Question	Answer	Marks	Guidance
1	State or imply ordinates 3, 2, 0, 4	**B1**	These and no more Accept in unsimplified form $\left\|2^0 - 4\right\|$ etc.
	Use correct formula, or equivalent, with $h = 1$ and four ordinates	**M1**	
	Obtain answer 5.5	**A1**	
		3	

Question	Answer	Marks	Guidance
2	Use law for the logarithm of a product, quotient or power	**M1**	Condone $\ln\frac{x}{x-1}$ for M1
	Obtain a correct equation free of logarithms	**A1**	e.g. $(2x-3)(x-1)=x^2$ or $x^2-5x+3=0$
	Solve a 3-term quadratic obtaining at least one root	**M1**	Must see working if using an incorrect quadratic $\left(\frac{5\pm\sqrt{13}}{2}\right)$
	Obtain answer $x = 4.30$ only	**A1**	Q asks for 2 dp. Do not ISW. Overspecified answers score A0 Overspecified and no working can score M1A0
		4	

Question	Answer	Marks	Guidance
3	State or imply $3y^2 + 6xy\dfrac{dy}{dx}$ as derivative of $3xy^2$	B1	
	State or imply $3y^2\dfrac{dy}{dx}$ as derivative of y^3	B1	
	Equate derivative of LHS to zero, substitute (1, 3) and find the gradient	M1	$\left(\dfrac{dy}{dx} = \dfrac{x^2+y^2}{y^2-2xy}\right)$ For incorrect derivative need to see the substitution
	Obtain final answer $\dfrac{10}{3}$ or equivalent	A1	3.33 or better. Allow $\dfrac{30}{9}$ ISW after correct answer seen
		4	

Question	Answer	Marks	Guidance
4	Use correct trig formula and obtain an equation in $\tan\theta$	**M1**	Allow with $45°$ e.g. $\frac{1}{\tan\theta}-\frac{1}{\frac{\tan\theta+\tan 45°}{1-\tan\theta\tan 45°}}=3$
	Obtain a correct horizontal equation in any form	**A1**	e.g. $1+\tan\theta-\tan\theta(1-\tan\theta)=3\tan\theta(1+\tan\theta)$
	Reduce to $2\tan^2\theta+3\tan\theta-1=0$	**A1**	or 3-term equivalent
	Solve 3-term quadratic and find a value of θ	**M1**	Must see working if using an incorrect quadratic
	Obtain answer $15.7°$	**A1**	One correct solution (degrees to at least 3 sf)
	Obtain answer $119.(3)°$	**A1**	Second correct solution and no others in range (degrees to at least 3 sf) Mark 0.274, 2.082 as MR: A0A1
		6	

Question	Answer	Marks	Guidance
5(i)	Use chain rule	**M1**	$k\cos\theta\sin^{-3}\theta\left(=-k\operatorname{cosec}^2\theta\cot\theta\right)$ Allow M1 for $-2\cos\theta\sin^{-1}\theta$
	Obtain correct answer in any form	**A1**	e.g. $-2\operatorname{cosec}^2\theta\cot\theta$, $\dfrac{-2\cos\theta}{\sin^3\theta}$ Accept $\dfrac{-2\sin\theta\cos\theta}{\sin^4\theta}$
		2	
5(ii)	Separate variables correctly and integrate at least one side	**B1**	$\int x\,dx=\int -\operatorname{cosec}^2\theta\cot\theta\,d\theta$
	Obtain term $\frac{1}{2}x^2$	**B1**	
	Obtain term of the form $\dfrac{k}{\sin^2\theta}$	**M1***	or equivalent
	Obtain term $\dfrac{1}{2\sin^2\theta}$	**A1**	or equivalent
	Use $x=4,\ \theta=\frac{1}{6}\pi$ to evaluate a constant, or as limits, in a solution with terms ax^2 and $\dfrac{b}{\sin^2\theta}$, where $ab\neq 0$	**DM1**	Dependent on the preceding M1
	Obtain solution $x=\sqrt{\left(\operatorname{cosec}^2\theta+12\right)}$	**A1**	or equivalent
		6	

Question	Answer	Marks	Guidance
6(i)	State correct expansion of $\sin(2x+x)$	B1	
	Use trig formulae and Pythagoras to express $\sin 3x$ in terms of $\sin x$	M1	
	Obtain a correct expression in any form	A1	e.g. $2\sin x(1-\sin^2 x)+\sin x(1-2\sin^2 x)$
	Obtain $\sin 3x \equiv 3\sin x - 4\sin^3 x$ correctly **AG**	A1	Accept $=$ for $\equiv$
		4	
6(ii)	Use identity, integrate and obtain $-\frac{3}{4}\cos x + \frac{1}{12}\cos 3x$	B1 B1	One mark for each term correct
	Use limits correctly in an integral of the form *a* cos *x* + *b* cos 3*x*, where $ab \neq 0$	M1	$\left(-\frac{3}{8}-\frac{1}{12}+\frac{3}{4}-\frac{1}{12}=-\frac{11}{24}+\frac{2}{3}\right)$
	Obtain answer $\frac{5}{24}$	A1	Must be exact. Accept simplified equivalent e.g. $\frac{15}{72}$ Answer only with no working is 0/4
		4	

Question	Answer	Marks	Guidance
7(i)	State at least one correct derivative	B1	$-2\sin\frac{1}{2}x$, $\frac{1}{(4-x)^2}$
	Equate product of derivatives to – 1	M1	or equivalent
	Obtain a correct equation, e.g. $2\sin\frac{1}{2}x=(4-x)^2$	A1	
	Rearrange correctly to obtain $a=4-\sqrt{2\sin\frac{a}{2}}$ **AG**	A1	
		4	
7(ii)	Calculate values of a relevant expression or pair of expressions at $a = 2$ and $a = 3$	M1	e.g. $a=2$ $2<2.7027..$ $\begin{pmatrix}0.703\\-0.412\end{pmatrix}$ $\begin{pmatrix}2.317\\-0.995\end{pmatrix}$ $a=3$ $3>2.587..$ Values correct to at least 2 dp
	Complete the argument correctly with correct calculated values	A1	
		2	
7(iii)	Use the iterative formula $a_{n+1}=4-\sqrt{(2\sin\frac{1}{2}a_n)}$ correctly at least once	M1	
	Obtain final answer 2.611	A1	
	Show sufficient iterations to 5 d.p. to justify 2.611 to 3 d.p., or show there is a sign change in the interval (2.6105, 2.6115)	A1	2, 2.70272, 2.60285, 2.61152, 2.61070, 2.61077 2.5, 2.62233, 2.60969, 2.61087, 2.61076 3, 2.58756, 2.61301, 2.61056, 2.61079 Condone truncation. Accept more than 5 dp
		3	

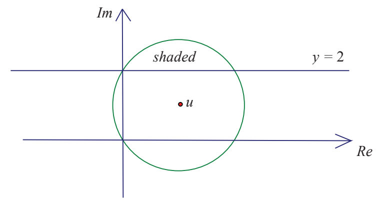
Question	Answer	Marks	Guidance
8(i)	State or imply the form $\dfrac{A}{2+x}+\dfrac{B}{3-x}+\dfrac{C}{(3-x)^2}$	**B1**	
	Use a correct method to obtain a constant	**M1**	
	Obtain one of A =2, B = 2, C = – 7	**A1**	
	Obtain a second value	**A1**	
	Obtain the third value	**A1**	[Mark the form $\dfrac{A}{2+x}+\dfrac{Dx+E}{(3-x)^2}$, where A = 2, D = – 2 and E = – 1, B1M1A1A1A1.]
		5	
8(ii)	Use a correct method to find the first two terms of the expansion of $(2+x)^{-1}$, $(3-x)^{-1}$ or $(3-x)^{-2}$, or equivalent, e.g. $\left(1+\dfrac{1}{2}x\right)^{-1}$	**M1**	
	Obtain correct unsimplified expansions up to the term in x^2 of each partial fraction	**A1** **A1** **A1**	**FT** on A, B and C $1-\dfrac{x}{2}+\dfrac{x^2}{4}$ $\dfrac{2}{3}\left(1+\dfrac{x}{3}+\dfrac{x^2}{9}\right)$ $-\dfrac{7}{9}\left(1+\dfrac{2x}{3}+\dfrac{3x^2}{9}\right)$
	Obtain final answer $\dfrac{8}{9}-\dfrac{43}{54}x+\dfrac{7}{108}x^2$	**A1**	
			For the A, D, E form of fractions give M1A1**ft**A1**ft** for the expanded partial fractions, then, if $D \neq 0$, M1 for multiplying out fully, and A1 for the final answer.
		5	

Question	Answer	Marks	Guidance
9(i)	Obtain a vector parallel to the plane, e.g. $\overrightarrow{CB} = 2\mathbf{i} + \mathbf{j}$	**B1**	
	Use scalar product to obtain an equation in a, b, c,	**M1**	e.g. $2a + b = 0$, $a + 5c = 0$, $a + b - 5c = 0$
	Obtain two correct equations in a, b, c	**A1**	
	Solve to obtain $a : b : c$,	**M1**	or equivalent
	Obtain $a : b : c = 5 : -10 : -1$,	**A1**	or equivalent
	Obtain equation $5x - 10y - z = -25$,	**A1**	or equivalent
	Alternative method 1		
	Obtain a vector parallel to the plane, e.g. $\overrightarrow{CD} = \mathbf{i} + 5\mathbf{k}$	**B1**	$\overrightarrow{BD} = -\mathbf{i} - \mathbf{j} + 5\mathbf{k}$
	Obtain a second such vector and calculate their vector product, e.g. $(2\mathbf{i} + \mathbf{j}) \times (\mathbf{i} + 5\mathbf{k})$	**M1**	
	Obtain two correct components	**A1**	
	Obtain correct answer, e.g. $5\mathbf{i} - 10\mathbf{j} - \mathbf{k}$	**A1**	
	Substitute to find d	**M1**	
	Obtain equation $5x - 10y - z = -25$,	**A1**	or equivalent

Question	Answer	Marks	Guidance
9(i)	**Alternative method 2**		
	Obtain a vector parallel to the plane, e.g. $\overrightarrow{DB} = \mathbf{i} + \mathbf{j} - 5\mathbf{k}$	**B1**	
	Obtain a second such vector and form correctly a 2-parameter equation for the plane	**M1**	
	State a correct equation, e.g. $\mathbf{r} = 3\mathbf{i} + 4\mathbf{j} + \lambda(\mathbf{i} + 5\mathbf{k}) + \mu(\mathbf{i} + \mathbf{j} - 5\mathbf{k})$	**A1**	
	State three equations in x, y, z, λ and μ	**A1**	
	Eliminate λ and μ	**M1**	
	Obtain equation $5x - 10y - z = -25$	**A1**	or equivalent
	Alternative method 3		
	Substitute for B and C and obtain $3a + 4b = d$ and $a + 3b = d$	**B1**	
	Substitute for D to obtain a third equation and eliminate one unknown (a, b, or d) entirely	**M1**	
	Obtain two correct equations in two unknowns, e.g. a, b, c	**A1**	
	Solve to obtain their ratio, e.g. $a : b : c$	**M1**	
	Obtain $a : b : c = 5 : -10 : -1$, $a : c : d = 5 : -1 : -25$, or $b : c : d = 10 : 1 : 25$	**A1**	or equivalent
	Obtain equation $5x - 10y - z = -25$	**A1**	or equivalent

Question	Answer	Marks	Guidance
9(i)	**Alternative method 4**		
	Substitute for B and C and obtain $3a + 4b = d$ and $a + 3b = d$	**B1**	
	Solve to obtain $a : b : d$	**M2**	or equivalent
	Obtain $a : b : d = 1 : -2 : -5$	**A1**	or equivalent
	Substitute for C to obtain c	**M1**	
	Obtain equation $5x - 10y - z = -25$	**A1**	or equivalent
		6	
9(ii)	State or imply a normal vector for the plane $OABC$ is **k**	**B1**	
	Carry out correct process for evaluating a scalar product of two relevant vectors, e.g. (5**i** – 10**j** – **k**).(**k**)	**M1**	i.e. correct process using **k** and their normal
	Using the correct process for calculating the moduli, divide the scalar product by the product of the moduli and evaluate the inverse cosine of the result	**M1**	Allow M1M1 for clear use of an incorrect vector that has been stated to be the normal to $OABC$
	Obtain answer 84.9° or 1.48 radians	**A1**	
		4	

Question	Answer	Marks	Guidance
10(i)	State or imply $r = 2$	B1	Accept $\sqrt{4}$
	State or imply $\theta = \frac{1}{6}\pi$	B1	
	Use a correct method for finding the modulus or the argument of u^4	M1	Allow correct answers from correct u with minimal working shown
	Obtain modulus 16	A1	
	Obtain argument $\frac{2}{3}\pi$	A1	Accept $16e^{i\frac{2\pi}{3}}$
		5	
10(ii)	Substitute u and carry out a correct method for finding u^3	M1	$\left(u^3 = 8i\right)$ Follow *their* u^3 if found in part **(i)**
	Verify u is a root of the given equation	A1	
	State that the other root is $\sqrt{3} - \mathrm{i}$	B1	
	Alternative method		
	State that the other root is $\sqrt{3} - \mathrm{i}$	B1	
	Form quadratic factor and divide cubic by quadratic	M1	$\left(z - \sqrt{3} - i\right)\left(z - \sqrt{3} + i\right)\left(= z^2 - 2\sqrt{3}z + 4\right)$
	Verify that remainder is zero and hence that u is a root of the given equation	A1	
		3	

Question	Answer	Marks	Guidance
10(iii)	Show the point representing u in a relatively correct position	B1	
	Show a circle with centre u and radius 2	B1	**FT** on the point representing u. Condone near miss of origin
	Show the line $y = 2$	B1	
	Shade the correct region	B1	
	Show that the line and circle intersect on $x = 0$	B1	Condone near miss
		5	