

Q	Marking instructions	AO	Marks	Typical solution
15(a)	Obtains an expression for either sector OCD or OBC For example $\frac{1}{2}r^2\theta$, $\frac{1}{2}OD^2\left(\frac{\pi}{2}-\theta\right)$ Condone 90 in place of $\frac{\pi}{2}$	1.1b	B1	Area of sector $OBC = \frac{1}{2}r^2\theta$ Area of triangle $OAC =$ $\frac{1}{2}OA \times OC \sin \theta$ $\frac{1}{2}r^2\theta - \frac{1}{2}r^2\cos \theta \sin \theta = \frac{1}{2}\frac{\pi r^2}{4}$
	Obtains an expression for the area of the triangle OAC in terms of θ For example $\frac{1}{2}r \times r \times \cos \theta \sin \theta$ $\frac{1}{2}r \times OA \sin \theta$ Do not award for $\frac{1}{2}ab \sin \theta$ unless a and b are clearly linked to the diagram	1.1b	B1	$\frac{1}{2}r^2\theta - \frac{1}{4}r^2 \times 2 \cos \theta \sin \theta = \frac{\pi r^2}{8}$ $\frac{1}{2}r^2\theta - \frac{1}{4}r^2 \sin 2\theta = \frac{\pi r^2}{8}$ $4r^2\theta - 2r^2 \sin 2\theta = \pi r^2$ $4\theta - 2 \sin 2\theta = \pi$
	Selects a method to obtain an expression for the area of gold or the area of silver in terms of θ and one other variable eg r For example for gold Subtracts their triangle OAC from their sector OBC to obtain an expression for the area of ABC Or for silver adds their triangle OAC to their sector OCD to obtain an expression for the area of $OACD$	3.1a	M1	
	Forms a correct equation in terms of θ and one other variable For example $\frac{1}{2}r^2\left(\frac{\pi}{2}-\theta\right) + \frac{1}{4}r^2 \sin 2\theta = \frac{\pi r^2}{8}$ $\frac{1}{2}r^2\theta - \frac{1}{2}r^2\cos \theta \sin \theta = \frac{1}{2}\frac{\pi r^2}{4}$ $\frac{1}{2}r^2\left(\frac{\pi}{2}-\theta\right) + \frac{1}{4}r^2 \sin 2\theta = \frac{1}{2}r^2\theta - \frac{1}{4}r^2 \sin 2\theta$	3.4	A1	
	Completes a reasoned argument to show $4\theta - 2 \sin 2\theta = \pi$	2.1	R1	
	Subtotal		5	

Q	Marking instructions	AO	Marks	Typical solution
15(b)	Evaluates $4\theta - 2\sin 2\theta - \pi$ Or Evaluates $\pi + 2\sin 2\theta - 4\theta$ at 1.1 ($\pm 0.358\dots$) and at 1.2 ($\mp 0.307\dots$) Or Evaluates using any two other appropriate values inside the interval but either side of root.	1.1a	M1	$4\theta - 2\sin 2\theta = \pi \Rightarrow 4\theta - 2\sin 2\theta - \pi = 0$ Let $f(\theta) = 4\theta - 2\sin 2\theta - \pi$ $f(1.1) = -0.358\dots < 0$ $f(1.2) = 0.307\dots > 0$ Hence the solution lies between 1.1 and 1.2
	Completes reasoned argument with reference to change of sign and the values 1.1 and 1.2 and correct rearrangement eg $4\theta - 2\sin 2\theta - \pi = 0$ and evaluation, accepting values rounded or truncated to 1 sf	2.1	R1	
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
15(c)	Differentiates $2\sin 2\theta$ to obtain $4\cos 2\theta$ OE PI $4\cos 2\theta$ or $4\cos 2 \times 1.1$ seen in denominator PI by correct θ_1	1.1b	B1	$\theta_{n+1} = \theta_n - \frac{4\theta_n - 2\sin 2\theta_n - \pi}{4 - 4\cos 2\theta_n}$ $\theta_1 = 1.1564$
	Obtains an expression of the form $\theta_n - \frac{\pm(4\theta_n - 2\sin 2\theta_n - \pi)}{\pm(4 - 4\cos 2\theta_n)}$ OE where θ_n can be θ_0 θ x or 1.1 condone missing subscripts PI by correct θ_1	1.1a	M1	
	Obtains AWR T 1.1564	1.1b	A1	
	Subtotal		3	

	Question 15 Total		10	
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