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 = $\frac{1}{2}OA\times OC\sin\theta$ $\frac{1}{2}r^2\theta-\frac{1}{2}r^2\cos\theta\sin\theta=\frac{1}{2}\frac{\pi r^2}{4}$ $\frac{1}{2}r^2\theta-\frac{1}{4}r^2\times 2\cos\theta\sin\theta=\frac{\pi r^2}{8}$ $\frac{1}{2}r^2\theta-\frac{1}{4}r^2\sin 2\theta=\frac{\pi r^2}{8}$ $4r^2\theta-2r^2\sin 2\theta=\pi r^2$ $4\theta-2\sin 2\theta=\pi$
	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	
	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…) and at 1.2 ($\mp$ 0.307…) 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 $f(\theta) = 4\theta - 2\sin 2\theta - \pi$ $f(1.1) = -0.358... < 0$ $f(1.2) = 0.307... > 0$ 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	$\theta_{n+1} = \theta_n - \dfrac{4\theta_n - 2\sin 2\theta_n - \pi}{4 - 4\cos 2\theta_n}$ $\theta_1 = 1.1564$
	Obtains an expression of the form $\theta_n - \dfrac{\pm(4\theta_n - 2\sin 2\theta_n - \pi)}{\pm(4 - 4\cos 2\theta_n)}$ 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 AWRT 1.1564	1.1b	A1	
	Subtotal		**3**	

	Question 15 Total		**10**	