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

x	0	$\frac{\pi}{16}$	$\frac{\pi}{8}$	$\frac{3\pi}{16}$	$\frac{\pi}{4}$
y	1	**1.01959**	**1.08239**	1.20269	**1.41421**

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 $\int \frac{3(u^2+1)}{2u} u du$ 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 $[\ 3x\left(2x-1\right)^{\frac{1}{2}}\ -\ \{\int 3\left(2x-1\right)^{\frac{1}{2}}\ \mathrm{d}x\}\ ]$ M1{M1A1} ……………. $-\ \left(2x-1\right)^{\frac{3}{2}}$ M1A1√ Uses limits 5 and 1 correctly; [42 – 26] 16 M1A1	

4.	Attempts $V = \pi\int x^2 e^{2x}\mathrm{d}x$	M1
	$= \pi\left[\frac{x^2e^{2x}}{2} - \int xe^{2x}dx\right]$ (M1 needs parts in the correct direction)	M1 A1
	$= \pi\left[\frac{x^2e^{2x}}{2} - \left(\frac{xe^{2x}}{2} - \int\frac{e^{2x}}{2}dx\right)\right]$ (M1 needs second application of parts)	M1 A1√
	M1A1√ refers to candidates $\int xe^{2x}\,\mathrm{d}x$, but dependent on prev. M1	
	$= \pi\left[\frac{x^2e^{2x}}{2} - \left(\frac{xe^{2x}}{2} - \frac{e^{2x}}{4}\right)\right]$	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)×
	$\tfrac{1}{4}(1+\frac{(-2)}{1}\left(\frac{x}{2}\right)+\frac{(-2)(-3)}{1.2}\left(\frac{x}{2}\right)^2+\frac{(-2)(-3)(-4)}{1.2.3}\left(\frac{x}{2}\right)^3)$	(M1A1)
	$= 4+8x,\ +27\tfrac{3}{4}x^2+80\tfrac{1}{2}x^3+...$	A1, A1 (7) **[11]**

6. (a)	$\lambda = -4 \to a = 18, \quad \mu = 1 \to b = 9$	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 $\quad (\lambda = -2)$	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
	$\frac{\mathrm{d}r}{\mathrm{d}t} = 0.0289 \quad (\approx 2.90 x 10^{-2})$ (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) = $\int 3 - 4\cos t + 2\cos 2t dt$ = $[3t - 4\sin t + \sin 2t]$ Substitutes the two correct limits $t = \frac{5\pi}{3}$ and $\frac{\pi}{3}$ and subtracts. $= 4\pi + 3\sqrt{3}$	