Q	Marking instructions	AO	Marks	Typical solution
10(a)	Recalls or uses the area of sector = $\frac{1}{2}r^2\theta$ r can be any letter or OA or OB or any consistent value throughout	1.2	B1	Area of sector = $\frac{1}{2}r^2\theta$ Area of triangle = $\frac{1}{2}ab\sin C$ Hence $\frac{1}{2}ab\sin C = \left(\frac{1}{2}\right)\frac{1}{2}r^2\theta$ $\frac{1}{2}r^2\sin\theta\cos\theta = \frac{1}{2}\left(\frac{1}{2}r^2\theta\right)$ $2\sin\theta\cos\theta = \theta$ $\theta = \sin 2\theta$
	Forms an equation relating the area of the triangle OAC and sector using $\frac{1}{2}bh = k\frac{1}{2}r^2\theta$ where $k > 0$	3.1a	M1	
	Deduces area of triangle is $\frac{1}{2}r\cos\theta \times r\sin\theta$ OE Must use trigonometry for height and base	2.2a	B1	
	Completes reasoned argument with clear use of double angle identity to show that $\theta = \sin 2\theta$ or $\sin 2\theta = \theta$	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
10(b)	Rearranges to obtain $\theta - \sin 2\theta = 0$ or $\sin 2\theta - \theta = 0$ (which may be seen in conclusion) **and** evaluates $\theta - \sin 2\theta$ or $\sin 2\theta - \theta$ at $\frac{\pi}{5}(0.6284)$ and $\frac{2\pi}{5}(1.257)$ Evaluates using any two other appropriate values inside the interval but either side of root.	1.1a	M1	$\theta = \sin 2\theta \Rightarrow \theta - \sin 2\theta = 0$ Let $f(\theta) = \theta - \sin 2\theta$ $f\left(\frac{\pi}{5}\right) = -0.3227\ldots < 0$ $f\left(\frac{2\pi}{5}\right) = 0.6688\ldots > 0$ Hence solution lies between $\frac{\pi}{5}$ and $\frac{2\pi}{5}$
	Completes reasoned argument with reference to change of sign and evidence of correct evaluation accepting values rounded or truncated to 1 sf Must refer to $\frac{\pi}{5}$ and $\frac{2\pi}{5}$ in the conclusion	2.1	R1	
	Subtotal		**2**	

Q	Marking instructions	AO	Marks	Typical solution
10(c)(i)	Differentiates $\sin 2\theta$ to obtain $2\cos 2\theta$ OE PI by correct θ_2 or θ_3 PI by sight of $2\cos\frac{2\pi}{5}$	1.1b	B1	$f(\theta) = \theta - \sin 2\theta$ $f'(\theta) = 1 - 2\cos 2\theta$ $\theta_{n+1} = \theta_n - \frac{\theta_n - \sin 2\theta_n}{1 - 2\cos 2\theta_n}$ $\theta_2 = 1.4732575...$ $\theta_3 = 1.0413241...$ $\theta_3 = 1.041$
	Obtains a correct expression for $\theta_n - \frac{\theta_n - \sin 2\theta_n}{1 - 2\cos 2\theta_n}$ Accept use of ANS or $\frac{\pi}{5}$ Condone missing or incorrect subscript PI by correct θ_2 or θ_3 AWRT θ_2 1.473	1.1a	M1	
	Obtains correct θ_3 AWRT θ_3 1.041	1.1b	A1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
10(c)(ii)	Explains that more iterations could be used Accept keep on using Newton Raphson, keep re-iterating	2.4	E1	Use more iterations
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
10(c)(iii)	States that $f'\left(\frac{\pi}{6}\right)=0$	2.4	E1	$f'\left(\frac{\pi}{6}\right)=0$ The value is on a stationary point
	Explains a general reason for the Newton Raphson iteration not to converge to a particular root Accept only • too close to a stationary point • the value is on a stationary point • the tangent does not cross the x-axis • it converges to a different root • the formula is undefined Accept equivalents to these five bullet points only	2.4	E1	
	Subtotal		**2**	

	Question 10 Total		**12**	