Question	Scheme	Marks	AOs
6(a)	Angle $AOB = \frac{\pi-\theta}{2}$	B1	2.2a
		(1)	
(b)	Area = $2\times\frac{1}{2}r^2\left(\frac{\pi-\theta}{2}\right)+\frac{1}{2}(2r)^2\theta$	M1	2.1
	$=\frac{1}{2}r^2\pi-\frac{1}{2}r^2\theta+2r^2\theta=\frac{3}{2}r^2\theta+\frac{1}{2}r^2\pi=\frac{1}{2}r^2(3\theta+\pi)$*	A1*	1.1b
		(2)	
(c)	Perimeter = $4r+2r\left(\frac{\pi-\theta}{2}\right)+2r\theta$	M1	3.1a
	$=4r+r\pi+r\theta$ or e.g. $r(4+\pi+\theta)$	A1	1.1b
		(2)	
			(5 marks)

Notes

(a)

B1: Deduces the correct expression for angle *AOB*

Note that $\frac{180-\theta}{2}$ scores B0

(b)

M1: Fully correct strategy for the area using their angle from (a) appropriately.

Need to see $2\times\frac{1}{2}r^2\alpha$ or just $r^2\alpha$ where α is their angle in terms of θ from part (a) + $\frac{1}{2}(2r)^2\theta$ with or without the brackets.

A1*: Correct proof. For this mark you can condone the omission of the brackets in $\frac{1}{2}(2r)^2\theta$ as long as they are recovered in subsequent work e.g. when this term becomes $2r^2\theta$

The first term must be seen expanded as e.g. $\frac{1}{2}r^2\pi-\frac{1}{2}r^2\theta$ or equivalent

(c)

M1: Fully correct strategy for the perimeter using their angle from (a) appropriately

Need to see $4r+2r\alpha+2r\theta$ where α is their angle from part (a) in terms of θ

A1: Correct simplified expression

Note that some candidates may change the angle to degrees at the start and all marks are available e.g.

(a) $\dfrac{180-\frac{180\theta}{\pi}}{2}$

(b) $2\left(\dfrac{180-\frac{180\theta}{\pi}}{2}\right)\times\frac{1}{360}\times\pi r^2+\frac{\theta}{360}\times\frac{180}{\pi}\times\pi(2r)^2=\frac{1}{2}\pi r^2-\frac{1}{2}r^2\theta+2r^2\theta=\frac{1}{2}r^2(3\theta+\pi)$

(c) $4r+2\left(\dfrac{180-\frac{180\theta}{\pi}}{2}\right)\times\frac{1}{360}\times2\pi r+\frac{180\theta}{\pi}\times\frac{1}{360}\times2\pi(2r)=4r+\pi r+r\theta$

Question	Scheme	Marks	AOs
3	States or uses $\frac{1}{2}r^2\theta=11$	B1	1.1b
	States or uses $2r+r\theta=4r\theta$	B1	1.1b
	Attempts to solve, full method $r=...$	M1	3.1a
	$r=\sqrt{33}$	A1	1.1b
			[4]
			(4 marks)

Notes:

B1: States or uses $\frac{1}{2}r^2\theta=11$ This may be implied with an embedded found value for θ

B1: States or uses $2r+r\theta=4r\theta$ or equivalent

M1: Full method to find $r=...$ This involves combining the equations to eliminate θ or find θ

The initial equations must be of the same "form" (see **) but condone slips when attempting to solve.

It cannot be scored from impossible values for θ Hence only score if $0<\theta<2\pi$ FYI $\theta=\frac{2}{3}$ radians

Allow this to be scored from equations such as $...r^2\theta=11$ and ones that simplify to $...r=...r\theta$ **

Allow their $2r+r\theta=4r\theta \Rightarrow \theta=..$ then substitute this into their $\frac{1}{2}r^2\theta=11$

Allow their $2r+r\theta=4r\theta \Rightarrow r\theta=..$ then substitute this into their $\frac{1}{2}r^2\theta=11$

Allow their $\frac{1}{2}r^2\theta=11 \Rightarrow \theta=\frac{..}{r^2}$ then substitute into their $2r+r\theta=4r\theta \Rightarrow r=..$

A1: $r=\sqrt{33}$ only but isw after a correct answer.

....

The whole question can be attempted using θ in degrees.

B1: States or uses $\frac{\theta}{360}\times\pi r^2=11$

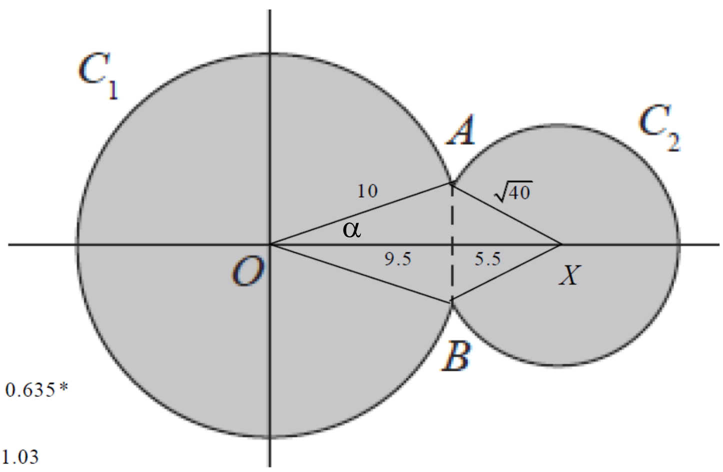
B1: States or uses $2r+\frac{\theta}{360}\times 2\pi r=4\times\frac{\theta}{360}\times 2\pi r$

Question	Scheme	Marks	AOs
3 (a)	Allow explanations such as • student should have worked in radians • they did not convert degrees to radians • 40 should be in radians • θ should be in radians • angle (or θ) should be $\frac{40\pi}{180}$ or $\frac{2\pi}{9}$ • correct formula is $\pi r^2\left(\frac{\theta}{360}\right)$ {where θ is in degrees} • correct formula is $\pi r^2\left(\frac{40}{360}\right)$	B1	2.3
		(1)	
(b) Way 1	{Area of sector = } $\frac{1}{2}(5^2)\left(\frac{2\pi}{9}\right)$	M1	1.1b
	$=\frac{25}{9}\pi$ {cm^2} or awrt 8.73 {cm^2}	A1	1.1b
		(2)	
(b) Way 2	{Area of sector = } $\pi(5^2)\left(\frac{40}{360}\right)$	M1	1.1b
	$=\frac{25}{9}\pi$ {cm^2} or awrt 8.73 {cm^2}	A1	1.1b
		(2)	
		(3 marks)	

Notes for Question 3

(a)	
B1:	Explains that the formula use is only valid when angle *AOB* is applied in radians. See scheme for examples of suitable explanations.
(b)	**Way 1**
M1:	Correct application of the sector formula using a correct value for θ in radians
Note:	Allow exact equivalents for θ e.g. $\theta=\frac{40\pi}{180}$ or θ in the range [0.68, 0.71]
A1*:	Accept $\frac{25}{9}\pi$ or awrt 8.73 **Note:** Ignore the units
(b)	**Way 2**
M1:	Correct application of the sector formula in degrees
A1:	Accept $\frac{25}{9}\pi$ or awrt 8.73 **Note:** Ignore the units.
Note:	Allow exact equivalents such as $\frac{50}{18}\pi$
Note:	Allow M1 A1 for $500\left(\frac{\pi}{180}\right)=\frac{25}{9}\pi$ {cm^2} or awrt 8.73 {cm^2}

Question	Scheme	Marks	AOs
11 (a)	Solves $x^2+y^2=100$ and $(x-15)^2+y^2=40$ simultaneously to find x or y E.g. $(x-15)^2+100-x^2=40 \Rightarrow x=...$	M1	3.1a
	Either $\Rightarrow -30x+325=40 \Rightarrow x=9.5$ Or $y=\dfrac{\sqrt{39}}{2}=$ awrt ± 3.12	A1	1.1b
	Attempts to find the angle AOB in circle C_1 Eg Attempts $\cos\alpha=\dfrac{"9.5"}{10}$ to find α then $\times 2$	M1	3.1a
	Angle $AOB = 2\times\arccos\left(\dfrac{9.5}{10}\right)=0.635$ rads (3sf) *	A1*	2.1
		(4)	
(b)	Attempts $10\times(2\pi-0.635)$ $= 56.48$	M1	1.1b
	Attempts to find angle AXB or AXO in circle C_2 (see diagram) E.g. $\cos\beta=\dfrac{15-"9.5"}{\sqrt{40}} \Rightarrow \beta=...$ (Note AXB =1.03 rads)	M1	3.1a
	Attempts $10\times(2\pi-0.635)+\sqrt{40}\times(2\pi-2\beta)$	dM1	2.1
	$= 89.7$	A1	1.1b
		(4)	
			(8 marks)
Notes:			



Angle $AOB = 0.635$*

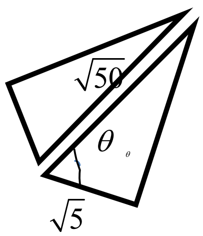
Angle $AXB = 1.03$

(a)

M1: For the key step in an attempt to find either coordinate for where the two circles meet. Look for an attempt to set up an equation in a single variable leading to a value for x or y.

A1: $x=9.5$ (or $y=\dfrac{\sqrt{39}}{2}=$ awrt ± 3.12)

Question Number	Scheme	Marks
12. (a)	$15^2 = 10^2 + 10^2 - 2\times10\times10\cos\angle BOC$	M1
	$\cos\angle BOC = \dfrac{10^2+10^2-15^2}{2\times10\times10}$ *or* $\dfrac{-25}{200}$ *or* -0.125	A1
	$\angle BOC = 1.696$ (N.B. 97.2 degrees is A0)	A1 **[3]**
(b)	Uses $s = 22\theta$ with their θ from part (a) not $-(2\pi-\theta)$	M1
	$r\theta = 22\times1.696 = 37.3(15)$	A1
	Perimeter $= r\theta + 15 + x + x, =\ 39 + \textit{their arc length}$ [76.3 (m)]	M1 A1ft **[4]**
(c)	area of sector $= \frac{1}{2}(22)^2\theta$ -not $-(2\pi-\theta)$	B1
	area of triangle $= \frac{1}{2}(10)^2\sin\theta$	B1
	Area of paved area = $\frac{1}{2}(22)^2\theta - \frac{1}{2}(10)^2\sin\theta = 410.432 - 49.6$ or $410.432 - \dfrac{75\sqrt{7}}{4} = 360.8$ or awrt 361 (m^2)	M1 A1
		[4]
		(11 marks)
	Notes	
(a)	M1: Uses cosine rule – must be correct or other correct trigonometry e.g. $2\times\theta$ where $\sin\theta = \dfrac{7.5}{10}$ A1: makes cos subject of formula correctly or uses $2\times\sin^{-1}\left(\dfrac{7.5}{10}\right)$ A1: accept awrt 1.696 (answer in degrees is A0). If answer is given as 1.70 (3sf) then A0 but remaining As are available (special case below)	
(b)	M1: Uses $s = 22\theta$ with their θ in radians, or correct formula for degrees if working in degrees A1: Accept awrt 37.3 (may be implied by their perimeter) M1: Adds arc length to 15 to two further equal lengths for Perimeter A1ft: Accept awrt 76.3 do not need metres ft on their arc length—so 39 + arc length	
(c)	B1: This formula **used** with their θ in radians or correct formula for degrees - allow miscopy of angle B1: Correct formula for area – may use half base times height M1: Subtracts correct triangle (two sides of length 10) from their sector A1: awrt 361 – do not need units Special case – uses 3 sf instead of 3 dp in part (a) Loses final A mark in part (a) but can have A marks in part (b) for 37.4 and 76.4 and can have A mark in part (c) for awrt 362	

Question Number	Scheme	Marks
11(a)(i)	$x^2+y^2-6x+2y+5=0$ Obtains $(x\pm 3)^2$ and $(y\pm 1)^2$	M1
	$(x-3)^2-9+(y+1)^2-1+5=0$ Obtains $(x-3)^2$ and $(y+1)^2$	A1
	Centre = $(3,-1)$	A1
(ii)	Radius^2 = $'3'^2+'-1'^2-5=5\Rightarrow r=\sqrt{5}$	M1A1
		(5)
(b)	Calculates $TQ=\sqrt{(8-3)^2+(4--1)^2}=\sqrt{50}$	M1A1
	 Uses $\cos\theta=\dfrac{\sqrt{5}}{\sqrt{50}}\Rightarrow\theta=1.249...$	M1A1
	angle *MQN* IS 2.498 radians to 3 decimal places	A1*
		(5)
(c)	Area of sector = $'\frac{1}{2}r^2\theta'=\frac{1}{2}\times\left(\sqrt{5}\right)^2\times 2.498\left(=\text{awrt } 6.24/6.25\right)$	M1A1
	Area of triangle $='\frac{1}{2}ab\sin C'=\frac{1}{2}\times\sqrt{5}\times\sqrt{50}\times\sin 1.249=\left(7.50\right)$	M1
	Shaded Area = 15.0 – 6.245 = 8.76 or 8.75	dM1,A1
		(5)
		(15 marks)

Mark (a)(i) and (a)(ii) together as one part.

(a)

M1 Obtains $(x\pm 3)^2$ and $(y\pm 1)^2$. This could be implied by the candidate writing down a centre of $(\pm 3,\pm 1)$

A1 Obtains $(x-3)^2$ **and** $(y+1)^2$

A1 Centre = $(3,-1)$. Accept this without any working for M1A1A1

M1 Uses r^2 = $'3'^2+'-1'^2-5=...\Rightarrow r=...$ The value of r^2 must be positive for this to be scored. Condone invisible bracketing. This may be implied by $r=$ awrt 2.24

A1 $r=\sqrt{5}$. Do not accept 2.24 on its own but remember to isw.
Note that the M1 A1 can be scored for correct radius following a centre of $(-3,+1)$

Alternative to part (a) using $x^2+y^2+2gx+2fy+c=0$, Centre $=(-g,-f)$ Radius $=\sqrt{g^2+f^2-c}$

M1 States that $2g=\pm 6$ and $2f=\pm 2$. This could be implied by the candidate writing down a centre of $(\pm 3,\pm 1)$

A1 States that $2g=-6$ **and** $2f=2$

A1 Centre = $(3,-1)$ Accept this without any working for M1A1A1

M1 Uses Radius $=\sqrt{'g'^2+'f'^2-c}$

Question Number	Scheme	Marks
9. (a)	$5^2 = 10^2 + 12^2 - 2\times10\times12\cos\angle XAB$, or $\cos\angle XAB = \frac{10^2+12^2-5^2}{2\times10\times12}$ or $\frac{219}{240}$ or 0.9125 or $\frac{73}{80}$	M1
	$\angle XAB = 0.421$ or 0.134π	A1 **[2]**
(b)	Area of sector is $\frac{1}{2}r^2\theta = \frac{1}{2}\times10^2\times\theta$	M1
	Area of major sector is $\frac{1}{2}\times r^2(2\pi - 2\times\text{"}0.421\text{"})$ or $\pi\times r^2 - \frac{1}{2}\times r^2\times2\times\text{"}0.421\text{"})$	M1
	= 272	A1 **[3]**
(c)	area of triangle $AXB = \frac{1}{2}10\times12\times\sin XAB$ **Way 2**: Find angle XBA and hence area XBY	M1
	area of kite = $2\times$ triangleAXB Area of kite = area of XBY + Area XAY	dM1
	= awrt 49 = 37.298 + 11.76 = 49	A1 [3]
	Way 3: Finds length XY by cosine rule or elementary trigonometry (8.173)	M1
	Uses area of kite = $\frac{1}{2}\text{"}8.173\text{"}\times12$	dM1
	= awrt 49	A1 [3]
		8 marks
	Notes	

(a) **M1**: Uses cosine rule – must be a correct statement , allow statement $5^2 = 10^2 + 12^2 - 2\times10\times12\cos\angle XAB$

A1: accept awrt 0.421 (answers in degrees gain M1 A0). Also 0.42 is A0

(b) **M1**: Uses area formula with r = 10 and any angle in radians. If they use degrees they must use the formula $\frac{\theta}{360}\times\pi10^2$

M1: Finds angle in major sector ft their angle from (a) and uses sector formula **or** subtracts minor area from circle (allow work in degrees) Must use $(2\pi - 2\times\text{"}0.421\text{"})$ but r may be 5 instead of 10 for this mark

A1: Accept awrt 272 (may reach this using degrees)

(c) Way 1: **M1**: Finds area of triangle AXB, using 10, 12 and their angle XAB

dM1: Doubles area of triangle AXB

Way 2: **M1**: Finds angle XBA (0.958..) by valid method (cosine rule) (**NOT 90 – XAB**) and hence area XBY $= \frac{1}{2}5\times5\times\sin1.9163$

dM1: Adds areas of triangles XBY and XAY (37.298 and 11.76)

Way 3: **M1**: Finds length XY by cosine rule or elementary trigonometry (8.173)

dM1: Uses area of kite = $\frac{1}{2}\text{"}8.173\text{"}\times12$

For each method A1: awrt 49- do not need units

Question Number	Scheme	Marks
11 (a)	States $r^2 = 1.2^2 + (r-0.4)^2$	M1
	$0.8r = 1.60 \Rightarrow r = 2.$	A1*
		(2)
(b)	Attempt to find the angle or 1/2 angle	
	$'\frac{1}{2}\theta' = \arcsin\left(\frac{1.2}{2}\right) \Rightarrow '\frac{1}{2}\theta' = awrt\,37°$ $awrt\ 0.64$ rads	M1
	cso $AOB = 1.2870$	A1*
		(2)
(c)	Attempts to find area of sector using degree or radian formula	
	Area sector $= \frac{'73.74'}{360} \times \pi \times 2^2$ or $\frac{1}{2} \times 2^2 \times '1.2870'$	M1
	Attempts area of triangle using the correct formula	
	$Area = \frac{1}{2} \times 2 \times 2 \times \sin '73.74°'$ or $Area = \frac{1}{2} \times 2 \times 2 \times \sin '1.2870'$	M1
	Area of sail = Sector -Triangle using the correct combination	
	$= \frac{1}{2} \times 2^2 \times '1.29' - \frac{1}{2} \times 2^2 \times \sin '1.29' = 0.654\left(m^2\right)$	dM1, A1
		(4)
		(8 marks)

(a)

M1 Attempts Pythagoras with lengths r, $(r-0.4)$ and 1.2 in the correct positions within the formula
Alternatively uses the given answer and attempts Pythagoras' theorem with $1.6, 1.2$ *and* 2

A1* Proceeds to $r = 2$ with no errors
If the alternative method is used, then there must be a statement such as hence true, r =2

(b)

M1 Attempts to find either the angle or half angle in the sector in either degrees or radians
For the half angle accept $\arctan\left(\frac{1.2}{1.6}\right)$, $\arcsin\left(\frac{1.2}{2}\right)$, $\arccos\left(\frac{1.6}{2}\right)$

For the whole angle accept $2.4^2 = 2^2 + 2^2 - 2 \times 2 \times 2 \times \cos\theta \Rightarrow \theta = ..$ or similar.

A1* cso. This is a given answer $AOB = 1.2870$
Allow from a value where ½ the angle lacks 4 dp of accuracy

(c)

M1 Correct method to find the area of the sector with radius 2 and angle 1.2870 radians
If angle was found in degrees use $= \frac{'73.74'}{360} \times \pi \times 2^2 = (2.574)$

If angle was found in radians use $= \frac{1}{2} \times 2^2 \times '1.2870'$

M1 Correct method to find the area of the isosceles triangle with lengths 2 and angle 1.2870
For the triangle AOB accept $\frac{1}{2} \times 2 \times 2 \times \sin '73.74'$ or $\frac{1}{2} \times 2 \times 2 \times \sin '1.2870' = (1.92)$

Also for triangle AOB accept use of $\frac{1}{2}bh = \frac{1}{2} \times 2.4 \times 1.6$. Note $\frac{1}{2}bh = \frac{1}{2} \times 2.4 \times 2$ is M0

dM1 Attempts the area of the sail using the correct combinations of sector - triangle.
It is dependent upon both previous M's
If the candidate uses the segment formula $\frac{1}{2} \times 2^2 \times '1.29' - \frac{1}{2} \times 2^2 \times \sin '1.29'$ all three M's can be awarded

A1 awrt $0.654\left(m^2\right)$

Question	Scheme	Marks
8. (a)	$\frac{\sin D}{5}=\frac{\sin 1.1}{6}$	M1
	$\sin D = 0.74267$ so $D = 0.84$	M1, A1
	$B = \pi-(1.1+0.84) = 1.20$ *	A1*
		[4]
(b)	Uses angle DBC = $\pi - 1.2 = \text{awrt } 1.94$	B1
	Area of sector is $\frac{1}{2}r^2\theta = \frac{1}{2}\times 6^2 \times '1.94'$ $(=34.9)$ or Area of triangle ABD $= \frac{1}{2}\times 5\times 6\times \sin 1.2$ $(=14.0)$	M1
	Total area is $\frac{1}{2}\times 6^2\times '1.94' + \frac{1}{2}\times 5\times 6\times \sin 1.2$	dM1
	$= 48.9\text{cm}^2$	A1
		[4]
		8 marks
	Notes	

(a)

M1: Uses sine rule – the sides and angles must be in the correct positions

M1: Makes sin *D* the subject and uses inverse sine (in degrees or radians)

A1: Accept awrt 0.84 or in degrees accept answers truncating $47.9..°$ or rounding to $48.0°$

A1*: Answer is printed so should see either $\pi-(1.1+\text{awrt } 0.84)$ **or** $\pi - 1.1 - \text{awrt } 0.84$ before you see 1.20

If the question was changed to degrees look for accuracy to one decimal places throughout the question for the final A1 mark. So $1.1 \text{ rads} = \text{awrt } 63.0°$ and $(180 - \text{awrt } 63.0 - \text{awrt } 48.0) = \text{awrt } 69.0.. \times \frac{\pi}{180} = 1.20$

There are many ways to attempt this question: For example

M1: Uses cosine rule $6^2 = 5^2 + x^2 - 2\times 5\times x\cos 1.1$ (where $x = AD$) and attempts to solve to find x. For information $x \approx 6.29$

M1: Uses cosine rule $\cos B = \frac{6^2+5^2-\text{their}'6.29'^2}{2\times 6\times 5}$

A1: Achieves $\cos B = \frac{6^2+5^2-(\text{awrt } 6.29)^2}{2\times 6\times 5}$

A1: 1.20*

(b)

B1: Uses angles on a straight line formula. Score for $\pi - 1.2$ or allow awrt 1.94 as evidence.
If converted to degrees accept awrt $111.2°$ as evidence

M1: Uses a correct area formula for the sector **or** a correct area formula for the triangle.
You may follow through on an incorrectly found angle *DBC*
For example $2\pi - 1.2$ is acceptable but $180° - 1.2$ is not as it is using mixed units.
If the angle was found in degrees, the correct formula must be used.
For the triangle the correct combinations of sides and angle should be attempted.
e.g. You may see the area of triangle $ABD = \frac{1}{2}5\times(\text{their } 6.29)\times \sin 1.1$ or $\frac{1}{2}6\times(\text{their } 6.29)\times \sin(\text{their } ADB)$

dM1: Adds together a correct area formula for the sector **and** a correct area formula for the triangle.
You may follow through on an incorrectly found angle *DBC* or *ADB*

A1: Accept awrt 48.9 (do not need units)

Question Number	Scheme		Marks
15	Area of triangle = $\frac{1}{2}\times(2r)^2\sin\left(\frac{\pi}{3}\text{ or }60\right)$ or $\frac{1}{2}\times(r)^2\sin\left(\frac{\pi}{3}\text{ or }60\right)$ Correct method for the area of either triangle. Ignore any reference to which triangle they are finding the area of.		M1
	Area of sector = $\frac{1}{2}\times r^2\times\frac{\pi}{3}$	Use of the sector formula $\frac{1}{2}r^2\theta$ with $\theta=\frac{\pi}{3}$ which may be embedded within a segment	M1
	Area R = Sector + 2 Segments $=\frac{1}{2}r^2\times\frac{\pi}{3}+2\times\left(\frac{1}{2}r^2\times\frac{\pi}{3}-\frac{1}{2}r^2\times\frac{\sqrt{3}}{2}\right)$ Area R = Triangle + 3 Segments $=\frac{1}{2}r^2\times\frac{\sqrt{3}}{2}+3\times\left(\frac{1}{2}r^2\times\frac{\pi}{3}-\frac{1}{2}r^2\times\frac{\sqrt{3}}{2}\right)$ Area R = 3 Sectors − 2 Triangles $=3\times\frac{1}{2}r^2\times\frac{\pi}{3}-2\times\left(\frac{1}{2}r^2\times\frac{\sqrt{3}}{2}\right)$ Area R = Big triangle − 3 White bits $=\frac{1}{2}\times(2r)^2\frac{\sqrt{3}}{2}-3\times\left(\frac{1}{2}r^2\times\frac{\sqrt{3}}{2}-\left(\frac{1}{2}r^2\times\frac{\pi}{3}-\frac{1}{2}r^2\times\frac{\sqrt{3}}{2}\right)\right)$ M1: A fully correct method (may be implied by a final answer of awrt $0.705r^2$) A1: Correct exact expression - for this to be scored $\sin\frac{\pi}{3}=\frac{\sqrt{3}}{2}$ must be seen		M1A1
	$=\frac{1}{2}\pi r^2-\frac{\sqrt{3}}{2}r^2=r^2\left(\frac{1}{2}\pi-\frac{\sqrt{3}}{2}\right)$	Cso (Allow $\frac{r^2}{2}\left(\pi-\sqrt{3}\right)$ or any exact equivalent with r^2 taken out as a common factor)	A1
			(5 marks)

Question Number	Scheme	Marks
6(a)	$\cos\angle BAC = \dfrac{12^2+10^2-6^2}{2\times12\times10} \Rightarrow \angle BAC = 0.5223$	M1A1
		(2)
(b)	Arc $BD = r\theta = 10\times0.5223$	M1
	Perimeter = 6+2+ 10×0.5223=13.22 (m)	dM1,A1
		(3)
(c)	Area of sector $BAD = \frac{1}{2}r^2\theta = \frac{1}{2}\times10^2\times0.5223 \quad (=26.116)$	M1
	Area of triangle $ABC\frac{1}{2}ab\sin C = \frac{1}{2}\times12\times10\times\sin0.5223 \quad (=29.932)$	M1
	Area of flowerbed BCD = $\frac{1}{2}\times12\times10\times\sin0.5223$ - $\frac{1}{2}\times10^2\times0.5223$	dM1
	= 3.81 / 3.82 (m^2)	A1
		(4)
		(9 marks)

(a)

M1 Attempts use of the formula $6^2 = 10^2+12^2-2\times10\times12\cos A$ or $\cos\angle BAC = \dfrac{12^2+10^2-6^2}{2\times12\times10}$

The sides must be in the correct "position" within the formula. Condone different notation Eg. θ

A1 $\angle BAC =$ awrt 0.5223 The angle in degrees (awrt $29.9°$) is A0

(b)

M1 Attempts arc formula: In radians uses Arc $BD = r\theta = 10\times"0.5223"$

In degrees uses Arc $BD = \dfrac{\theta}{360}\times2\pi r = \dfrac{"29.9"}{360}\times2\pi\times10$

dM1 Dependent upon the arc formula having been used. It is for calculating the perimeter as 8 + arc length.

A1 Perimeter = awrt 13.22 (m)

(c)

M1 Attempts area of sector formula: Area of sector $BAD = \frac{1}{2}r^2\theta = \frac{1}{2}\times10^2\times"0.5223"$

In degrees uses Area of sector $BAD = \dfrac{\theta}{360}\times\pi r^2 = \dfrac{"29.9"}{360}\times\pi\times10^2$

M1 Attempts area of triangle formula: Area of triangle ABC = $\frac{1}{2}ab\sin C = \frac{1}{2}\times12\times10\times\sin"0.5223"$

You may see Herons formula used with $S = \dfrac{10+6+12}{2} = (14)$ and $A = \sqrt{S(S-10)(S-6)(S-12)}$

Watch for other methods including the calculation of a perpendicular.

dM1 Dependent upon both correct formulae. It is scored for finding area of triangle - area of sector

A1 Allow awrt 3.81 or 3.82 (m^2)

Question Number	Scheme	Marks
4.(a)	Attempts Area $=\frac{1}{2}ab\sin C \Rightarrow 24\sqrt{3}=\frac{1}{2}3x\times x\sin 60°$	M1
	Uses $\sin 60° = \frac{\sqrt{3}}{2}$ oe $\Rightarrow x^2 = 32 \Rightarrow x = 4\sqrt{2}$	dM1A1*
		[3]
(b)	Uses $BC^2 = \left(12\sqrt{2}\right)^2 + \left(4\sqrt{2}\right)^2 - 2\left(12\sqrt{2}\right)\left(4\sqrt{2}\right)\cos 60°$	M1
	$\Rightarrow BC^2 = 224 \Rightarrow BC = 4\sqrt{14}$	A1,A1
		[3]
		(6 marks)

(a)

M1 Attempts to use Area $=\frac{1}{2}ab\sin C$ Score for sight of $24\sqrt{3}=\frac{1}{2}3x\times x\sin 60°$

dM1 Either using $24\sqrt{3}=\frac{1}{2}3x\times x\sin 60°$ with $\sin 60° = \frac{\sqrt{3}}{2}$(which may be implied) to reach a form $x^2 = k$

So sight of $x^2 = \frac{16\sqrt{3}}{\sin 60°}$ oe $\Rightarrow x = 4\sqrt{2}$ would imply $\sin 60° = \frac{\sqrt{3}}{2}$ and $x^2 = k$

Or sight of a correct simplified intermediate line followed by the correct answer.

Eg. $24\sqrt{3}=\frac{1}{2}3x\times x\sin 60° \Rightarrow 3x^2 = 96 \Rightarrow x = 4\sqrt{2}$

It cannot be awarded for $24\sqrt{3}=\frac{1}{2}3x\times x\times\frac{\sqrt{3}}{2} \Rightarrow x = 4\sqrt{2}$

A1* This is a show that and you must see $x = 4\sqrt{2}$ following $x^2 = 32$ OR $x^2 = 16\times 2$ or $x = \sqrt{32}$ for the A1* to be scored

If you see a candidate start $41.57 = \frac{1}{2}3x\times x\times 0.866 \Rightarrow x^2 = 32 \Rightarrow x = 4\sqrt{2}$ award M1, dM1, A0

Alternatively candidate can assume that $x = 4\sqrt{2}$ and attempt $\frac{1}{2}4\sqrt{2}\times 12\sqrt{2}\sin 60°$ for M1, $\frac{1}{2}4\sqrt{2}\times 12\sqrt{2}\times\frac{\sqrt{3}}{2} = 24\sqrt{2}$ for dM1 and make a statement for A1*

(b)

M1 Uses the cosine rule $BC^2 = \left(4\sqrt{2}\right)^2 + \left(12\sqrt{2}\right)^2 - 2\left(4\sqrt{2}\right)\left(12\sqrt{2}\right)\cos 60°$ Condone missing brackets

Can be scored for $BC^2 = (3x)^2 + (x)^2 - 2(3x)(x)\cos 60°$ It can be awarded for an attempt with their x

Also accept the form $\cos 60° = \frac{\left(12\sqrt{2}\right)^2 + \left(4\sqrt{2}\right)^2 - BC^2}{2\left(12\sqrt{2}\right)\left(4\sqrt{2}\right)}$

A1 $BC^2 = 224$ May be implied by $BC = \sqrt{224}$ or $4\sqrt{14}$

A1 $BC = 4\sqrt{14}$

If you see a candidate start $BC^2 = (5.66)^2 + (16.97)^2 - 2(5.66)(16.97)\cos 60° \Rightarrow BC = 4\sqrt{14}$ award M1, A1, A0

Question Number	Scheme	Marks
4. (a)	**Usually answered in radians: Uses** $BCD = 3.5 \times (angle)$, $= 3.5 \times 1.77 = 6.195$ (m) (accept awrt 6.20)	M1 A1 **(2)**
(b)	Area = $\frac{1}{2}(3.5)^2 \times 1.77 = 10.84$ (m^2)	M1 A1 **(2)**
(c)	Area of triangle = $\frac{1}{2} \times 3.7 \times 3.5 \times \sin(\text{angle})$, $= \frac{1}{2} \times 3.7 \times 3.5 \times \sin(\frac{\pi}{2} - \frac{1.77}{2})$ (=awrt 4.1) Total area = $"10.84" + 2 \times "4.101"$ = 19.04	M1, A1 M1 A1cao **(4)** **[8]**
	Notes	
(a)	M1: uses $s = 3.5 \times \theta$ with θ in radians or completely correct work in degrees A1: awrt 6.20 or just 6.2 (do not need to see units) Correct answer can imply the method.	
(b)	M1 for attempt to use $A = \frac{1}{2} \times 3.5^2 \times \theta$ (Accept θ in degrees.) A1 for awrt 10.84 (do not need to see units) isw if correct answer is followed by 10.8. Correct answer can imply the method.	
(c)	M1: Uses area of triangle $\frac{1}{2} \times 3.7 \times 3.5 \times \sin(\text{angle})$ Must be correct method for area of triangle but may be less direct. A1: Correct expression using correct angle i.e. $\frac{\pi}{2} - \frac{1.77}{2}$ or awrt 0.69 or awrt 39 degrees (need at least 2 sf if no other work seen, but may be implied by correct final answer) If correct expression is given then isw (so e.g. isw an answer of 0.0775 implying angle set to degrees on calculator) M1: Adds **twice** their **second calculated area** (even if rectangle or segment) to their sector area (may have been slips or errors in one or both formulae – such as missing ½ or mixture of degrees and radians or weak attempt at triangle area) so M0A0M1A0 is a possible mark distribution A1: 19.04 cao (common answer through insufficient accuracy is 19.08 which loses final mark) **Special Case**. The mark profile M1A0M1A0M1A0M1A0 can be given if the angle is misunderstood as 1.77π or as AFB for example If $"10.84" + 3.5 \times 3.7 \sin(\text{angle})$ is used then this can gain both M marks and the A marks if correct. But use of $3.5 \times 3.7 \sin(\text{angle})$ and later doubled and added to "10.84" is 1st M0, 2nd M1.	

Question number	Scheme	Marks
5	$x^2 + y^2 - 10x + 6y + 30 = 0$	
(a)	Uses any appropriate method to find the coordinates of the centre, e.g achieves $(x \pm 5)^2 + (y \pm 3)^2 = \dots$. Accept (±5,±3) as indication of this.	M1