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. $10 + 2 \times 10\times\sin45°$ (= $10+10\sqrt{2}$ =24.14..)			M1	Method to find *HE*
	$0.5 \times (10 + 10+10\sqrt{2}) \times 5\sqrt{2}$ (=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	(10 – 2) × 180 oe (= 1440) **or** (6 – 2) × 180 oe (= 720)		4	M1	for a method to find the sum of the interior angles of a decagon or a hexagon
	'1440' – 148 – 2×150 – 2×168 – 2×134 – 2×125 (=138) **or** '1440' – 1302 (= 138) **or** '720' – 148÷2 – 150 – 168 – 134 – 125 (= 69) **or** '720' – 651 (= 69)			M1	Allow omission of one angle
	360 – '138' **or** 360 – 2 × '69'			M1	
		222		A1	
	Alternative method (exterior angles)				
	360 – 2×(180 – 125) – 2×(180 – 134) – 2×(180 – 168) – 2×(180 – 150) – (180 – 148) **or** 360 – 2×55 – 2×46 – 2×12 – 2×30 – 32		4	M2	If not M2 then award M1 for at least 3 or (180 – 125) , (180 – 134) , (180 – 168) , (180 – 150), (180 – 148) **or** at least 3 of 55, 46, 12, 30, 32
	180 + '42'			M1	
		222		A1	
					Total 4 marks

3	180 – 2 × 66 (= 48) (360 – "48") ÷ 2 (= 156) 180 – "156" (= 24) 360 ÷ "24"		3	M1 M1ft	Could be marked on diagram Final stage of calculation
	Alt : 180 – 2 × 66 (= 48) 360 ÷ (0.5 × "48")			M1 M1ft	Could be marked on diagram Final stage of calculation
	Alt:180 – 2 × 66 (= 48) (360 – "48") ÷ 2 (= 156) $\frac{180(n-2)}{n}$ = "156" "24"n = 360 or $\frac{180(15-2)}{15}$ (= 156)			M1 M1ft	Could be marked on diagram Final stage of calculation or embedded correct answer.
		15		A1	
					Total 3 marks

4	(a)	(0.5 ×) 9.3 × 14.7 × sin106 **or** (9.3 × cos 16) × 14.7 **or** (9.3 × sin 74) × 14.7		2	M1 for applying the area of a triangle formula using correct values (to find half of the area of the parallelogram) **or** for a correct method to find the area of the parallelogram
			131		A1 awrt 131
	(b)	(GE^2 =) $9.3^2 + 14.7^2 - 2 \times 9.3 \times 14.7 \times \cos106$		3	M1 for the correct use of the cosine rule
		377(.9….) **or** 378 **or** 86.49 + 216.09 + 75.3… **or** 302.58 + 75.3….			M1 (dep on M1)for the correct order of operations
			19.4		A1 for 19.4 – 19.5
					Total 5 marks

5	$(5-2)\times 180\div 5\ (=108)$ **or** $360\div 5\ (=72)$		5	M1	for method to find an interior or exterior angle of a pentagon
	$(6-2)\times 180\div 6\ (=120)$ **or** $360\div 6\ (=60)$			M1	for method to find an interior or exterior angle of a hexagon
	$360-108-120\ (=132)$ **or** $60+72\ (=132)$ **or** $(180-\text{'}120\text{'})+(180-\text{'}108\text{'})$			M1	dep on M2 for a correct method to find angle *EDI* using correct figures
	$360-\text{'}72\text{'}-\text{'}60\text{'}-\text{'}132\text{'}\ (=96)$			M1	for a complete method to find angle x
		96		A1	dep on correct working
				Note:	Angles may be seen on diagram throughout
					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	

7	eg $\tan BAP=\frac{2}{5}$ or $\sin BAP=\frac{2}{\sqrt{5^2+2^2}}$ or $\frac{\sin BAP}{2}=\frac{\sin 90}{\sqrt{5^2+2^2}}$ $\cos BAP=\frac{5}{\sqrt{5^2+2^2}}$ or $\cos BAP=\frac{5^2+(\sqrt{5^2+2^2})^2-2^2}{2\times 5\times\sqrt{29}}$		5	M1	for setting up a trig equation for angle *BAP*
	eg $(BAP=)\tan^{-1}\left(\frac{2}{5}\right)(=21.8...)$ or $(BAP=)\sin^{-1}\left(\frac{2}{\sqrt{5^2+2^2}}\right)$ or $(BAP=)\sin^{-1}\left(\frac{2\sin 90}{\sqrt{5^2+2^2}}\right)$ $(BAP=)\cos^{-1}\left(\frac{5}{\sqrt{5^2+2^2}}\right)$ or $BAP=\cos^{-1}\left(\frac{5^2+(\sqrt{5^2+2^2})^2-2^2}{2\times 5\times\sqrt{5^2+2^2}}\right)$			M1	for a complete method to find angle *BAP* ($=21.8\ldots$.) [M2 for $90-\tan^{-1}\frac{5}{2}$ ie $90-68.2$]
	eg (int angle =) $(6-2)\times 180\div 6(=120)$ **or** (ext angle =) $360\div 6(=60)$			M1	**Indep** for a method to find the size of one interior **or** one exterior angle in a regular hexagon – **could be seen on diagram**
	eg "120" – "21.8" **or** 180 – "60" – "21.8"			M1	for a complete method to find angle *PAF* where all values have come from a correct method
		98.2		A1	accept 98.1 – 98.3
					Total 5 marks

8	360 ÷ 8 (= 45) or 360 ÷ 5 (= 72) or 180 – (360 ÷ 8) (= 135) oe or 180 – (360 ÷ 5) (= 108) oe		4	M1 finding interior or exterior angle of octagon or pentagon Angles may be seen on diagram – but must be obtuse if interior and acute if exterior.
	'72' – '45' (= 27) or '135' – '108' (= 27)			M1 (dep 1st M1) using a pair of interior or pair of exterior angles to find angle *IBC* Angle may be seen on diagram.
	$\frac{180-'27'}{2}$ (= 76.5)			M1
		76.5		A1
				Total 4 marks

9	$\frac{360}{10}$ **(=** 36) ext angle **or** $\frac{(10-2)\times 180}{10}$ **(=** 144)		4	M1	method to find interior or exterior angle. (angles may be seen on diagram)
	x = "144" – 90 (= 54) or $x = \frac{"540"-3\times"144"}{2}$ (=54) or $x = 90-"36"(=54)$ 54 on the diagram is insufficient – must see working			M1	method to find x (must show it is intended to be x) eg use of int angle – 90º use of ext angle + x = 90º use of pentagon *GHIJA* All figures in " " must come from correct working
	$BAD = CDA = GDE = DGF = \frac{360-2\times"144"}{2}$ (= 36)			M1	A correct method to find an angle of 36º within the shape (not exterior angle) or 36º shown in correct place in diagram
	There are other correct methods. Please check for correct working.	x = 54 y = 54		A1	dep on M3 to find each of x and y and the correct value of 54 for both from correct working
					Total 4 marks
ALT	*ADG* = "144" – 2 × "36" (= 72)			M1	
	JA is parallel to *GD*			M1	
	DGA = *DAG* (*y*) [isosceles triangle]			M1	
	$x = DGA = y$	shown		A1	
	There are other correct methods. Please check for correct working.				**Total 4 marks**

10	*SCD* = 128° **or** *BCS* = 32° **or** *TSC* = 180 – 128 (= 52)		4	M1	angles need to be identified or may be seen marked on the diagram	M2 for (*BCD* =) 128 + 32 (= 160) **or** (*DCV* =) 52 – 32 (= 20) (may be seen marked on the diagram). To award these marks 160 or 20 must be clearly used or identified as the interior or exterior angle.
	eg (int ∠ =)128 + 32(= 160) **or** (ext ∠ =)180 – (128 + 32)(= 20) **or** (ext ∠ =)"52" – 32(= 20)			M1	(dep on previous M1) for method to find the size of one interior or exterior angle, may be seen marked on the diagram.	
	eg 180(n – 2) = "160"n **or** 360 ÷ "20"			M1	for setting up an equation for the sum of interior angles **or** 360 ÷ "20"	
	Working required	18		A1	dep on M2	
						Total 4 marks

11	3 × 180 (= 540) or 360 – [(180 – 90) + (180 – 135) + (180 – 67) + (180 – 119)] (= 51) or 360 – (90 + 45 + 113 + 61) (= 51)		3	M1
	90 + 135 + 67 + 119 + x = "540" oe 411 + x = "540" oe or "540" – (90 + 135 + 67 + 119) or 3 × 180 – (90 + 135 + 67 + 119) oe or 540 – 411 or 180 – "51" oe			M1
	Correct answer scores full marks (unless from obvious incorrect working)	129		A1
				Total 3 marks

12	eg $(6-2)\times 180\ (=720)$		4	M1	for a method to find the sum of the interior angles for a hexagon
	eg $"720"-(90+95+149+104+57)(=225)$			M1	for a method to find the missing angle in the hexagon
	eg $\frac{360}{"225"-180}$ **or** $\frac{360}{"45"}$ **or** $\frac{180(n-2)}{n}="225"$ oe **or** $\frac{180(n-2)}{n}="135"$			M1	for a complete method
	Working required	8		A1	cao dep on M2 NB: the answer of 8 can be gained from assuming that *AB* splits reflex *GBC* into 2 equal angles – without gaining the first 2 method marks [M0M0 is awarded] Award SCB1 for the student who gains an answer of 8 from this assumption or trial and improvement or no method shown
					Total 4 marks

13	(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
	$"145.489..."-"110.11..."+\pi r^2="110.11..."-\pi r^2$ oe **or** $5\times("29.097..."-"22.022...")+\pi r^2=5\times"22.022..."-\pi r^2$ 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

14	eg $DEK = \frac{360}{9}$ **or** 40 **or** interior angle = $\frac{(9 - 2) \times 180}{9}$ **or** 140 or $OFK = 140 \div 2$ (= 70) or $FOK = \frac{2}{9} \times 360$ (= 80) or $EDK = 180 - 0.5 \times 140$ (=110) Angles marked correctly (any exterior or interior angle) gains this mark		3	M1	method to find interior or exterior angle or correct interior or exterior angle stated or shown correctly on diagram or for using 70° for *OFK* or 80° for *FOK* or 110 for *EDK* If a student has only found an interior or exterior angle and has clearly mixed up interior and exterior angles this mark cannot be awarded but can still award for any of the others angles stated
	$EDK = 110$ and $DEK = 40$ or $FOK = 80$ and $OFK = 70$ or $ODE = 70$ and $DEK = 40$ or $FED = 140$ and $EDK = 110$ oe			M1	For two correct angles that can lead directly to the answer in a single step (eg 180 – both angles or one angle minus the other)
	Correct answer scores full marks (unless from obvious incorrect working)	30		A1	
					Total 3 marks