1	*EITHER:* State or imply non-modular inequality $(x+2a)^2 > (3(x-a))^2$, or corresponding quadratic equation, or pair of linear equations $(x+2a) = \pm 3(x-a)$	B1	
	Make reasonable solution attempt at a 3-term quadratic, or solve two linear equations for x	M1	
	Obtain critical values $x = \frac{1}{4}a$ and $x = \frac{5}{2}a$	A1	
	State answer $\frac{1}{4}a < x < \frac{5}{2}a$	A1	
	OR: Obtain critical value $x = \frac{5}{2}a$ from a graphical method, or by inspection, or by solving a linear equation or inequality	B1	
	Obtain critical value $x = \frac{1}{4}a$ similarly	B2	
	State answer $\frac{1}{4}a < x < \frac{5}{2}a$	B1	**4**
	[Do not condone $\leqslant$ for $<$.]		
2	Remove logarithms and obtain $5 - e^{-2x} = e^{\frac{1}{2}}$, or equivalent	B1	
	Obtain a correct value for e^{-2x}, e^{2x}, e^{-x} or e^{x}, e.g. $e^{2x} = 1/(5 - e^{\frac{1}{2}})$	B1	
	Use correct method to solve an equation of the form $e^{2x} = a$, $e^{-2x} = a$, $e^{x} = a$ or $e^{-x} = a$ where $a > 0$. [The M1 is dependent on the correct removal of logarithms.]	M1	
	Obtain answer $x = -0.605$ only.	A1	**4**
3	Use $\cos(A+B)$ formula to obtain an equation in $\cos x$ and $\sin x$	M1	
	Use trig formula to obtain an equation in $\tan x$ (or $\cos x$ or $\sin x$)	M1	
	Obtain $\tan x = \sqrt{3} - 4$, or equivalent (or find $\cos x$ or $\sin x$)	A1	
	Obtain answer $x = -66.2°$	A1	
	Obtain answer $x = 113.8°$ and no others in the given interval	A1	**5**
	[Ignore answers outside the given interval. Treat answers in radians as a misread $(-1.16,\ 1.99)$.]		
	[The other solution methods are *via* $\cos x = \pm 1/\sqrt{(1+(\sqrt{3}-4)^2)}$ and $\sin x = \pm(\sqrt{3}-4)/\sqrt{(1+(\sqrt{3}-4)^2)}$.]		
4	**(i)** State $\frac{dx}{dt} = 1 - \sec^2 t$, or equivalent	B1	
	Use chain rule	M1	
	Obtain $\frac{dy}{dt} = -\frac{\sin t}{\cos t}$, or equivalent	A1	
	Use $\frac{dy}{dx} = \frac{dy}{dt} \div \frac{dx}{dt}$	M1	
	Obtain the given answer correctly.	A1	**5**
	(ii) State or imply $t = \tan^{-1}(\frac{1}{2})$	B1	
	Obtain answer $x = -0.0364$	B1	**2**

5	**(i)**	Differentiate f(x) and obtain $f'(x) = (x-2)^2 g'(x) + 2(x-2)g(x)$		B1	
		Conclude that $(x-2)$ is a factor of $f'(x)$		B1	**2**
	(ii)	*EITHER:*	Substitute $x = 2$, equate to zero and state a correct equation, e.g. $32 + 16a + 24 + 4b + a = 0$	B1	
			Differentiate polynomial, substitute $x = 2$ and equate to zero or divide by $(x-2)$ and equate constant remainder to zero	M1*	
			Obtain a correct equation, e.g. $80 + 32a + 36 + 4b = 0$	A1	
		OR1:	Identify given polynomial with $(x-2)^2(x^3 + Ax^2 + Bx + C)$ and obtain an equation in a and/or b	M1*	
			Obtain a correct equation, e.g. $\frac{1}{4}a - 4(4+a) + 4 = 3$	A1	
			Obtain a second correct equation, e.g. $-\frac{3}{4}a + 4(4+a) = b$	A1	
		OR2:	Divide given polynomial by $(x-2)^2$ and obtain an equation in a and b	M1*	
			Obtain a correct equation, e.g. $29 + 8a + b + 0$	A1	
			Obtain a second correct equation, e.g. $176 + 47a + 4b = 0$	A1	
		Solve for a or for b		M1(dep*)	
		Obtain $a = -4$ and $b = 3$		A1	**5**
6	**(i)**	Use correct arc formula and form an equation in r and x		M1	
		Obtain a correct equation in any form		A1	
		Rearrange in the given form		A1	**3**
	(ii)	Consider sign of a relevant expression at $x = 1$ and $x = 1.5$, or compare values of relevant expressions at $x = 1$ and $x = 1.5$		M1	
		Complete the argument correctly with correct calculated values		A1	**2**
	(iii)	Use the iterative formula correctly at least once		M1	
		Obtain final answer 1.21		A1	
		Show sufficient iterations to 4 d.p. to justify 1.21 to 2 d.p., or show there is a sign change in the interval (1.205,1.215)		A1	**3**
7	**(a)**	*EITHER*:	Substitute and expand $(-1+\sqrt{5}\,\mathrm{i})^3$ completely	M1	
			Use $\mathrm{i}^2 = -1$ correctly at least once	M1	
			Obtain $a = -12$	A1	
			State that the other complex root is $-1-\sqrt{5}\,\mathrm{i}$	B1	
		OR1:	State that the other complex root is $-1-\sqrt{5}\,\mathrm{i}$	B1	
			State the quadratic factor $z^2 + 2z + 6$	B1	
			Divide the cubic by a 3-term quadratic, equate remainder to zero and solve for a or, using a 3-term quadratic, factorise the cubic and determine a	M1	
			Obtain $a = -12$	A1	
		OR2:	State that the other complex root is $-1-\sqrt{5}\mathrm{i}$	B1	
			State or show the third root is 2	B1	
			Use a valid method to determine a	M1	
			Obtain $a = -12$	A1	
		OR3:	Substitute and use De Moivre to cube $\sqrt{6}\mathrm{cis}(114.1^\circ)$, or equivalent	M1	
			Find the real and imaginary parts of the expression	M1	
			Obtain $a = -12$	A1	
			State that the other complex root is $-1-\sqrt{5}\mathrm{i}$	B1	**4**

	(b) *EITHER:*	Substitute $w = \cos 2\theta + \mathrm{i}\sin 2\theta$ in the given expression	B1	
		Use double angle formulae throughout	M1	
		Express numerator and denominator in terms of $\cos\theta$ and $\sin\theta$ only	A1	
		Obtain given answer correctly	A1	
	OR:	Substitute $w = \mathrm{e}^{2\mathrm{i}\theta}$ in the given expression	B1	
		Divide numerator and denominator by $\mathrm{e}^{\mathrm{i}\theta}$, or equivalent	M1	
		Express numerator and denominator in terms of $\cos\theta$ and $\sin\theta$ only	A1	
		Obtain the given answer correctly	A1	**4**
8	**(i)**	Use product rule	M1	
		Obtain derivative in any correct form	A1	
		Differentiate first derivative using the product rule	M1	
		Obtain second derivative in any correct form, e.g. $-\frac{1}{2}\sin\frac{1}{2}x - \frac{1}{4}x\cos\frac{1}{2}x - \frac{1}{2}\sin\frac{1}{2}x$	A1	
		Verify the given statement	A1	**5**
	(ii)	Integrate and reach $kx\sin\frac{1}{2}x + l\int\sin\frac{1}{2}x\,\mathrm{d}x$	M1*	
		Obtain $2x\sin\frac{1}{2}x - 2\int\sin\frac{1}{2}x\,\mathrm{d}x$, or equivalent	A1	
		Obtain indefinite integral $2x\sin\frac{1}{2}x + 4\cos\frac{1}{2}x$	A1	
		Use correct limits $x = 0$, $x = \pi$ correctly	M1(dep*)	
		Obtain answer $2\pi - 4$, or exact equivalent	A1	**5**
9	**(i)**	State or imply $\frac{\mathrm{d}N}{\mathrm{d}t} = kN(1-0.01N)$ and obtain the given answer $k = 0.02$	B1	**1**
	(ii)	Separate variables and attempt integration of at least one side	M1	
		Integrate and obtain term $0.02t$, or equivalent	A1	
		Carry out a relevant method to obtain A or B such that $\frac{1}{N(1-0.01N)} \equiv \frac{A}{N} + \frac{B}{1-0.01N}$, or equivalent	M1*	
		Obtain $A = 1$ and $B = 0.01$, or equivalent	A1	
		Integrate and obtain terms $\ln N - \ln(1-0.01N)$, or equivalent	A1$\sqrt{}$	
		Evaluate a constant or use limits $t = 0$, $N = 20$ in a solution with terms $a\ln N$ and $b\ln(1-0.01N)$, $ab \neq 0$	M1(dep*)	
		Obtain correct answer in any form, e.g. $\ln N - \ln(1-0.01N) = 0.02t + \ln 25$	A1	
		Rearrange and obtain $t = 50\ln(4N/(100-N))$, or equivalent	A1	**8**
	(iii)	Substitute $N = 40$ and obtain $t = 49.0$	B1	**1**

10	(i)	*EITHER:*	State or imply $\overrightarrow{AB}$ and $\overrightarrow{AC}$ correctly in component form	B1	
			Using the correct processes evaluate the scalar product $\overrightarrow{AB}.\overrightarrow{AC}$, or equivalent	M1	
			Using the correct process for the moduli divide the scalar product by the product of the moduli	M1	
			Obtain answer $\frac{20}{21}$	A1	
		OR:	Use correct method to find lengths of all sides of triangle ABC	M1	
			Apply cosine rule correctly to find the cosine of angle BAC	M1	
			Obtain answer $\frac{20}{21}$	A1	**4**
	(ii)		State an exact value for the sine of angle BAC, e.g. $\sqrt{41}/21$	B1$\sqrt{}$	
			Use correct area formula to find the area of triangle ABC	M1	
			Obtain answer $\frac{1}{2}\sqrt{41}$, or exact equivalent	A1	**3**
			[SR: Allow use of a vector product, e.g. $\overrightarrow{AB}\times\overrightarrow{AC} = -6\mathbf{i}+2\mathbf{j}-\mathbf{k}$ B1$\sqrt{}$. Using correct process for the modulus, divide the modulus by 2 M1. Obtain answer $\frac{1}{2}\sqrt{41}$ A1.]		
	(iii)	*EITHER*:	State or obtain $b = 0$	B1	
			Equate scalar product of normal vector and $\overrightarrow{BC}$ (or $\overrightarrow{CB}$) to zero	M1	
			Obtain $a + b - 4c = 0$ (or $a - 4c = 0$)	A1	
			Substitute a relevant point in $4x + z = d$ and evaluate d	M1	
			Obtain answer $4x + z = 9$, or equivalent	A1	
		*OR*1:	Attempt to calculate vector product of relevant vectors, e.g. $(\mathbf{j})\times(\mathbf{i}+\mathbf{j}-4\mathbf{k})$	M1	
			Obtain two correct components of the product	A1	
			Obtain correct product, e.g. $-4\mathbf{i}-\mathbf{k}$	A1	
			Substitute a relevant point in $4x + z = d$ and evaluate d	M1	
			Obtain $4x + z = 9$, or equivalent	A1	
		*OR*2:	Attempt to form 2-parameter equation for the plane with relevant vectors	M1	
			State a correct equation, e.g. $\mathbf{r} = 2\mathbf{i} + 4\mathbf{j} + \mathbf{k} + \lambda(\mathbf{j}) + \mu(\mathbf{i}+\mathbf{j}-4\mathbf{k})$	A1	
			State 3 equations in x, y, z, λ and μ	A1	
			Eliminate μ	M1	
			Obtain answer $4x + z = 9$, or equivalent	A1	
		*OR*3:	State or obtain $b = 0$	B1	
			Substitute for B and C in the plane equation and obtain $2a + c = d$ and $3a - 3c = d$ (or $2a + 4b + c = d$ and $3a + 5b - 3c = d$)	B1	
			Solve for one ratio, e.g. $a : d$	M1	
			Obtain $a : c : d$, or equivalent	M1	
			Obtain answer $4x + z = 9$, or equivalent	A1	
		OR4:	Attempt to form a determinant equation for the plane with relevant vectors	M1	
			State a correct equation, e.g. $\begin{vmatrix} x-2 & y-4 & z-1 \\ 0 & 1 & 0 \\ 1 & 1 & -4 \end{vmatrix} = 0$	A1	
			Attempt to use a correct method to expand the determinant	M1	
			Obtain two correct terms of a 3-term expansion, or equivalent	A1	
			Obtain answer $4x + z = 9$, or equivalent	A1	**5**