1	*EITHER*:	Use law of the logarithm of a power or quotient and remove logarithms	M1	
		Obtain a 3-term quadratic equation $x^2 - x - 3 = 0$, or equivalent	A1	
		Solve 3-term quadratic obtaining 1 or 2 roots	M1	
		Obtain answer 2.30 only	A1	
	*OR*1:	Use an appropriate iterative formula, e.g. $x_{n+1} = \exp\left(\frac{1}{2}\ln(3x_n + 4)\right) - 1$ correctly at least once	M1	
		Obtain answer 2.30	A1	
		Show sufficient iterations to at least 3 d.p. to justify 2.30 to 2 d.p., or show there is a sign change in the interval (2.295, 2.305)	A1	
		Show there is no other root	A1	
	*OR*2:	Use calculated values to obtain at least one interval containing the root	M1	
		Obtain answer 2.30	A1	
		Show sufficient calculations to justify 2.30 to 3 s.f., e.g. show it lies in (2.295, 2.305)	A1	
		Show there is no other root	A1	[4]

2	**(i)**	Using the formulae $\frac{1}{2}r^2\theta$ and $\frac{1}{2}bh$, form an equation an a and θ	M1	
		Obtain given answer	A1	[2]
	(ii)	Use the iterative formula correctly at least once	M1	
		Obtain answer θ = 1.32	A1	
		Show sufficient iterations to 4 d.p. to justify 1.32 to 2 d.p., or show there is a sign change in the interval (1.315, 1.325)	A1	[3]

3	*EITHER*:	State a correct unsimplified term in x or x^2 of $(1-x)^{\frac{1}{2}}$ or $(1+x)^{-\frac{1}{2}}$	B1	
		State correct unsimplified expansion of $(1-x)^{\frac{1}{2}}$ up to the term in x^2	B1	
		State correct unsimplified expansion of $(1+x)^{-\frac{1}{2}}$ up to the term in x^2	B1	
		Obtain sufficient terms of the product of the expansions of $(1-x)^{\frac{1}{2}}$ and $(1+x)^{-\frac{1}{2}}$	M1	
		Obtain final answer $1-x+\frac{1}{2}x^2$	A1	
	*OR*1:	State that the given expression equals $(1-x)(1-x^2)^{-\frac{1}{2}}$ and state that the first term of the expansion of $(1-x^2)^{-\frac{1}{2}}$ is 1	B1	
		State correct unsimplified term in x^2 of $(1-x^2)^{-\frac{1}{2}}$	B1	
		State correct unsimplified expansion of $(1-x^2)^{-\frac{1}{2}}$ up to the term in x^2	B1	
		Obtain sufficient terms of the product of $(1-x)$ and the expansion	M1	
		Obtain final answer $1-x+\frac{1}{2}x^2$	A1	
	*OR*2:	State correct unsimplified expansion of $(1+x)^{\frac{1}{2}}$ up to the term in x^2	B1	
		Multiply expansion by $(1-x)$ and obtain $1-2x+2x^2$	B1	
		Carry out correct method to obtain one non-constant term of the expansion of $\left(1-2x+2x^2\right)^{\frac{1}{2}}$	M1	
		Obtain a correct unsimplified expansion with sufficient terms	A1	
		Obtain final answer $1-x+\frac{1}{2}x^2$	A1	[5]
		[Treat $(1+x)^{-1}(1-x^2)^{\frac{1}{2}}$ by the *EITHER* scheme.]		
		[Symbolic coefficients, e.g. $\binom{\frac{1}{2}}{2}$, are not sufficient for the B marks.]		

4	Use trig formulae to express equation in terms of $\cos\theta$ and $\sin\theta$	M1	
	Use Pythagoras to obtain an equation in $\sin\theta$	M1	
	Obtain 3-term quadratic $2\sin^2\theta-2\sin\theta-1=0$, or equivalent	A1	
	Solve a 3-term quadratic and obtain a value of θ	M1	
	Obtain answer, e.g. 201.5°	A1	
	Obtain second answer, e.g. 338.5°, and no others in the given interval	A1	[6]
	[Ignore answers outside the given interval. Treat answers in radians (3.52, 5.91) as a misread and deduct A1 from the marks for the angles.]		

5	Separate variables correctly and attempt integration of both sides	B1	
	Obtain term $-e^{-y}$, or equivalent	B1	
	Obtain term $\frac{1}{2}e^{2x}$, or equivalent	B1	
	Evaluate a constant, or use limits $x=0$, $y=0$ in a solution containing terms ae^{-y} and be^{2x}	M1	
	Obtain correct solution in any form, e.g. $-e^{-y}=\frac{1}{2}e^{2x}-\frac{3}{2}$	A1	
	Rearrange and obtain $y=\ln(2/(3-e^{2x}))$, or equivalent	A1	[6]

6	**(i)**	State derivative in any correct form, e.g. $3\cos x - 12\cos^2 x\sin x$	B1 + B1	
		Equate derivative to zero and solve for sin 2x, or sin x or cos x	M1	
		Obtain answer $x = \frac{1}{12}\pi$	A1	
		Obtain answer $x = \frac{5}{12}\pi$	A1	
		Obtain answer $x = \frac{1}{2}\pi$ and no others in the given interval	A1√	[6]
	(ii)	Carry out a method for determining the nature of the relevant stationary point	M1	
		Obtain a maximum at $\frac{1}{12}\pi$ correctly	A1	[2]
		[Treat answers in degrees as a misread and deduct A1 from the marks for the angles.]		
7	**(i)**	*EITHER*: Multiply numerator and denominator by 1 + 3i, or equivalent	M1	
		Simplify numerator to –5 + 5i, or denominator to 10, or equivalent	A1	
		Obtain final answer $-\frac{1}{2} + \frac{1}{2}\mathrm{i}$, or equivalent	A1	
		OR: Obtain two equations in x and y, and solve for x or for y	M1	
		Obtain $x = -\frac{1}{2}$ or $y = \frac{1}{2}$, or equivalent	A1	
		Obtain final answer $-\frac{1}{2} + \frac{1}{2}\mathrm{i}$, or equivalent	A1	[3]
	(ii)	Show B and C in relatively correct positions in an Argand diagram	B1	
		Show u in a relatively correct position	B1√	[2]
	(iii)	Substitute exact arguments in the LHS arg(1 + 2i) – arg(1 – 3i) = arg u, or equivalent	M1	
		Obtain and use $\arg u = \frac{3}{4}\pi$	A1	
		Obtain the given result correctly	A1	[3]

8	**(i)**	State or imply $2u\,du = -dx$, or equivalent	B1	
		Substitute for x and dx throughout	M1	
		Obtain integrand $\frac{-10u}{6-u^2+u}$, or equivalent	A1	
		Show correct working to justify the change in limits and obtain the given answer correctly	A1	[4]
	(ii)	State or imply the form of fractions $\frac{A}{3-u}+\frac{B}{2+u}$ and use a relevant method to find A or B	M1	
		Obtain $A = 6$ and $B = -4$	A1	
		Integrate and obtain $-6\ln(3-u)-4\ln(2+u)$, or equivalent	A1√ + A1√	
		Substitute limits correctly in an integral of the form $a\ln(3-u)+b\ln(2+u)$	M1	
		Obtain the given answer correctly having shown sufficient working	A1	[6]
		[The f.t. is on A and B.]		
9	**(i)**	Use correct product rule	M1	
		Obtain derivative in any correct form, e.g. $\frac{\ln x}{2\sqrt{x}}+\frac{\sqrt{x}}{x}$	A1	
		Carry out a complete method to form an equation of the tangent at $x = 1$	M1	
		Obtain answer $y = x - 1$	A1	[4]
	(ii)	State or imply that the indefinite integral for the volume is $\pi\int x(\ln x)^2\,dx$	B1	
		Integrate by parts and reach $ax^2(\ln x)^2 + b\int x^2.\frac{\ln x}{x}\,dx$	M1*	
		Obtain $\frac{1}{2}x^2(\ln x)^2 - \int x\ln x\,dx$, or unsimplified equivalent	A1	
		Attempt second integration by parts reaching $cx^2\ln x + d\int x^2.\frac{1}{x}\,dx$	M1(dep*)	
		Complete the integration correctly, obtaining $\frac{1}{2}x^2(\ln x)^2 - \frac{1}{2}x^2\ln x + \frac{1}{4}x^2$	A1	
		Substitute limits $x = 1$ and $x = e$, having integrated twice	M1(dep*)	
		Obtain answer $\frac{1}{4}\pi(e^2-1)$, or exact equivalent	A1	[7]
		[If π omitted, or 2π or π/2 used, give B0 and then follow through.]		
		[Integration using parts $x\ln x$ and $\ln x$ is also viable.]		

10	**(i)**	*EITHER*:	Substitute coordinates of a general point of *l* in given equation of plane *m*	M1	
			Obtain equation in λ in any correct form	A1	
			Verify that the equation is not satisfied for any value of λ	A1	
		*OR*1:	Substitute for **r** in the vector equation of plane *m* and expand scalar product	M1	
			Obtain equation in λ in any correct form	A1	
			Verify that the equation is not satisfied for any value of λ	A1	
		*OR*2:	Expand scalar product of a normal to *m* and a direction vector of *l*	M1	
			Verify scalar product is zero	A1	
			Verify that one point of *l* does not lie in the plane	A1	
		*OR*3:	Use correct method to find perpendicular distance of a general point of *l* from *m*	M1	
			Obtain a correct unsimplified expression in terms of λ	A1	
			Show that the perpendicular distance is 4/3, or equivalent, for all λ	A1	
		*OR*4:	Use correct method to find the perpendicular distance of a particular point of *l* from *m*	M1	
			Obtain answer 4/3, or equivalent	A1	
			Show that the perpendicular distance of a second point is also 4/3, or equivalent	A1	[3]
	(ii)	*EITHER*:	Express general point of *l* in component form, e.g. $(1 + 2\lambda, 1 + \lambda, -1 + 2\lambda)$	B1	
			Substitute in given equation of *n* and solve for λ	M1	
			Obtain position vector $5\mathbf{i} + 3\mathbf{j} + 3\mathbf{k}$ from $\lambda = 2$	A1	
		OR:	State or imply plane *n* has vector equation $\mathbf{r}.(2\mathbf{i} - 2\mathbf{j} + \mathbf{k}) = 7$, or equivalent	B1	
			Substitute for **r**, expand scalar product and solve for λ	M1	
			Obtain position vector $5\mathbf{i} + 3\mathbf{j} + 3\mathbf{k}$ from $\lambda = 2$	A1	[3]
	(iii)		Form an equation in λ by equating perpendicular distances of a general point of *l* from *m* and *n*	M1*	
			Obtain a correct modular or non-modular equation in λ in any form	A1√	
			Solve for λ and obtain a point, e.g. $7\mathbf{i} + 4\mathbf{j} + 5\mathbf{k}$ from $\lambda = 3$	A1	
			Obtain a second point, e.g. $3\mathbf{i} + 2\mathbf{j} + \mathbf{k}$ from $\lambda = 1$	A1	
			Use a correct method to find the distance between the two points	M1(dep*)	
			Obtain answer 6	A1	[6]
			[The f.t. is on the components of *l*.]		