<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>1.</td><td>Differentiates</td><td>M1</td></tr>
<tr><td></td><td>to obtain : $6x+8y\frac{dy}{dx}-2,$
$\ldots\ldots\ldots\ldots\ldots\ldots\ldots+(6x\frac{dy}{dx}+6y)=0$</td><td>A1,
+(B1)</td></tr>
<tr><td></td><td>$\left[\frac{dy}{dx}=\frac{2-6x-6y}{6x+8y}\right]$</td><td></td></tr>
<tr><td></td><td>Substitutes $x=1, y=-2$ into expression involving $\frac{dy}{dx}$, to give $\frac{dy}{dx}=-\frac{8}{10}$</td><td>M1, A1</td></tr>
<tr><td></td><td>Uses line equation with numerical ‘gradient’ y - (- 2) = (their gradient)(x - 1)
or finds c and uses $y=(\textit{their gradient})\ x + "c"$</td><td>M1</td></tr>
<tr><td></td><td>To give $5y+4x+6=0$ (or equivalent = 0)</td><td>A1√ [7]</td></tr>
<tr><td>2.
(a)</td><td>
<table>
<tr><td>x</td><td>0</td><td>$\frac{\pi}{16}$</td><td>$\frac{\pi}{8}$</td><td>$\frac{3\pi}{16}$</td><td>$\frac{\pi}{4}$</td></tr>
<tr><td>y</td><td>1</td><td>1.01959</td><td>1.08239</td><td>1.20269</td><td>1.41421</td></tr>
</table>
M1 for one correct, A1 for all correct</td><td>M1 A1
(2)</td></tr>
<tr><td>(b)</td><td>Integral = $\frac{1}{2}\times\frac{\pi}{16}\times\{1+1.4142+2(1.01959+...+1.20269)\}$
$\left(=\frac{\pi}{32}\ x\ 9.02355\right)$ = 0.8859</td><td>M1 A1√
A1 cao
(3)</td></tr>
<tr><td>(c)</td><td>Percentage error = $\frac{approx-0.88137}{0.88137}\times100$ = 0.51 % (allow 0.5% to 0.54% for A1)
M1 gained for $(\pm)\ \frac{approx-\ln(1+\sqrt{2})}{\ln(1+\sqrt{2})}$</td><td>M1 A1 (2)
[7]</td></tr>
</table>

Question Number	Scheme	Marks
3.	Uses substitution to obtain x = f(u) $\left[\frac{u^2+1}{2}\right]$,	M1
	and to obtain $u\frac{du}{dx}$ = const. or equiv.	M1
	Reaches $\int \frac{3(u^2+1)}{2u}udu$ or equivalent	A1
	Simplifies integrand to $\int\left(3u^2+\frac{3}{2}\right)\mathrm{d}u$ or equiv.	M1
	Integrates to $\frac{1}{2}u^3+\frac{3}{2}u$	M1 A1√
	A1√ dependent on all previous Ms	
	Uses new limits 3 and 1 substituting and subtracting (or returning to function of x with old limits)	M1
	To give 16 cso	A1
		[8]
	"By Parts" Attempt at " right direction" by parts M1 $[\ 3x\left(2x-1)^{\frac{1}{2}}\right)\ -\ \{\int 3\left(2x-1\right)^{\frac{1}{2}}\ \mathrm{d}x\}\ ]$ M1{M1A1} ……………. $-\ \left(2x-1\right)^{\frac{3}{2}}$ M1A1√ Uses limits 5 and 1 correctly; [42 – 26] 16 M1A1	

4.	Attempts $V = \pi\int x^2e^{2x}\mathrm{d}x$	M1
	$=\pi\left[\frac{x^2e^{2x}}{2} - \int xe^{2x}dx\right]$ (M1 needs parts in the correct direction)	M1 A1
	$= \pi[\frac{x^2e^{2x}}{2} - \left(\frac{xe^{2x}}{2} - \int\frac{e^{2x}}{2}dx\right)]$ (M1 needs second application of parts)	M1 A1√
	M1A1√ refers to candidates $\int xe^{2x}\mathrm{d}x$, but dependent on prev. M1	
	$= \pi[\frac{x^2e^{2x}}{2} - \left(\frac{xe^{2x}}{2} - \frac{e^{2x}}{4}\right)]$	A1 cao
	Substitutes limits 3 and 1 and subtracts to give… [dep. on second and third Ms]	dM1
	$=\pi\left[\frac{13}{4}e^6 - \frac{1}{4}e^2\right]$ or any correct exact equivalent.	A1 **[8]**
	[Omission of π loses first and last marks only]	

Question Number	Scheme	Marks
5. (a)	Considers $3x^2+16=A(2+x)^2+B(1-3x)(2+x)+C(1-3x)$	
	and substitutes x = –2 , or x = 1/3 ,	M1
	or compares coefficients and solves simultaneous equations	
	To obtain A = 3, and C = 4	A1, A1
	Compares coefficients or uses simultaneous equation to show B = 0.	B1 (4)
(b)	Writes $3(1-3x)^{-1}+4(2+x)^{-2}$	M1
	$=3(1+3x,+9x^2+27x^3+......)$ +	(M1, A1)
	$\frac{4}{4}(1+\frac{(-2)}{1}\left(\frac{x}{2}\right)+\frac{(-2)(-3)}{1.2}\left(\frac{x}{2}\right)^2+\frac{(-2)(-3)(-4)}{1.2.3}\left(\frac{x}{2}\right)^3+....)$	(M1 A1)
	$=4+8x,\ +27\tfrac{3}{4}x^2+80\tfrac{1}{2}x^3+...$	A1, A1 (7)
	Or uses $(3x^2+16)(1-3x)^{-1}(2+x)^{-2}$	M1
	$(3x^2+16)\ (1+3x,+9x^2+27x^3+)\ \times$	(M1A1)×
	$¼(1+\frac{(-2)}{1}\left(\frac{x}{2}\right)+\frac{(-2)(-3)}{1.2}\left(\frac{x}{2}\right)^2+\frac{(-2)(-3)(-4)}{1.2.3}\left(\frac{x}{2}\right)^3)$	(M1A1)
	$=4+8x,+27\tfrac{3}{4}x^2+80\tfrac{1}{2}x^3+...$	A1, A1 (7) **[11]**

6. (a)	$\lambda = -4 \rightarrow a = 18, \qquad \mu = 1 \rightarrow b = 9$	M1 A1, A1 (3)
(b)	$\begin{pmatrix} 8+\lambda \\ 12+\lambda \\ 14-\lambda \end{pmatrix} \bullet \begin{pmatrix} 1 \\ 1 \\ -1 \end{pmatrix}$ =0	M1
	$\therefore 8+\lambda+12+\lambda-14+\lambda=0$	A1
	Solves to obtain λ ($\lambda=-2$)	dM1
	Then substitutes value for λ to give P at the point (6, 10, 16) (any form)	M1, A1 (5)
(c)	OP = $\sqrt{36+100+256}$	M1
	(= $\sqrt{392}$) $= 14\sqrt{2}$	A1 cao (2) **[10]**
7. (a)	$\frac{dV}{dr} = 4\pi r^2$	B1 (1)
(b)	Uses $\frac{dr}{dt} = \frac{dV}{dt} . \frac{dr}{dV}$ in any form, $= \frac{1000}{4\pi r^2 (2t+1)^2}$	M1,A1 (2)
(c)	$V = \int 1000(2t+1)^{-2} dt$ and integrate to $p\ (2t+1)^{-1}$, $= -500(2t+1)^{-1}(+c)$	M1, A1
	Using V=0 when t=0 to find c , (c = 500 , or equivalent)	M1
	$\therefore V = 500(1 - \frac{1}{2t+1})$ (any form)	A1 (4)
(d)	(i) Substitute t = 5 to give V,	M1,
	then use $r = \sqrt[3]{\left(\frac{3V}{4\pi}\right)}$ to give *r* , = *4.77*	M1, A1 (3)
	(ii) Substitutes t = 5 and r = ‘their value’ into ‘their’ part (b)	M1
	$\frac{dr}{dt} = 0.0289 \quad (\approx 2.90 x 10^{-2})$ (cm/s) $*$ AG	A1 (2) **[12]**

8. (a) Solves y = 0 $\Rightarrow$ $\cos t = \frac{1}{2}$ to obtain $t = \frac{\pi}{3}$ *or* $\frac{5\pi}{3}$ (need both for A1)

Or substitutes **both** values of *t* and shows that *y* = 0

(b)

$$\frac{dx}{dt} = 1 - 2\cos t$$

Area= $\int y dx = \int_{\pi/3}^{5\pi/3} (1 - 2\cos t)(1 - 2\cos t) dt$ = $\int_{\frac{\pi}{3}}^{\frac{5\pi}{3}} (1 - 2\cos t)^2 dt$ $*$ AG

(c)

Area = $\int 1 - 4\cos t + 4\cos^2 t dt$ 3 terms

= $\int 1 - 4\cos t + 2(\cos 2t + 1)dt$ (use of correct double angle formula)

= $\int 3 - 4\cos t + 2\cos 2t dt$

= $\left[3t - 4\sin t + \sin 2t\right]$

Substitutes the two correct limits $t = \frac{5\pi}{3}$ and $\frac{\pi}{3}$ and subtracts.

$= 4\pi + 3\sqrt{3}$