Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
1	Use Pythagoras' theorem to show that the length of $OB = 2\sqrt{3}$ or $OD = 2\sqrt{3}$ or states $BD = 4\sqrt{3}$	M1	2.2a	6th Solve problems involving arc length and sector area in context.
	Makes an attempt to find $\angle DAB$ or $\angle DCB$. For example, $\cos \angle DAO = \frac{2}{4}$ is seen.	M1	2.2a	
	Correctly states that $\angle DAB = \frac{2\pi}{3}$ or $\angle DCB = \frac{2\pi}{3}$	A1	1.1b	
	Makes an attempt to find the area of the sector with a radius of 4 and a subtended angle of $\frac{2\pi}{3}$ For example, $A = \frac{1}{2} \times 4^2 \times \frac{2\pi}{3}$ is shown.	M1	2.2a	
	Correctly states that the area of the sector is $\frac{16\pi}{3}$	A1	1.1b	
	Recognises the need to subtract the sector area from the area of the rhombus in an attempt to find the shaded area. For example, $\frac{16\pi}{3} - 8\sqrt{3}$ is seen.	M1	3.2a	
	Recognises that to find the total shaded area this number will need to be multiplied by 2. For example, $2 \times \left(\frac{16\pi}{3} - 8\sqrt{3}\right)$	M1	3.2a	
	Using clear algebra, correctly manipulates the expression and gives a clear final answer of $\frac{2}{3}\left(16\pi - 24\sqrt{3}\right)$	A1	1.1b	
				(8 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
2a	Shows that $2\cos 3\theta \approx 2\left(1-\frac{9\theta^2}{2}\right) = 2-9\theta^2$	**M1**	2.1	6th Understand small-angle approximations for sin, cos and tan (angle in radians).
	Shows that $2\cos 3\theta - 1 \approx 1-9\theta^2 = (1-3\theta)(1+3\theta)$	**M1**	1.1b	
	Shows $1+\sin\theta+\tan 2\theta = 1+\theta+2\theta = 1+3\theta$	**M1**	2.1	
	Recognises that $\frac{1+\sin\theta+\tan 2\theta}{2\cos 3\theta - 1} \approx \frac{1+3\theta}{(1-3\theta)(1+3\theta)} = \frac{1}{1-3\theta}$	**A1**	1.1b	
		(4)		
2b	When θ is small, $\frac{1}{1-3\theta} \approx 1$	**A1**	1.1b	7th Use small-angle approximations to solve problems.
		(1)		
				(5 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	Writes tan$x$ and sec$x$ in terms of sin$x$ and cos$x$. For example, $\frac{\tan x - \sec x}{1-\sin x} = \frac{\left(\frac{\sin x}{\cos x} - \frac{1}{\cos x}\right)}{\left(\frac{1-\sin x}{1}\right)}$	M1	2.1	5th Understand the functions sec, cosec and cot.
	Manipulates the expression to find $\left(\frac{\sin x - 1}{\cos x}\right) \times \left(\frac{1}{1-\sin x}\right)$	M1	1.1b	
	Simplifies to find $-\frac{1}{\cos x} = -\sec x$	A1	1.1b	
		(3)		
3b	States that $-\sec x = \sqrt{2}$ or $\sec x = -\sqrt{2}$	B1	2.2a	6th Use the functions sec, cosec and cot to solve simple trigonometric problems.
	Writes that $\cos x = -\frac{1}{\sqrt{2}}$ or $x = \cos^{-1}\left(-\frac{1}{\sqrt{2}}\right)$	M1	1.1b	
	Finds $x = \frac{3\pi}{4}, \frac{5\pi}{4}$	A1	1.1b	
		(3)		
				(6 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
4	States that $\sin\theta = \dfrac{BD}{1}$ and concludes that $BD = \sin\theta$	M1	3.1	6th Prove $\sec^2 x = 1 + \tan^2 x$ and $\text{cosec}^2 x = 1 + \cot^2 x$.
	States that $\cos\theta = \dfrac{AD}{1}$ and concludes that $AD = \cos\theta$	M1	3.1	
	States that $\angle DBC = \theta$	M1	2.2a	
	States that $\tan\theta = \dfrac{DC}{\sin\theta}$ and concludes that $DC = \dfrac{\sin^2\theta}{\cos\theta}$ oe.	M1	3.1	
	States that $\cos\theta = \dfrac{\sin\theta}{BC}$ and concludes that $BC = \tan\theta$ oe.	M1	3.1	
	Recognises the need to use Pythagoras' theorem. For example, $AB^2 + BC^2 = AC^2$	M1	2.2a	
	Makes substitutions and begins to manipulate the equation: $1+\tan^2\theta = \left(\dfrac{\cos\theta}{1} + \dfrac{\sin^2\theta}{\cos\theta}\right)^2$ $1+\tan^2\theta = \left(\dfrac{\cos^2\theta + \sin^2\theta}{\cos\theta}\right)^2$	M1	1.1b	
	Uses a clear algebraic progression to arrive at the final answer: $1+\tan^2\theta = \left(\dfrac{1}{\cos\theta}\right)^2$ $1+\tan^2\theta = \sec^2\theta$	A1	1.1b	
				(8 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
5	Uses the double-angle formulae to write: $6\sin\theta\cos 60 + 6\cos\theta\sin 60 = 8\sqrt{3}\cos\theta$	M1	2.2a	6th Use the double-angle formulae for sin, cos and tan.
	Uses the fact that $\cos 60 = \frac{1}{2}$ and $\sin 60 = \frac{\sqrt{3}}{2}$ to write: $3\sin\theta + 3\sqrt{3}\cos\theta = 8\sqrt{3}\cos\theta$	M1	1.1b	
	Simplifies this expression to $\tan\theta = \frac{5\sqrt{3}}{3}$	M1	1.1b	
	Correctly solves to find $\theta = 70.9°, 250.9°$	A1	1.1b	
				(4 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
6a	Writes $(\sin 3\theta + \cos 3\theta)^2 \equiv (\sin 3\theta + \cos 3\theta)(\sin 3\theta + \cos 3\theta)$ $\equiv \sin^2 3\theta + 2\sin 3\theta \cos 3\theta + \cos^2 3\theta$	M1	1.1b	7th Use addition formulae and/or double-angle formulae to solve equations.
	Uses $\sin^2 3\theta + \cos^2 3\theta \equiv 1$ and $2\sin 3\theta \cos 3\theta \equiv \sin 6\theta$ to write: $(\sin 3\theta + \cos 3\theta)^2 \equiv 1 + \sin 6\theta$ Award one mark for each correct use of a trigonometric identity.	A2	2.2a	
		(3)		
6b	States that: $1 + \sin 6\theta = \frac{2+\sqrt{2}}{2}$	B1	2.2a	7th Use addition formulae and/or double-angle formulae to solve equations.
	Simplifies this to write: $\sin 6\theta = \frac{\sqrt{2}}{2}$	M1	1.1b	
	Correctly finds $6\theta = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{9\pi}{4}, \frac{11\pi}{4}$ Additional answers might be seen, but not necessary in order to award the mark.	M1	1.1b	
	States $\theta = \frac{\pi}{24}, \frac{3\pi}{24}$ Note that $\theta \neq \frac{9\pi}{24}, \frac{11\pi}{24}$. For these values 3θ lies in the third quadrant, therefore $\sin 3\theta$ and $\cos 3\theta$ are both negative and cannot be equal to a positive surd.	A1	1.1b	
		(4)		
				(7 marks)

Notes

6b

Award all 4 marks if correct final answer is seen, even if some of the 6θ angles are missing in the preceding step.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
7a	States: $R\cos(\theta+\alpha) \equiv R\cos\theta\cos\alpha - R\sin\theta\sin\alpha$ Or: $5\cos\theta - 8\sin\theta \equiv R\cos\theta\cos\alpha - R\sin\theta\sin\alpha$	**M1**	1.1b	6th Understand how to use identities to rewrite a$\cos x$ + b$\sin x$.
	Deduces that: $5 = R\cos\alpha \qquad 8 = R\sin\alpha$	**M1**	1.1b	
	States that $R = \sqrt{89}$ Use of $\sin^2\theta + \cos^2\theta = 1$ might be seen, but is not necessary to award the mark.	**A1**	1.1b	
	Finds that $\alpha = 1.0122$ $\tan\alpha = \frac{8}{5}$ might be seen, but is not necessary to award the mark.	**A1**	1.1b	
		(4)		
7b	Uses the maths from part **a** to deduce that $T_{\max} = 1100 + \sqrt{89} = 1109.43°C$	**A1**	3.4	7th Solve problems involving a$\cos x$ + b$\sin x$.
	Recognises that the maximum temperature occurs when $\cos\left(\frac{x}{3} + 1.0122\right) = 1$	**M1**	3.4	
	Solves this equation to find $\frac{x}{3} = 2\pi - 1.0122$	**M1**	1.1b	
	Finds x = 15.81 hours	**A1**	1.1b	
		(4)		

7c	Deduces that $1097 = 1100 + \sqrt{89}\cos\left(\frac{x}{3} + 1.0122\right)$	**M1**	3.4	8th Use trigonometric functions and identities to solve problems in a range of unfamiliar contexts.
	Begins to solve the equation. For example, $\cos\left(\frac{x}{3} + 1.0122\right) = -\frac{3}{\sqrt{89}}$ is seen.	**M1**	1.1b	
	States that $\frac{x}{3} + 1.0122 = 1.8944,\ 2\pi - 1.8944,\ 2\pi + 1.8944$ Further values may be seen, but are not necessary in order to award the mark.	**M1**	1.1b	
	Finds that x = 2.65 hours, 10.13 hours, 21.50 hours	**A1**	1.1b	
		(4)		
				(12 marks)

Notes