Question	Answer	Marks	Guidance
1	$\frac{dy}{dx} = 3x^{1/2} - 3 - 2x^{-1/2}$	B2,1,0	
	at $x = 4$, $\frac{dy}{dx} = 6 - 3 - 1 = 2$	M1	
	Equation of tangent is $y = 2(x-4)$ OE	A1FT	Equation through (4, 0) with *their* gradient
		4	

Question	Answer	Marks	Guidance
2	$f'(x) = 3x^2 - 2x - 8$	M1	Attempt differentiation
	$-\frac{4}{3}$, 2 SOI	A1	
	$f'(x) > 0 \Rightarrow x < -\frac{4}{3}$ SOI	M1	Accept $x > 2$ in addition. FT *their* solutions
	Largest value of a is $-\frac{4}{3}$	A1	Statement in terms of a. Accept $a \leqslant -\frac{4}{3}$ or $a < -\frac{4}{3}$. Penalise extra solutions
		4	

Question	Answer	Marks	Guidance
3(i)	$\dfrac{3a}{1-r}=\dfrac{a}{1+2r}$	**M1**	Attempt to equate 2 sums to infinity. At least one correct
	$3+6r=1-r$	**DM1**	Elimination of 1 variable (a) at any stage and multiplication
	$r=-\dfrac{2}{7}$	**A1**	
		3	
3(ii)	$½n\left[2\times 15+(n-1)4\right]=½n\left[2\times 420+(n-1)(-5)\right]$	**M1A1**	Attempt to equate 2 sum to n terms, at least one correct (**M1**). Both correct (**A1**)
	$n=91$	**A1**	
		3	

Question	Answer	Marks	Guidance
4(i)	$V = \frac{1}{3}\pi r^2(18-r) = 6\pi r^2 - \frac{1}{3}\pi r^3$	**B1**	AG
		1	
4(ii)	$\frac{dV}{dr} = 12\pi r - \pi r^2 = 0$	**M1**	Differentiate and set = 0
	$\pi r(12-r) = 0 \rightarrow r = 12$	**A1**	
	$\frac{d^2V}{dr^2} = 12\pi - 2\pi r$	**M1**	
	Sub $r = 12 \rightarrow 12\pi - 24\pi = -12\pi \rightarrow$ MAX	**A1**	AG
		4	
4(iii)	Sub $r = 12,\ h = 6 \rightarrow \text{Max } V = 288\pi$ or 905	**B1**	
		1	

Question	Answer	Marks	Guidance
5(i)	$\cos A = 8/10 \rightarrow A = 0.6435$	B1	AG Allow other valid methods e.g. $\sin A = 6/10$
		1	
5(ii)	*EITHER:* Area $\Delta ABC = ½ \times 16 \times 6$ or $½ \times 10 \times 16 \sin 0.6435 = 48$	(M1A1	
	Area 1 sector $½ \times 10^2 \times 0.6435$	M1	
	Shaded area $= 2 \times$ *their* sector $-$ *their* ΔABC	M1)	
	OR: $\Delta BDE = 12$, $\Delta BDC = 30$	(B1 B1	
	Sector = 32.18	M1	
	2×segment + ΔBDE	M1)	
	=16.4	A1	
		5	

Question	Answer	Marks	Guidance
6(i)	Mid-point of AB = (3, 5)	**B1**	Answers may be derived from simultaneous equations
	Gradient of AB = 2	**B1**	
	Eqn of perp. bisector is $y-5=-\frac{1}{2}(x-3) \rightarrow 2y=13-x$	**M1A1**	AG For **M1** FT from mid-point and gradient of AB
		4	
6(ii)	$-3x+39=5x^2-18x+19 \rightarrow (5)(x^2-3x-4)(=0)$	**M1**	Equate equations and form 3-term quadratic
	$x=4$ or -1	**A1**	
	$y=4\frac{1}{2}$ or 7	**A1**	
	$CD^2=5^2+2\frac{1}{2}^2 \rightarrow CD=\sqrt{\frac{125}{4}}$	**M1A1**	Or equivalent integer fractions ISW
		5	

Question	Answer	Marks	Guidance
7(a)	$a = -2, \quad b = 3$	B1B1	
		2	
7(b)(i)	$s + s^2 - sc + 2c + 2sc - 2c^2 = s + sc \rightarrow s^2 - 2c^2 + 2c = 0$	B1	Expansion of brackets must be correct
	$1 - \cos^2\theta - 2\cos^2\theta + 2\cos\theta = 0$	M1	Uses $s^2 = 1 - c^2$
	$3\cos^2\theta - 2\cos\theta - 1 = 0$	A1	AG
		3	
7(b)(ii)	$\cos\theta = 1$ or $-\frac{1}{3}$	B1	
	$\theta = 0°$ or $109.5°$ or $-109.5°$	B1B1B1 FT	FT for – *their* 109.5°
		4	

Question	Answer	Marks	Guidance
8(a)	*EITHER:* $\overrightarrow{PR} = 2\overrightarrow{PQ} = 2(\mathbf{q}-\mathbf{p})$	**(B1**	
	$\overrightarrow{OR} = \mathbf{p}+2\mathbf{q}-2\mathbf{p} = 2\mathbf{q}-\mathbf{p}$	**M1A1)**	
	OR: $\overrightarrow{QR} = \overrightarrow{PQ} = \mathbf{q}-\mathbf{p}$	**(B1**	
	$\overrightarrow{OR} = \overrightarrow{OQ} + \overrightarrow{QR} = \mathbf{q}+\mathbf{q}-\mathbf{p} = 2\mathbf{q}-\mathbf{p}$	**M1A1)**	Or other valid method
		3	
8(b)	$6^2 + a^2 + b^2 = 21^2$ SOI	**B1**	
	$18 + 2a + 2b = 0$	**B1**	
	$a^2 + (-a-9)^2 = 405$	**M1**	Correct method for elimination of a variable. (Or same equation in *b*)
	$(2)(a^2 + 9a - 162)(=0)$	**A1**	Or same equation in *b*
	$a = 9$ or -18	**A1**	
	$b = -18$ or 9	**A1**	
		6	

Question	Answer	Marks	Guidance
9(i)	$gg(x) = g(2x - 3) = 2(2x - 3) - 3 = 4x - 9$	**M1A1**	
		2	
9(ii)	$y = \dfrac{1}{x^2 - 9} \to x^2 = \dfrac{1}{y} + 9$ OE	**M1**	Invert; add 9 to both sides or with *x/y* interchanged
	$f^{-1}(x) = \sqrt{\dfrac{1}{x} + 9}$	**A1**	
	Attempt soln of $\sqrt{\dfrac{1}{x} + 9} > 3$ or attempt to find range of f. $(y > 0)$	**M1**	
	Domain is $x > 0$ CAO	**A1**	May simply be stated for **B2**
		4	

Question	Answer	Marks	Guidance
9(iii)	*EITHER:* $\dfrac{1}{(2x-3)^2-9}=\dfrac{1}{7}$	(M1	
	$(2x-3)^2=16$ or $4x^2-12x-7=0$	A1	
	$x = 7/2$ or $-1/2$	A1	
	$x = 7/2$ only	A1)	
	OR: g(x) = $f^{-1}\left(\dfrac{1}{7}\right)$	(M1	
	g(x) = 4	A1	
	$2x - 3 = 4$	A1	
	$x = 7/2$	A1)	
		4	

Question	Answer	Marks	Guidance
10(i)	Area $=\int ½\left(x^4-1\right)\mathrm{d}x = ½\left[\frac{x^5}{5}-x\right]$	*B1	
	$½\left[\frac{1}{5}-1\right]-0 \quad = \quad (-)\frac{2}{5}$	DM1A1	Apply limits 0→1
		3	
10(ii)	Vol $=\pi\int y^2\mathrm{d}x \quad = \quad ¼(\pi)\int\left(x^8-2x^4+1\right)\mathrm{d}x$	M1	(If middle term missed out can only gain the M marks)
	$¼(\pi)\left[\frac{x^9}{9}-\frac{2x^5}{5}+x\right]$	*A1	
	$¼(\pi)[\left(\frac{1}{9}-\frac{2}{5}+1\right]-0$	DM1	
	$\frac{8\pi}{45}$ or 0.559	A1	
		4	

Question	Answer	Marks	Guidance
10(iii)	Vol $= \pi \int x^2 \mathrm{d}y \ = \ (\pi)\int (2y+1)^{1/2}\, \mathrm{d}y$	**M1**	Condone use of x if integral is correct
	$(\pi)\left[\dfrac{(2y+1)^{3/2}}{3/2}\right][\div 2]$	***A1A1**	Expect $(\pi)\left[\dfrac{(2y+1)^{3/2}}{3}\right]$
	$(\pi)\left[\dfrac{1}{3}-0\right]$	**DM1**	
	$\dfrac{\pi}{3}$ or 1.05	**A1**	Apply $-\dfrac{1}{2} \to 0$
		5	