1		Use law of the logarithm of a power	M1	
		Obtain a correct linear equation in any form, e.g. $x = (x-2)\ln 3$	A1	
		Obtain answer $x = 22.281$	A1	**[3]**
2	**(i)**	State or imply ordinates 2, 1.1547…, 1, 1.1547…	B1	
		Use correct formula, or equivalent, with $h = \frac{1}{6}\pi$ and four ordinates	M1	
		Obtain answer 1.95	A1	**[3]**
	(ii)	Make recognisable sketch of $y = \operatorname{cosec} x$ for the given interval	B1	
		Justify a statement that the estimate will be an overestimate	B1	**[2]**
3		Substitute $x = -\frac{1}{3}$, equate result to zero or divide by $3x + 1$ and equate the remainder to zero and obtain a correct equation, e.g. $-\frac{1}{27}a + \frac{1}{9}b - \frac{1}{3} + 3 = 0$	B1	
		Substitute $x = 2$ and equate result to 21 or divide by $x - 2$ and equate constant remainder to 21	M1	
		Obtain a correct equation, e.g. $8a + 4b + 5 = 21$	A1	
		Solve for a or for b	M1	
		Obtain $a = 12$ and $b = -20$	A1	**[5]**
4	**(i)**	Use chain rule correctly at least once	M1	
		Obtain either $\frac{dx}{dt} = \frac{3\sin t}{\cos^4 t}$ or $\frac{dy}{dt} = 3\tan^2 t \sec^2 t$, or equivalent	A1	
		Use $\frac{dy}{dx} = \frac{dy}{dt} \div \frac{dx}{dt}$	M1	
		Obtain the given answer	A1	**[4]**
	(ii)	State a correct equation for the tangent in any form	B1	
		Use Pythagoras	M1	
		Obtain the given answer	A1	**[3]**
5	**(i)**	Substitute $z = 1 + \mathrm{i}$ and obtain $w = \frac{1+2\mathrm{i}}{1+\mathrm{i}}$	B1	
		EITHER: Multiply numerator and denominator by the conjugate of the denominator, or equivalent	M1	
		Simplify numerator to $3 + \mathrm{i}$ or denominator to 2	A1	
		Obtain final answer $\frac{3}{2} + \frac{1}{2}\mathrm{i}$, or equivalent	A1	
		OR: Obtain two equations in x and y, and solve for x or for y	M1	
		Obtain $x = \frac{3}{2}$ or $y = \frac{1}{2}$, or equivalent	A1	
		Obtain final answer $\frac{3}{2} + \frac{1}{2}\mathrm{i}$, or equivalent	A1	**[4]**

	(ii)	*EITHER*: Substitute $w = z$ and obtain a 3-term quadratic equation in z, e.g. $\mathrm{i}z^2 + z - \mathrm{i} = 0$	B1	
		Solve a 3-term quadratic for z or substitute $z = x + \mathrm{i}y$ and use a correct method to solve for x and y	M1	
		OR: Substitute $w = x + \mathrm{i}y$ and obtain two correct equations in x and y by equating real and imaginary parts	B1	
		Solve for x and y	M1	
		Obtain a correct solution in any form, e.g. $z = \dfrac{-1 \pm \sqrt{3}\,\mathrm{i}}{2\mathrm{i}}$	A1	
		Obtain final answer $-\dfrac{\sqrt{3}}{2} + \dfrac{1}{2}\mathrm{i}$	A1	[4]
6	(i)	Integrate and reach $bx\ln 2x - c\int x.\dfrac{1}{x}\,\mathrm{d}x$, or equivalent	M1*	
		Obtain $x\ln 2x - \int x.\dfrac{1}{x}\,\mathrm{d}x$, or equivalent	A1	
		Obtain integral $x\ln 2x - x$, or equivalent	A1	
		Substitute limits correctly and equate to 1, having integrated twice	M1(dep*)	
		Obtain a correct equation in any form, e.g. $a\ln 2a - a + 1 - \ln 2 = 1$	A1	
		Obtain the given answer	A1	[6]
	(ii)	Use the iterative formula correctly at least once	M1	
		Obtain final answer 1.94	A1	
		Show sufficient iterations to 4 d.p. to justify 1.94 to 2d.p. or show that there is a sign change in the interval (1.935, 1.945).	A1	[3]
7	(i)	Separate variables correctly and attempt to integrate at least one side	B1	
		Obtain term $\ln R$	B1	
		Obtain $\ln x - 0.57x$	B1	
		Evaluate a constant or use limits $x = 0.5$, $R = 16.8$, in a solution containing terms of the form $a\ln R$ and $b\ln x$	M1	
		Obtain correct solution in any form	A1	
		Obtain a correct expression for R, e.g. $R = xe^{(3.80 - 0.57x)}$, $R = 44.7xe^{-0.57x}$ or $R = 33.6xe^{(0.285 - 0.57x)}$	A1	[6]
	(ii)	Equate $\dfrac{\mathrm{d}R}{\mathrm{d}x}$ to zero and solve for x	M1	
		State or imply $x = 0.57^{-1}$, or equivalent, e.g. 1.75	A1	
		Obtain $R = 28.8$ (allow 28.9)	A1	[3]
8	(i)	Use $\sin(A + B)$ formula to express $\sin 3\theta$ in terms of trig. functions of 2θ and θ	M1	
		Use correct double angle formulae and Pythagoras to express $\sin 3\theta$ in terms of $\sin\theta$	M1	
		Obtain a correct expression in terms of $\sin\theta$ in any form	A1	
		Obtain the given identity	A1	[4]
		[SR: Give M1 for using correct formulae to express RHS in terms of $\sin\theta$ and $\cos 2\theta$, then M1A1 for expressing in terms of $\sin\theta$ and $\sin 3\theta$ only, or in terms of $\cos\theta$, $\sin\theta$, $\cos 2\theta$ and $\sin 2\theta$, then A1 for obtaining the given identity.]		

	(ii)	Substitute for x and obtain the given answer		B1	[1]
	(iii)	Carry out a correct method to find a value of x		M1	
		Obtain answers 0.322, 0.799, –1.12		A1 + A1 + A1	[4]
		[Solutions with more than 3 answers can only earn a maximum of A1 + A1.]			
9	(i)	State or imply the form $\frac{A}{1-x}+\frac{B}{2-x}+\frac{C}{(2-x)^2}$		B1	
		Use a correct method to determine a constant		M1	
		Obtain one of $A = 2$, $B = -1$, $C = 3$		A1	
		Obtain a second value		A1	
		Obtain a third value		A1	[5]
		[The alternative form $\frac{A}{1-x}+\frac{Dx+E}{(2-x)^2}$, where $A = 2$, $D = 1$, $E = 1$ is marked B1M1A1A1A1 as above.]			
	(ii)	Use correct method to find the first two terms of the expansion of $(1-x)^{-1}, (2-x)^{-1}, (2-x)^{-2}, (1-\frac{1}{2}x)^{-1}$ or $(1-\frac{1}{2}x)^{-2}$		M1	
		Obtain correct unsimplified expansions up to the term in x^2 of each partial fraction		A1✓ + A1✓ + A1✓	
		Obtain final answer $\frac{9}{4}+\frac{5}{2}x+\frac{39}{16}x^2$, or equivalent		A1	[5]
		[Symbolic binomial coefficients, e.g. $\begin{pmatrix}-1\\1\end{pmatrix}$ are not sufficient for M1. The ✓ is on A,B,C.]			
		[For the A,D,E form of partial fractions, give M1 A1✓ A1✓ for the expansions then, if $D \neq 0$, M1 for multiplying out fully and A1 for the final answer.]			
		[In the case of an attempt to expand $(x^2-8x+9)(1-x)^{-1}(2-x)^{-2}$, give M1A1A1 for the expansions, M1 for multiplying out fully, and A1 for the final answer.]			
10	(i)	*EITHER*:	Find $\overrightarrow{AP}$ (or $\overrightarrow{PA}$) for a point P on l with parameter λ, e.g. $\mathbf{i}-17\mathbf{j}+4\mathbf{k}+\lambda(-2\mathbf{i}+\mathbf{j}-2\mathbf{k})$	B1	
			Calculate scalar product of $\overrightarrow{AP}$ and a direction vector for l and equate to zero	M1	
			Solve and obtain $\lambda = 3$	A1	
			Carry out a complete method for finding the length of AP	M1	
			Obtain the given answer 15 correctly	A1	
		*OR*1:	Calling (4, –9, 9) B, state $\overrightarrow{BA}$ (or $\overrightarrow{AB}$) in component form, e.g. $-\mathbf{i}+17\mathbf{j}-4\mathbf{k}$	B1	
			Calculate vector product of $\overrightarrow{BA}$ and a direction vector for l, e.g. $(-\mathbf{i}+17\mathbf{j}-4\mathbf{k})\times(-2\mathbf{i}+\mathbf{j}-2\mathbf{k})$	M1	
			Obtain correct answer, e.g. $-30\mathbf{i}+6\mathbf{j}+33\mathbf{k}$	A1	
			Divide the modulus of the product by that of the direction vector	M1	
			Obtain the given answer correctly	A1	
		*OR*2:	State $\overrightarrow{BA}$ (or $\overrightarrow{AB}$) in component form	B1	
			Use a scalar product to find the projection of BA (or AB) on l	M1	
			Obtain correct answer in any form, e.g. $\frac{27}{\sqrt{9}}$	A1	
			Use Pythagoras to find the perpendicular	M1	

	Obtain the given answer correctly	A1	
*OR*3:	State $\overrightarrow{BA}$ (or $\overrightarrow{AB}$) in component form	B1	
	Use a scalar product to find the cosine of *ABP*	M1	
	Obtain correct answer in any form, e.g. $\dfrac{27}{\sqrt{9}.\sqrt{306}}$	A1	
	Use trig. to find the perpendicular	M1	
	Obtain the given answer correctly	A1	
*OR*4:	State $\overrightarrow{BA}$ (or $\overrightarrow{AB}$) in component form	B1	
	Find a second point *C* on *l* and use the cosine rule in triangle *ABC* to find the cosine of angle *A, B*, or *C*, or use a vector product to find the area of *ABC*	M1	
	Obtain correct answer in any form	A1	
	Use trig. or area formula to find the perpendicular	M1	
	Obtain the given answer correctly	A1	
*OR*5:	State correct $\overrightarrow{AP}$ (or $\overrightarrow{PA}$) for a point *P* on *l* with parameter λ in any form	B1	
	Use correct method to express AP^2 (or *AP*) in terms of λ	M1	
	Obtain a correct expression in any form, e.g. $(1-2\lambda)^2+(-17+\lambda)^2+(4-2\lambda)^2$	A1	
	Carry out a method for finding its minimum (using calculus, algebra or Pythagoras)	M1	
	Obtain the given answer correctly	A1	**[5]**
(ii) *EITHER*:	Substitute coordinates of a general point of *l* in equation of plane and either equate constant terms or equate the coefficient of λ to zero, obtaining an equation in *a* and *b*	M1*	
	Obtain a correct equation, e.g. $4a-9b-27+1=0$	A1	
	Obtain a second correct equation, e.g. $-2a+b+6=0$	A1	
	Solve for *a* or for *b*	M1(dep*)	
	Obtain $a=2$ and $b=-2$	A1	
OR:	Substitute coordinates of a point of *l* and obtain a correct equation, e.g. $4a-9b=26$	B1	
	EITHER: Find a second point on *l* and obtain an equation in *a* and *b*	M1*	
	Obtain a correct equation	A1	
	OR: Calculate scalar product of a direction vector for *l* and a vector normal to the plane and equate to zero	M1*	
	Obtain a correct equation, e.g. $-2a+b+6=0$	A1	
	Solve for *a* or for *b*	M1(dep*)	
	Obtain $a=2$ and $b=-2$	A1	**[5]**