Question Number	Scheme	Notes	Marks
1	$\mathbf{P} = \begin{pmatrix} p-1 & p+1 \\ -3 & p \end{pmatrix}$		
(a)	$\{\det \mathbf{P} =\}\ \ p(p-1)-(-3)(p+1)$ Award for **any** correct expression for det **P**. **If expanded immediately** allow one sign error only in one term of $p^2 - p + 3p + 3$ which can be implied by $p^2 \pm 4p + 3$ provided this has not come from $ad + bc$		M1
	$p^2 + 2p + 3$	Correct 3TQ. Terms in any order. Ignore "=0"	A1
			(2)
(b)	If (a) is incorrect, only the M mark is available in (b) and this mark requires working with a 3TQ [from (a) or reattempted] which $\neq 0$ for all real p		
	The M mark requires doing enough work so that only an explanation and conclusion is then needed, e.g., correct numerical expression (or value) for determinant, correct use of formula, correct completion of the square, correct vertex (stated or via graph or differentiation) The A mark always requires an appropriate explanation **and** non-singular/not singular/isn't/can't be singular or "has inverse". Do not accept just "shown" etc.		
	1. Discriminant: d or $b^2 - 4ac = 2^2 - 4(1)(3)\ \ \{= 4 - 12 = -8\}$ Negative or $d < 0$ or $b^2 < 4ac$, no (real) solution or $\det \mathbf{P} \neq 0$, so non-singular M1: Correct numerical expression (or value) for the discriminant. Allow comparison of b^2 with $4ac$ A1: Explanation and conclusion. **2. Using formula:** $p = \dfrac{-2 \pm \sqrt{2^2 - 4(1)(3)}}{2(1)}\ \ \left\{= \dfrac{-2 \pm \sqrt{-8}}{2} = -1 \pm \sqrt{2}\,\mathrm{i}\right\}$ $\{\sqrt{-8}\}$ not real/possible or complex (accept imaginary) or no solution or $\det \mathbf{P} \neq 0$, so non-singular M1: Correct numerical expression for p A1: Explanation and conclusion. **3. Using completing the square:** $p^2 + 2p + 3 = (p+1)^2 + 2$ $\neq 0$ or > 0 or $\square$ 2 (not > 2) or min. value = 2 so non-singular Might see $(p+1)^2 = -2$ or $p + 1 = \{\pm\}\sqrt{-2}$ or $\{\pm\}\sqrt{2}\,\mathrm{i}$ or $p = -1\{\pm\}\sqrt{2}\,\mathrm{i}$ followed by not real/possible/complex roots, so non-singular M1: $p^2 + 2p + 3 = (p+1)^2 + 2$ A1: Explanation and conclusion. **Cases continue overleaf**		M1 A1

Question Number	Scheme	Notes	Marks
1(b) cont.	**4. Differentiation:** $\frac{\mathrm{d}y}{\mathrm{d}p}=0\Rightarrow 2p+2=0\Rightarrow p=-1\Rightarrow p^2+2p+3=2$ Minimum or "U-shape" or $a>0$ or appropriate sketch, so non-singular M1: For -1 and 2 A1: Full explanation and conclusion. **5. Vertex just stated:** Vertex is at $(-1,\ 2)$ "U-shape" or $a>0$ or appropriate sketch, so non-singular M1: Correct vertex. If preceded by $p^2+2p+3=(p+1)^2+2$ award at that point for CTS A1: Full explanation and conclusion.		
			(2)
(c)	$\mathbf{P}=\begin{pmatrix}p-1 & p+1\\ -3 & p\end{pmatrix}\Rightarrow$ $\{\mathbf{P}^{-1}=\}\ \frac{1}{"p^2+2p+3"}\begin{pmatrix}p & -p-1\\ 3 & p-1\end{pmatrix}$ **or** $\begin{pmatrix}\frac{p}{"p^2+2p+3"} & \frac{-p-1}{"p^2+2p+3"}\\ \frac{3}{"p^2+2p+3"} & \frac{p-1}{"p^2+2p+3"}\end{pmatrix}$	M1: $\frac{1}{"p^2+2p+3"}\times$(a **changed** 2×2 **P**) (their changed **P** must not be or become constant) **OR** sight of Adj(**P**) i.e. $\begin{pmatrix}p & -p-1\\ 3 & p-1\end{pmatrix}$ oe which may be labelled as $\mathbf{P}^{-1}$ A1ft: Correct inverse ft their det **P** [from part (a) or reattempted] provided it is (and remains) a function of p and accept det **P** unsimplified. Condone if det **P** clearly miscopied or rewritten incorrectly e.g., $(p+1)^2-2$ Allow $-1(p+1)$ for $-p-1$ but A0 if $-(-3)$ for 3 Isw when a correct or correct ft answer is seen unless a value for p is substituted	M1A1ft
			(2)
			Total 6