1	Ext angle of octagon = 360 ÷ 8 (= 45) **or** Int angle of octagon (8 – 2) × 180 ÷ 8 oe (= 135)		6	M1	for method to find the size of one exterior **or** one interior angle of a regular octagon
	e.g. $10 + 2 \times 10 \times \sin 45$ ($= 10+10\sqrt{2}$ or 24.1...) **or** e.g. $\frac{10\sin 112.5}{\sin 22.5}$ (= 24.1…)			M1	method to find *HE* **or** *AD* 22.5 comes from (180 – "135") ÷ 2 112.5 comes from "135" – "22.5"
	e.g. 10 × ("$10+10\sqrt{2}$") (= 100 + $100\sqrt{2}$ or 241.4...) **or** 10 × "24.1…" (= 241.4…)			M1	area *ADEH*
	e.g. 10 × sin45° (=5 $\sqrt{2}$ or 7.07...) **or** e.g. $\sqrt{10^2+10^2-2\times10\times10\times\cos\text{"}135\text{"}}$ (= 18.4…) **or** $\frac{10\sin\text{"}135\text{"}}{\sin 22.5}$ (= 18.4…)			M1	finds perpendicular height of triangle *ACD* (may be found before, but must realise this is also height of triangle) **or** finds the length of *AC* 22.5 comes from (180 – "135") ÷ 2
	e.g. 0.5 × "24.1..." × "7.07…" (= 85.3...) **or** $0.5\times10\times\text{"}18.4...\text{"}\times\sin 112.5$ (= 85.3…)			M1	finds the area of triangle *ACD* 112.5 comes from "135" – "22.5"
		327		A1	accept 326 – 327
	Alternative (splitting octagon into triangles and subtracting trapezium and triangle)				
	Ext angle of octagon = 360 ÷ 8 (= 45) **or** Int angle of octagon (8 – 2) × 180 ÷ 8 oe (= 135) **or** one of 8 angles at centre = 360 ÷ 8 (= 45)		6	M1	for method to find the size of one exterior **or** one interior angle of a regular octagon **or** method to find one angle at centre of octagon when split into 8 equal triangles
	e.g. 0.5 × 10 × 5 × tan67.5 (= 60.35...) **or** $0.5\times\left(\frac{10\sin 67.5}{\sin 45}\right)^2\times\sin 45$ (= 60.35...) **or** Octagon = 8 × "60.35" (= 482.8...)			M1	Area of one triangle (one-eighth of octagon) **or** octagon
	e.g. 10 + 2 × 10×sin45°(= $10+10\sqrt{2}$ =24.14..)			M1	Method to find *HE*
	0.5 × (10 + $10+10\sqrt{2}$)×$5\sqrt{2}$ (=120.71...)			M1	Method to find area of trapezium *HEGF*
	0.5 × 10 × 10 × sin135°(= 35.35...)			M1	Method to find area of triangle *ABC*
		327		A1	accept 326 – 327
					Total 6 marks

2	[chord *AB* =] $\sqrt{5^2+5^2-2\times5\times5\times\cos 50}$ **or** 2 × 5 × sin25 (= 10sin25 or 4.226...)		6	M1	oe
	[$\angle APB$ =] $\cos^{-1}\left(\frac{4^2+4^2-\text{"4.226..."}^2}{2\times4\times4}\right)$ (=63.77...) **or** [$\angle OPA$ =] $\sin^{-1}\left(\frac{0.5\times\text{"4.226..."}}{4}\right)$ (= 31.88...)			M1	oe may use other methods but must be a complete method for $\angle APB$ **or** $\angle OPA$ (see below for sine rule)
	[Area sector *AOB* =] $\frac{50}{360}\times\pi\times5^2$ ($=\frac{125}{36}\pi$ or 10.9...)			M1	oe independent
	[Area sector *APB* =] $\frac{\text{"63.77..."}}{360}\times\pi\times4^2$ (= 8.90...)			M1	oe NB: 2 × "31.88…" = "63.77…"
	$\left(\frac{50}{360}\pi\times5^2-\frac{1}{2}\times5^2\times\sin 50\right)+\left(\frac{\text{"63.77..."}}{360}\times\pi\times4^2-\frac{1}{2}\times4^2\times\sin\text{"63.77..."}\right)$			M1	oe (10.9…– 9.57…) + (8.90… – 7.17…)
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	3.06		A1	allow 3 – 3.1
	Alternative version (using line of symmetry *OP* in quadrilateral *OAPB*)				**Total 6 marks**
	[$\angle OPA$] $= \sin^{-1}\left(\frac{5\sin 25}{4}\right)$ (= 31.88..)		6	M1	oe (see above for cosine rule & trig)
	[Area sector *APB* =] $\frac{2\times\text{"31.88..."}}{360}\times\pi\times4^2$ (= 8.90...)			M1	oe
	[Area *OAPB* =] 2 × ½ × 5 × 4 × sin(180 – "31.88.." – 25) (=16.75...)			M1	oe
	[Area sector *AOB* =] $\frac{50}{360}\times\pi\times5^2$ ($=\frac{125}{36}\pi$ = 10.9...)			M1	oe independent
	[Area **R** =] "10.9..." + "8.90..." – "16.75..."			M1	oe
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	3.06		A1	allow 3 – 3.1
					Total 6 marks

3	0.5 × π × 6^2 (= 56.54…) **or** 12 × 6 (= 72) **or** π × 6^2 oe		3	M1	
	"72" – "56.54…"			M1	dep M1 for a complete method
		15.5		A1	15.4 to 15.5
					Total 3 marks

4	75×2 (=150)		5	M1	"150" for AOC may be seen on diagram.
	$\frac{"150" \times \pi r^2}{360}$ oe (= $1.309r^2$ or $\frac{5\pi}{12}r^2$)			M1	dep 1st M1
	$0.5 \times \sin$ ("150") $\times r^2$ oe (= $0.25r^2$)			M1	dep 1st M1 a complete method to find the area of triangle OAC in terms of r
	eg $\frac{150\pi}{360}r^2 - 0.5\sin(150)r^2 = 200$ oe or $(1.309... - 0.25)r^2 = 200$			M1	correct equation in r^2 or rearranged to make r^2 or r the subject.
		13.7		A1	accept 13.7 – 13.8
					Total 5 marks

5	$8^2 + 15^2$ (= 289)		5	M1	
	$\sqrt{8^2 + 15^2}$ (=17)			M1	
	$\pi \times \left("\frac{17}{2}"\right)^2$ (= 226.98...) **or** $0.5 \times 15 \times 8$ (= 60)			M1	
	$\pi \times \left("\frac{17}{2}"\right)^2 - 0.5 \times 15 \times 8$ ("226.98" – "60")			M1	
		167		A1	Accept answers which round to 167
					Total 5 marks

6	eg $0.5 \times x \times x \times \sin 60$ $\left(= \frac{\sqrt{3}}{4}x^2 = 0.433...x^2\right)$ oe where $x = PQ$ eg $0.5 \times 2n \times 2n \times \sin 60 \left(= \sqrt{3}n^2 = 1.732...n^2\right)$ oe where $2n = PQ$ or use $0.5 \times b \times h$ where $h = \sqrt{x^2 - (0.5x)^2}$ $(= \frac{\sqrt{3}}{2}x)$ oe		4	M1	For expression for area of triangle [using $AB = x$ and $PQ = \frac{2}{3}x$ gives $\frac{\sqrt{3}}{9}x^2 = 0.192...x^2$] (correct expression in 1 variable eg PQ)
	eg $6 \times 0.5 \times 1.5x \times 1.5x \times \sin 60$ $\left(= \frac{27\sqrt{3}}{8}x^2 = 5.845...x^2\right)$ oe eg $6 \times 0.5 \times 3n \times 3n \times \sin 60$ $\left(= \frac{27\sqrt{3}}{2}n^2 = 23.382...n^2\right)$ oe or eg $2(\frac{1}{2} \times 1.5x \times 1.5x \times \sin 120) + 1.5x \times AE$ where $AE = \sqrt{(1.5x)^2 + (1.5x)^2 - 2 \times 1.5x \times 1.5x \times \cos 120}$ $\left(= \frac{27\sqrt{3}}{8}x^2 = 5.845...x^2\right)$ or use of $6 \times 0.5 \times b \times h$, finding h by Pythagoras			M1	for expression for area of hexagon [using $AB = x$ and $PQ = \frac{2}{3}x$ gives $\frac{3\sqrt{3}}{2}x^2 = 2.598...x^2$] (correct expression in 1 variable eg AB)
	eg $6 \times 0.5 \times 1.5x \times 1.5x \times \sin 60 - 0.5 \times x \times x \times \sin 60 = 72\sqrt{3}$ oe **or** $\left(\frac{27\sqrt{3}}{8} - \frac{\sqrt{3}}{4}\right)x^2 = 72\sqrt{3}$ **or** $(5.845\ldots - 0.433\ldots)x^2 = 124.7\ldots$ **or** eg $6 \times 0.5 \times 3n \times 3n \times \sin 60 - 0.5 \times 2n \times 2n \times \sin 60 = 72\sqrt{3}$ oe $\left(\frac{27\sqrt{3}}{2} - \sqrt{3}\right)n^2 = 72\sqrt{3}$ or $(23.382\ldots - 1.732\ldots)n^2 = 124.7\ldots$			M1	for a correct equation for shaded area (correct equation in 1 variable, eg PQ or x etc)
		4.8		A1	
					Total 4 marks

7	eg $2d \times 2d - 4 \times \pi \times (\frac{1}{2}d)^2 (= 40)$ oe or $4r \times 4r - 4 \times \pi \times r^2 (= 40)$ oe or $x^2 - 4\pi\left(\frac{1}{4}x\right)^2 (= 40)$ oe or $w^2 - \pi\left(\frac{1}{2}w\right)^2 (= 10)$ oe		4	M1	oe a **correct** expression or a correct equation for the shaded area (must be in one unknown only) where d = diameter r = radius x = side of large square w = side of square when shape divided into 4
	$d = \sqrt{\frac{40}{4-\pi}} (= 6.826...)$ or $2d = \sqrt{\frac{160}{4-\pi}} (= 13.652\ldots)$ oe $r = \sqrt{\frac{40}{16-4\pi}} (3.413...)$ or $4r = \sqrt{\frac{640}{16-4\pi}} (= 13.652...)$ oe $x = \sqrt{\frac{40}{1-0.25\pi}} (13.652\ldots)$ or $w = \sqrt{\frac{10}{1-0.25\pi}} (= 6.826\ldots)$oe			M1	oe a correct expression for d or $2d$ or r or $4r$ or x or w
	(perimeter =) 8 × "6.826…" (8 × diameter(or side of small square when divided)) or 16 × "3.413..." (16 × radius) oe or 4 × "13.652…"(4 × side of square)			M1ft	dep on first M1 For substituting values into a calculation for the perimeter use of **their** r, d, x, w
		54.6		A1	54.4 - 54.7
					Total 4 marks

8	3 × 2.5 (= 7.5) oe or 2 × 3 × 2.5 (= 15) oe or 12 × 3 (= 36) oe or 2 × 12 × 3 (= 72) oe or 12 × 2.5 (= 30)		6	M1 for area of rectangle
	(2 × 3 × 2.5) + (2 × 12 × 3) + (12 × 2.5) (= 117) or (2 × 7.5) + (2 × 36) + (12 × 2.5) (= 117) or 15 + 72 + 30 (= 117)			M1 for a complete method to find the surface area
	1 + 0.1 (= 1.1) **or** 100(%) + 10(%) (= 110(%)) **or** $\frac{26.95}{110}$ (= 0.245) oe			M1
	26.95 ÷ "1.1" (= 24.5(0)) **or** 26.95 ÷ "110" × 100 (= 24.5(0)) **or** 26.95 × 100 ÷ "110" (= 24.5(0)) oe **or** "0.245" × 100 (= 24.5(0)) oe			M1 dep on previous M1
	"117" ÷ 15 (= 7.8 or 8) **and** "8" × "24.50" (= 196) **or** "117" ÷ 15 (= 7.8 or 8) **and** 200 ÷ "24.5" (= 8.1...) **or** "117" ÷ 15 (= 7.8 or 8) **and** 200 ÷ "8" (= 25)			M1for working with a whole number of tins (rounded up) to reach figures where a decision can be made
		Correct figures to show that Jonty is correct		A1 e.g. 196 7.8 or 8 **and** 8.1... 24.5 **and** 25
				Total 6 marks

9	$(\angle AOC =) 132 \times 2 (= 264)$		3	M1 for method to find angle at the centre. Do not award this mark if contradicted on the diagram eg if obtuse AOC is labelled as 264
	eg $\frac{"264"}{360} \times 2 \times \pi \times 8.5$ $(= 39.1...$ or $\frac{187}{15}\pi)$ **or** $2 \times \pi \times 8.5 - \frac{360 - "264"}{360} \times 2 \times \pi \times 8.5$ $(= 39.1...$ or $\frac{187}{15}\pi)$ **or** $\frac{"264"}{360} \times 2 \times \pi \times 8.5 + 2 \times 8.5$ **or** $2 \times \pi \times 8.5 - \frac{360 - "264"}{360} \times 2 \times \pi \times 8.5 + 2 \times 8.5$			M1 for a method to find the length of arc AC or perimeter of the sector – allow use of their AOC as long as clearly labelled
	Correct answer scores full marks (unless from obvious incorrect working)	56.2		A1 accept 56.1 – 56.2
				Total 3 marks

10	$\pi \times 4.8^2 \times \frac{72}{360}$ (= 14.4(76…)) oe		5	M1 for finding the area of the sector
	$\frac{1}{2} \times 4.8^2 \times \sin 72$ (= 10.9(56…) or 11) oe or $\frac{1}{2} \times 5.6(4...) \times 3.8(8...)$ oe			M1 for finding the area of the triangle (Allow use of cosine rule/sine rule/SOHCAHTOA/Pythagoras to find *AC* (5.6(427.8…)) and *OM* (3.8(8328…)) where *M* is the midpoint of *AC*)
	"14.4(76…)" – "10.9(56…)" (= 3.520…)			M1 for finding the shaded area with all figures from correct working
	"3.5(20…)" × 14 × 3 × 60 "3.5(20…)" × 2520			M1
	Award marks within the range from correct working	8870		A1 accept 8820 – 8950 from correct working
				Total 5 marks

11	(radius of large circle =) $\frac{4}{\cos 54}$ **or** $\frac{4}{\sin 36}$ **or** $\frac{8 \sin 54}{\sin 72}$ **or** $\sqrt{\frac{8^2}{2 - 2\cos 72}}$ (= 6.805...) **or** (height of 1 triangle within pentagon =) 4tan54 (=5.505...) oe		6	M1 for a complete method to find the radius of the large circle **or** the perpendicular height of one triangle within the pentagon
	(area of large circle =) $\pi \times ("6.805...")^2$ (= 145.489...) oe **or** (area of sector =) $\frac{72}{360} \times \pi \times ("6.805...")^2$ (= 29.097...) oe			M1 for a complete method to find the area of the large circle **or** the area of a sector of the large circle
	(area of pentagon =) 5 × ½ × 8 × "5.505..." (= 80tan54 = 110.11...) **or** 10 × ½ × 4 × "5.505..." (= 80tan54 = 110.11...) **or** 5 × ½ × "6.805..." × "6.805..." × sin72 (= 110.11...) oe **OR** (area of one triangle =) ½ × 8 × "5.505..." (= 22.022...) **or** ½ × "6.805..." × "6.805..." × sin72 (= 22.022...) **or** ½ × "6.805..." × 8 × sin54 (= 22.022...) oe			M1 for a complete method to find the area of the pentagon **OR** the area of one triangle eg *OED* or equivalent
	"145.489..." – "110.11..." + πr^2 = "110.11..." – πr^2 oe **or** 5 × ("29.097..." – "22.022...") + πr^2 = 5 × "22.022..." – πr^2 oe			M1 for a correct equation for the radius of the smaller circle
	$2\pi r^2 = 2 \times$ "110.11..." – "145.489..." (= 74.731...) oe			M1 for a correct rearranged equation with the area of the circle the subject or better
	Correct answer scores full marks (unless from obvious incorrect working)	3.45		A1 accept 3.43 – 3.45
				Total 6 marks