1		$2(x-3)^2-11$	**B1B1B1** **[3]**	For 2, $(x-3)^2$, −11. Or a=2, b= 3, c= 11
2		$\left[\dfrac{(2x+1)^{\frac{3}{2}}}{\frac{3}{2}}\right]$ [÷2] (+c) $7=9+c$ $y=\dfrac{(2x+1)^{\frac{3}{2}}}{3}-2$ or unsimplified	**B1B1** **M1** **A1** **[4]**	Attempt subst $x=4, y=7$. c must be there. Dep. on attempt at integration. $c=-2$ sufficient
3	**(i)**	$a^5-5a^4x+10a^3x^2-10a^2x^3+....$	**B2,1,0** **[2]**	Ok full expansion (ignore extra terms) Descending: Ok if full expansion but max B1 for 4 terms
	(ii)	$(1-ax)(..10a^3x^2-10a^2x^3..)=(x^3)(-10a^4-10a^2)$ $-10a^4-10a^2=-200$ $a^2=4$ ignore $a^2=-5$ $a=\pm 2$ cao	**M1** **A1**√ **M1** **A1** **[4]**	Attempt to find coeff. of x^3 from 2 terms Ft from *their* $10a^3$,$-10a^2$ from part (i) Attempt soln. for a^2 from 3-term quad. in a^2 Ignore any imaginary solutions
4	**(i)**	$\tan\theta=1/3$ $\theta=18.4°$ only	**M1** **A1** **[2]**	Ignore solns. outside range 0→180
	(ii)	**tan**$2x=(\pm)1/\sqrt{3}$ Must be sq. root soi $(x)=15$ $(x)=$ any correct second value (75, 105, 165) $(x)=$ cao	**M1** **A1** **A1**√ **A1** **[4]**	$\sin 2x=(\pm)1/2$ **or** $\cos 2x=(\pm)\sqrt{3/2}$ using $c^2+s^2=1$. Not $\tan x=(\pm)\dfrac{1}{\sqrt{3}}$ etc. ft for (90 ± their 15) or (180 – their 15) All four correct. Extra solns in range 1
5	**(i)**	$\overrightarrow{AB}=\begin{pmatrix}5\\-1\\-2\end{pmatrix}-\begin{pmatrix}3\\2\\-3\end{pmatrix}=\begin{pmatrix}2\\-3\\1\end{pmatrix}$ $\overrightarrow{BC}=\begin{pmatrix}6\\1\\2\end{pmatrix}-\begin{pmatrix}5\\-1\\-2\end{pmatrix}=\begin{pmatrix}1\\2\\4\end{pmatrix}$ $\overrightarrow{AB}.\overrightarrow{BC}=2-6+4$ oe must be seen = 0 hence $ABC=90°$	**B1** **B1** **M1** **A1** **[4]**	Or $\overrightarrow{BA},\overrightarrow{CB}$. Allow any combination. Ignore labels. Could be part of calculation for angle ABC AG Alt methods Pythag, Cosine Rule

	(ii)	$\left\|\overrightarrow{AB}\right\| = \sqrt{14}$, $\left\|\overrightarrow{BC}\right\| = \sqrt{21}$ oe Area $= \frac{1}{2}\sqrt{14}\sqrt{21}$ 8.6 oe	**B1** **M1** **A1** **[3]**	At least one correct Reasonable attempt at vectors and their magnitudes Allow $\frac{7\sqrt{6}}{2}$
6	**(i)**	Attempt to find $(f^{-1})^{-1}$	**M1**	
		$2xy = 1 - 5x$ or $\frac{1}{2x} = y + \frac{5}{2}$ Allow 1 sign error	**A1**	Or with x/y transposed.
		$x = \frac{1}{2y+5}$ oe Allow 1 sign error (total)	**A1**	Or with x/y transposed. Allow $x = \frac{\frac{1}{2}}{y+\frac{5}{2}}$.
		$(f(x)) = \frac{1}{2x+5}$ for $x \geqslant -\frac{9}{4}$ **(Allow** $-\frac{9}{4} \leqslant x \leqslant \infty$**)**	**A1 B1** **[5]**	Allow $\frac{\frac{1}{2}}{x+\frac{5}{2}}$. Condone $x > \frac{-9}{4}$, $(\frac{-9}{4}, \infty)$ (etc.)
	(ii)	$\mathbf{f}^{-1}\left(\frac{1}{x}\right) = \frac{1-\frac{5}{x}}{\frac{2}{x}}$ $\frac{x-5}{2}$ or $\frac{1}{2}x - \frac{5}{2}$	**M1** **A1** **[2]**	Reasonable attempt to find $\mathbf{f}^{-1}\left(\frac{1}{x}\right)$.
7	**(i)**	$(9-p)^2 + (3p)^2 = 169$ $10p^2 - 18p - 88\,(=0)$ oe $p = 4$ ***or*** $-11/5$ oe	**M1** **A1** **A1** **[3]**	Or $\sqrt{\ } = 13$ 3-term quad
	(ii)	Gradient of given line $= -\frac{2}{3}$ Hence gradient of $AB = \frac{3}{2}$ $\frac{3}{2} = \frac{3p}{9-p}$ oe eg $\left(\frac{-2}{3}\right)\left(\frac{3p}{9-p}\right) = 1$ (includes previous M1) $p = 3$	**B1** **M1** **M1** **A1** **[4]**	Attempt using $m_1 m_2 = -1$ Or vectors $\begin{pmatrix} 9-p \\ 3p \end{pmatrix} . \begin{pmatrix} 3 \\ -2 \end{pmatrix}$
8	**(i)**	$-(x+1)^{-2} - 2(x+1)^{-3}$	**M1A1** **A1** **[3]**	M1 for recognisable attempt at differentn. Allow $\frac{-x^2 - 4x - 3}{(x+1)^4}$ from Q rule. (A2,1,0)

(ii)	$f'(x) < 0$ hence decreasing	**B1** **[1]**	Dep. on *their* (i) < 0 for $x >$ 1
(iii)	$\frac{-1}{(x+1)^2} - \frac{2}{(x+1)^3} = 0$ **or** $\frac{-x^2-4x-3}{(x+1)^4} = 0$ $\frac{-(x+1)-2}{(x+1)^3} = 0 \rightarrow -x-1-2=0$ or $-x^2-4x-3=0$ $x=-3,\ y=-1/4$	**M1*** **M1** **Dep*** **A1A1** **[4]**	Set $\frac{dy}{dx}$ to 0 OR mult by $(x+1)^3$ or $(x+1)^5$ (i.e.×mult) × multn $\rightarrow -(x+1)^3 - 2(x+1)^2 = 0$ (−3, −1/4) www scores 4/4
9 (a)	2222/17 (=131 or 130.7) 131 × 17 (=2227) −2222 + 2227 = 5	**M1** **M1** **A1** **[3]**	Ignore signs. Allow 2239/17→131.7 or 132 Ignore signs. Use 131. 5 www gets 3/3
(b)	$r = \frac{2\cos\theta}{\sqrt{3}}$ soi oe $(-1<)\frac{2\cos\theta}{\sqrt{3}} < 1$ or $(0<)\frac{2\cos\theta}{\sqrt{3}} < 1$ soi $\pi/6,\ 5\pi/6$ soi (but dep. on M1) $\pi/6 < \theta < 5\pi/6$ cao	**B1** **M1**√ **A1A1** **A1** **[5]**	 Ft on *their r*. Ignore a 2nd inequality on LHS Allow 30º, 150º. Accept ≤
10 (i)	$\frac{dy}{dx} = 6 - 6x$ At $x=2$, gradient $=-6$ soi $y-9=-6(x-2)$ oe Expect $y=-6x+21$ When $y=0,\ x=3\frac{1}{2}$ cao	**B1** **B1**√ **M1** **A1** **[4]**	 Line through (2, 9) and with gradient *their* −6
(ii)	Area under curve: $\int 9+6x-3x^2\,dx = 9x+3x^2-x^3$ $(27+27-27)-(18+12-8)$ Area under tangent: $\frac{1}{2}\times\frac{3}{2}\times 9\ (=\frac{27}{4})$ Area required $\frac{27}{4} - 5 = \frac{7}{4}$	**B2,1,0** **M1** **B1**√ **A1** **[5]**	Allow unsimplified terms Apply limits 2,3. Expect 5 OR $\int_2^{7/2}(-6x+21)\,dx\ (\rightarrow \frac{27}{4})$. Ft on *their* $-6x+21$ and/or *their* 7/2.

11	**(i)**	$OC = r\cos\alpha$ or $AC = r\sin\alpha$ or oe soi (Area $\Delta OAC =) \frac{1}{2}r^2 \sin\alpha \cos\alpha$ $\frac{1}{2}r^2 \sin\alpha\cos\alpha = \frac{1}{2}\times\frac{1}{2}r^2\alpha$ oe ***sin*** α ***cos*** $\alpha = \frac{1}{2}\alpha$	**M1** **A1** **M1** **A1** **[4]**	Or e.g. $\frac{1}{2}r^2\alpha - \frac{1}{2}r^2\cos\alpha\sin\alpha = \frac{1}{4}r^2\alpha$ $\frac{1}{2}r^2\alpha - \frac{1}{2}r^2\cos\alpha\sin\alpha = \frac{1}{2}r^2\cos\alpha\sin\alpha$ AG
	(ii)	Perimeter $\Delta OAC = r + r\sin\alpha + r\cos\alpha = 2.4(0)r$ Perim. $ACB = r\alpha + r\sin\alpha + r - r\cos\alpha = 2.18r$ or $2.17r$ Ratio $= \frac{2.4(0)}{2.18 \text{ or } 2.17} : 1 = 1.1 : 1$	**M1A1** **M1A1** **A1** **[5]**	Allow with r a number. 2.0164 gets M1A0 Allow with r a number. 0.9644 gets M1A0 Allow 2.2 www. Use of cos = 0.6, sin = 0.8, $\alpha = 0.9$ is PA 1
	(iii)	54.3º cao	**B1** **[1]**	