1	**Either** Obtain correct unsimplified version of x or x^2 term in expansion of $(2+x)^{-2}$ or $(1+\frac{1}{2}x)^{-2}$	M1	
	Correct first term 4 from correct work	B1	
	Obtain $-4x$	A1	
	Obtain $+3x^2$	A1	
	Or Differentiate and evaluate f(0) and f′(0) where $f'(x) = k(2+x)^{-3}$	M1	
	State correct first term 4	B1	
	Obtain $-4x$	A1	
	Obtain $+3x^2$	A1	[4]
2	Use correct quotient or product rule or equivalent	M1	
	Obtain $\dfrac{(1+e^{2x}).2e^{2x} - e^{2x}.2e^{2x}}{(1+e^{2x})^2}$ or equivalent	A1	
	Substitute $x = \ln 3$ into attempt at first derivative and show use of relevant logarithm property at least once in a correct context	M1	
	Confirm given answer $\frac{9}{50}$ legitimately	A1	[4]
3	**(i)** State or imply $R = 17$	B1	
	Use correct trigonometric formula to find α	M1	
	Obtain 61.93° with no errors seen	A1	[3]
	(ii) Evaluate $\cos^{-1}\frac{12}{R}$ $(= 45.099)$	M1	
	Obtain answer 107.0°	A1	
	Carry out correct method for second answer	M1	
	Obtain answer 16.8° and no others between 0° and 360°	A1	[4]

4	(i)	Separate variables and attempt integration on both sides	M1*	
		Obtain $2N^{0.5}$ on left-hand side or equivalent	A1	
		Obtain $-60e^{-0.02t}$ on right-hand side or equivalent	A1	
		Use 0 and 100 to evaluate a constant or as limits in a solution containing terms $aN^{0.5}$ and $be^{-0.02t}$	DM1*	
		Obtain $2N^{0.5} = -60e^{-0.02t} + 80$ or equivalent	A1	
		Conclude with $N = (40 - 30e^{-0.02t})^2$ or equivalent	A1	[6]
	(ii)	State number approaches 1600 or equivalent, following expression of form $(c + de^{-0.02t})^n$	B1√	[1]
5	(i)	**Either** Use integration by parts and reach an expression $kx^2 \ln x \pm n \int x^2 . \frac{1}{x} dx$	M1	
		Obtain $\frac{1}{2}x^2 \ln x - \int \frac{1}{2}x \, dx$ or equivalent	A1	
		Obtain $\frac{1}{2}x^2 \ln x - \frac{1}{4}x^2$	A1	
		Or Use Integration by parts and reach an expression $kx(x\ln x - x) \pm m \int x\ln x - x dx$	M1	
		Obtain $I = (x^2 \ln x - x^2) - I + \int x dx$	A1	
		Obtain $\frac{1}{2}x^2 \ln x - \frac{1}{4}x^2$	A1	
		Substitute limits correctly and equate to 22, having integrated twice	DM1*	
		Rearrange and confirm given equation $a = \sqrt{\dfrac{87}{2\ln a - 1}}$	A1	[5]
	(ii)	Use iterative process correctly at least once	M1	
		Obtain final answer 5.86	A1	
		Show sufficient iterations to 4 d.p. to justify 5.86 or show a sign change in the interval (5.855, 5.865)	A1	
		$(6 \rightarrow 5.8030 \rightarrow 5.8795 \rightarrow 5.8491 \rightarrow 5.8611 \rightarrow 5.8564)$		[3]

6	(i)	Use correct method for finding modulus of their w^2 or w^3 or both	M1	
		Obtain $\|w^2\| = 2$ and $\|w^3\| = 2\sqrt{2}$ or equivalent	A1	
		Use correct method for finding argument of their w^2 or w^3 or both	M1	
		Obtain $\arg(w^2) = -\frac{1}{2}\pi$ or $\frac{3}{2}\pi$ and $\arg(w^3) = \frac{1}{4}\pi$	A1ft	[4]
	(ii)	Obtain centre $-\frac{1}{2}-\frac{1}{2}i$ (their w^2)	B1ft	
		Calculate the diameter or radius using $\|w-w^2\|$ w21 or right-angled triangle or cosine rule or equivalent	M1	
		Obtain radius $\frac{1}{2}\sqrt{10}$ or equivalent	A1	
		Obtain $\|z + \frac{1}{2} + \frac{1}{2}i\| = \frac{1}{2}\sqrt{10}$ or equivalent	A1ft	[4]
7	(i)	Substitute $x = \frac{1}{2}$ and equate to zero		
		or divide by $(2x-1)$, reach $\frac{a}{2}x^2 + kx + ...$and equate remainder to zero		
		or by inspection reach $\frac{a}{2}x^2 + bx + c$ and an equation in b/c		
		or by inspection reach $Ax^2 + Bx + a$ and an equation in A/B	M1	
		Obtain $a = 2$	A1	
		Attempt to find quadratic factor by division or inspection or equivalent	M1	
		Obtain $(2x-1)(x^2+2)$	A1cwo	[4]
	(ii)	State or imply form $\dfrac{A}{2x-1} + \dfrac{Bx+C}{x^2+2}$, following factors from part **(i)**	B1√	
		Use relevant method to find a constant	M1	
		Obtain $A = -4$, following factors from part **(i)**	A1√	
		Obtain $B = 2$	A1	
		Obtain $C = 5$	A1	

8	**(i)**	Differentiate y to obtain $3\sin^2 t\cos t - 3\cos^2 t\sin t$ o.e.	B1	
		Use $\frac{dy}{dx} = \frac{dy}{dt} / \frac{dt}{dx}$	M1	
		Obtain given result $-3\sin t\cos t$	A1cwo	[3]
	(ii)	Identify parameter at origin as $t = \frac{3}{4}\pi$	B1	
		Use $t = \frac{3}{4}\pi$ to obtain $\frac{3}{2}$	B1	[2]
	(iii)	Rewrite equation as equation in one trig variable e.g. $\sin 2t = -\frac{2}{3}$, $9\sin^4 x - 9\sin^2 x + 1 = 0$, $\tan^2 x + 3\tan x + 1 = 0$	B1	
		Find at least one value of t from equation of form $\sin 2t = k$ o.e.	M1	
		Obtain 1.9	A1	
		Obtain 2.8 and no others	A1	[4]

9	(i)	Calculate scalar product of direction of l and normal to p	M1	
		Obtain 4 x 2 + 3 × (–2) + (–2) × 1 = 0 and conclude accordingly	A1	[2]
	(ii)	Substitute $(a, 1, 4)$ in equation of p and solve for a	M1	
		Obtain $a = 4$	A1	[2]
	(iii)	**Either** Attempt use of formula for perpendicular distance using $(a, 1, 4)$	M1	
		Obtain at least $\dfrac{2a-2+4-10}{\sqrt{4+4+1}} = 6$	A1	
		Obtain $a = 13$	A1	
		Attempt solution of $\dfrac{2a-8}{3} = -6$	M1	
		Obtain $a = -5$	A1	
		Or Form equation of parallel plane and substitute $(a, 1, 4)$	M1	
		Obtain $\frac{2a+2}{3} - \frac{10}{3} = 6$	A1	
		Obtain $a = 13$	A1	
		Solve $\frac{2a+2}{3} - \frac{10}{3} = -6$	M1	
		Obtain $a = -5$	A1	
		Or State a vector from a pt on the plane to $(a, 1, 4)$ *e.g.* $\begin{pmatrix} a-5 \\ 1 \\ 4 \end{pmatrix}$ or $\begin{pmatrix} a \\ 1 \\ -6 \end{pmatrix}$	B1	
		Calculate the component of this vector in the direction of the unit normal and equate to 6 : $\frac{1}{3}\begin{pmatrix} a-5 \\ 1 \\ 4 \end{pmatrix}.\begin{pmatrix} 2 \\ -2 \\ 1 \end{pmatrix} = 6$	M1	
		Obtain $a = 13$	A1	
		Solve $\frac{1}{3}\begin{pmatrix} a-5 \\ 1 \\ 4 \end{pmatrix}.\begin{pmatrix} 2 \\ -2 \\ 1 \end{pmatrix} = -6$	M1	
		Obtain $a = -5$	A1	

		Or		
		State or imply perpendicular line $\mathbf{r} = \begin{pmatrix} a \\ 1 \\ 4 \end{pmatrix} + \mu \begin{pmatrix} 2 \\ -2 \\ 1 \end{pmatrix}$	B1	
		Substitute components for p and solve for μ	M1	
		Obtain $\mu = \dfrac{8-2a}{9}$	A1	
		Equate distance between $(a,\ 1,\ 4)$ and foot of perpendicular to ±6	M1	
		Obtain $\dfrac{3(8-2a)}{9} = \pm 6$ or equivalent and hence –5 and 13	A1	[5]
10	**(i)**	State or imply $\dfrac{du}{dx} = \sec^2 x$	B1	
		Express integrand in terms of u and du	M1	
		Integrate to obtain $\dfrac{u^{n+1}}{n+1}$ or equivalent	A1	
		Substitute correct limits correctly to confirm given result $\dfrac{1}{n+1}$	A1	[4]
	(ii)	**(a)** Use $\sec^2 x = 1 + \tan^2 x$ twice	M1	
		Obtain integrand $\tan^4 x + \tan^2 x$	A1	
		Apply result from part **(i)** to obtain $\frac{1}{3}$	A1	[3]
		Or Use $\sec^2 x = 1 + \tan^2 x$ and the substitution from **(i)**	M1	
		Obtain $\int u^2 \mathrm{d}u$	A1	
		Apply limits correctly and obtain $\frac{1}{3}$	A1	
		(b) Arrange, perhaps implied, integrand to $t^9 + t^7 + 4(t^7 + t^5) + t^5 + t^3$	B1	
		Attempt application of result from part **(i)** at least twice	M1	
		Obtain $\dfrac{1}{8} + \dfrac{4}{6} + \dfrac{1}{4}$ and hence $\frac{25}{24}$ or exact equivalent	A1	[3]