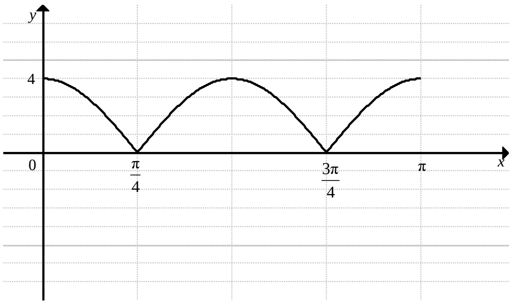
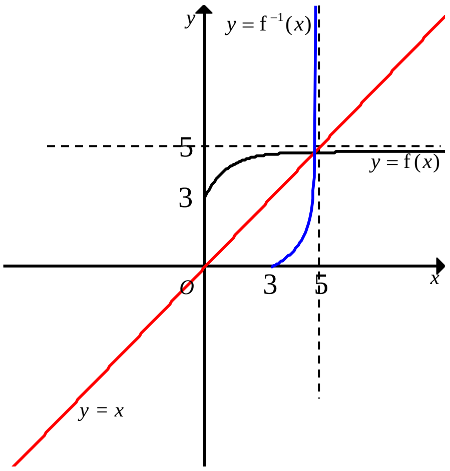
Question	Answer	Marks	Partial Marks
1	Correct sketch 	**3**	**B1** for correct shape, with 3 consistent maxima, 2 cusps on the *x*-axes and reasonable symmetry **B1** for $\left(\frac{\pi}{4},\ 0\right)$ and $\left(\frac{3\pi}{4},\ 0\right)$ either seen on the graph or stated; must have attempted a graph of correct shape **B1** for starts with (0, 4) **and** ends with (π, 4) and (0, 4) either seen on the graph or stated; must have attempted a graph correct shape
2	$\frac{11x^2}{12+1-4\sqrt{3}}$	**B1**	
	$\frac{11x^2\left(13+4\sqrt{3}\right)}{\left(13-4\sqrt{3}\right)\left(13+4\sqrt{3}\right)}$	**M1**	**FT** *their* expression of equivalent difficulty
	$\frac{11x^2\left(13+4\sqrt{3}\right)}{169-48}$ or $\frac{143x^2+44\sqrt{3}x^2}{169-48}$	**A1**	
	$\frac{x^2\left(13+4\sqrt{3}\right)}{11}$ or $\frac{13x^2+4\sqrt{3}x^2}{11}$	**A1**	mark final answer
	Alternative method		
	$\left(\frac{x\sqrt{11}(2\sqrt{3}+1)}{(2\sqrt{3}-1)(2\sqrt{3}+1)}\right)^2$	**(M1)**	
	$\left(\frac{x\sqrt{11}(2\sqrt{3}+1)}{12-1}\right)^2$ or $\left(\frac{2\sqrt{33}x+x\sqrt{11}}{12-1}\right)^2$	**(A1)**	
	$\frac{11x^2(12+1+4\sqrt{3})}{121}$ or $\frac{132x^2+11x^2+4\sqrt{363}x^2}{121}$	**(A1)**	
	$\frac{x^2\left(13+4\sqrt{3}\right)}{11}$	**(A1)**	mark final answer

Question	Answer	Marks	Partial Marks
3	$(5x + 4)^2 * (2x - 3)^2$ soi where * is any inequality sign or =	**M1**	
	$21x^2 + 52x + 7 * 0$	**A1**	
	Critical values: $-\frac{1}{7}$, $-\frac{7}{3}$ soi	**A1**	
	$-\frac{7}{3} \leqslant x \leqslant -\frac{1}{7}$ mark final answer	**A1**	**FT** *their* derived critical values
	Alternative method		
	$5x + 4 * 2x - 3$ oe soi and $5x + 4 * 3 - 2x$ oe soi where * is any inequality sign or =	**(M1)**	
	Critical values: $-\frac{1}{7}$, $-\frac{7}{3}$ soi	**(A2)**	**A1** for $-\frac{1}{7}$ or $-\frac{7}{3}$
	$-\frac{7}{3} \leqslant x \leqslant -\frac{1}{7}$ mark final answer	**(A1)**	**FT** *their* derived critical values
4	$[y =] \frac{1}{\operatorname{cosec} 5x} = \sin 5x$ nfww	**B1**	
	$\int_0^{\frac{\pi}{5}} y \, dx = \left[-\frac{\cos 5x}{5} \right]_0^{\frac{\pi}{5}}$	**B1**	**FT** *their* $a\sin 5x$
	$-\frac{1}{5}\cos\left(5 \times \frac{\pi}{5}\right) - \left(-\frac{1}{5}\cos(5 \times 0)\right)$	**M1**	**FT** *their* $a(k\cos bx)$ where $k < 0$ or $k = \frac{1}{5}$
	$\frac{2}{5}$	**A1**	
5(a)	$1^3 - 2(1^2) - 19 + 20 = 0$	**1**	
5(b)	$(x - 1)(x^2 - x - 20)$	**M2**	**M1** for two terms correct in the quadratic factor
	$(x - 1)(x + 4)(x - 5)$	**A1**	
5(c)	$e^y = 1, e^y = 5$	**M1**	
	$y = 0, y = \ln 5$ mark final answer	**A1**	1.61 or decimal equivalent for ln5 seen is A0 as calculator use not permitted

Question	Answer	Marks	Partial Marks
6(a)(i)	$\frac{1}{8}$ or 0.125	**2**	**M1** for $64(0.5)^9$ oe
6(a)(ii)	$\frac{1023}{8}$ or 127.875	**2**	**M1** for $\frac{64(1-0.5^{10})}{1-0.5}$ oe
6(a)(iii)	128	**1**	
6(b)	$\frac{20}{2}\{2a+19d\}-400=2\times\frac{10}{2}\{2a+9d\}$ oe, soi	**M2**	**M1** for $\frac{20}{2}\{2a+19d\}$ or $\frac{10}{2}\{2a+9d\}$ soi
	$5a = a + 5d$ soi	**M1**	
	$d = 4$	**A1**	
	$a = 5$	**A1**	
	27 nfww	**B1**	must have earned all previous marks
7(a)	$\frac{\mathrm{d}}{\mathrm{d}x}(\cos^2 x)=-2\cos x\sin x$ soi	**B1**	
	Attempts the quotient rule $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-2\cos x\sin x\tan x-(1+\cos^2 x)\sec^2 x}{\tan^2 x}$	**M1**	**FT** *their* $\frac{\mathrm{d}}{\mathrm{d}x}(\cos^2 x)$
	Fully correct isw	**A1**	**FT** *their* $\frac{\mathrm{d}}{\mathrm{d}x}(\cos^2 x)$ only
	$\frac{\delta y}{h}\approx \textit{their}\left.\frac{\mathrm{d}y}{\mathrm{d}x}\right\|_{x=\frac{\pi}{4}}$	**M1**	
	$\delta y\approx -4h$ cao	**A1**	

Question	Answer	Marks	Partial Marks
7(a)	**Alternative method 1**		
	$\frac{d}{dx}(\cos^3 x) = -3\cos^2 x \sin x$ soi	**(B1)**	
	Attempts the quotient rule: $\frac{dy}{dx} = \frac{(\sin x)(-\sin x - 3\cos^2 x \sin x) - (\cos x + \cos^3 x)\cos x}{\sin^2 x}$	**(M1)**	**FT** *their* $\frac{d}{dx}(\cos^3 x)$
	Fully correct isw	**(A1)**	**FT** *their* $\frac{d}{dx}(\cos^3 x)$ only
	$\frac{\delta y}{h} \approx$ *their* $\left.\frac{dy}{dx}\right\|_{x=\frac{\pi}{4}}$	**(M1)**	
	$\delta y \approx -4h$ cao	**(A1)**	
	Alternative method 2		
	$\frac{d}{dx}\left(\frac{2}{\tan x}\right) = -2(\tan x)^{-2}\sec^2 x$	**(B1)**	
	Attempts the product rule $\frac{dy}{dx} = -2(\tan x)^{-2}\sec^2 x - (\sin x(-\sin x) + \cos x(\cos x))$	**(M1)**	**FT** *their* $\frac{d}{dx}\left(\frac{2}{\tan x}\right)$
	Fully correct isw	**(A1)**	**FT** *their* $\frac{d}{dx}\left(\frac{2}{\tan x}\right)$ only
	$\frac{\delta y}{h} \approx$ *their* $\left.\frac{dy}{dx}\right\|_{x=\frac{\pi}{4}}$	**(M1)**	
	$\delta y \approx -4h$ cao	**(A1)**	

Question	Answer	Marks	Partial Marks
7(b)	$\frac{dy}{dx} = -3(x-3)^{-4}$ oe, soi	**B1**	
	$\frac{d^2y}{dx^2} = -4 \times -3(x-3)^{-5}$ oe, soi	**B1**	
	$\frac{(x-3)^2 + 3(x-3) - 4}{(x-3)^5}$ or $\left[\frac{x-3+3}{(x-3)^4} - \frac{4}{(x-3)^5} = \right]\frac{x(x-3)-4}{(x-3)^5}$	**M1**	**FT** $\frac{dy}{dx} = k(x-3)^{-4}$ and $\frac{d^2y}{dx^2} = m(x-3)^{-5}$ where k and m are constants
	Correct completion to given answer: $\frac{x^2-3x-4}{(x-3)^5} = \frac{(x+1)(x-4)}{(x-3)^5}$	**A1**	
8(a)(i)	$3 \leqslant x < 5$	**B2**	**B1** for $x \geqslant 3$ or for $x < 5$ or for 3 and 5 in an incorrect inequality
8(a)(ii)	$x = \sqrt{5x-4}$ and rearrangement to $x^2 - 5x + 4[=0]$	**B1**	
	Factorises $x^2 - 5x + 4$ or solves *their* $x^2 - 5x + 4 = 0$	**M1**	
	$x = 4$ only, nfww	**A1**	
8(a)(iii)	Correct pair of graphs. 	**4**	**B1** for correct shape for f; may not be over correct domain but must have positive y-intercept and appear to tend to an asymptote in the 1st quadrant **B1** for (0, 3) and f in 1st quadrant only; must have attempted correct shape **B1** for asymptote at $y = 5$; must have attempted correct shape **B1** for a correct reflection of *their* f in the line $y = x$ **Maximum of 3 marks if not fully correct**

Question	Answer	Marks	Partial Marks
8(b)	$\mathrm{f}^{-1}(x) = -\ln\frac{5-x}{2}$ or $\mathrm{f}^{-1}(x) = \ln\frac{2}{5-x}$ oe	2	**M1** for a complete attempt to find the inverse function with at most one sign or arithmetic error: Putting $y = \mathrm{f}(x)$ and changing subject to x and swopping x and y or swopping x and y and changing subject to y
	Correct simplified form e.g. $\left[\mathrm{f}^{-1}\mathrm{g}(x) =\right] -\ln\frac{2-5x}{2(1-x)}$ or $\left[\mathrm{f}^{-1}\mathrm{g}(x) =\right]\ln\frac{2-2x}{2-5x}$	2	**M1 FT** for a correct unsimplified form of the function; FT providing of equivalent difficulty
9(a)	$6.5\left(\frac{3\pi}{8}\right) + 5.2\left(\frac{3\pi}{8}\right) + 2(6.5-5.2)$	**M2**	**M1** for $6.5\left(\frac{3\pi}{8}\right)$ or $5.2\left(\frac{3\pi}{8}\right)$
	16.38 to 16.4	**A1**	
9(b)	[Angle *PRQ* =] 2ϕ soi	**B1**	
	$y = 2a\cos\phi$ oe or $y = \frac{a\sin(\pi - 2\phi)}{\sin\phi}$ oe $y^2 = a^2 + a^2 - 2a^2\cos(\pi - 2\phi)$ oe or $y^2 = a^2 + a^2 + 2a^2\cos(2\phi)$ oe	**B1**	
	Complete and correct plan soi: $\pi a^2 - \frac{1}{2}(2a\cos\phi)^2(2\phi)$ oe or $\pi a^2 - \frac{1}{2}\left(\frac{a\sin(\pi-2\phi)}{\sin\phi}\right)^2(2\phi)$ oe or $\pi a^2 - \frac{1}{2}(a^2 + a^2 - 2a^2\cos(\pi - 2\phi))(2\phi)$ oe or $\pi a^2 - \frac{1}{2}(a^2 + a^2 + 2a^2\cos(2\phi))(2\phi)$	**M1**	**FT** *their* 2ϕ and *their* expression for y or y^2 in terms of a and ϕ
	$a^2\left(\pi - 4\phi\cos^2\phi\right)$ or $\pi a^2 - \frac{a^2\phi\sin^2(\pi-2\phi)}{\sin^2\phi}$ or $\pi a^2 - 2\phi(a^2 - a^2\cos(\pi - 2\phi))$ or $\pi a^2 - 2\phi(a^2 + a^2\cos 2\phi)$ oe	**A1**	

Question	Answer	Marks	Partial Marks
10(a)(i)	$v = 3t^2 + c$	**M1**	
	$v = 3t^2 - 1$	**A1**	
	When $t = 3$ $v = 26$	**A1**	
10(a)(ii)	$s = t^3 - t + c$	**M1**	**FT** $kt^2 + c$
	$s = t^3 - t - 4$	**A1**	
	When $t = 3$ $s = 20$	**A1**	
10(b)	$v = \frac{-18e^3}{e^t} + c$ oe	**M1**	
	$v = \frac{-18e^3}{e^t} + 44$ oe	**A1**	**FT** (*their* 26) + 18
	$s = \frac{18e^3}{e^t} + their\,44t + d$ oe	**M1**	**dep** on previous **M1**
	$s = \frac{18e^3}{e^t} + 44t - 130$ oe, cao	**A1**	

Question	Answer	Marks	Partial Marks
11	Solves $\sin(4x - \pi) = 0$ oe	**M1**	
	$a = \frac{3\pi}{4}$	**A1**	
	$\frac{dy}{dx} = 4\cos(4x - \pi)$	**B2**	**B1** for $\frac{dy}{dx} = k\cos(4x - \pi)$, where $k > 0$ or $k = -4$
	$\left[\frac{-1}{4\cos(4 \times their\frac{3\pi}{4} - \pi)} = \right] -\frac{1}{4}$	**B2**	**FT** *their* $a = \frac{n\pi}{4}$, n is a positive integer **B1** for $\frac{-1}{theirk\cos(4 \times their\frac{3\pi}{4} - \pi)}$
	$y - 0 = -\frac{1}{4}\left(x - \frac{3\pi}{4}\right)$ or $0 = -\frac{1}{4}\left(\frac{3\pi}{4}\right) + c$ oe	**M1**	**FT** *their* perpendicular gradient and *their a*
	$B\left(0, \frac{3\pi}{16}\right)$ soi	**B1**	
	[Exact area =] $\frac{9\pi^2}{128}$	**B1**	