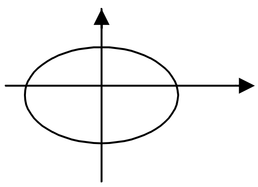
Question Number	Scheme	Marks
1. (*a*)	$10x, +(2y+2x\frac{dy}{dx}), -6y\frac{dy}{dx}=0$	M1, (B1), A1
	At (1 , 2) $\quad 10+(4+2\frac{dy}{dx})-12\frac{dy}{dx}=0$	M1
	$\therefore \frac{dy}{dx}=\frac{14}{10}=1.4 \text{ or } \frac{7}{5} \text{ or } 1\frac{2}{5}$	A1 (5)
(*b*)	The gradient of the normal is $-\frac{5}{7}$	M1
	Its equation is $y-2=-\frac{5}{7}(x-1)$ (allow tangent)	M1
	$y=-\frac{5}{7}x+2\frac{5}{7}$ or $y=-\frac{5}{7}x+\frac{19}{7}$	A1cao (3)
		(8 marks)
2.	$[\text{f}(x)]^2=x^2+\frac{4}{x^4}+\frac{4}{x}$	M1
	$\int[\text{f}(x)]^2\,\text{d}x=\left[\frac{x^3}{3}-\frac{4}{3x^3}+4\ln x\right]$	M1 A1 B1
	$\int_1^2[\text{f}(x)]^2\,\text{d}x=\left(\frac{8}{3}-\frac{4}{24}+4\ln 2\right)-\left(\frac{1}{3}-\frac{4}{3}+4\ln 1\right)$	M1
	$\left(=\frac{7}{2}+4\ln 2\right)$	
	$V=\pi\int_1^2[\text{f}(x)]^2\ \text{d}x \Rightarrow V=\pi\left(\frac{7}{2}+\ln 16\right)$ or $a=\frac{7}{2}$, $b=16$	M1 A1 A1
		(8 marks)

Question Number	Scheme		Marks	
3. (*a*)	x 0 $\frac{\pi}{6}$ $\frac{\pi}{3}$ $\frac{\pi}{2}$	1, 0	B1	
	y 1 1.46 1.42 0	1.146, 1.42	B1, B1	(3)
(*b*)	$I \approx \frac{1}{2}\left(\frac{\pi}{6}\right)\ldots$		B1	
	$\approx \ldots(1+2(1.46+1.42)+0)$		M1 A1 ft	
	≈ 1.8		A1	(4)
(*c*)	underestimates		B1	
	diagram or explanation		B1	(2)
	NB. Exact answer is $\frac{1}{2}\left(e^{\frac{\pi}{2}}-1\right) \approx 1.905\ldots$			
				(9 marks)
4. (*a*)	$5\cos t = 0 : t = \frac{\pi}{2},\ y = 2\ (0,\ 2)$		M1 A1	
	$t = \frac{3\pi}{2}, y = -6\quad (0, -6)$			
	$4\sin t = 2 : t = \frac{\pi}{6},\ x = \frac{5\sqrt{3}}{2}\quad t = \frac{5\pi}{6},\ x = -\frac{5\sqrt{3}}{2}\quad (\pm\frac{5\sqrt{3}}{2}, 0)$		M1 A1	(4)
(*b*)		shape	B1	
		position	B1	(2)
	$\frac{dx}{dt} = -5\sin t,\quad \frac{dy}{dt} = 4\cos t,\qquad \frac{dy}{dx} = \frac{-4\cos t}{5\sin t}$		M1 A1	
(*c*)	$y = \frac{5\tan\frac{\pi}{6}}{4}(x - \frac{5\sqrt{3}}{2})$, i.e. $8\sqrt{3}y = 10x - 25\sqrt{3}$ ★		M1 A1	(4)
				(10 marks)

Question Number	Scheme	Marks
5. (a)	$f^1(x)=0$ for maximum (or stationary point or turning point)	B1
	$f^1(1.48) = e^{1.48} - 2\times 1.48^2 = 0.0121\ldots$ $f^1(1.49) = \quad\quad = -0.0031\ldots$	M1
	change of sign $\therefore$ root / maximum in range	A1 (3)
(b)	$y = e^x - \frac{2}{3}x^3 \; (+c)$	M1 A1
	at $(0,\,5)$ $\quad 5 = e^0 - 0 + c$	M1
	$\underline{c=4}$ $\quad \left(y = e^x - \frac{2}{3}x^3 + 4\right)$ $\quad (c=4)$	A1 (4)
(c)	Area $= \int_0^2 \left(e^x - \frac{2}{3}x^3 + 4\right)dx$	M1
	$= \left[e^x - \frac{2}{12}x^4 + 4x\right]_0^2$	A1
	$= \left(e^2 - \frac{16}{6} + 8\right) - \left(e^{0} - 0 + 0\right)$	M1
	$= e^2 + 4\frac{1}{3}$ *or* $e^2 + \frac{13}{3}$	A1 cao (4)
		(11 marks)

Question Number	Scheme	Marks
6. (*a*)	$na = -6, \qquad \frac{n(n-1)}{2}a^2 = 27$	B1 B1
	Attempts solution by eliminating variable	
	e.g. $\frac{n(n-1)36}{n^2} = 54$ or $-\frac{6}{a}(-\frac{6}{a}-1)a^2 = 54$	M1
	$n = -2, \qquad a = 3$	A1 A1 (5)
(*b*)	$\frac{(-2)(-3)(-4)3^3}{6} = -108$ for M1 allow a instead of a^3	M1 A1 (2)
(*c*)	$\lvert x\rvert < \frac{1}{3}$ or $-\frac{1}{3} < x < \frac{1}{3}$	B1 ft (1)
7. (*a*)	$1 \times 4 - 2 \times 1 - 2 \times 1 = 0$, i.e. $\begin{pmatrix} 1 \\ -2 \\ 2 \end{pmatrix} . \begin{pmatrix} 4 \\ 1 \\ -1 \end{pmatrix} = 0$, therefore perpendicular.	M1 A1 (2)
(*b*)	$3 + \lambda = 9 + 4\mu$	M1
	and *either* $4 - 2\lambda = 1 + \mu$ *or* $-5 + 2\lambda = -2 - \mu$	A1
	Eliminate to obtain $\mu = -1$ or $\lambda = 2$	M1 A1
	Point is $(5, 0, -1)$ Vector is $\begin{pmatrix} 5 \\ 0 \\ -1 \end{pmatrix}$	B1 (5)
(*c*)	$\lambda = -3 \Rightarrow$ point lies on first line l_1	M1 A1
	show contradiction for $\mu \Rightarrow$ point not on l_2	B1 (3)
(*d*)	$\sqrt{(5^2 + 10^2 + 10^2)} = 15 \Rightarrow 1.5$ km	M1 A1 (2)
		(12 marks)

Question Number	Scheme	Marks
8. (*a*)	$\int \frac{\mathrm{d}x}{(1-2x)(1-4x)} = \int k \quad \mathrm{d}t$	B1
	$\int \frac{-1}{1-2x} + \frac{2}{1-4x} \mathrm{d}x = \int k \quad \mathrm{d}t$	M1 A1
	$\frac{1}{2} \ln (1-2x) - \frac{1}{2} \ln (1-4x) = kt \; (+\frac{1}{2} c)$	M1 A1 A1
	$\ln \frac{1-2x}{1-4x} = 2kt + c \quad (*)$	A1 cso (7)
(*b*)	Use $x = 0$ when $t = 0 \Rightarrow c = 0$	B1
	$\therefore \frac{1-2x}{1-4x} = \mathrm{e}^{2kt}$	M1
	$\therefore x(4\mathrm{e}^{2kt} - 2) = \mathrm{e}^{2kt} - 1, \quad \therefore x = \frac{\mathrm{e}^{2kt} - 1}{4\mathrm{e}^{2kt} - 2}$	M1 A1 (4)
(*c*)	As $t \to \infty, x \to \frac{1}{4}$	M1 A1 (2)
		(13 marks)