmatrix}, \quad =\begin{pmatrix}3x-2(x+3)\\ -x+4(x+3)\end{pmatrix},$	M1, A1,
	$=\begin{pmatrix}x-6\\ 3x+12\end{pmatrix}$, which was of the form $(k - 6, 3k + 12)$	A1
	Or $\begin{pmatrix}3 & -2\\ -1 & 4\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}, \quad =\begin{pmatrix}3x-2y\\ -x+4y\end{pmatrix}=\begin{pmatrix}k-6\\ 3k+12\end{pmatrix},$ and solves simultaneous equations	M1
	Both equations correct and eliminate one letter to get $x = k$ or $y = k + 3$ or $10x-10y=-30$ or equivalent.	A1
	Completely correct work (to $x = k$ and $y = k + 3$), and conclusion lies on $y=x+3$	A1
Notes	(a) Allow sign slips for first M1 (b) Allow sign slip for determinant for first M1 (This mark may be awarded for 1/10 appearing in inverse matrix.) Second M1 is for correctly treating the 2 by 2 matrix, ie for $\begin{pmatrix}4 & 2\\ 1 & 3\end{pmatrix}$ Watch out for determinant (3 + 4) – (-1 + -2) = 10 – M0 then final answer is A0 (c) M1 for multiplying matrix by appropriate column vector A1 correct work (ft wrong determinant) A1 for conclusion	

Jan 2010 Q5

Question Number	Scheme	Marks
Q5	(a) det $\mathbf{A} = a(a+4)-(-5\times 2) = a^2+4a+10$	M1 A1 (2)
	(b) $a^2+4a+10=(a+2)^2+6$ Positive for all values of a, so $\mathbf{A}$ is non-singular	M1 A1ft A1cso (3)
	(c) $\mathbf{A}^{-1} = \frac{1}{10}\begin{pmatrix} 4 & 5 \\ -2 & 0 \end{pmatrix}$ B1 for $\frac{1}{10}$	B1 M1 A1 (3) **[8]**
	Notes (a) Correct use of $ad-bc$ for M1 (b) Attempt to complete square for M1 Alt 1 Attempt to establish turning point (e.g. calculus, graph) M1 Minimum value 6 for A1ft Positive for all values of a, so $\mathbf{A}$ is non-singular for A1 cso Alt 2 Attempt at b^2-4ac for M1. Can be part of quadratic formula Their correct -24 for first A1 No real roots or equivalent, so $\mathbf{A}$ is non-singular for final A1cso (c) Swap leading diagonal, and change sign of other diagonal, with numbers or a for M1 Correct matrix independent of 'their $\frac{1}{10}$ award' final A1	

Jan 2010 Q9

Question Number	Scheme	Marks
Q9	(a) $45°$ or $\frac{\pi}{4}$ rotation (anticlockwise), about the origin	B1, B1 (2)
	(b) $\begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix}\begin{pmatrix} p \\ q \end{pmatrix} = \begin{pmatrix} 3\sqrt{2} \\ 4\sqrt{2} \end{pmatrix}$	M1
	$p - q = 6$ and $p + q = 8$ or equivalent	M1 A1
	$p = 7$ and $q = 1$ both correct	A1 (4)
	(c) Length of OA (= length of OB) = $\sqrt{7^2 + 1^2}$, $= \sqrt{50} = 5\sqrt{2}$	M1, A1 (2)
	(d) $M^2 = \begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix}\begin{pmatrix} \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix} = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$	M1 A1 (2)
	(e) $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}\begin{pmatrix} 3\sqrt{2} \\ 4\sqrt{2} \end{pmatrix}$ so coordinates are $(-4\sqrt{2}, 3\sqrt{2})$	M1 A1 (2) [12]
	Notes Order of matrix multiplication needs to be correct to award Ms (a) More than one transformation 0/2 (b) Second M1 for correct matrix multiplication to give two equations Alternative: (b) $\mathbf{M}^{-1} = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix}$ First M1 A1 $\begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{pmatrix}\begin{pmatrix} 3\sqrt{2} \\ 4\sqrt{2} \end{pmatrix} = \begin{pmatrix} 7 \\ 1 \end{pmatrix}$ Second M1 A1 (c) Correct use of their p and their q award M1 (e) Accept column vector for final A1.	

June 2010 Q2

Question Number	Scheme	Marks
2.	(a) $\mathbf{M} = \begin{pmatrix} 4 & 3 \\ 6 & 2 \end{pmatrix}$ Determinant: $(8-18) = -10$	B1
	$\mathbf{M}^{-1} = \frac{1}{-10}\begin{pmatrix} 2 & -3 \\ -6 & 4 \end{pmatrix}$ $\left[= \begin{pmatrix} -0.2 & 0.3 \\ 0.6 & -0.4 \end{pmatrix} \right]$	M1 A1 (3)
	(b) Setting $\Delta = 0$ and using $2a^2 \pm 18 = 0$ to obtain $a =$.	M1
	$a = \pm 3$	A1 cao (2) **5 marks**
	Notes: (a) B1: must be -10 M1: for correct attempt at changing elements in major diagonal and changing signs in minor diagonal. Three or four of the numbers in the matrix should be correct – eg allow one slip A1: for any form of the correct answer, with correct determinant then isw. Special case: a not replaced is B0M1A0 (b) Two correct answers, $a = \pm 3$, with no working is M1A1 Just $a = 3$ is M1A0, and also one of these answers rejected is A0. Need 3 to be simplified (not $\sqrt{9}$).	

June 2010 Q6

Question Number	Scheme	Marks
6.	(a) $\begin{pmatrix} 8 & 0 \\ 0 & 8 \end{pmatrix}$	B1 (1)
	(b) $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$	B1 (1)
	(c) $\mathbf{T} = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}\begin{pmatrix} 8 & 0 \\ 0 & 8 \end{pmatrix} = \begin{pmatrix} 8 & 0 \\ 0 & -8 \end{pmatrix}$	M1 A1 (2)
	(d) $\mathbf{AB} = \begin{pmatrix} 6 & 1 \\ 4 & 2 \end{pmatrix}\begin{pmatrix} k & 1 \\ c & -6 \end{pmatrix} = \begin{pmatrix} 6k+c & 0 \\ 4k+2c & -8 \end{pmatrix}$	M1 A1 A1 (3)
	(e) "$6k+c=8$" and "$4k+2c=0$" Form equations and solve simultaneously $k=2$ and $c=-4$	M1 A1 (2) **9 marks**
	Alternative method for (e) **M1:** $\mathbf{AB} = \mathbf{T} \Rightarrow \mathbf{B} = \mathbf{A}^{-1}\mathbf{T} =$ and compare elements to find k and c. Then A1 as before.	
	<u>Notes</u> (c) M1: Accept multiplication of their matrices either way round (this can be implied by correct answer) A1: cao (d) M1: Correct matrix multiplication method implied by one or two correct terms in correct positions. A1: for three correct terms in correct positions 2nd A1: for all four terms correct and simplified (e) M1: follows their previous work but must give two equations from which k and c can be found and there must be attempt at solution getting to $k=$ or $c=$. A1: is cao (but not cso - may follow error in position of $4k+2c$ earlier).	

Jan 2011 Q2

Question Number	Scheme		Marks
2.			
(a)	$\mathbf{A} = \begin{pmatrix} 2 & 0 \\ 5 & 3 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} -3 & -1 \\ 5 & 2 \end{pmatrix}$		
	$\mathbf{AB} = \begin{pmatrix} 2 & 0 \\ 5 & 3 \end{pmatrix}\begin{pmatrix} -3 & -1 \\ 5 & 2 \end{pmatrix}$		
	$= \begin{pmatrix} 2(-3)+0(5) & 2(-1)+0(2) \\ 5(-3)+3(5) & 5(-1)+3(2) \end{pmatrix}$	A correct method to multiply out two matrices. Can be implied by two out of four correct elements.	M1
	$= \begin{pmatrix} -6 & -2 \\ 0 & 1 \end{pmatrix}$	Any three elements correct	A1
		Correct answer	A1
		Correct answer only 3/3	(3)
(b)	Reflection; about the y-axis.	Reflection	M1
		y-axis (or $x = 0$.)	A1
			(2)
(c)	$\mathbf{C}^{100} = \mathbf{I} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ or $\mathbf{I}$	B1
			(1)
			[6]

Jan 2011 Q 8

Question Number	Scheme		Marks
8.	$\mathbf{A} = \begin{pmatrix} 2 & -2 \\ -1 & 3 \end{pmatrix}$		
(a)	$\det \mathbf{A} = 2(3) - (-1)(-2) = 6 - 2 = \underline{4}$	$\underline{4}$	B1 (1)
(b)	$\mathbf{A}^{-1} = \frac{1}{4}\begin{pmatrix} 3 & 2 \\ 1 & 2 \end{pmatrix}$	$\frac{1}{\det \mathbf{A}}\begin{pmatrix} 3 & 2 \\ 1 & 2 \end{pmatrix}$	M1
		$\frac{1}{4}\begin{pmatrix} 3 & 2 \\ 1 & 2 \end{pmatrix}$	A1 (2)
(c)	$\text{Area}(R) = \frac{72}{4} = \underline{18}\ (\text{units})^2$	$\frac{72}{\text{their } \det \mathbf{A}}$ or $72(\text{their } \det \mathbf{A})$	M1
		$\underline{18}$ or ft answer.	A1 $\sqrt{}$ (2)
(d)	$\mathbf{AR} = \mathbf{S} \Rightarrow \mathbf{A}^{-1}\mathbf{AR} = \mathbf{A}^{-1}\mathbf{S} \Rightarrow \mathbf{R} = \mathbf{A}^{-1}\mathbf{S}$		
	$\mathbf{R} = \frac{1}{4}\begin{pmatrix} 3 & 2 \\ 1 & 2 \end{pmatrix}\begin{pmatrix} 0 & 8 & 12 \\ 4 & 16 & 4 \end{pmatrix}$	At least one attempt to apply $\mathbf{A}^{-1}$ by any of the three vertices in $\mathbf{S}$.	M1
	$= \frac{1}{4}\begin{pmatrix} 8 & 56 & 44 \\ 8 & 40 & 20 \end{pmatrix}$		
	$= \begin{pmatrix} 2 & 14 & 11 \\ 2 & 10 & 5 \end{pmatrix}$	At least one correct **column** o.e.	A1 $\sqrt{}$
		At least two correct **columns** o.e.	A1
	Vertices are $(2, 2)$, $(14, 10)$ and $(11, 5)$.	All three **coordinates** correct.	A1 (4)
			[9]

June 2011 Q3 - Note Ö = √

Question Number	Scheme	Notes	Marks
3. (a)	$\mathbf{A} = \begin{pmatrix} 1 & Ö2 \\ Ö2 & -1 \end{pmatrix}$		
(i)	$\mathbf{A}^2 = \begin{pmatrix} 1 & Ö2 \\ Ö2 & -1 \end{pmatrix}\begin{pmatrix} 1 & Ö2 \\ Ö2 & -1 \end{pmatrix}$		
	$= \begin{pmatrix} 1+2 & Ö2 - Ö2 \\ Ö2 - Ö2 & 2+1 \end{pmatrix}$	A correct method to multiply out two matrices. Can be implied by two out of four correct elements.	M1
	$= \begin{pmatrix} 3 & 0 \\ 0 & 3 \end{pmatrix}$	Correct answer	A1
			(2)
(ii)	**Enlargement**; scale factor 3, centre $(0, 0)$.	**Enlargement**; scale factor **3**, centre **(0, 0)**	B1; B1
	Allow 'from' or 'about' for centre and 'O' or 'origin' for (0, 0)		
			(2)
(b)	$\mathbf{B} = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$		
	Reflection; in the line $y = -x$.	**Reflection**; $y = -x$	B1; B1
	Allow 'in the axis' 'about the line' $y = -x$ etc.		
	The question does not specify a <u>single</u> transformation so we would need to accept any combinations that are correct e.g. Anticlockwise rotation of 90° about the origin followed by a reflection in the x-axis is acceptable. In cases like these, the combination has to be <u>completely</u> correct and scored as B2 (no part marks). If in doubt consult your Team Leader.		(2)
(c)	$\mathbf{C} = \begin{pmatrix} k+1 & 12 \\ k & 9 \end{pmatrix}$, k is a constant.		
	$\mathbf{C}$ is singular $\Rightarrow$ $\det \mathbf{C} = 0$. (Can be implied)	$\det \mathbf{C} = 0$	B1
	Special Case $\frac{1}{9(k+1)-12k} = 0$ **B1(implied)M0A0**		
	$9(k+1) - 12k \ (= 0)$	Applies $9(k+1) - 12k$	M1
	$9k + 9 = 12k$		
	$9 = 3k$		
	$k = 3$	$k = 3$	A1
	$k = 3$ with no working can score full marks		(3)
			9

June 2011 Q5

Question Number	Scheme	Notes	Marks
5.	$\mathbf{A} = \begin{pmatrix} -4 & a \\ b & -2 \end{pmatrix}$, where a and b are constants.		
(a)	$\mathbf{A}\begin{pmatrix} 4 \\ 6 \end{pmatrix} = \begin{pmatrix} 2 \\ -8 \end{pmatrix}$		
	Therefore, $\begin{pmatrix} -4 & a \\ b & -2 \end{pmatrix}\begin{pmatrix} 4 \\ 6 \end{pmatrix} = \begin{pmatrix} 2 \\ -8 \end{pmatrix}$	Using the information in the question to form the matrix equation. Can be implied by both correct equations below.	M1
	Do not allow this mark for other incorrect statements unless interpreted correctly later e.g. $\begin{pmatrix} 4 \\ 6 \end{pmatrix}\begin{pmatrix} -4 & a \\ b & -2 \end{pmatrix} = \begin{pmatrix} 2 \\ -8 \end{pmatrix}$ would be M0 unless followed by correct equations or $\begin{pmatrix} -16+6a \\ 4b-12 \end{pmatrix} = \begin{pmatrix} 2 \\ -8 \end{pmatrix}$		
	So, $-16 + 6a = 2$ and $4b - 12 = -8$ Allow $\begin{pmatrix} -16+6a \\ 4b-12 \end{pmatrix} = \begin{pmatrix} 2 \\ -8 \end{pmatrix}$	Any one correct equation. Any correct horizontal line	M1
	giving $a = 3$ and $b = 1$.	Any one of $a = 3$ or $b = 1$.	A1
		Both $a = 3$ and $b = 1$.	A1
			(4)
(b)	$\det \mathbf{A} = 8 - (3)(1) = 5$	Finds determinant by applying $8 -$ their ab.	M1
		$\det \mathbf{A} = 5$	A1
	Special case: The equations -16 + 6b = 2 and 4a – 12 = -8 give a = 1 and b = 3. This comes from incorrect matrix multiplication. This will score nothing in (a) but allow all the marks in (b).		
	Note that $\det \mathbf{A} = \frac{1}{8-ab}$ scores M0 here but the following 2 marks are available. However, beware $\det \mathbf{A} = \frac{1}{8-ab} = \frac{1}{5} \Rightarrow area\,S = \frac{30}{\frac{1}{5}} = 150$ This scores M0A0 M1A0		
	Area $S = (\det \mathbf{A})(\text{Area } R)$		
	Area $S = 5 \times 30 = 150$ (units)^2	$\frac{30}{\text{their } \det \mathbf{A}}$ or $30 \times (\text{their } \det \mathbf{A})$	M1
		150 or ft answer	A1 $\sqrt{}$
	If their det A < 0 then allow ft provided final answer > 0		(4)
	In (b) Candidates may take a more laborious route for the area scale factor and find the area of the unit square, for example, after the transformation represented by A. This needs to be complete method to score any marks. Correctly establishing the area scale factor M1. Correct answer 5 A1. Then mark as original scheme.		
			8

Jan 2012 Q4

Question Number	Scheme	Notes	Marks
4(a)	$\begin{pmatrix}0&1\\1&0\end{pmatrix}\begin{pmatrix}1&2&2\\1&1&4\end{pmatrix}=\begin{pmatrix}1&1&4\\1&2&2\end{pmatrix}$	Attempt to multiply the right way round with at least 4 correct elements	M1
	T' has coordinates (1,1), (1,2) and (4,2) or $\begin{pmatrix}1\\1\end{pmatrix},\begin{pmatrix}1\\2\end{pmatrix},\begin{pmatrix}4\\2\end{pmatrix}$ **NOT just** $\begin{pmatrix}1&1&4\\1&2&2\end{pmatrix}$	Correct coordinates or vectors	A1
			(2)
(b)	**Reflection** in the line $\boldsymbol{y=x}$	Reflection	B1
		$y=x$	B1
	Allow 'in the axis' 'about the line' $y=x$ etc. Provided both features are mentioned ignore any reference to the origin unless there is a clear contradiction.		
			(2)
(c)	$\mathbf{QR}=\begin{pmatrix}4&-2\\3&-1\end{pmatrix}\begin{pmatrix}1&2\\3&4\end{pmatrix}=\begin{pmatrix}-2&0\\0&2\end{pmatrix}$	2 correct elements	M1
		Correct matrix	A1
	Note that $\mathbf{RQ}=\begin{pmatrix}1&2\\3&4\end{pmatrix}\begin{pmatrix}4&-2\\3&-1\end{pmatrix}=\begin{pmatrix}10&-4\\24&-10\end{pmatrix}$ **scores M0A0 in (c) but allow all the marks in (d) and (e)**		
			(2)
(d)	$\det(\mathbf{QR})=-2\times2-0=-4$	"-2"x"2" – "0"x"0"	M1
		-4	A1
	Answer only scores 2/2 $\dfrac{1}{\det(\mathbf{QR})}$ **scores M0**		**(2)**
(e)	Area of $T=\frac{1}{2}\times1\times3=\frac{3}{2}$	Correct area for T	B1
	Area of $T''=\frac{3}{2}\times4=6$	Attempt at "$\frac{3}{2}$"$\times\pm$"4"	M1
		6 or follow through their det(QR) x Their triangle area provided area > 0	A1ft
			(3)
			Total 11

Jan 2012 Q8

Question Number	Scheme	Notes	Marks
8(a)	$\det(\mathbf{A}) = 3\times 0 - 2\times 1 (= -2)$	Correct attempt at the determinant	M1
	$\det(\mathbf{A}) \neq 0$ (so **A** is non singular)	det(A) = -2 **and** some reference to zero	A1
	$\frac{1}{\det(\mathbf{A})}$ **scores M0**		**(2)**
(b)	$\mathbf{BA}^2 = \mathbf{A} \Rightarrow \mathbf{BA} = \mathbf{I} \Rightarrow \mathbf{B} = \mathbf{A}^{-1}$	Recognising that $\mathbf{A}^{-1}$ is required	M1
	$\mathbf{B} = -\frac{1}{2}\begin{pmatrix} 3 & -1 \\ -2 & 0 \end{pmatrix}$	At least 3 correct terms in $\begin{pmatrix} 3 & -1 \\ -2 & 0 \end{pmatrix}$	M1
		$\frac{1}{\text{their } \det(\text{A})}\begin{pmatrix} * & * \\ * & * \end{pmatrix}$	B1ft
		Fully correct answer	A1
	Correct answer only score 4/4		**(4)**
	Ignore poor matrix algebra notation if the intention is clear		**Total 6**
(b) Way 2	$\mathbf{A}^2 = \begin{pmatrix} 2 & 3 \\ 6 & 11 \end{pmatrix}$	Correct matrix	B1
	$\begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} 2 & 3 \\ 6 & 11 \end{pmatrix} = \begin{pmatrix} 0 & 1 \\ 2 & 3 \end{pmatrix} \Rightarrow \begin{matrix} 2a+6b=0 \\ 3a+11b=1 \end{matrix} \; or \; \begin{matrix} 2c+6d=2 \\ 3c+11d=3 \end{matrix}$	2 equations in a and b **or** 2 equations in c and d	M1
	$a = -\frac{3}{2}, b = \frac{1}{2}, c = 1, d = 0$	M1 Solves for a and b or c and d A1 All 4 values correct	M1A1
(b) Way 3	$\mathbf{A}^2 = \begin{pmatrix} 2 & 3 \\ 6 & 11 \end{pmatrix}$	Correct matrix	B1
	$\left(\mathbf{A}^2\right)^{-1} = \frac{1}{"2"\times"11"-"3"\times"6"}\begin{pmatrix} "11" & "-3" \\ "-6" & "2" \end{pmatrix}$ **see note**	Attempt inverse of $\mathbf{A}^2$	M1
	$\mathbf{A}\left(\mathbf{A}^2\right)^{-1} = \frac{1}{4}\begin{pmatrix} 0 & 1 \\ 2 & 3 \end{pmatrix}\begin{pmatrix} 11 & -3 \\ -6 & 2 \end{pmatrix} or \frac{1}{4}\begin{pmatrix} 11 & -3 \\ -6 & 2 \end{pmatrix}\begin{pmatrix} 0 & 1 \\ 2 & 3 \end{pmatrix}$	Attempts $\mathbf{A}\left(\mathbf{A}^2\right)^{-1} or \left(\mathbf{A}^2\right)^{-1}\mathbf{A}$	M1
	$\mathbf{B} = -\frac{1}{2}\begin{pmatrix} 3 & -1 \\ -2 & 0 \end{pmatrix}$	Fully correct answer	A1
(b) Way 4	$\mathbf{BA} = \mathbf{I}$	Recognising that $\mathbf{BA} = \mathbf{I}$	B1
	$\begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} 0 & 1 \\ 2 & 3 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \Rightarrow \begin{matrix} 2b=1 \\ a+3b=0 \end{matrix} \; or \; \begin{matrix} 2d=0 \\ c+3d=1 \end{matrix}$	2 equations in a and b **or** 2 equations in c and d	M1
	$a = -\frac{3}{2}, b = \frac{1}{2}, c = 1, d = 0$	M1 Solves for a and b or c and d A1 All 4 values correct	M1A1

June 2012 Q2

Question Number	Scheme	Notes	Marks
2. (a)	$\mathbf{A} = \begin{pmatrix} 3 & 1 & 3 \\ 4 & 5 & 5 \end{pmatrix}$, $\mathbf{B} = \begin{pmatrix} 1 & 1 \\ 1 & 2 \\ 0 & -1 \end{pmatrix}$		
	$\mathbf{AB} = \begin{pmatrix} 3 & 1 & 3 \\ 4 & 5 & 5 \end{pmatrix}\begin{pmatrix} 1 & 1 \\ 1 & 2 \\ 0 & -1 \end{pmatrix}$		
	$= \begin{pmatrix} 3+1+0 & 3+2-3 \\ 4+5+0 & 4+10-5 \end{pmatrix}$	A correct method to multiply out two matrices. Can be implied by two out of four correct (unsimplified) elements in a <u>dimensionally correct</u> matrix. A 2x2 matrix with a number or a calculation at each corner.	M1
	$= \begin{pmatrix} 4 & 2 \\ 9 & 9 \end{pmatrix}$	Correct answer	A1
	A correct answer with no working can score both marks		
			[2]
(b)	$\mathbf{C} = \begin{pmatrix} 3 & 2 \\ 8 & 6 \end{pmatrix}$, $\mathbf{D} = \begin{pmatrix} 5 & 2k \\ 4 & k \end{pmatrix}$, where k is a constant,		
	$\mathbf{C} + \mathbf{D} = \begin{pmatrix} 3 & 2 \\ 8 & 6 \end{pmatrix} + \begin{pmatrix} 5 & 2k \\ 4 & k \end{pmatrix} = \begin{pmatrix} 8 & 2k+2 \\ 12 & 6+k \end{pmatrix}$	An attempt to add C to D. Can be implied by two out of four correct (unsimplified) elements in a <u>dimensionally correct</u> matrix.	M1
	E does not have an inverse $\Rightarrow$ $\det \mathbf{E} = 0$.		
	$8(6+k) - 12(2k+2)$	Applies "$ad - bc$" to **E** where **E** is a 2x2 matrix.	M1
	$8(6+k) - 12(2k+2) = 0$	States or applies $\det(\mathbf{E}) = 0$ where $\det(\mathbf{E}) = ad - bc$ or $ad + bc$ only and **E** is a 2x2 matrix.	M1
	Note $8(6+k) - 12(2k+2) = 0$ or $8(6+k) = 12(2k+2)$ could score both M's		
	$48 + 8k = 24k + 24$ $24 = 16k$		
	$k = \frac{3}{2}$		A1 oe
			[4]
			6 marks

June 2012 Q9

Question Number	Scheme	Notes	Marks
9. (a)	$\det \mathbf{M} = 3(-5) - (4)(2) = -15 - 8 = \underline{-23}$	$\underline{-23}$	B1
			[1]
(b)	Therefore, $\begin{pmatrix} 3 & 4 \\ 2 & -5 \end{pmatrix}\begin{pmatrix} 2a-7 \\ a-1 \end{pmatrix} = \begin{pmatrix} 25 \\ -14 \end{pmatrix}$	Using the information in the question to form the matrix equation. Can be implied by any of the correct equations below.	M1
	Either, $3(2a-7)+4(a-1)=25$ or $2(2a-7)-5(a-1)=-14$ or $\begin{pmatrix} 3(2a-7)+4(a-1) \\ 2(2a-7)-5(a-1) \end{pmatrix} = \begin{pmatrix} 25 \\ -14 \end{pmatrix}$	Any one correct equation (unsimplified) inside or outside matrices	A1
	giving $a = 5$	$a = 5$	A1
			[3]
(c)	$\text{Area}(ORS) = \frac{1}{2}(6)(4);\ = \underline{12}\ (\text{units})^2$	M1: $\frac{1}{2}(6)(\text{Their } a-1)$ A1: 12 **cao and cso**	M1A1
	Note A(6, 0) is sometimes misinterpreted as (0, 6) – this is the wrong triangle and scores M0 e.g.1/2x6x3 = 9		
			[2]
(d)	$\text{Area}(OR'S') = \pm 23 \times (12)$	$\pm \det \mathbf{M} \times$ (their part (c) answer)	M1
		$\underline{276}$ (follow through provided area > 0)	A1$\sqrt{}$
	A method not involving the determinant requires the coordinates of R$'$ to be calculated ((18, 12)) and then a <u>correct</u> method for the area e.g. (26x25 – 7x13 – 9x12 – 7x25) M1 = 276 A1		
			[2]
(e)	Rotation; 90° anti-clockwise (or 270° clockwise) about $(0,\ 0)$.	B1: Rotation, Rotates, Rotate, Rotating (not **turn**) B1: 90° anti-clockwise (or 270° clockwise) about (around/from etc.) $(0,\ 0)$	B1;B1
			[2]
(f)	$\mathbf{M} = \mathbf{BA}$	$\mathbf{M} = \mathbf{BA}$, seen or implied.	M1
	$\mathbf{A}^{-1} = \frac{1}{(0)(0)-(1)(-1)}\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix};\ = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	$\mathbf{A}^{-1} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	A1
	$\mathbf{B} = \begin{pmatrix} 3 & 4 \\ 2 & -5 \end{pmatrix}\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	Applies $\mathbf{M}$(their $\mathbf{A}^{-1}$)	M1
	$\mathbf{B} = \begin{pmatrix} -4 & 3 \\ 5 & 2 \end{pmatrix}$		A1
	NB some candidates state $\mathbf{M} = \mathbf{AB}$ and then calculate $\mathbf{MA}^{-1}$ or state $\mathbf{M} = \mathbf{BA}$ and then calculate $\mathbf{A}^{-1}\mathbf{M}$. These could score M0A0 M1A1ft and M1A1M0A0 respectively.		**[4]**
			14 marks
	Special case		
(f)	$\mathbf{M} = \mathbf{AB}$	$\mathbf{M} = \mathbf{AB}$, seen or implied.	M0
		$\mathbf{A}^{-1} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	A0
	$\mathbf{B} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\begin{pmatrix} 3 & 4 \\ 2 & -5 \end{pmatrix} = \begin{pmatrix} 2 & -5 \\ -3 & -4 \end{pmatrix}$	Applies (their $\mathbf{A}^{-1}$)$\mathbf{M}$	M1A1ft

Jan 2013 Q4

Question Number	Scheme	Marks
4.	(a) $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$	B1 **(1)**
	(b) $\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$	B1 **(1)**
	(c) $\mathbf{R} = \mathbf{QP}$	B1 **(1)**
	(d) $\mathrm{R} = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$	M1 A1 cao **(2)**
	(e) Reflection in the y axis	B1 B1 **(2)** **[7]**
Notes	(a) and (b) Signs must be clear for B marks. (c) Accept **QP** or their 2x2 matrices in the correct order only for B1. (d) M for their **QP** where answer involves ±1 and 0 in a 2x2 matrix, A for correct answer only. (e) First B for Reflection, Second B for 'y axis' or 'x=0'. Must be single transformation. Ignore any superfluous information.	

Jan 2013 Q6

Question Number	Scheme	Marks
6.	(a) Determinant: $2 - 3a = 0$ and solve for $a =$	M1
	So $a = \frac{2}{3}$ or equivalent	A1 **(2)**
	(b) Determinant: $(1\times 2)-(3\times -1)=5 \quad (\Delta)$	
	$Y^{-1}=\frac{1}{5}\begin{pmatrix}2 & 1\\ -3 & 1\end{pmatrix} \quad \left[=\begin{pmatrix}0.4 & 0.2\\ -0.6 & 0.2\end{pmatrix}\right]$	M1A1 **(2)**
	(c) $\frac{1}{5}\begin{pmatrix}2 & 1\\ -3 & 1\end{pmatrix}\begin{pmatrix}1-\lambda\\ 7\lambda-2\end{pmatrix}=\frac{1}{5}\begin{pmatrix}2-2\lambda+7\lambda-2\\ -3+3\lambda+7\lambda-2\end{pmatrix}=\begin{pmatrix}\lambda\\ 2\lambda-1\end{pmatrix}$	M1depM1A1 A1 **(4)** **[8]**
	<u>Alternative method for (c)</u>	
	$\begin{pmatrix}1 & -1\\ 3 & 2\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}1-\lambda\\ 7\lambda-2\end{pmatrix}$ so $x-y=1-\lambda$ and $3x+2y=7\lambda-2$	M1M1
	Solve to give $x=\lambda$ and $y=2\lambda-1$	A1A1
Notes	(b) M for $\frac{1}{\text{their det}}\begin{pmatrix}2 & 1\\ -3 & 1\end{pmatrix}$ (c) First M for their $\mathbf{Y}^{-1}\mathbf{B}$ in correct order with **B** written as a 2x1 matrix, second M dependent on first for attempt at multiplying their matrices resulting in a 2x1 matrix, first A for λ, second A for $2\lambda-1$ Alternative for (c) First M to obtain two linear equations in x, y, λ Second M for attempting to solve for x or y in terms of λ	

June 2013 Q1

Question Number	Scheme	Notes	Marks
1.	$\mathbf{M}=\begin{pmatrix} x & x-2 \\ 3x-6 & 4x-11 \end{pmatrix}$		
	$\det\mathbf{M} = x(4x-11)-(3x-6)(x-2)$	Correct attempt at determinant	M1
	$x^2+x-12\ (=0)$	Correct 3 term quadratic	A1
	$(x+4)(x-3)\ (=0) \rightarrow x = \ldots$	Their 3TQ = 0 and attempts to solve relevant quadratic using factorisation or completing the square or correct quadratic formula leading to $x =$	M1
	$x=-4,\ x=3$	Both values correct	A1
			(4)
			Total 4
Notes			
	$x(4x-11)=(3x-6)(x-2)$ award first M1		
	$\pm(x^2+x-12)$ seen award first M1A1		
	Method mark for solving 3 term quadratic: 1. Factorisation $(x^2+bx+c)=(x+p)(x+q)$, where $\lvert pq\rvert=\lvert c\rvert$, leading to x = $(ax^2+bx+c)=(mx+p)(nx+q)$, where $\lvert pq\rvert=\lvert c\rvert$ and $\lvert mn\rvert=\lvert a\rvert$, leading to x = 2. Formula Attempt to use correct formula (with values for a, b and c). 3. Completing the square Solving $x^2+bx+c=0$: $\left(x\pm\frac{b}{2}\right)^2 \pm q \pm c,\quad q\neq 0,$ leading to x =...		
	Both correct with no working 4/4, only one correct 0/4		

June 2013 Q8

Question Number	Scheme	Notes	Marks
8(a)	$\mathbf{A}^2 = \begin{pmatrix} 6 & -2 \\ -4 & 1 \end{pmatrix}\begin{pmatrix} 6 & -2 \\ -4 & 1 \end{pmatrix} = \begin{pmatrix} 44 & -14 \\ -28 & 9 \end{pmatrix}$	M1:Attempt both $\mathbf{A}^2$ and $7\mathbf{A} + 2\mathbf{I}$	M1A1
	$7\mathbf{A} + 2\mathbf{I} = \begin{pmatrix} 42 & -14 \\ -28 & 7 \end{pmatrix} + \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix} = \begin{pmatrix} 44 & -14 \\ -28 & 9 \end{pmatrix}$	A1: Both matrices correct	
	OR $\mathbf{A}^2 - 7\mathbf{A} = \mathbf{A}(\mathbf{A} - 7\mathbf{I})$	M1 for expression and attempt to substitute and multiply (2x2)(2x2)=2x2	
	$\mathbf{A}(\mathbf{A} - 7\mathbf{I}) = \begin{pmatrix} 6 & -2 \\ -4 & 1 \end{pmatrix}\begin{pmatrix} -1 & -2 \\ -4 & -6 \end{pmatrix} = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix} = 2\mathbf{I}$	A1 cso	
			(2)
(b)	$\mathbf{A}^2 = 7\mathbf{A} + 2\mathbf{I} \Rightarrow \mathbf{A} = 7\mathbf{I} + 2\mathbf{A}^{-1}$	Require one correct line using accurate expressions involving $\mathbf{A}^{-1}$ and identity matrix to be clearly stated as $\mathbf{I}$.	M1
	$\mathbf{A}^{-1} = \frac{1}{2}(\mathbf{A} - 7\mathbf{I})$ *		A1* cso
	Numerical approach award 0/2.		
			(2)
(c)	$\mathbf{A}^{-1} = \frac{1}{2}\begin{pmatrix} -1 & -2 \\ -4 & -6 \end{pmatrix}$	Correct inverse matrix or equivalent	B1
	$\frac{1}{2}\begin{pmatrix} -1 & -2 \\ -4 & -6 \end{pmatrix}\begin{pmatrix} 2k+8 \\ -2k-5 \end{pmatrix} = \frac{1}{2}\begin{pmatrix} -2k-8+4k+10 \\ -8k-32+12k+30 \end{pmatrix}$	Matrix multiplication involving their inverse and k: (2x2)(2x1)=2x1. N.B. $\begin{pmatrix} 6 & -2 \\ -4 & 1 \end{pmatrix}\begin{pmatrix} 2k+8 \\ -2k-5 \end{pmatrix}$ is M0	M1
	$\begin{pmatrix} k+1 \\ 2k-1 \end{pmatrix}$ or $(k+1,\ 2k-1)$	$(k+1)$ first A1, $(2k-1)$ second A1	A1,A1
	Or:		
	$\begin{pmatrix} 6 & -2 \\ -4 & 1 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2k+8 \\ -2k-5 \end{pmatrix}$	Correct matrix equation.	B1
	$6x - 2y = 2k + 8$ $-4x + y = -2k - 5 \Rightarrow x = ... or\ y = ...$	Multiply out and attempt to solve simultaneous equations for x or y in terms of k.	M1
	$\begin{pmatrix} k+1 \\ 2k-1 \end{pmatrix}$ or $(k+1,\ 2k-1)$	$(k+1)$ first A1, $(2k-1)$ second A1	A1,A1
			(4)
			Total 8

June 2013R Q2

Question Number	Scheme		Marks
2.	$\mathbf{A} = \begin{pmatrix} 2k+1 & k \\ -3 & -5 \end{pmatrix}$, $\mathbf{B} = \mathbf{A} + 3\mathbf{I}$		
(i)(a)	$\mathbf{B} = \mathbf{A} + 3\mathbf{I} = \begin{pmatrix} 2k+1 & k \\ -3 & -5 \end{pmatrix} + 3\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	For applying $\mathbf{A} + 3\mathbf{I}$. Can be implied by three out of four correct elements in candidate's final answer. Solution must come from addition.	M1
	$= \begin{pmatrix} 2k+4 & k \\ -3 & -2 \end{pmatrix}$	Correct answer.	A1
			[2]
(b)	**B** is singular $\Rightarrow$ $\det \mathbf{B} = 0$.		
	$-2(2k+4) - (-3k) = 0$	Applies "$ad - bc$" to **B** and equates to 0	M1
	$-4k - 8 + 3k = 0$		
	$k = -8$	$k = -8$	A1cao
			[2]
(ii)	$\mathbf{C} = \begin{pmatrix} 2 \\ -3 \\ 4 \end{pmatrix}$, $\mathbf{D} = \begin{pmatrix} 2 & -1 & 5 \end{pmatrix}$, $\mathbf{E} = \mathbf{CD}$		
	$\mathbf{E} = \begin{pmatrix} 2 \\ -3 \\ 4 \end{pmatrix}\begin{pmatrix} 2 & -1 & 5 \end{pmatrix} = \begin{pmatrix} 4 & -2 & 10 \\ -6 & 3 & -15 \\ 8 & -4 & 20 \end{pmatrix}$	Candidate writes down a 3×3 matrix.	M1
		Correct answer.	A1
			[2] **6**

June 2013R Q6

Question Number	Scheme		Marks
6.	$\mathbf{A} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$, $\mathbf{B} = \begin{pmatrix} 2 & 3 \\ 1 & 4 \end{pmatrix}$		
(a)	$\mathbf{P} = \mathbf{AB} \left\{ = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 2 & 3 \\ 1 & 4 \end{pmatrix} \right\}$	$\mathbf{P} = \mathbf{AB}$, seen or implied.	M1
	$\mathbf{P} = \begin{pmatrix} 1 & 4 \\ -2 & -3 \end{pmatrix}$	Correct answer.	A1
			[2]
(b)	$\det \mathbf{P} = 1(-3) - (4)(-2) \; \{= -3 + 8 = 5\}$	Applies "$ad - bc$".	M1
	$\text{Area}(T) = \underline{\frac{24}{5}} \text{ (units)}^2$	$\frac{24}{\text{their } \det \mathbf{P}}$, dependent on previous M	dM1
		$\underline{\frac{24}{5}}$ or $\underline{4.8}$	A1ft
			[3]
(c)	$\mathbf{QP} = \mathbf{I} \Rightarrow \mathbf{QPP}^{-1} = \mathbf{IP}^{-1} \Rightarrow \mathbf{Q} = \mathbf{P}^{-1}$		
	$\mathbf{Q} = \mathbf{P}^{-1} = \frac{1}{5}\begin{pmatrix} -3 & -4 \\ 2 & 1 \end{pmatrix}$	$\mathbf{Q} = \mathbf{P}^{-1}$ stated or an attempt to find $\mathbf{P}^{-1}$.	M1
		Correct ft inverse matrix.	A1ft
			[2] 7
	Using **BA,** area is the same in (b) and inverse is $\frac{1}{5}\begin{pmatrix} 1 & -2 \\ 4 & -3 \end{pmatrix}$ in (c) and could gain ft marks.		