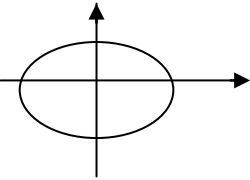


Question Number	Scheme	Marks
<p>1. (a)</p> <p>(b)</p>	$10x + (2y + 2x \frac{dy}{dx}), -6y \frac{dy}{dx} = 0$ <p>At (1, 2) $10 + (4 + 2 \frac{dy}{dx}) - 12 \frac{dy}{dx} = 0$</p> $\therefore \frac{dy}{dx} = \frac{14}{10} = 1.4 \text{ or } \frac{7}{5} \text{ or } 1\frac{2}{5}$ <p>The gradient of the normal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

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

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

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

Question Number	Scheme	Marks
8.	(a) $\int \frac{dx}{(1-2x)(1-4x)} = \int k \, dt$	B1
	$\int \frac{-1}{1-2x} + \frac{2}{1-4x} dx = \int k \, dt$	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
	$\therefore \frac{1-2x}{1-4x} = e^{2kt}$	M1
	$\therefore x(4e^{2kt} - 2) = e^{2kt} - 1, \therefore x = \frac{e^{2kt} - 1}{4e^{2kt} - 2}$	M1 A1 (4)
(c)	As $t \rightarrow \infty, x \rightarrow \frac{1}{4}$	M1 A1 (2)
		(13 marks)