Question	Answer	Marks	Guidance
1(i)	$1 + 6y + 15y^2$	**B1**	CAO
		1	
1(ii)	$1+6\left(px-2x^2\right)+15\left(px-2x^2\right)^2$	**M1**	SOI. Allow $6C1\times1^5\left(px-2x^2\right)$, $6C2\times1^4\left(px-2x^2\right)^2$
	$\left(15p^2-12\right)(x^2)=48\left(x^2\right)$	**A1**	1 term from each bracket and equate to 48
	$p = 2$	**A1**	**SC:** A1 $p = 4$ from $15p - 12 = 48$
		3	

Question	Answer	Marks	Guidance
2	$(y=)\left[(x-3)^2\right][-2]$	***B1** **DB1**	DB1 dependent on 3 in 1st bracket
	$x-3=(\pm)\sqrt{y+2}$ **or** $y-3=(\pm)\sqrt{x+2}$	**M1**	Correct order of operations
	$\left(g^{-1}(x)\right)=3+\sqrt{x+2}$	**A1**	Must be in terms of x
	Domain (of g^{-1}) is $(x) > -1$	**B1**	Allow $(-1, \infty)$. Do not allow $y > -1$ or $g(x) > -1$ or $g^{-1}(x) > -1$
		5	

Question	Answer	Marks	Guidance
3	$\frac{dy}{dx} = 3x^2 + 2x - 8$	**B1**	
	Set to zero (SOI) and solve	**M1**	
	(Min) $a = -2$, (Max) $b = 4/3$. – in terms of a and b.	**A1** **A1**	Accept $a \geqslant -2$, $b \leqslant \frac{4}{3}$ **SC**: A1 for $a > -2$, $b < \frac{4}{3}$ or for $-2 < x < \frac{4}{3}$
		4	

Question	Answer	Marks	Guidance
4(i)	Angle $CAO = \frac{\pi}{3}$	**B1**	
		1	
4(ii)	(Sector AOC) $= \frac{1}{2}r^2 \times their\frac{\pi}{3}$	**M1**	SOI
	$(\Delta ABC) = \frac{1}{2}(r)(2r)\sin\left(their\frac{\pi}{3}\right)$ **or** $\frac{1}{2}(2r)(r)\frac{\sqrt{3}}{2}$ **or** $\frac{1}{2}(r)(r)\sqrt{3}$	**M1**	For M1M1, $their\frac{\pi}{3}$ must be of the form $k\pi$ where $0 < k < ½$
	$(\Delta ABC) = \frac{1}{2}(r)(2r)\sin\left(\frac{\pi}{3}\right)$ **or** $\frac{1}{2}(2r)(r)\frac{\sqrt{3}}{2}$ **or** $\frac{1}{2}(r)(r)\sqrt{3}$	**A1**	All correct
	$r^2\left(\frac{\sqrt{3}}{2}\right) - \frac{1}{2}r^2\left(\frac{\pi}{3}\right)$	**A1**	
		4	

Question	Answer	Marks	Guidance
5(i)	$S = 28x^2,\ V = 8x^3$	B1B1	SOI
	$7V^{\frac{2}{3}} = 7 \times 4x^2 = S$	B1	AG, WWW
		3	
5(ii)	$\left(\frac{dS}{dV}\right) = \frac{14V^{-\frac{1}{3}}}{3} = \frac{14}{30}$ SOI when $V = 1000$	*M1 A1	Attempt to differentiate For M mark $\left(\frac{dS}{dV}\right)$ to be of form $kV^{-\frac{1}{3}}$
	$\left(\frac{dV}{dt} = \frac{dS}{dt} \times \frac{dV}{dS}\right)$ OE used with $\frac{dS}{dt} = 2$ **and** $\frac{1}{their\ \frac{14}{30}}$	DM1	
	$\frac{30}{7}$ or 4.29	A1	OE
	Alternative method for question 5(ii)		
	$V = \frac{S^{\frac{3}{2}}}{7\sqrt{7}} \rightarrow \left(\frac{dV}{dS}\right) = \frac{3}{2} \times S^{\frac{1}{2}} \times \frac{1}{7\sqrt{7}} = \frac{30}{14}$ SOI when $S = 700$	*M1 A1	Attempt to differentiate For M mark $\left(\frac{dV}{dS}\right)$ to be of form $kS^{\frac{1}{2}}$
	$\left(\frac{dV}{dt} = \frac{dS}{dt} \times \frac{dV}{dS}\right)$ OE used with $\frac{dS}{dt} = 2$ **and** $\frac{1}{their\ \frac{14}{30}}$	DM1	
	$\frac{30}{7}$ or 4.29	A1	OE

Question	Answer	Marks	Guidance
5(ii)	**Alternative method for question 5(ii)**		
	Attempt to find either $\frac{dV}{dx}$ **or** $\left(\frac{dS}{dx} \text{ and } \frac{dV}{dS}\right)$ together with either $\frac{dx}{dt}$ **or** x	*M1	
	$\frac{dV}{dx} = 24x^2$ **or** $\left(\frac{dS}{dx} = 56x \text{ and } \frac{dV}{dS} = \frac{3x}{7}\right)$, $\frac{dx}{dt} = \frac{1}{140}$ **or** $x = 5$ (A1)	A1	
	Correct method for $\frac{dV}{dt}$	DM1	
	$\frac{30}{7}$ or 4.29	A1	OE
		4	

Question	Answer	Marks	Guidance
6(i)	$3kx-2k=x^2-kx+2 \rightarrow x^2-4kx+2k+2\ (=0)$	**B1**	kx terms combined correctly-implied by correct b^2-4ac
	Attempt to find b^2-4ac	**M1**	Form a quadratic equation in k
	1 and $-\frac{1}{2}$	**A1**	SOI
	$k>1,\ k<-\frac{1}{2}$	**A1**	Allow $x>1,\ x<-1/2$
		4	
6(ii)	$y=3x-2, \quad y=-\frac{3}{2}x+1$	**M1**	Use of *their* k values (twice) in $y=3kx-2k$
	$3x-2=-\frac{3}{2}x+1$ OR $y+2=2-2y$	**M1**	Equate *their* tangent equations OR substitute $y=0$ into both lines
	$x=\frac{2}{3}, \rightarrow y=0$ in one or both lines	**A1**	Substitute $x=\frac{2}{3}$ in one or both lines
		3	

Question	Answer	Marks	Guidance
7(i)	$3\cos^4\theta + 4\left(1-\cos^2\theta\right) - 3(=0)$	**M1**	Use $s^2 = 1 - c^2$
	$3x^2 + 4(1-x) - 3(=0) \rightarrow 3x^2 - 4x + 1(=0)$	**A1**	AG
		2	
7(ii)	Attempt to solve for x	**M1**	Expect x = 1, 1/3
	$\cos\theta = (\pm)1,\ (\pm)0.5774$	**A1**	Accept $(\pm)\left(\frac{1}{\sqrt{3}}\right)$ SOI
	$(\theta =)$ 0º, 180º, 54.7º, 125.3º	**A3,2,1,0**	A2,1,0 if more than 4 solutions in range
		5	

Question	Answer	Marks	Guidance
8(i)	$(2x-1)^{\frac{1}{2}}<2$ or $3(2x-1)^{\frac{1}{2}}<6$	M1	SOI
	$2x-1<4$	A1	SOI
	$\frac{1}{2}<x<\frac{5}{2}$	A1 A1	Allow 2 separate statements
		4	
8(ii)	$f(x) = [3(2x-1)^{3/2} \div \left(\frac{3}{2}\right) \div (2)]\ \ [-6x]\ \ (+c)$	B1 B1	
	Subsitute $x = 1$, $y = -3$ into an integrated expression.	M1	Dependent on c being present ($c = 2$)
	$f(x) = (2x-1)^{\frac{3}{2}} - 6x + 2$	A1	
		4	

Question	Answer	Marks	Guidance
9(i)	$\frac{5k-6}{3k}=\frac{6k-4}{5k-6} \rightarrow (5k-6)^2=3k(6k-4)$	M1	OR any valid relationship
	$25k^2-60k+36=18k^2-12k \rightarrow 7k^2-48k+36$	A1	AG
		2	
9(ii)	$k=\frac{6}{7}$, 6	B1B1	Allow 0.857(1) for $\frac{6}{7}$
	When $k=\frac{6}{7}$, $r=-\frac{2}{3}$	B1	Must be exact
	When $k=6$, $r=\frac{4}{3}$	B1	
		4	
9(iii)	Use of $S_\infty=\frac{a}{1-r}$ with $r=their-\frac{2}{3}$ and $a=3\times their\frac{6}{7}$	M1	Provided 0 < |*their* –2/3| < 1
	$\frac{18}{7}\div\left(1+\frac{2}{3}\right)=\frac{54}{35}$ or 1.54	A1	FT if 0.857(1) has been used in part (ii).
		2	

Question	Answer	Marks	Guidance
10(i)	$\mathbf{AX}=\begin{pmatrix}6\\2\\3\end{pmatrix}$, and one of $\mathbf{AB}=\begin{pmatrix}18\\6\\9\end{pmatrix}$, $\mathbf{XB}=\begin{pmatrix}12\\4\\6\end{pmatrix}$, $\mathbf{BX}=\begin{pmatrix}-12\\-4\\-6\end{pmatrix}$	B1B1	
	State $\mathbf{AB}=3\mathbf{AX}$ (or $\mathbf{XB}=2\mathbf{AX}$ or $\mathbf{AB}=\frac{3}{2}\mathbf{XB}$ etc) hence straight line **OR** $\frac{\mathbf{AX.AB}}{\lvert\mathbf{AX}\rvert\lvert\mathbf{AB}\rvert}=1$ $(\rightarrow\theta=0)$ or $\frac{\mathbf{AX.BX}}{\lvert\mathbf{AX}\rvert\lvert\mathbf{BX}\rvert}=-1$ $(\rightarrow\theta=180)$ hence straight line	B1	WWW A conclusion (i.e. a straight line) is required.
		3	
10(ii)	$\mathbf{CX}=\begin{pmatrix}-3\\6\\2\end{pmatrix}$	B1	
	$\mathbf{CX.AX}=-18+12+6$	M1	
	= 0 (hence CX is perpendicular to AX)	A1	
		3	
10(iii)	$\lvert\mathbf{CX}\rvert=\sqrt{3^2+6^2+2^2}$, $\lvert\mathbf{AB}\rvert=\sqrt{18^2+6^2+9^2}$ Both attempted	M1	
	Area $\Delta\,ABC=\frac{1}{2}\times$ *their* $21\times$ *their* $7=73\frac{1}{2}$	M1A1	Accept answers which round to 73.5
		3	

Question	Answer	Marks	Guidance
11(i)	$\frac{dy}{dx} = -2(x-1)^{-3}$	B1	
	When $x = 2$, $m = -2 \rightarrow$ gradient of normal $= -\frac{1}{m}$	M1	m must come from differentiation
	Equation of normal is $y - 3 = ½(x - 2) \rightarrow y = ½x + 2$	A1	AG Through (2, 3) with gradient $-\frac{1}{m}$. Simplify to AG
		3	

Question	Answer	Marks	Guidance
11(ii)	$(\pi)\int y_1^2(\mathrm{d}x), (\pi)\int y_2^2(\mathrm{d}x)$	*M1	Attempt to integrate y^2 for at least one of the functions
	$(\pi)\int\left(\frac{1}{2}x+2\right)^2$ or $\left(\frac{1}{4}x^2+2x+4\right)$ $(\pi)\int\left((x-1)^{-4}+4(x-1)^{-2}+4\right)$	A1A1	A1 for $\left(\frac{1}{2}x+2\right)^2$ depends on an attempt to integrate this form later
	$(\pi)\left[\frac{2}{3}\left(\frac{1}{2}x+2\right)^3 \text{ or } \frac{1}{12}x^3+x^2+4x\right]$ $(\pi)\left[\frac{(x-1)^{-3}}{-3}+\frac{4(x-1)^{-1}}{-1}+4x\right]$	A1A1	Must have at least 2 terms correct for each integral
	$(\pi)\left\{18-\frac{125}{12} or \frac{2}{3}+4+8-\left(\frac{1}{12}+1+4\right)\right\}\ \left\{\frac{-1}{24}-2+12-\left(\frac{-1}{3}-4+8\right)\right\}$	DM1	Apply limits to at least 1 integrated expansion
	Attempt to add 2 volume integrals (or 1 volume integral + frustum) $\pi\left\{7\frac{7}{12}+6\frac{7}{24}\right\}$	DM1	
	$13\frac{7}{8}\pi$ or $\frac{111}{8}\pi$ or 13.9π or 43.6	A1	$\frac{2}{3}+4+8-\left(\frac{1}{12}+1+4\right)\ \frac{-1}{24}-2+12-\left(\frac{-1}{3}-4+8\right)$
		8	