Question	Answer	Marks
1	Remove logarithm and obtain $1+2^x = e^2$	B1
	Use correct method to solve an equation of the form $2^x = a$, where $a > 0$	M1
	Obtain answer $x = 2.676$	A1
	Total:	**3**

Question	Answer	Marks
2	*EITHER*:	
	State or imply non-modular inequality $(x-4)^2 < (2(3x+1))^2$, or corresponding quadratic equation, or pair of linear equations $x-4 = \pm 2(3x+1)$	(B1
	Make reasonable solution attempt at a 3-term quadratic, or solve two linear equations for x	M1
	Obtain critical values $x = -\frac{6}{5}$ and $x = \frac{2}{7}$	A1
	State final answer $x < -\frac{6}{5}$, $x > \frac{2}{7}$	A1)
	OR:	
	Obtain critical value $x = -\frac{6}{5}$ from a graphical method, or by inspection, or by solving a linear equation or inequality	(B1
	Obtain critical value $x = \frac{2}{7}$ similarly	B2
	State final answer $x < -\frac{6}{5}$, $x > \frac{2}{7}$	B1)
	Total:	**4**

Question	Answer	Marks
3(i)	Sketch a relevant graph, e.g. $y = e^{-\frac{1}{2}x}$	B1
	Sketch a second relevant graph, e.g. $y = 4 - x^2$, and justify the given statement	B1
	Total:	**2**
3(ii)	Calculate the value of a relevant expression or values of a pair of expressions at $x = -1$ and $x = -1.5$	M1
	complete the argument correctly with correct calculated values	A1
	Total:	**2**

Question	Answer	Marks
3(iii)	Use the iterative formula correctly at least once	M1
	Obtain final answer – 1.41	A1
	Show sufficient iterations to 4 d.p. to justify – 1.41 to 2 d.p., or show there is a sign change in the interval (– 1.415, – 1.405)	A1
	Total:	**3**

Question	Answer	Marks
4(i)	State $R = 17$	B1
	Use trig formula to find α	M1
	Obtain $\alpha = 61.93°$ with no errors seen	A1
	Total:	**3**
4(ii)	Evaluate $\cos^{-1}(4/17)$ to at least 1d.p. (76.39° to 2 d.p.)	B1$\sqrt{}$
	Use a correct method to find a value of x in the interval $0° < x < 180°$	M1
	Obtain answer, e.g. $x = 7.2°$	A1
	Obtain second answer, e.g. $x = 110.8°$ and no others	A1
	[Ignore answers outside the given interval.]	
	[Treat answers in radians as a misread.]	
	Total:	**4**

Question	Answer	Marks
5	Use product rule	M1
	Obtain correct derivative in any form	A1
	Equate derivative to zero, use Pythagoras and obtain a quadratic equation in $\tan x$	M1
	Obtain $\tan^2 x - a\tan x + 1 = 0$, or equivalent	A1
	Use the condition for a quadratic to have only one root	M1
	Obtain answer $a = 2$	A1
	Obtain answer $x = \frac{1}{4}\pi$	A1
	Total:	**7**

Question	Answer	Marks
6(i)	Verify that the point with position vector $\mathbf{i}+2\mathbf{j}-3\mathbf{k}$ lies in the plane	**B1**
	EITHER:	
	Find a second point on l and substitute its coordinates in the equation of p	**(M1**
	Verify that the second point, e.g. (3, 1, – 2), lies in the plane	**A1)**
	OR:	
	Expand scalar product of a normal to p and the direction vector of l	**(M1**
	Verify scalar product is zero	**A1)**
	Total:	**3**

Question	Answer	Marks
6(ii)	*EITHER*:	
	Use scalar product to obtain a relevant equation in a, b and c, e.g. $2a-b+c=0$	(B1
	Obtain a second relevant equation, e.g. $3a+b-5c=0$, and solve for one ratio e.g. $a:b$	M1
	Obtain $a:b:c=4:13:5$, or equivalent	A1
	Substitute (3, – 1, 2) and the values of a, b and c in the general equation and find d	M1
	Obtain answer $4x+13y+5z=9$, or equivalent	A1)
	*OR*1:	
	Attempt to calculate vector product of relevant vectors, e.g. $(2\mathbf{i}-\mathbf{j}+\mathbf{k})\times(3\mathbf{i}+\mathbf{j}-5\mathbf{k})$	(M1
	Obtain two correct components	A1
	Obtain correct answer, e.g. $4\mathbf{i}+13\mathbf{j}+5\mathbf{k}$	A1
	Substitute (3, – 1, 2) in $4x+13y+5z=d$, or equivalent, and find d	M1
	Obtain answer $4x+13y+5z=9$, or equivalent	A1)
	*OR*2:	
	Using the relevant point and relevant vectors form a 2-parameter equation for the plane	(M1
	State a correct equation, e.g. $\mathbf{r}=3\mathbf{i}-\mathbf{j}+2\mathbf{k}+\lambda(2\mathbf{i}-\mathbf{j}+\mathbf{k})+\mu(3\mathbf{i}+\mathbf{j}-5\mathbf{k})$	A1
	State three correct equations in x, y, z, λ and μ	A1
	Eliminate λ and μ	M1
	Obtain answer $4x+13y+5z=9$, or equivalent	A1)
	*OR*3:	
	Using the relevant point and relevant vectors form a determinant equation for the plane	(M1
	State a correct equation, e.g. $\begin{vmatrix} x-3 & y+1 & z-2 \\ 2 & -1 & 1 \\ 3 & 1 & -5 \end{vmatrix}=0$	A1
	Attempt to expand the determinant	M1
	Obtain or imply two correct cofactors	A1

Question	Answer	Marks
	Obtain answer $4x+13y+5z=9$, or equivalent	A1)
	Total:	**5**

Question	Answer	Marks
7(i)	State or imply $\dfrac{dV}{dt} = 2\dfrac{dh}{dt}$	B1
	State or imply $\dfrac{dV}{dt} = 1 - 0.2\sqrt{h}$	B1
	Obtain the given answer correctly	B1
	Total:	**3**
7(ii)	State or imply $du = -\dfrac{1}{2\sqrt{h}}\ dh$, or equivalent	B1
	Substitute for h and dh throughout	M1
	Obtain $T = \displaystyle\int_3^5 \frac{20(5-u)}{u}\ du$, or equivalent	A1
	Integrate and obtain terms $100\ln u - 20u$, or equivalent	A1
	Substitute limits $u = 3$ and $u = 5$ correctly	M1
	Obtain answer 11.1, with no errors seen	A1
	Total:	**6**

Question	Answer	Marks
8(i)	Substitute $z = -1 + \mathrm{i}$ and attempt expansions of the z^2 and z^4 terms	M1
	Use $\mathrm{i}^2 = -1$ at least once	M1
	Complete the verification correctly	A1
	Total:	3
8(ii)	State second root $z = -1 - \mathrm{i}$	B1
	Carry out a complete method for finding a quadratic factor with zeros $-1 + \mathrm{i}$ and $-1 - \mathrm{i}$	M1
	Obtain $z^2 + 2z + 2$, or equivalent	A1
	Attempt division of p(z) by $z^2 + 2z + 2$ and reach a partial quotient $z^2 + kz$	M1
	Obtain quadratic factor $z^2 - 2z + 5$	A1
	Solve 3-term quadratic and use $\mathrm{i}^2 = -1$	M1
	Obtain roots 1 + 2i and 1 – 2i	A1
	Total:	7

Question	Answer	Marks
9(i)	State or imply the form $\frac{A}{2+x} + \frac{Bx + C}{4 + x^2}$	B1
	Use a relevant method to determine a constant	M1
	Obtain one of the values $A = -2$, $B = 1$, $C = 4$	A1
	Obtain a second value	A1
	Obtain the third value	A1
	Total:	5

Question	Answer	Marks
9(ii)	Use correct method to obtain the first two terms of the expansion of $(1+\frac{1}{2}x)^{-1}$, $(2+x)^{-1}$, $(1+\frac{1}{4}x^2)^{-1}$ or $(4+x^2)^{-1}$	M1
	Obtain correct unsimplified expansions up to the term in x^2 of each partial fraction	A1√ + A1√
	Multiply out up to the term in x^2 by $Bx+C$, where $BC \neq 0$	M1
	Obtain final answer $\frac{3}{4}x - \frac{1}{2}x^2$	A1
	[Symbolic binomial coefficients, e.g. ${}_{-1}C_2$, are not sufficient for the first M1. The f.t. is on *A*, *B*, *C*.]	
	[In the case of an attempt to expand $x(6-x)(2+x)^{-1}(4+x^2)^{-1}$, give M1A1A1 for the expansions, M1 for multiplying out fully, and A1 for the final answer.]	
	Total:	**5**

Question	Answer	Marks
10(i)	State or imply derivative is $2\dfrac{\ln x}{x}$	B1
	State or imply gradient of the normal at $x = \mathrm{e}$ is $-\frac{1}{2}\mathrm{e}$, or equivalent	B1
	Carry out a complete method for finding the *x*-coordinate of *Q*	M1
	Obtain answer $x = \mathrm{e} + \dfrac{2}{\mathrm{e}}$, or exact equivalent	A1
	Total:	**4**
10(ii)	Justify the given statement by integration or by differentiation	B1
	Total:	**1**
10(iii)	Integrate by parts and reach $ax(\ln x)^2 + b\int x.\dfrac{\ln x}{x}\,\mathrm{d}x$	M1*
	Complete the integration and obtain $x(\ln x)^2 - 2x\ln x + 2x$, or equivalent	A1
	Use limits $x = 1$ and $x = \mathrm{e}$ correctly, having integrated twice	DM1
	Obtain exact value $\mathrm{e} - 2$	A1
	Use *x*- coordinate of *Q* found in part **(i)** and obtain final answer $\mathrm{e} - 2 + \dfrac{1}{\mathrm{e}}$	B1√
	Total:	**5**