Question	Answer	Marks	Guidance
1	$8\left(1-\cos^2\theta\right)+6\cos\theta+1 \quad [=0]$	**M1**	Expect $8\cos^2\theta-6\cos\theta-9=0$.
	$(4\cos\theta+3)(2\cos\theta-3) \quad [=0]$	**A1**	Factors or formula or completing square must be shown.
	$[\rightarrow \cos\theta=-0.75\rightarrow\theta=]\ 138.6°$ only,	**A1**	AWRT, ignore solutions outside the given range, answer in radians A0.
		3	

Question Number	Scheme	Marks
9 (a) (i)	Stretch parallel to the x-axis $\times\frac{1}{2}$ or stretch parallel to the y-axis $\times\sqrt{2}$	M1, A1
(ii)	Translate by the vector $\begin{pmatrix}0\\12\end{pmatrix}$ (or translate up by 12 (units))	M1, A1
		(4)
(b) (i)	$12-\sqrt{x}=\sqrt{2}\sqrt{x}$	
	$12=\left(\sqrt{2}+1\right)\sqrt{x}$	M1
	$\Rightarrow\sqrt{x}=\frac{12}{\sqrt{2}+1}\times\frac{\sqrt{2}-1}{\sqrt{2}-1}=12\left(\sqrt{2}-1\right)$ *	dM1, A1 *
Alt (i)	$12-\sqrt{x}=\sqrt{2x}\Rightarrow\left(12-\sqrt{x}\right)^2=2x\Rightarrow x+24\sqrt{x}-144=0$	M1
	$\Rightarrow\left(\sqrt{x}\right)=\frac{-24\pm\sqrt{24^2-4\times-144}}{2}=-12\pm\frac{12}{2}\sqrt{4+8}=-12\pm12\sqrt{2}$	dM1
	$\sqrt{x}>0\Rightarrow\sqrt{x}=-12+12\sqrt{2}=12\left(\sqrt{2}-1\right)$*	A1
(ii)	$\Rightarrow x=12^2\left(\sqrt{2}-1\right)^2=144\left(2+1-2\sqrt{2}\right)=144\left(3-2\sqrt{2}\right)$	M1, A1
	$y\left\{=12-\sqrt{x}=12-12\left(\sqrt{2}-1\right)\right\}=12\left(2-\sqrt{2}\right)$	B1
	Or common acceptable alt forms: $P\left(432-288\sqrt{2},\quad 24-12\sqrt{2}\right)$	
		(6) **(10 marks)**

Question	Answer	Marks	Guidance
9(b)	[Centre is] $(-4, 3)$	**B1**	SOI
	Radius gradient $= \dfrac{(their\,3)-10}{(their-4)-2}$ $\left[=\dfrac{7}{6}\right]$	***M1**	Attempt at finding the gradient of the radius using $(2, 10)$ and their centre, but not P, Q, the mid-point of PR or QR.
	Either $\dfrac{-1}{\left(their\,\dfrac{7}{6}\right)} = \dfrac{y-10}{x-2}$ Or $10 = \dfrac{-1}{\left(their\,\dfrac{7}{6}\right)} \times 2 + c \Rightarrow c = ...$	**DM1**	OE Correct method to find the equation of the tangent using $\dfrac{-1}{their\text{ radius gradient}}$ and $(2, 10)$.
	$y-10 = -\dfrac{6}{7}(x-2)$ or $y = \left(-\dfrac{6}{7}\right)x + \dfrac{82}{7}$	**A1**	OE Correct equation but not stated in the required form.
	$6x+7y-82=0$ or $82-6x-7y=0$	**A1**	All correct terms on one side, but condone them being in the wrong order.
	Alternative Method for Question 9(b)		
	$x^2+y^2+8x-6y-60=0$	**B1**	OE Equation of the circle.
	$2x+2y\dfrac{dy}{dx}+8-6\dfrac{dy}{dx}=0$ Or $\dfrac{dy}{dx} = \dfrac{-2x-8}{2}\left(85-x^2-8x-16\right)^{-\frac{1}{2}}$	***M1**	Differentiate implicitly to arrive at an expression with two terms containing $\dfrac{dy}{dx}$. Or rearrange to make y the subject and differentiate to arrive at an expression of the form $f'(x) \times f(x)$.

Question	Answer	Marks	Guidance
9(a)	$ar = \dfrac{24}{100} \times \dfrac{a}{1-r}$	**M1**	Form an equation using a numerical form of the percentage and correct formula for u_2 and S_∞
	$100r^2-100r+24[=0]$	**A1**	OE. All 3 terms on one side of an equation.
	$(20r-8)(5r-3)[=0] \rightarrow r = \dfrac{2}{5}, \dfrac{3}{5}$	**A1**	Dependent on factors or formula seen from their quadratic.
		3	

Question	Answer	Marks	Guidance
9(b)	$3\times\{(a+4d)\} = \{(2(a+1)+11(d+1))\}$	***M1**	SOI Attempt to cross multiply with contents of at least one { } correct
	Simplifies to $a+d=13$	**A1**	
	$\left[\dfrac{5}{2}\right]\times 3\{(2a+4d)\} = \left[\dfrac{5}{2}\right]\times 2\{(4(a+1)+4(d+1))\}$	***M1**	SOI Attempt to cross multiply with contents of at least one { } correct
	Simplifies to $-a+2d=8$	**A1**	
	Solve 2 linear equations simultaneously	**DM1**	Elimination or substitution expected
	$d=7,\ a=6$	**A1**	**SC B1** for a=6, d=7 without complete working
		6	

Question	Answer	Marks	Guidance
8(a)	$[\text{fg}(x)=]1/(2x+1)^2-1$	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 $\text{fg}(x)=3$ 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	
	$\text{g}(x)=-2$	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 (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	

Question	Answer	Marks	Guidance
10(a)	$\left\{\frac{(4x+2)^{-1}}{-1}\right\}\{\div 4\}$ or eg $\left\{\frac{1}{16}\right\}\{-(x+0.5)^{-1}\}$ or $\frac{-1}{(16x+8)}$	B1 B1	OE If more than one function of x present then B0 B0.
	$0-(-1/24)$	M1	Apply limits to an integral, ∞ must be used correctly.
	1/24	A1	Allow 0.0417 AWRT.
		4	
10(b)	$\frac{dy}{dx}=\{-2(4x+2)^{-3}\}$ $\{\times 4\}$	B1 B1	Allow unsimplified forms.
	Recognise $\frac{dy}{dx}=-1$	B1	SOI
	their $\frac{-8}{(4x+2)^3}=$ *their* -1	M1	Must be numerical. Must be some attempt to solve *their* equation and $\frac{dy}{dx}\neq 0$.
	(0, ¼)	A1 A1	Accept $x=0$, $y=¼$. $y=¼$ must be from $x=0$ not $x=-1$.
		6	

Question	Answer	Marks	Guidance
8(a)	$a=\frac{1}{2}$	B1	
	$b=\frac{\pi}{3}$	B1	$b=\frac{\pi}{3}+4n\pi, n\geqslant 0$.
		2	
8(b)	x-coordinate = $\{4p\}$ $\{-8\}$	B1 B1	OE, e.g. $4(p-2)$.
	y-coordinate = $-3q$	B1	
		3	

Question	Answer	Marks	Guidance
9(a)	$6\sin 0.9=\frac{AC}{2}$ or $AC^2=6^2+6^2-2\times 6\times 6\cos 1.8$	M1	OE Correct working in degrees is acceptable throughout.
	$AC = 9.40$	A1	SOI Accept 9.39 – 9.41, may be used but not seen for A1.
	Angle CAB = ½(π – 1.8)	M1	SOI Expect 0.6708 (or 0.671).
	Arc CD = *their* 9.40 × *their* 0.6708	M1	Expect 6.306 (or 6.31), do not accept 6 for *their* AC or 1.8 for CAB.
	[Perimeter = 6 + 3.40 + 6.306 =] 15.7	A1	Accept 15.69 – 15.72.
		5	

Question	Answer	Marks	Guidance
9(b)	Sector ADC – ΔABC = ½ × *their* 9.40^2 × *their* 0.6708 – ½ × 6^2 × sin 1.8	M1 M1	Accept correct use of their answers from part **(a).**
	[29.64 – 17.53 =] 12.1	A1	AWRT
		3	

Question	Answer	Marks	Guidance
10(a)	Gradient of $AB=-\frac{3}{5}$, gradient of $BC=\frac{5}{3}$ or lengths of all 3 sides or vectors	M1	Attempting to find required gradients, sides or vectors
	$m_{ab}m_{bc}=-1$ or Pythagoras or $\overrightarrow{AB}.\overrightarrow{BC}=0$ or $\cos ABC=0$ from cosine rule	A1	WWW
		2	
10(b)	Centre = mid-point of $AC=(2,4)$	B1	
		1	

Question	Answer	Marks	Guidance
10(c)	$(x-\text{their } x_c)^2+(y-\text{their } y_c)^2\left[=r^2\right]$ or $(\text{their } x_c-x)^2+(\text{their } y_c-y)^2=\left[r^2\right]$	M1	Use of circle equation with *their* centre
	$(x-2)^2+(y-4)^2=17$	A1	Accept $x^2-4x+y^2-8y+3=0$ OE
		2	
10(d)	$\left(\frac{x+3}{2},\frac{y+0}{2}\right)=(2,4)$ or $\mathbf{BE}=2\mathbf{BD}=2\begin{pmatrix}-1\\4\end{pmatrix}$ Or Equation of BE is $y=-4(x-3)$ or $y-4=-4(x-2)$ leading to $y=-4x+12$ Substitute equation of BE into circle and form a 3-term quadratic.	M1	Use of mid-point formula, vectors, steps on a diagram May be seen to find x coordinate at E
	$(x,y)=(1,8)$ or $\mathbf{OE}=\begin{pmatrix}3\\0\end{pmatrix}+\begin{pmatrix}-2\\8\end{pmatrix}=\begin{pmatrix}1\\8\end{pmatrix}$	A1	E = (1, 8) Accept without working for both marks **SC B2**
	Gradient of BD, m, = –4 or gradient $AC=\frac{1}{4}$ = gradient of tangent	B1	Or gradient of BE = -4
	Equation of tangent is $y-8=¼(x-1)$ OE	M1 A1	For M1, equation through *their* E or (1, 8) (not, A, B or C) and with gradient $\frac{-1}{\text{their}-4}$
		5	

Question	Answer	Marks	Guidance
1	$4C1\times p\times\frac{1}{p^3}x^3$	**B1**	OE soi Can be seen in an expansion.
	$\frac{4}{p^2}=144$	**B1**	OE Correct with correct power of p and only one p term.
	$p=\pm\frac{1}{6}$	**B1 B1**	OE $\pm\frac{2}{12}$ etc. Allow ± 0.167 for B1 B1. **SC B1** for $\pm\sqrt{\frac{1}{36}}$ B1 only,
		4	