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 = 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 $\frac{\mathrm{d}x}{\mathrm{d}t} = \frac{3\sin t}{\cos^4 t}$ or $\frac{\mathrm{d}y}{\mathrm{d}t} = 3\tan^2 t\sec^2 t$, or equivalent — A1
Use $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y}{\mathrm{d}t} \div \frac{\mathrm{d}x}{\mathrm{d}t}$ — 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 + 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 + 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. $iz^2 + z - i = 0$ B1
Solve a 3-term quadratic for z or substitute $z = x + iy$ and use a correct method to solve for x and y M1
OR: Substitute $w = x + iy$ 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. $z = \dfrac{-1 \pm \sqrt{3}\,i}{2i}$ A1
Obtain final answer $-\dfrac{\sqrt{3}}{2} + \dfrac{1}{2}i$ A1 **[4]**

6 **(i)** Integrate and reach $bx\ln 2x - c\int x.\dfrac{1}{x}\,dx$, or equivalent M1*
Obtain $x\ln 2x - \int x.\dfrac{1}{x}\,dx$, 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 $\dfrac{dR}{dx}$ 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. $\binom{-1}{1}$ 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. $\frac{27}{\sqrt{9}.\sqrt{306}}$	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]**