Question	Answer	Marks	Guidance
1	$f'(x) = \left[-(3x+2)^{-2}\right] \times [3] + [2x]$	**B2, 1, 0**	
	< 0 hence decreasing	**B1**	Dependent on at least B1 for $f'(x)$ and must include < 0 or '(always) neg'
		3	

Question	Answer	Marks	Guidance
2	[Stretch] [factor 2, x direction (or y-axis invariant)]	***B1** **DB1**	
	[Translation or Shift] [1 unit in y direction] **or** [Translation/Shift] $\left[\begin{pmatrix}0\\1\end{pmatrix}\right]$	**B1B1**	Accept transformations in either order. Allow (0, 1) for the vector
		4	

Question	Answer	Marks	Guidance
3	$(\pi)\int(y-1)\,\mathrm{d}y$	*M1	SOI Attempt to integrate x^2 or $(y-1)$
	$(\pi)\left[\dfrac{y^2}{2}-y\right]$	A1	
	$(\pi)\left[\left(\dfrac{25}{2}-5\right)-\left(\dfrac{1}{2}-1\right)\right]$	DM1	Apply limits 1 → 5 to an integrated expression
	8π or AWRT 25.1	A1	
		4	

Question	Answer	Marks	Guidance
4	$\dfrac{\mathrm{d}y}{\mathrm{d}x}=2x-2$	B1	
	$\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{4}{6}$	B1	OE, SOI
	$\mathit{their}\,(2x-2)=\mathit{their}\,\dfrac{4}{6}$	M1	LHS and RHS must be *their* $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ expression and value
	$x=\dfrac{4}{3}$ oe	A1	
		4	

Question	Answer	Marks	Guidance
5	$2\tan\theta - 6\sin\theta + 2 = \tan\theta + 3\sin\theta + 2 \rightarrow \tan\theta - 9\sin\theta\ (=0)$	**M1**	Multiply by denominator and simplify
	$\sin\theta - 9\sin\theta\cos\theta\ (=0)$	**M1**	Multiply by $\cos\theta$
	$\sin\theta(1-9\cos\theta)\ (=0) \rightarrow \sin\theta = 0,\quad \cos\theta = \frac{1}{9}$	**M1**	Factorise and attempt to solve at least one of the factors = 0
	$\theta = 0$ or $83.6°$ (only answers in the given range)	**A1A1**	
		5	

Question	Answer	Marks	Guidance
6(a)	$5C2\ \left[2(x)\right]^3 \left[\frac{a}{\left(x^2\right)}\right]^2$	**B1**	SOI Can include correct x's
	$10 \times 8 \times a^2 \left(\frac{x^3}{x^4}\right) = 720\left(\frac{1}{x}\right)$	**B1**	SOI Can include correct x's
	$a = \pm 3$	**B1**	
		3	
6(b)	$5C4\ \left[2(x)\right]\left[\frac{\textit{their } a}{\left(x^2\right)}\right]^4$	**B1**	SOI *Their a* can be just <u>one</u> of their values (e.g. just 3). Can gain mark from within an expansion but must use *their* value of *a*
	810 identified	**B1**	Allow with x^{-7}
		2	

Question	Answer	Marks	Guidance
7	$OC = 6\cos 0.8 = 4.18(0)$	M1A1	SOI
	Area sector $OCD = \frac{1}{2}(their\, 4.18)^2 \times 0.8$	*M1	OE
	$\Delta OCA = \frac{1}{2} \times 6 \times their\, 4.18 \times \sin 0.8$	M1	OE
	Required area = *their* ΔOCA – *their* sectorOCD	DM1	SOI. If not seen *their* areas of sector and triangle must be seen
	2.01	A1	CWO. Allow or better e.g. 2.0064
		6	

Question	Answer	Marks	Guidance
8(a)	2%	B1	
		1	
8(b)	Bonus = $600 + 23 \times 100 = 2900$	B1	
	Salary = 30000×1.03^{23}	M1	Allow 30000×1.03^{24} (60984)
	= 59207.60	A1	Allow answers of 3significant figure accuracy or better
	$\dfrac{their\, 2900}{their\, 59200}$	M1	SOI
	4.9(0)%	A1	
		5	

Question	Answer	Marks	Guidance
9(a)	$\left[2(x+3)^2\right]$ $[-7]$	B1B1	Stating $a=3, b=-7$ gets B1B1
		2	
9(b)	$y=2(x+3)^2-7 \rightarrow 2(x+3)^2=y+7 \rightarrow (x+3)^2=\frac{y+7}{2}$	M1	First 2 operations correct. Condone sign error or with x/y interchange
	$x+3=(\pm)\sqrt{\frac{y+7}{2}} \rightarrow x=(\pm)\sqrt{\frac{y+7}{2}}-3 \rightarrow \mathrm{f}^{-1}(x)=-\sqrt{\frac{x+7}{2}}-3$	A1FT	FT on *their* a and b. Allow $y = ...$
	Domain: $x \geqslant -5$ **or** $\geqslant -5$ **or** $[-5, \infty)$	B1	Do not accept $y=\ldots,\ f(x)=\ldots, f^{-1}(x)=\ldots$
		3	
9(c)	$\mathrm{fg}(x) = 8x^2-7$	B1FT	SOI. FT on *their* –7 from part **(a)**
	$8x^2-7=193 \rightarrow x^2=25 \rightarrow x=-5$ only	B1	
	Alternative method for question 9(c)		
	$\mathrm{g}(x) = \mathrm{f}^{-1}(193) \rightarrow 2x-3=-\sqrt{100}-3$	M1	FT on *their* $\mathrm{f}^{-1}(x)$
	$x=-5$ only	A1	
		2	
9(d)	(Largest k is) $-\frac{1}{2}$	B1	Accept $-\frac{1}{2}$ or $k \leqslant -\frac{1}{2}$
		1	

Question	Answer	Marks	Guidance
10(a)	$2(a+3)^{\frac{1}{2}}-a=0$	M1	SOI. Set $\frac{dy}{dx}=0$ when $x=a$. Can be implied by an answer in terms of a
	$4(a+3)=a^2 \rightarrow a^2-4a-12=0$	M1	Take a to RHS and square. Form 3-term quadratic
	$(a-6)(a+2) \rightarrow a=6$	A1	Must show factors, or formula or completing square. Ignore $a=-2$ **SC** If a is never used maximum of M1A1 for $x=6$,with visible solution
		3	
10(b)	$\frac{d^2y}{dx^2}=(x+3)^{-\frac{1}{2}}-1$	B1	
	Sub *their a* $\rightarrow \frac{d^2y}{dx^2}=\frac{1}{3}-1=-\frac{2}{3}$ $(or<0)\rightarrow$ MAX	M1A1	A mark only if completely correct If the second differential is not $-\frac{2}{3}$ correct conclusion must be drawn to award the M1
		3	
10(c)	$(y=)\frac{2(x+3)^{\frac{3}{2}}}{\frac{3}{2}}-\frac{1}{2}x^2\ \ (+c)$	B1B1	
	Sub $x=$ *their a* and $y=14$ $\rightarrow 14=\frac{4}{3}(9)^{\frac{3}{2}}-18+c$	M1	Substitute into an integrated expression. c must be present. Expect $c=-4$
	$y=\frac{4}{3}(x+3)^{\frac{3}{2}}-\frac{1}{2}x^2-4$	A1	Allow $f(x)=....$
		4	

Question	Answer	Marks	Guidance
11(a)	$(\tan x - 2)(3\tan x + 1)\ (=0)$. **or** formula **or** completing square	**M1**	Allow reversal of signs in the factors. Must see a method
	$\tan x = 2$ or $-\frac{1}{3}$	**A1**	
	$x = 63.4°$ (only value in range) or $161.6°$ (only value in range)	**B1FT** **B1FT**	
		4	
11(b)	Apply $b^2 - 4ac < 0$	**M1**	SOI. Expect $25 - 4(3)(k) < 0$, tan x must not be in coefficients
	$k > \frac{25}{12}$	**A1**	Allow $b^2 - 4ac = 0$ leading to correct $k > \frac{25}{12}$ for M1A1
		2	
11(c)	$k = 0$	**M1**	SOI
	$\tan x = 0$ or $\frac{5}{3}$	**A1**	
	$x = 0°$ or $180°$ or $59.0°$	**A1**	All three required
		3	

Question	Answer	Marks	Guidance
12(a)	Centre = (2, –1)	**B1**	
	$r^2 = \left[2-(-3)\right]^2 + \left[-1-(-5)\right]^2$ or $\left[2-7\right]^2 + \left[-1-3\right]^2$ OE	**M1**	OR $\frac{1}{2}\left[(-3-7)^2 + (-5-3)^2\right]$ OE
	$(x-2)^2 + (y+1)^2 = 41$	**A1**	Must not involve surd form **SCB3** $(x+3)(x-7)+(y+5)(y-3)=0$
		3	
12(b)	Centre = *their* (2, –1) + $\begin{pmatrix} 8 \\ 4 \end{pmatrix}$ = (10, 3)	**B1FT**	SOI FT on *their* (2, –1)
	$(x-10)^2 + (y-3)^2 = \textit{their}\ 41$	**B1FT**	FT on *their* 41 even if in surd form **SCB2** $(x-5)(x-15)+(y+1)(y-7)=0$
		2	

Question	Answer	Marks	Guidance
12(c)	Gradient m of line joining centres = $\frac{4}{8}$ OE	**B1**	
	Attempt to find mid-point of line.	**M1**	Expect (6, 1)
	Equation of RS is $y-1=-2(x-6)$	**M1**	Through *their* (6, 1) with gradient $\frac{-1}{m}$
	$y=-2x+13$	**A1**	AG
	Alternative method for question 12(c)		
	$(x-2)^2+(y+1)^2-41=(x-10)^2+(y-3)^2-41$ OE	**M1**	
	$x^2-4x+4+y^2+2y+1=x^2-20x+100+y^2-6y+9$ OE	**A1**	Condone 1 error **or** errors caused by 1 error in the first line
	$16x+8y=104$	**A1**	
	$y=-2x+13$	**A1**	AG
		4	
12(d)	$(x-10)^2+(-2x+13-3)^2=41$	**M1**	Or eliminate y between C_1 and C_2
	$x^2-20x+100+4x^2-40x+100=41 \rightarrow 5x^2-60x+159=0$	**A1**	AG
		2	