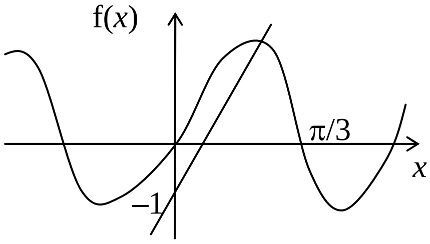
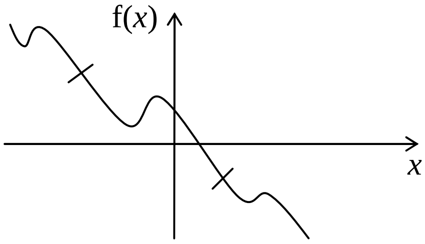
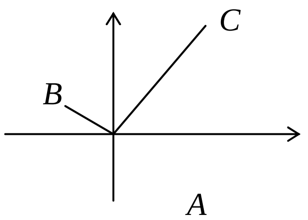
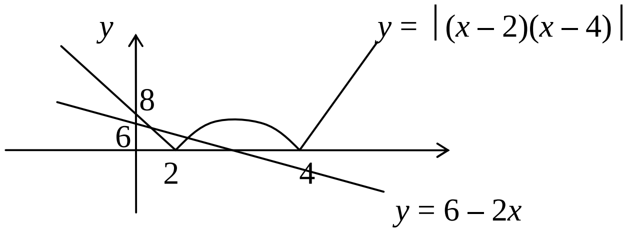
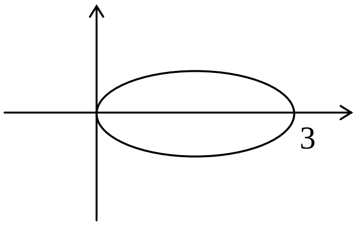
Question Number	Scheme	Marks
1. (*a*)	$(r+1)^3 - (r-1)^3 = (r^3 + 3r^2 + 3r + 1) - (r^3 - 3r^2 + 3r - 1)$	M1
	$= 6r^2 + 2$	A1 (2)
(*b*)	$\sum_{r=1}^{n}(6r^2+2) = 2^3 - 0^3$ attempt to use an identity	M1
	$= 3^3 - 1^3$	
	$4^3 - 2^3$	
	$\vdots \quad \vdots$	
	$(n-1)^3 - (n-3)^3$	
	$n^3 - (n-2)^3$	
	$(n+1)^3 - (n-1)^3$ differences (must see)	M1
	$= (n+1)^3 + n^3 - 1^3$	A1
	$6\sum_{r=1}^{n} r^2 = (n+1)^3 + n^3 - 1 - 2n$ 2*n* or equiv.	B1
	$= 2n^3 + 3n^2 + n$	
	$\sum_{r=1}^{n} r^2 = \frac{1}{6}n(2n+1)(n+1)$ **(*)** Sub. Σ2 and ÷ 6 or equiv. c.s.o.	M1, A1
		(6 marks)
2. (*a*)	 $y = \sin 3x$	B1
	$y = 2x - 1$	B1
	1 point where they meet	B1 (3)
or	 Shape	B1
	Asymptotic behaviour to $y = -2x + 1$	B1
	Cross *x*-axis once + comment	B1
(*b*)	$f'(x) = 3\cos 3x - 2$ Attempt to diff. cos3*x* + two terms for M1	M1, A1
	$u_1 = 0.8 - \dfrac{0.075}{-4.212}$	M1
	$= 0.8179$	A1
	$u_2 = 0.8177$	A1 (5)
		(8 marks)

Question Number	Scheme	Marks
3. (*a*)	$\lvert z \rvert = 2\sqrt{2}$ $\lvert w \rvert = 2$	M1, A1
	$\therefore \lvert wz^2 \rvert = (2\sqrt{2})^2 \times 2 = 16$	M1, A1
	$\arg z = -\frac{\pi}{4}$ $\arg w = \frac{5\pi}{6}$; $\therefore$ $\arg wz^2 = -\frac{\pi}{4} - \frac{\pi}{4} + \frac{5\pi}{6} = \frac{\pi}{3}$, 60°	M1, A1 (6)
ALT	$z^2 = -8\text{i}$; $\therefore z^2 w = 8 + 8\sqrt{3}\text{i}$	M1, A1
	$\lvert z^2 w \rvert = \sqrt{8^2 + 8^2 \times 3}$	M1
	$= 16$	A1
	$\arg z^2 w = \tan^{-1}\sqrt{3}$	M1
	$= \frac{\pi}{3}$	A1
(*b*)	 Points *A* and *B*	B1
	Point *C*	B1ft
	angle $BOC = \frac{5\pi}{6} - \frac{\pi}{3}$	M1
	$= \frac{\pi}{2}$, 90°	A1 (4)
		(10 marks)
4. (*a*)	IF $= e^{\int 1+\frac{3}{x}\,dx}$	M1
	$= e^{x+3\ln x}$	A1
	$= e^x e^{\ln x^3}$ must see	
	$= x^3 e^x$	A1 (3)
(*b*)	$x^3 e^x y = \int x^3 e^x \frac{1}{x^2}\,dx$	M1
	$= \int x e^x\,dx$	
	$= xe^x - e^x + c$ $\int$ by parts	M1 A1
	$y = \frac{1}{x^2} - \frac{1}{x^3} + \frac{c}{x^3}e^{-x}$ o.e.	A1 (4)
(*c*)	$\text{I} = ce^{-1}$ $\therefore$ $c = e^1$	M1
	$y = \frac{1}{4} - \frac{1}{8} + \frac{e.e^{-2}}{8}$	M1
	$= \frac{1}{8}(1 + e^{-1})$	A1 (3)
	or = 0.171 0.171 or better	
		(10 marks)

Question Number	Scheme	Marks
5. (*a*)	 Line crosses axes	B1
	Curve shape	B1
	Axes contacts 6, 8, 3	B1
	Cusps at 2 and 4	B1 (4)
(*b*)	$6 - 2x = (x-2)(x-4)$ and $-6 + 2x = (x-2)(x-4)$	M1, M1
	$x^2 - 4x + 2 = 0$ $\quad$ $x^2 - 8x + 14 = 0$ $\quad$ either	M1
	$x = \dfrac{4 \pm \sqrt{16-8}}{2}$ $\quad$ $x = \dfrac{8 \pm \sqrt{64-56}}{2}$	
	$= 2 - \sqrt{2}$ $\quad$ $= 4 - \sqrt{2}$	A1, A1 (5)
(c)	$2 - \sqrt{2} < x < 4 - \sqrt{2}$	M1, A1 (2)
		(11 marks)
6. (*a*)	$m^2 + 4m + 5 = 0$	M1
	$m = \dfrac{-4 \pm \sqrt{-4}}{2}$	
	$= -2 \pm \mathrm{i}$	A1
	$y = \mathrm{e}^{-2x}(A\cos x \pm B\sin x)$	M1
	$\text{PI} = \lambda \sin 2x + \mu \cos 2x$ $\quad$ PI & attempt diff.	M1
	$y' = 2\lambda \cos 2x - 2\mu \sin 2x$	
	$y'' = -4\lambda \sin 2x - 4\mu \cos 2x$	A1
	$\therefore -4\lambda - 8\mu + 5\lambda = 65$	
	$-4\mu + 8\lambda + 5\mu = 0$ $\quad$ subst. in eqn. & equate	M1
	$\lambda - 8\mu = 65$	
	$8\lambda + \mu = 0$ $\quad$ solving sim. eqn.	M1
	$64\lambda + 8\mu = 0$	
	$65\lambda = 65$	
	$\lambda = 1,\ \mu = -8$	A1
	$y = \mathrm{e}^{-2x}(A\cos x + B\sin x) + \sin 2x - 8\cos 2x$ $\quad$ ft on their λ and μ	A1ft (9)
(*b*)	As $x \to \infty$, $\mathrm{e}^{-2x} \to 0$ $\therefore$ $y \to \sin 2x - 8\cos 2x$	B1ft
	$y \to R\sin(2x + \alpha)$	M1
	$R = \sqrt{65}$	
	$\alpha = \tan^{-1}{-8} = -1.446$ or $-82.9°$	A1 (3)
		(12marks)

Question Number	Scheme		Marks
7. (*a*)		Shape + horiz. axis	B1
		3	B1 (2)
(*b*)	Area = $\frac{1}{2}\int r^2\,d\theta$		
	$= \frac{1}{2}\int 9\cos^2 2\theta\,d\theta$	use of $\frac{1}{2}\int r^2$	M1
	$= \frac{9}{2}\int \frac{\cos 4\theta + 1}{2}\,d\theta$	use of $\cos 4\theta = 2\cos^2 2\theta - 1$	M1
	$= \frac{9}{2}\left[\frac{\sin 4\theta}{8} + \frac{\theta}{2}\right]_{\frac{\pi}{6}}^{\frac{\pi}{4}}$	$\int$	dM1, A1
	$= \frac{9}{2}\left[\frac{\pi}{8} - \frac{\sqrt{3}}{16} - \frac{\pi}{12}\right]$	subst. $\frac{\pi}{4}$ and $\frac{\pi}{6}$	M1
	$= \frac{9}{2}\left[\frac{\pi}{24} - \frac{\sqrt{3}}{16}\right]$ or 0.103		A1 (6)
(*c*)	$r\sin\theta = 3\sin\theta\cos 2\theta$		
	$\frac{dy}{d\theta} = 3\cos\theta\cos 2\theta - 6\sin\theta\sin 2\theta$	diff. $r\sin\theta$	M1, A1
	$\frac{dy}{d\theta} = 0 \Rightarrow\ 6\cos^2\theta - 3\cos\theta - 12\sin^2\theta\cos\theta = 0$	use of $\frac{dy}{d\theta} = 0$	M1
	$6\cos^2\theta - 3\cos\theta - 12(1 - \cos^2\theta)\cos\theta = 0$	use double angle formula	M1
	$18\cos^3\theta - 15\cos\theta = 0$	solving	M1
	$\cos\theta = 0$ or $\cos^2\theta = \frac{5}{6}$ or $\tan^2\theta = \frac{1}{5}$ or $\sin^2\theta = \frac{1}{6}$		A1
	$\therefore\ r = 3(2 \times \frac{5}{6}) - 1$		
	$= 2$		
	$\therefore r\sin\theta = 2\sqrt{\frac{1}{6}}$	use of $d = 2r\sin\theta$	M1
	$d = \frac{2\sqrt{6}}{3}$		A1 (8)
			(16 marks)