1	$\pi \times 12^2 \times \frac{AOC}{360} (=100)$		4	M1	oe for setting up a correct expression for the area of the sector (or equation)
	$(AOC =) \frac{100 \times 360}{\pi \times 12^2} \left(= \frac{250}{\pi}\right)$			M1	for correctly rearranging for AOC
	(Angle ABC =) "79.57747" ÷ 2 (= 39.7887… or $\frac{125}{\pi}$)			M1	ft dep 1st M1 **and** 'x' less than 360 for dividing their 'AOC' by 2
		39.8		A1	for awrt 39.8 accept $\frac{125}{\pi}$
					Total 4 marks

2	$(2+\sqrt{5}) \times AC = (2\sqrt{5}) \times (2\sqrt{5}+4+\sqrt{5})$ or $(2+\sqrt{5}) \times AC = (2\sqrt{5}) \times (3\sqrt{5}+4)$ or $(2+\sqrt{5}) \times (AB+2+\sqrt{5}) = (2\sqrt{5}) \times (2\sqrt{5}+4+\sqrt{5})$		5	M1	for using the intersecting chord theorem correctly eg may label $AB = x$ or $AC = x$ oe
	$(AC =) \frac{(2\sqrt{5}) \times (2\sqrt{5}+4+\sqrt{5})}{(2+\sqrt{5})}$ or $(AC =) \frac{(30+8\sqrt{5})}{(2+\sqrt{5})}$			M1	dep 1st M1 for rearranging for AC may use $AB+2+\sqrt{5}$ on LHS
	$(AC =) \frac{(30+8\sqrt{5})}{(2+\sqrt{5})} \times \frac{(2-\sqrt{5})}{(2-\sqrt{5})}$ or $(AB =) \frac{(21+4\sqrt{5})}{(2+\sqrt{5})} \times \frac{(2-\sqrt{5})}{(2-\sqrt{5})}$			M1	indep for multiplying by the conjugate of the denominator of *their* fraction, so long as fraction in the form $\frac{a+b\sqrt{5}}{c+d\sqrt{5}}$
	$(AC =) \frac{60-30\sqrt{5}+16\sqrt{5}-40}{4-5} (=14\sqrt{5}-20)$ or $(AB =) \frac{42-21\sqrt{5}+8\sqrt{5}-20}{4-5}$			M1	dep 3rd M1 for multiplying out the numerator
	$(AB =) \frac{20-14\sqrt{5}}{-1} - (2+\sqrt{5})$	$13\sqrt{5}-22$		A1	allow $p = 13$ and $q = -22$
					Total 5 marks

3	(a)(i)		122	1	B1	
	(a)(ii)		reason	1	B1	(dep on a correct answer or a correct method seen for (i)) Opposite angles in a cyclic quadrilateral sum to 180°
	(b)	360 – 2 × 58 or 2 × '122'		2	M1	ft from (a)
			244		A1	
						Total 4 marks

4	(AOC =) 38 × 2 (= 76)		4	M1	
		52		A1	
				B2	(dep on M1) for all reasons relevant to their method – underlined words must be seen. angle at the centre is 2 × (double) angle at circumference / angle at circumference is ½ angle at centre angles in a triangle add to 180° **or** angles in a triangle add to 180° base angles in an isosceles triangle (are equal) If not B2 then award B1 (dep on M1) for a correct circle theorem
					Total 4 marks

5	eg 9 × 6 = 8 × PD oe		2	M1	A correct equation involving PD
		6.75		A1	oe
					Total 2 marks

6	Angle $CAD = 28°$ or angle $ACB = 32°$ or angle $ACD = 90°$ or angle $ABD = 90°$		4	M1	
		30°		A1	For a correct answer of 30
	Angles in the **same segment** are equal, **angle** in a **semicircle** is 90° (or **angle** at centre is **double** angle at **circumference** oe) angles in a **triangle** add up to **180°**/**angles** in a **triangle** **isosceles** triangle **alternate** angles vertically **opposite angles (or vertically opposite)** **angles** at a **point** **opposite angles** in a **cyclic quad**rilateral angle between **tangent** and **radius (diameter)** **alternate segment** theorem **angles subtended** by the **same arc**(or **chord**) at the **circumference** (or **on the circle)**			B2	Dep on M1 for all correct reasons for their method used (if not B2 then award B1(dep on M1) for a correct circle theorem reason)
					Total 4 marks

7	$ORQ = 90 - 60$ (=30) **or** $OQR = 30$ **or** $PQR = 0.5 \times (360 - 238)$ (= 61) **or** $QPR = 60$ **or** $OPR = \frac{180-(360-238)}{2}$ (= 29)		4	M1	The correct working or the correct angle for *ORQ* **or** *OQR* **or** *PQR* **or** *QPR* **or** *OPR*. Must be clearly stated as the correct angle or shown on the diagram in correct position. (eg just seeing 30 in working without a label is not sufficient for the award of this mark)
	Working not required, so correct answer scores M1A1 (unless from obvious incorrect working)	31		A1	if not on answer line, may be seen on diagram or clearly labelled
	NB: degrees symbol not essential for reasons *We will allow the symbol* Δ *for 'triangle'* ∠ *for angle* Σ *for sum*	full reasons for method used		B2	(dep on a fully correct method that should lead to the answer) for fully correct reasons for method used (underlined words **must** be seen) eg Angle between tangent and radius is 90° Angles around a point total 360° Angle at centre is twice angle at circumference/edge Total of angles in triangle is 180° / triangle 180° Base angles in an isosceles triangle (or 2 sides equal, so 2 angles equal) Angles in a quadrilateral total 360° or quadrilateral 360° / Accept "4-sided shape" or "quad" Alternate segment theorem (B1 dep on M1 for at least one reason for method used)
					Total 4 marks

8	$[ADC =]$ 180 – 98 (= 82)		6	M1	may be seen on diagram
	$[AC^2 =] 8^2 + 7.5^2 - 2\times8\times7.5\times\cos(98)$ (=136.95...)			M1	correct equation for *AC* or AC^2
	$[AC =]\sqrt{"136.95"}$ **or** $\sqrt{64+56.25+16.7...}$ (=11.7...) oe			M1	complete method to find *AC* showing correct order of operations
	eg $[[AD =]\frac{"11.7"\sin 35}{\sin"82"}$ (= 6.77..) **or** $[DC =]\frac{"11.7"\times\sin"63"}{\sin"82"}$ (=10.5..)oe (where **"82" = 180 – 98** , "63" = 180 – "82" – 35)			M1	correct calculation for *AD* **or** *DC* dep on 1st M1 and 2nd M1
	eg $[AD =]\frac{"11.7"\sin 35}{\sin"82"}$ **and** $[DC =]\frac{"11.7"\sin"63"}{\sin"82"}$ oe **or** $[AD =]\frac{"11.7"\sin 35}{\sin"82"}$ **and** $[DC =]\sqrt{"11.7"^2+"6.77"^2-2\times"11.7"\times"6.77"\times\cos"63"}$ $[DC =]\frac{"11.7"\sin"63"}{\sin"82"}$ **and** $[AD =]\sqrt{"11.7"^2+"10.5"^2-2\times"11.7"\times"10.5"\times\cos 35}$ Where "63" = 180 – "82" – 35			M1	correct calculations for *AD* **and** *DC* (*AD* = 6.77... *DC* = 10.5...) dep on 1st M1 and 2nd M1
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	32.8		A1	accept 32.7 – 32.9
					Total 6 marks

9	*BFD* = 39°	*BED* = 39°		4	B1	
	BDE = 180 – (18 + 39)	*EBD* = 18° **and** *BDE* = 180 – (18 + 39)			M1	
			123		A1	
					B1	dep on M1 for all correct circle theorems relevant for their method e.g. alternate segment theorem **and** opposite angles in a cyclic quadrilateral sum to 180° **or** alternate segment theorem **and** angles in same segment are equal
						Total 4 marks

10	(a) (i)		62	3	B1	
	(a) (ii)		118		B1ft	180 – their (a)(i)
	(b)		62		B1	
						Total 3 marks

11	*PRS* = 90 **or** *PQS* = 90 **or** *PSR* = 180 −136 (= 44)		3	M1	may be seen on diagram. Must be labelled on diagram or identified using 3 letter notation.
	RPS = 180 − 90 – "44" oe **or** *RQS* = 136 – 90 (= 46)			M1	for a complete method
		46		A1	
					Total 3 marks

12	*ABC* = 90° **and** *ACB* (= *ADB*) = 180 – 90 – 55 (= 35) **or** *ABO* = 55° **and** *AOB* = 180 – 2 × 55 (= 70) **or** *BDC* = 55°, *ADC* = 90° **and** *ADB* = 90 – 55 (= 35)		4	M1
		35		A1 for *ADB* = 35
	Angles in a semicircle are 90° Angles in a triangle add to 180° (Angles in a triangle add to 180°) Angles in the same segment (are equal) OR angles at the circumference subtend(ed) from the same arc/chord of the circle (are equal) **or** Angles in an isosceles triangle (are equal) Angles in a triangle sum to 180° (Angles in a triangle add to 180°) Angle at the centre is 2 × (double) angle at circumference / angle at circumference is ½ angle at centre **or** Angles in the same segment (are equal) OR angles at the circumference subtend(ed) from the same arc/chord of the circle Angles in a semicircle are 90°			B2 (dep on M1) for all 3 reasons appropriate to their method B1 (dep on M1) for one correct circle theorem appropriate to their method) NB For the third method only 2 reasons are required
				Total 4 marks

13	*DFE* = 42° or *DOG* = 180 – 2 × 42 (= 96) or *EFG* = 90° or *EDG* = 90° or *DEG* = 90 – 42 (= 48)		4	M1	used or seen in diagram (must be clearly labelled if not in diagram)
		48°		A1	award 2 marks for 48 unless from an incorrect method
	angles in same segment **or** angles from same chord **or** angles at the circumference subtended from the same arc of the circle angles in a semicircle are 90° angles in a semicircle are 90° angle subtended by diameter is 90° angle at centre twice angle at circumference oe angles in a triangle add to 180 angles in a triangle add to 180			B2	Dep on a fully correct method to find angle *DFG* for a full set of reasons relevant to their method. B1 dep on M1 for at least one relevant **circle theorem.**
					Total 4 marks

14	(a)(i)		140	1	B1	
	(a)(ii)		opposite angles of a cyclic quadrilateral (add to 180°) oe	1	B1	dep on B1 in (a)(i) or seeing 180 – 40 with no contradiction oe eg angle at centre is double (2 ×) angle at circumference oe **AND** angles around a point (or point 360)
	(b)	*ADB* = 66 or *ABO* = 90 – 66 (=24) or *BAO* = 90 – 66 (=24) or $ODB = \frac{180-80}{2}$ (= 50) or *DOB* reflex = 280		3	M1	Clearly labelled in working or shown on diagram
		For 2 of: *ADB* = 66 or *ABO* = 90 – 66 (=24) or *BAO* = 90 – 66 (=24) or $ODB = \frac{180-80}{2}$ (= 50) *DOB* reflex = 280			M1	(award M2 for $360-(280+40+24)$ oe
		Correct answer scores full marks (unless from obvious incorrect working)	16		A1	
						Total 5 marks

15	180 – 78 – 78 oe or (90 – 78) × 2 oe		2	M1 for a complete **correct** method to find angle *ABC*. This is not awarded if the angles are incorrectly labelled unless they have clearly started again (Ignore incorrect angles on the diagram if a student shows a correct method leading to the required answer)
	Correct answer scores full marks (unless from obvious incorrect working)	24		A1 award full marks if 24 is seen in the correct place on the diagram unless contradicted on the answer line
				Total 2 marks

16	*DCO* = 90 (or right (angle)) or *DAO* = 90 (or right (angle)) Could also be awarded for *CAO* + *CAD* = 90 or *DAC* + *CAO* = 90		3	M1	may be marked on diagram – also allow right angle 'square' symbol on diagram	M2 implied by 360 – 90 – 90 – 48 **or** 360 – 228
	Obtuse *AOC* = 360 – 90 – 90 – 48 (= 132)oe **or** Obtuse *AOC* = 2(180 – (0.5 × 48) – 90) (= 132) **or** Obtuse *AOC* = 180 – "24" – "24" or 180 – 48 (if working with $\triangle DAC$ and $\triangle OAC$) **or** Reflex *AOC* = 90 + 90 + 48			M1	**dep on M1** being awarded may be marked on diagram	
	Correct answer scores full marks (unless from obvious incorrect working)	228		A1	SC if no other marks awarded 132 gains B1	
						Total 3 marks

17	(a) (i)		90	2	B1	
	(a) (ii)		Angle in a semicircle is 90° oe Angle in a semicircle is 90° oe Triangle in semicircle is 90° oe Angle at centre is double (oe eg ×2) angle at circumference oe Angle at circumference is half (oe) angle at centre. oe		B1	dep on B1 in (a)(i) Valid reason given, underlined words give minimally acceptable answer.
	(b) (i)		22	2	B1	
	(b) (ii)		Angles in the same segment (are equal) **or** angles at the circumference subtended from the same arc of the circle **or** angles on the same chord		B1	dep on B1 in (b)(i) Valid reason given, underlined words give minimally acceptable answer.
						Total 4 marks