Question	Answer	Marks
1	Use law of the logarithm of a power or a quotient	M1
	Remove logarithms and obtain a correct equation in x. e.g. $x^2 + 1 = ex^2$	A1
	Obtain answer 0.763 and no other	A1
	Total:	**3**
2	*EITHER*: State or imply non-modular inequality $(x-3)^2 < (3x-4)^2$, or corresponding equation	(B1
	Make reasonable attempt at solving a three term quadratic	M1
	Obtain critical value $x = \frac{7}{4}$	A1
	State final answer $x > \frac{7}{4}$ only	A1)
	*OR*1: State the relevant critical inequality $3 - x < 3x - 4$, or corresponding equation	(B1
	Solve for x	M1
	Obtain critical value $x = \frac{7}{4}$	A1
	State final answer $x > \frac{7}{4}$ only	A1)
	*OR*2: Make recognizable sketches of $y = \|x-3\|$ and $y = 3x - 4$ on a single diagram	(B1
	Find x-coordinate of the intersection	M1
	Obtain $x = \frac{7}{4}$	A1
	State final answer $x > \frac{7}{4}$ only	A1)
	Total:	**4**

Question	Answer	Marks
3(i)	Use correct formulae to express the equation in terms of cos θ and sin θ	M1
	Use Pythagoras and express the equation in terms of cos θ only	M1
	Obtain correct 3-term equation, e.g. $2\cos^4\theta + \cos^2\theta - 2 = 0$	A1
	Total:	3
3(ii)	Solve a 3-term quadratic in $\cos^2\theta$ for cos θ	M1
	Obtain answer $\theta = 152.1°$ only	A1
	Total:	2
4(i)	State $\frac{dy}{dt} = 4 + \frac{2}{2t-1}$	B1
	Use $\frac{dy}{dx} = \frac{dy}{dt} \div \frac{dx}{dt}$	M1
	Obtain answer $\frac{dy}{dx} = \frac{8t-2}{2t(2t-1)}$, or equivalent e.g. $\frac{2}{t} + \frac{2}{4t^2 - 2t}$	A1
	Total:	3
4(ii)	Use correct method to find the gradient of the normal at $t = 1$	M1
	Use a correct method to form an equation for the normal at $t = 1$	M1
	Obtain final answer $x + 3y - 14 = 0$, or horizontal equivalent	A1
	Total:	3

Question	Answer	Marks
5(i)	State $\frac{dy}{dt} = -\frac{2y}{(1+t)^2}$, or equivalent	B1
	Separate variables correctly and attempt integration of one side	M1
	Obtain term $\ln y$, or equivalent	A1
	Obtain term $\frac{2}{(1+t)}$, or equivalent	A1
	Use $y = 100$ and $t = 0$ to evaluate a constant, or as limits in an expression containing terms of the form $a \ln y$ and $\frac{b}{1+t}$	M1
	Obtain correct solution in any form, e.g. $\ln y = \frac{2}{1+t} - 2 + \ln 100$	A1
	Total:	6
5(ii)	State that the mass of B approaches $\frac{100}{e^2}$, or **exact** equivalent	B1
	State or imply that the mass of A tends to zero	B1
	Total:	2

Question	Answer	Marks
6(i)	*EITHER:* Substitute $x = 2 - \mathrm{i}$ (or $x = 2 + \mathrm{i}$) in the equation and attempt expansions of x^2 and x^3	(M1
	Equate real and/or imaginary parts to zero	M1
	Obtain $a = -2$	A1
	Obtain $b = 10$	A1)
	*OR*1: Substitute $x = 2 - \mathrm{i}$ in the equation and attempt expansions of x^2 and x^3	(M1
	Substitute $x = 2 + \mathrm{i}$ in the equation and add/subtract the two equations	M1
	Obtain $a = -2$	A1
	Obtain $b = 10$	A1)
	*OR*2: Factorise to obtain $(x-2+\mathrm{i})(x-2-\mathrm{i})(x-p)$ $\left(=\left(x^2-4x+5\right)(x-p)\right)$	(M1
	Compare coefficients	M1
	Obtain $a = -2$	A1
	Obtain $b = 10$	A1)
	*OR*3: Obtain the quadratic factor $(x^2 - 4x + 5)$	(M1
	Use algebraic division to obtain a real linear factor of the form $x - p$ and set the remainder equal to zero	M1
	Obtain $a = -2$	A1
	Obtain $b = 10$	A1)
	*OR*4: Use $\alpha\beta = 5$ and $\alpha + \beta = 4$ in $\alpha\beta + \beta\gamma + \gamma\alpha = -3$	(M1
	Solve for γ and use in $\alpha\beta\gamma = -b$ and/or $\alpha + \beta + \gamma = -a$	M1
	Obtain $a = -2$	A1
	Obtain $b = 10$	A1)

Question	Answer	Marks
	OR5: Factorise as (x–- (2-i))($x^2 + ex + g$) and compare coefficients to form an equation in a and b	**(M1**
	Equate real and/or imaginary parts to zero	**M1**
	Obtain $a = -2$	**A1**
	Obtain $b = 10$	**A1)**
	Total:	**4**
6(ii)	Show a circle with centre $2-\ \mathrm{i}$ in a relatively correct position	**B1**
	Show a circle with radius 1 and centre not at the origin	**B1**
	Show the perpendicular bisector of the line segment joining 0 to – i	**B1**
	Shade the correct region	**B1**
	Total:	**4**
7(i)	Use quotient or chain rule	**M1**
	Obtain given answer correctly	**A1**
	Total:	**2**
7(ii)	*EITHER*: Multiply numerator and denominator of LHS by $1+\sin\theta$	**(M1**
	Use Pythagoras and express LHS in terms of sec θ and tan θ	**M1**
	Complete the proof	**A1)**
	OR1: Express RHS in terms of cos θ and sin θ	**(M1**
	Use Pythagoras and express RHS in terms of sin θ	**M1**
	Complete the proof	**A1)**
	OR2: Express LHS in terms of secθ and tanθ	**(M1**
	Multiply numerator and denominator by secθ + tanθ and use Pythagoras	**M1**
	Complete the proof	**A1)**
	Total:	**3**

Question	Answer	Marks
7(iii)	Use the identity and obtain integral $2\tan\theta + 2\sec\theta - \theta$	B2
	Use correct limits correctly in an integral containing terms $a\tan\theta$ and $b\sec\theta$	M1
	Obtain answer $2\sqrt{2} - \frac{1}{4}\pi$	A1
	Total:	**4**
8(i)	State or imply the form $\dfrac{A}{3x+2} + \dfrac{Bx+C}{x^2+5}$	B1
	Use a relevant method to determine a constant	M1
	Obtain one of the values $A = 2$, $B = 1$, $C = -3$	A1
	Obtain a second value	A1
	Obtain the third value	A1
	Total:	**5**
8(ii)	Use correct method to find the first two terms of the expansion of $(3x+2)^{-1}$, $(1+\frac{3}{2}x)^{-1}$, $(5+x^2)^{-1}$ or $(1+\frac{1}{5}x^2)^{-1}$ [Symbolic coefficients, e.g. $\binom{-1}{2}$ are not sufficient]	M1
	Obtain correct unsimplified expansions up to the term in x^2 of each partial fraction. The FT is on A, B, C. from part (i)	A1FT + A1FT
	Multiply out up to the term in x^2 by $Bx + C$, where $BC \neq 0$	M1
	Obtain **final answer** $\frac{2}{5} - \frac{13}{10}x + \frac{237}{100}x^2$, or equivalent	A1
	Total:	**5**
9(i)	*EITHER*: Find $\overrightarrow{AP}$ for a general point P on l with parameter λ, e.g.$(8 + 3\lambda, -3 - \lambda, 4 + 2\lambda)$	(B1
	Equate scalar product of $\overrightarrow{AP}$ and direction vector of l to zero and solve for λ	M1
	Obtain $\lambda = -\frac{5}{2}$ and foot of perpendicular $\frac{3}{2}\mathbf{i} + \frac{3}{2}\mathbf{j} + 3\mathbf{k}$	A1
	Carry out a complete method for finding the position vector of the reflection of A in l	M1
	Obtain answer $2\mathbf{i} + \mathbf{j} + 2\mathbf{k}$	A1)

Question	Answer	Marks
	OR: Find $\overrightarrow{AP}$ for a general point P on l with parameter λ, e.g.$(8 + 3\lambda, -3 - \lambda, 4 + 2\lambda)$	(B1
	Differentiate $\|AP\|^2$ and solve for λ at minimum	M1
	Obtain $\lambda = -\frac{5}{2}$ and foot of perpendicular $\frac{3}{2}\mathbf{i} + \frac{3}{2}\mathbf{j} + 3\mathbf{k}$	A1
	Carry out a complete method for finding the position vector of the reflection of A in l	M1
	Obtain answer $2\mathbf{i} + \mathbf{j} + 2\mathbf{k}$	A1)
	Total:	**5**
9(ii)	*EITHER:* Use scalar product to obtain an equation in a, b and c, e.g. $3a - b + 2c = 0$	(B1
	Form a second relevant equation, e.g. $9a - b + 8c = 0$ and solve for one ratio, e.g. $a : b$	M1
	Obtain final answer $a : b : c = 1 : 1 : -1$ and state plane equation $x + y - z = 0$	A1)
	*OR*1: Attempt to calculate vector product of two relevant vectors, e.g. $(3\mathbf{i} - \mathbf{j} + 2\mathbf{k}) \times (9\mathbf{i} - \mathbf{j} + 8\mathbf{k})$	(M1
	Obtain two correct components	A1
	Obtain correct answer, e.g. $-6\mathbf{i} - 6\mathbf{j} + 6\mathbf{k}$, and state plane equation $-x - y + z = 0$	A1)
	*OR*2: Using a relevant point and relevant vectors, attempt to form a 2-parameter equation for the plane, e.g. $\mathbf{r} = 6\mathbf{i} + 6\mathbf{k} + s(3\mathbf{i} - \mathbf{j} + 2\mathbf{k}) + t(9\mathbf{i} - \mathbf{j} + 8\mathbf{k})$	(M1
	State 3 correct equations in x, y, z, s and t	A1
	Eliminate s and t and state plane equation $x + y - z = 0$, or equivalent	A1)
	*OR*3: Using a relevant point and relevant vectors, attempt to form a determinant equation for the plane, e.g. $\begin{vmatrix} x-3 & y-1 & z-4 \\ 3 & -1 & 2 \\ 9 & -1 & 8 \end{vmatrix} = 0$	(M1
	Expand a correct determinant and obtain two correct cofactors	A1
	Obtain answer $-6x - 6y + 6z = 0$, or equivalent	A1)
	Total:	**3**

Question	Answer	Marks
9(iii)	*EITHER*: Using the correct processes, divide the scalar product of $\overrightarrow{OA}$ and a normal to the plane by the modulus of the normal or make a recognisable attempt to apply the perpendicular formula	**(M1**
	Obtain a correct expression in any form, e.g. $\dfrac{1+2-4}{\sqrt{(1^2+1^2+(-1)^2)}}$, or equivalent	**A1 FT**
	Obtain answer $1/\sqrt{3}$, or exact equivalent	**A1)**
	OR1: Obtain equation of the parallel plane through A, e.g. $x+y-z=-1$ [The f.t. is on the plane found in part (**ii**).]	**(B1 FT**
	Use correct method to find its distance from the origin	**M1**
	Obtain answer $1/\sqrt{3}$, or exact equivalent	**A1)**
	OR2: Form equation for the intersection of the perpendicular through A and the plane [FT on their **n**]	**(B1 FT**
	Solve for λ	**M1**
	$\lvert\lambda\mathbf{n}\rvert=\dfrac{1}{\sqrt{3}}$	**A1)**
	Total:	**3**
10(i)	Use correct product rule	**M1**
	Obtain correct derivative in any form $\left(y'=2x\cos 2x-2x^2\sin 2x\right)$	**A1**
	Equate to zero and derive the given equation	**A1**
	Total:	**3**
10(ii)	Use the iterative formula correctly at least once e.g. $0.5\to 0.55357\to 0.53261\to 0.54070\to 0.53755$	**M1**
	Obtain final answer 0.54	**A1**
	Show sufficient iterations to 4 d.p. to justify 0.54 to 2 d.p., or show there is a sign change in the interval (0.535, 0.545)	**A1**
	Total:	**3**

Question	Answer	Marks
10(iii)	Integrate by parts and reach $ax^2 \sin 2x + b\int x \sin 2x \, dx$	*M1
	Obtain $\frac{1}{2}x^2 \sin 2x - \int 2x.\frac{1}{2}\sin 2x \, dx$	A1
	Complete integration and obtain $\frac{1}{2}x^2 \sin 2x + \frac{1}{2}x\cos 2x - \frac{1}{4}\sin 2x$, or equivalent	A1
	Substitute limits $x = 0$, $x = \frac{1}{4}\pi$, having integrated twice	DM1
	Obtain answer $\frac{1}{32}(\pi^2 - 8)$, or exact equivalent	A1
	Total:	5