Question	Answer	Marks
3(a)	$(y) = f(-x)$	B1
		1
3(b)	$(y) = 2f(x)$	B1
		1
3(c)	$(y) = f(x+4) - 3$	B1 B1
		2

Question Number	Scheme	Marks
8 (a)	States or implies that gradient of tangent is 24	B1
	Solves $f'(3) = 24$ to find k. E.g $4\times3^2 + k\times3 + 3 = 24 \Rightarrow k = \dots$	M1
	$3k + 39 = 24 \Rightarrow k = \dfrac{24-39}{3} = -5$ *	A1*
		(3)
(b)	$f'(x) = 4x^2 - 5x + 3 \Rightarrow f(x) = \dfrac{4}{3}x^3 - \dfrac{5}{2}x^2 + 3x + c$	M1 A1
	Substitutes $x = 3, y = -\dfrac{3}{24} + 5$ into $y = f(x)$ to find "c"	dM1
	$f(x) = \dfrac{4}{3}x^3 - \dfrac{5}{2}x^2 + 3x - \dfrac{141}{8}$	A1
		(4)
		(7 marks)

Question	Answer	Marks	Guidance
8(d)	Finding $f^{-1}(29)$ [= 5]	M1	Or solving f(x) = 29 [using *their* completed square form, OE].
	Finding $f^{-1}($*their* $5)$	M1	Or solving f(x) = *their* 5.
	$x = 3$	A1	If using f(x) method, $x = 1$ must be discarded.
	Alternative solution for Question 8(d)		
	$3\left(3(x-2)^2+2\right)-2)^2+2=29$ using *their* completed square form	M1	Or $3\left(3x^2-12x+14\right)^2-12\left(3x^2-12x+14\right)+14=29$. Allow if the '$=29$' appears later in the working.
	Solving as far as $9(x-2)^4=9$ or $x^2-4x+3=0$	DM1	OE Or $[27]\left(x^4-8x^3+24x^2-32x+15\right)=0$.
	$x = 3$ only	A1	WWW Only dependent on the first M1.
		3	

Question Number	Scheme	Marks
5(a)	$f'(x)=12x^{-\frac{1}{2}}+\frac{x}{3}-4$	
	One of $x^{-\frac{1}{2}}\to x^{\frac{1}{2}}$, $-4\to -4x$, $x\to x^2$	M1
	$f(x)=\int 12x^{-\frac{1}{2}}+\frac{x}{3}-4\,dx=24x^{\frac{1}{2}}+\frac{x^2}{6}-4x+c$	A1A1
	$8=24(9)^{\frac{1}{2}}+\frac{(9)^2}{6}-4(9)+c\Rightarrow c=...$	dM1
	$(f(x)=)\ 24x^{\frac{1}{2}}+\frac{x^2}{6}-4x-\frac{83}{2}$	A1
		(5)
(b)	$f'(9)=\frac{12}{\sqrt{9}}+\frac{9}{3}-4\quad(=3)$	M1
	$3\to -\frac{1}{3}$	dM1
	$y-8="-\frac{1}{3}"(0-9)$	M1
	(0, 11)	A1
		(4)
		(9 marks)

Question	Answer	Marks	Guidance
5(d)	(1, 5)	B1 FT	FT each coordinate, (*their*8 – 7, *their*2 + 3) Allow vector notation and absence of brackets.
		B1 FT	
		2	

Question	Answer	Marks	Guidance
6(a)	$f(x)=(x-1)^2+4$	B1	
	$g(x)=(x+2)^2+9$	B1	
	$g(x)=f(x+3)+5$	B1 B1	B1 for each correct element. Accept $p=3, q=5$
		4	

Question	Answer	Marks	Guidance
6(b)	Translation or Shift	B1	
	$\begin{pmatrix}-3\\5\end{pmatrix}$ or acceptable explanation	B1 FT	If given as 2 single translations both must be described correctly e.g. $\begin{pmatrix}-3\\0\end{pmatrix}$ & $\begin{pmatrix}0\\5\end{pmatrix}$ FT from *their* $f(x+p)+q$ *or their* $f(x)\to g(x)$ Do not accept $\begin{pmatrix}1\\4\end{pmatrix}$ or $\begin{pmatrix}-2\\9\end{pmatrix}$
		2	

Question	Scheme	Marks
11(a)	$x=\dfrac{5\pi}{2}$ **or** $y=12$	B1
	$x=\dfrac{5\pi}{2}$ **and** $y=12$	B1
		(2)
(b)	$x=\dfrac{3\pi}{2}$ **or** $y=-21$	B1
	$x=\dfrac{3\pi}{2}$ **and** $y=-21$	B1
		(2)
(c)(i)	$(A=)-12$	B1
(ii)	$(B=)\dfrac{5\pi}{4}$	B1
		(2)
		Total 6

Question	Answer	Marks	Guidance
11(b)	$g^{-1}(x)=\frac{1}{4}(x-k)$	**B1**	
	$g^{-1}f(x)=\frac{1}{4}(10+6x-x^2-k)=4x+k$	**M1**	OE May use *their* completed square form for f(*x*).
	Simplify the quadratic equation obtained from $g^{-1}f(x)=g(x)$ provided *k* is present and apply $b^2-4ac=0$ to this quadratic equation	***M1**	Expect $x^2+10x-10+5k=0$.
	Obtain $100-4(5k-10)=0$ and hence $k=7$	**A1**	
	Use *their k* to form and solve a quadratic in x	**DM1**	Allow if *their* quadratic has two solutions.
	$(-5,-13)$ only	**A1**	**SC B1** if no method seen.
	Alternative Method for first 4 marks		
	State $f(x)=gg(x)$	**(B1)**	
	$gg(x)=16x+5k$	**(M1)**	
	Apply $b^2-4ac=0$ to quadratic equation obtained from $f(x)=gg(x)$	**(*M1)**	Provided *k* is present.
	$100-4(5k-10)=0$ and hence $k=7$	**(A1)**	
		6	

Question	Answer	Marks
9(a)	$\left[(x-2)^2\right][-1]$	**B1 B1**
		2
9(b)	Smallest $c=2$ (**FT** on *their* part **(a)**)	**B1FT**
		1
9(c)	$y=(x-2)^2-1 \rightarrow (x-2)^2=y+1$	***M1**
	$x=2(\pm)\sqrt{y+1}$	**DM1**
	$(f^{-1}(x))=2+\sqrt{x+1}$ for $x>8$	**A1**
		3

Question	Answer	Marks
9(d)	$gf(x) = \frac{1}{(x-2)^2 - 1 + 1} = \frac{1}{(x-2)^2}$ OE	B1
	Range of gf is $0 < gf(x) < \frac{1}{9}$	B1 B1
		3

Question Number	Scheme	Marks
5 (a)	Attempts $r\theta = 5 \times 1.2$ Perimeter $= 5 + 5 + 6 = 16$ (km)	M1 A1 **(2)**
(b)	Attempts $\frac{1}{2}r^2\theta = \frac{1}{2} \times 5^2 \times 1.2$ Area $AOP = \frac{1}{4} \times \left(\frac{1}{2} \times 5^2 \times 1.2\right) = 3.75 \text{ km}^2$ *	M1 M1, A1* **(3)**
(c)	Sets $\frac{1}{2} \times 5 \times OP \times \sin 1.2 = 3.75 \Rightarrow OP = ...$ $OP = 1.6...$ $AP^2 = 5^2 + "1.6.."^2 - 2 \times 5 \times "1.6.." \times \cos 1.2$ $AP = 4.7\text{km}$ or 4700m	M1 A1 M1 A1cso **(4)** **(9 marks)**

Question	Answer	Marks	Guidance
5(b)	$g(x) = 2f(-x-1)$ or $a = 2,\ b = -1,\ c = -1$	B1	First B1 for $a = 2$ and no additional terms added to the function. $a = -2$ is B0.
		B1	Second B1 for $b = -1$ and $c = -1$.
		2	

Question Number	Scheme	Marks
7ai	$\text{f}'(4)=\dfrac{4(4)^2+10-7(4)^{\frac{1}{2}}}{4(4)^{\frac{1}{2}}}=\dfrac{15}{2}$	B1
ii	$"\dfrac{15}{2}"\to-\dfrac{2}{15}$	M1
	$y+1="-\dfrac{2}{15}"(x-4)$	M1
	$2x+15y+7=0$	A1
		(4)
b	$\dfrac{4x^2+10-7x^{\frac{1}{2}}}{4x^{\frac{1}{2}}}=\pm...x^{\frac{3}{2}}\pm...x^{-\frac{1}{2}}\pm...$	M1
	Two of the terms of $x^{\frac{3}{2}}+\dfrac{5}{2}x^{-\frac{1}{2}}-\dfrac{7}{4}$	A1
	$\displaystyle\int\left(x^{\frac{3}{2}}+\frac{5}{2}x^{-\frac{1}{2}}-\frac{7}{4}\right)\mathrm{d}x=\frac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\frac{7}{4}x\ \ (+c)$	dM1A1ft
	$\dfrac{2}{5}(4)^{\frac{5}{2}}+5(4)^{\frac{1}{2}}-\dfrac{7}{4}(4)+c=-1\Rightarrow c=...$	ddM1
	$(\text{f}(x)=)\ \dfrac{2}{5}x^{\frac{5}{2}}+5x^{\frac{1}{2}}-\dfrac{7}{4}x-\dfrac{84}{5}$	A1
		(6)
		(10 marks)

Question	Answer	Marks	Guidance
7(c)	$\text{gf}(x)=2\left(\dfrac{3}{x-2}+1\right)-2$ or $2\left(\dfrac{x+1}{x-2}\right)-2$	**M1**	Substitute f(x) into g(x).
	$\dfrac{6}{x-2}$	**A1**	
		2	

Question	Answer	Marks	Guidance
8(a)	$[\mathrm{fg}(x)=]1/(2x+1)^2-1$	B1	SOI
	$1/(2x+1)^2-1=3$ leading to $4(2x+1)^2=1$ or $\frac{1}{(2x+1)}=[\pm]2$ or $16x^2+16x+3=0$	M1	Setting $\mathrm{fg}(x)=3$ and reaching a stage before $2x+1=\pm½$ or reaching a 3 term quadratic in x
	$2x+1=\pm½$ or $2x+1=-½$ or $(4x+1)(4x+3)[=0]$	A1	Or formula or completing square on quadratic
	$x=-\frac{3}{4}$ only	A1	
	Alternative method for Question 8(a)		
	$x^2-1=3$	M1	
	$g(x)=-2$	A1	
	$\frac{1}{(2x+1)}=-2$	M1	
	$x=-\frac{3}{4}$ only	A1	
		4	

Question	Answer	Marks	Guidance
8(b)	$y=\frac{1}{(2x+1)^2}-1$ leading to $(2x+1)^2=\frac{1}{y+1}$ leading to $2x+1=[\pm]\frac{1}{\sqrt{y+1}}$	*M1	Obtain $2x+1$ or $2y+1$ as the subject
	$x=[\pm]\frac{1}{2\sqrt{y+1}}-\frac{1}{2}$	DM1	Make $x(\text{or } y)$ the subject
	$-\frac{1}{2\sqrt{x+1}}-\frac{1}{2}$	A1	OE e.g. $-\frac{\sqrt{x+1}}{2x+2}-\frac{1}{2}$, $-\left(\sqrt{\frac{-x}{4x+4}+\frac{1}{4}}+\frac{1}{2}\right)$
		3	