Question Number	Scheme	Marks
1. (*a*)	$1 - 3x, + 9x^2, - 27x^3 + \ldots$	B1, B1, B1 (3)
(*b*)	$(1 + x)(1 - 3x + 9x^2 - 27x^3\ldots)$	
	$= 1 + (x - 3x) + (9x^2 - 3x^2) + (19x^3 - 27x^3) \ldots.$	M1
	$= 1 - 2x + 6x^2 - 18x^3$ *	A1 (2)
(*c*)	$x = .01$	B1
	$1 - 0.02 + 0.0006 - 0.000018, = 0.98058$	M1, A1 cao (3)
		(8 marks)
2. (*a*)	Uses $\frac{A}{(2x-3)} + \frac{B}{(x+1)}$	M1
	Considers $-2x + 13 = A(x + 1) + B(2x - 3)$ and substitutes $x = -1$ **or** $x = 1.5$, or compares coefficients and solves simultaneous equations	M1
	To obtain $A = 4$ and $B = -3$.	A1, A1 (4)
(*b*)	Separates variables $\int \frac{1}{y}\,dy = \int \frac{4}{2x-3} - \frac{3}{x+1}\,dx$	M1
	$\ln y = 2\ln(2x-3) - 3\ln(x+1) + C$	A1, B1 ft
	Substitutes to give $\ln 4 = 2\ln 1 - 3\ln 3 + C$ and finds C (ln 108)	M1
	$\ln y = \ln(2x-3)^2 - \ln(x+1)^3 (+\ln 108)$	M1
	$= \ln \frac{C(2x-3)^2}{(x+1)^3}$	A1
	$\therefore y = \frac{108(2x-3)^2}{(x+1)^3}$	A1 cso (7)
	Or $y = e^{2\ln(2x-3) - 3\ln(x+) + \ln 108}$ special case M1 A2	
		(11 marks)

Question Number	Scheme	Marks
3. (*a*)	x: 0, 0.5, 1, 1.5, 2 ; y: 2, 2.25, 3, 4.25, 6 ≥ 2 correct *y*s	M1
	$R \approx \frac{1}{2} \times \frac{1}{2}$, [2 + 2{2.25 + 3 + 4.25} + 6]	B1, [M1 A1 ft]
	$\frac{27}{4}$ or 6.75	A1 (5)
(*b*)	Since curve bends under straight line → overestimate	M1 (1)
(*c*)	$V = \pi\int_0^2 y^2 \mathrm{d}x = \pi\int_0^2 \left(x^4 + 4x^2 + 4\right)\mathrm{d}x$ $\pi\int y^2$, $y^2 = (\quad)$	M1 M1
	$= \pi\left[\frac{x^5}{5} + \frac{4}{3}x^3 + 4x\right]_0^2$ $x^n \to x^{n+1}$	M1 A1
	$= \pi\left[\left(\frac{32}{5} + \frac{32}{3} + 8\right) - (0)\right]$ Use of correct limits	M1
	$= \frac{\pi}{15}[96 + 160 + 120] = \frac{376}{15}\pi$ (or $25\frac{1}{15}$ or 25.1π)	A1 (6)
		(12 marks)
4. (*a*)	$\frac{\mathrm{d}V}{\mathrm{d}t} = -kV$	B1
	$\int \frac{1}{V}\mathrm{d}V = -k\int \mathrm{d}t$, $\ln V = -kt$	M1
	$\ln V = -kt + C$ $V = Ae^{-kt}$ *	A1 (3)
(*b*)	$t = 0$, $V = 20\,000$: $20000 = A$	B1
	$t = 3$, $V = 11000$: $11000 = Ae^{-3k}$	M1,
	$e^{-3k} = 0.55$	
	$-3k = \ln 0.55$	
	$k \approx 0.199(3)$ (*allow* 0.2)	A1
	$t = 10$ $V = 20\,000e^{-10k}$; = £2700	M1;A1 (5)
(*c*)	$500 = 20000e^{-kt}$ $e^{-kt} = 0.025$	M1
	$-0.199t = \ln 0.025$	A1√
	$t \approx 18.5$ (18.44) *accept* 18 *or* 19 *yrs*	A1 (3)
		(11 marks)

Question Number	Scheme	Marks
5. (*a*)	$\frac{8}{x} - x^2 = 0 \quad \Rightarrow \quad x^3 = 8 \quad \Rightarrow \quad x = 2$	M1 A1 (2)
(*b*)	$\left(\frac{8}{x} - x^2\right) = x^4 - 16x + \frac{64}{x^2}$ M1 3(or 4) terms	M1 A1
	$\int \left(x^4 - 16x + 64x^{-2}\right) dx = \frac{x^5}{5} - 8x^2 - \frac{64}{x}$	M1 A1
	$\left[\frac{x^5}{5} - 8x^2 - \frac{64}{x}\right]_1^2 = \left(\frac{32}{5} - 32 - 32\right) - \left(\frac{1}{5} - 8\right) - 64$	M1 A1 ft
	Volume is $\frac{71}{5}\pi$ (units^3)	A1 (7)
		(9 marks)
6. (*a*)	$\mathbf{r} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k} \pm \lambda(4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k})$ or $\mathbf{r} = 5\mathbf{i} - 3\mathbf{j} \pm \lambda(4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k})$ (or any equivalent vector equation)	M1A1 (2)
(*b*)	Show that $\mu = -3$	B1 (1)
(*c*)	Using $\cos\theta = \frac{(4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}).(\mathbf{i} - 2\mathbf{j} + 2\mathbf{k})}{\sqrt{(4^2 + 5^2 + 3^2)}\sqrt{(1^2 + 2^2 + 2^2)}}$	M1
	$= \frac{20}{15\sqrt{2}} = \frac{4}{3\sqrt{2}}$ (ft on $4\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}$) num, denom.	A1 ft A1 ft
	$\theta = 19.5°$ (allow 19 or 20 if no wrong working is seen)	A1 (4)
(*d*)	Shortest distance = $AC \sin\theta$	M1
	$AC = \sqrt{((a-1)^2 + 2^2 + (b+3)^2)}$ (= 3)	M1A1
	Shortest distance = 1 unit	A1 (4)
		(11 marks)

Question Number	Scheme	Marks
7. (*a*)	$y^2 = 81\sin^2 2t$	M1
	$= 81 \times 4\sin^2 t\cos^2 t$	M1
	$= 4 \times 9(1 - \cos^2 t) \times 9\cos^2 t$	M1
	$= 4(9 - x^2)\,x^2$	A1 (4)
(*b*)	$\int y\,\mathrm{d}x =, \quad -\int_{\frac{\pi}{2}}^{0} 9\sin 2t\, 3\sin t\,\mathrm{d}t$	M1, A1
	$= \int_{0}^{\frac{\pi}{2}} 27\sin 2t\sin t\,\mathrm{d}t$	B1 (3)
(*c*)	$27\int_{0}^{\frac{\pi}{2}} \sin 2t\sin t\,\mathrm{d}t = 27\int 2\sin^2 t\cos t\,\mathrm{d}t$	M1
	$27\left[\frac{2}{3}\sin^3 t\right], = 18$	M1 A1, A1 (4)
(*d*)	Rectangular area = 18 × 6 = 108	M1 A1
	Red area = Rectangular – 4 × Blue = 108 – 72 = 36	M1 A1 (4)
		(15 marks)