Question Number	Scheme	Marks
8(a)(i)	$2\pi - \frac{2\pi}{3} = \frac{4\pi}{3}$	B1
	Area of sector $= \frac{1}{2}\times 3^2 \times "\frac{4}{3}\pi" = 6\pi$ (m^2)	M1A1
	Length of arc $= 3\times "\frac{4}{3}\pi" \Rightarrow$ Perimeter $= 4\pi + 6$ (m)	M1A1
(ii)		**(5)**
(b)	$\frac{1}{2}\times 3^2 \times \sin\left(\frac{2}{3}\pi\right) = \frac{9\sqrt{3}}{4}$ (m^2)	M1A1
		(2)
(c)	Eg $AB^2 = 3^2 + 3^2 - 2\times 3\times 3\times \cos\left(\frac{2}{3}\pi\right) \Rightarrow AB^2 = 27 \Rightarrow AB = 3\sqrt{3}$ (m) *	M1A1*
		(2)
(d)	$\frac{\sin BAC}{8} = \frac{\sin\left(\frac{\pi}{6}\right)}{3\sqrt{3}} \Rightarrow \sin BAC = ...$ or $BAC = ...$	M1
	$\sin BAC =$ awrt $\frac{4\sqrt{3}}{9}$ or $BAC =$ awrt 0.88 $(0.8785\ldots)$	A1
	Area $ABC = \frac{1}{2}\times 3\sqrt{3}\times 8\times \sin(\pi - \frac{\pi}{6} - "0.88")$ $(= 20.4896....)$	M1
	Total area = "18.8"+"3.90"+"20.5"	dM1
	= awrt 43 (m^2)	A1
		(5)
		(14 marks)

If lengths or areas are found in other parts then credit can be awarded for these as long as they are referred to or used in the relevant part.

(a)(i)

B1 Finds the correct angle for the sector *AOBX*. They may find the minor sector first and then subtract from the area of the whole circle so may be implied from later work. They may also work in degrees. Sight of $\theta = \frac{4\pi}{3}$ on the diagram or within their working scores this mark.

M1 States or uses $\frac{1}{2}r^2\theta$ with $r = 3$ and $\theta = \frac{2\pi}{3}$ or $\theta = \frac{4\pi}{3}$ or the equivalent method working in degrees. May be implied by the correct answer, expression or awrt 9.42 or awrt 18.8

A1 6π (m^2) cao must be exact. Isw after a correct answer.

(ii)

M1 States or uses $r\theta$ with $r = 3$ and $\theta = \frac{2\pi}{3}$ or $\theta = \frac{4\pi}{3}$ or the equivalent method working in degrees. The addition of two radii to find the perimeter is not required for this mark. May be implied by the correct answer, expression or awrt 6.28 or awrt 12.6

A1 $4\pi + 6$ (m) cao must be exact. Isw after a correct answer.

(b)

M1 States or uses $\frac{1}{2}ab\sin C$ with $a = b = 3, \theta = \frac{2}{3}\pi$ (or may work in degrees). Alternatively, they may split the isosceles triangle into two right angled triangles including finding *AB*. Score for the overall method or awrt 3.90

A1 $\frac{9\sqrt{3}}{4}$ (m^2) or exact equivalent. Isw after a correct answer

(c)

M1 Correct method (which may be seen in earlier work but referred to in (c)) by for example

- using the cosine rule with $a=b=3, \theta = "\frac{2}{3}\pi"$
- splitting the isosceles triangle into two right angled triangles eg $2\times 3\times \sin\left(\frac{\pi}{3}\right)$
- using the sine rule such that $\frac{AB}{\sin\left(\frac{2\pi}{3}\right)} = \frac{3}{\sin\left(\frac{\pi}{6}\right)} \Rightarrow AB = ...$

A1* $3\sqrt{3}$ (m) with no errors in their calculations. Minimum expected to see is a simplified expression for AB (or AB^2) which is not $3\sqrt{3}$. Eg via the cosine rule this would be either $AB^2 = 27$ or $AB = \sqrt{27}$ via the sine rule eg $\frac{3\sin(\frac{2\pi}{3})}{\sin(\frac{\pi}{6})}$ or via splitting the triangle up into two right angle triangles $2\times 3\times \sin\left(\frac{\pi}{3}\right)$ oe. Accept alternative labelling for AB eg x

You do not need to see the exact values for the the trig functions within their working.

(d) **Beware there are many methods with incorrect working leading to 43 so you will need to check carefully that their method is sound.**

M1 Attempts to use the sine rule to find sin *BAC* or angle *BAC*. Award for the appropriate lengths and angles in the correct positions within a correct equation. Do not be concerned with the mechanics of the rearrangement, although it must be a solvable equation. Alternatively attempts to solve a quadratic in *AC* using the cosine rule.

$(3\sqrt{3})^2 = AC^2 + 8^2 - 2\times AC\times 8\times \cos\left(\frac{\pi}{6}\right) \Rightarrow AC = ...$ $(= \sqrt{11} + 4\sqrt{3} = \text{awrt } 10.2)$

A1 Correct value for $\sin BAC$, angle *BAC* (awrt 0.88 or 50.3 in degrees) or *AC*

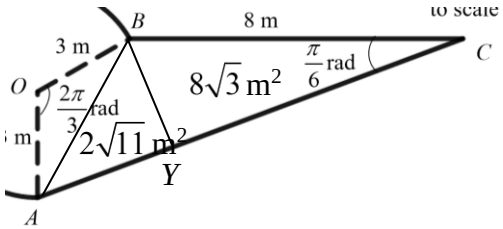
M1 Correct method to find the area of triangle *ABC* using either their angle *ABC* from $\pi - \frac{\pi}{6} - "BAC"$ or their length *AC*. May work in degrees.

dM1 Adds their (a)(i) + their (b) + their triangle *ABC* together to the find area of the pond. It is dependent on all of the previous method marks in (d) only

A1 awrt 43 (m^2) from a correct method. Also allow the exact answer $6\pi + 2\sqrt{11} + \frac{41}{4}\sqrt{3}$ oe

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Alt (d) Forms two right angled triangles with the perpendicular to side AC from point B



M1 Height of the triangle *ABC* is $BY = 8\sin\left(\frac{\pi}{6}\right)$

A1 $BY = 4$ may be implied

M1 Attempts to find the area of triangle *ABC*. Usually this is by attempting to find length *AC* split into *AY* and *YC* eg $AY = \sqrt{\left(3\sqrt{3}\right)^2 - "4"^2}$ $\left(=\sqrt{11}\right)$ and length $YC = 8\cos\left(\frac{\pi}{6}\right) = 4\sqrt{3}$

$\Rightarrow$ Area $ABC = \frac{1}{2}\times\left(\sqrt{11} + 4\sqrt{3}\right)\times 4$. Score for the overall method condoning slips.

Alternatively, they may attempt the cosine rule to find $AC \Rightarrow$ Area $ABC = ...$

dM1A1 Follows main scheme

Question Number	Scheme	Marks
9(a)	$\frac{1}{2}x^2-10x+22=\frac{1}{2}(x\pm...)^2\pm...$ or states $a=\frac{1}{2}$	B1
	$\frac{1}{2}x^2-10x+22=\frac{1}{2}(x\pm10)^2\pm...$ or states $a=\frac{1}{2}$ and $b=\pm10$	M1
	$\frac{1}{2}x^2-10x+22=\frac{1}{2}(x-10)^2-28$	A1
		(3)
(b)	$("10","-28")$	B1ftB1ft
		(2)
(c)(i)	Gradient of tangent $=8$	B1
	$\frac{dy}{dx}=x-10=8\Rightarrow x=...$	M1
	$x=18,\ y=4$	A1A1
(c)(ii)	$k-\frac{1}{8}\times"18"="4"\Rightarrow k=\frac{25}{4}$	dM1A1
		(6)
(d)	One of x …"10" or y „ "$\frac{25}{4}$"$-\frac{1}{8}x$ or y …$\frac{1}{2}x^2-10x+22$	B1ft
	Two of x …"10" or y „ "$\frac{25}{4}$"$-\frac{1}{8}x$ or y …$\frac{1}{2}x^2-10x+22$	B1ft
	All three of x …10, y „ $\frac{25}{4}-\frac{1}{8}x$ and y …$\frac{1}{2}x^2-10x+22$	B1
		(3)
		(14 marks)

(a) If there is a contradiction between the embedded values of *a*, *b* and *c* within their expression and their stated values then the embedded values take precedence.

B1 Achieves $\frac{1}{2}x^2-10x+22=\frac{1}{2}(x\pm...)^2\pm...$ or states that $a=\frac{1}{2}$

M1 Deals correctly with the first two terms of $\frac{1}{2}x^2-10x+22$

Scored for $\frac{1}{2}x^2-10x+22=\frac{1}{2}(x\pm10)^2\pm...$ or states that $a=\frac{1}{2}$ & $b=\pm10$ (may be found using symmetry by finding the roots)

A1 $\frac{1}{2}x^2-10x+22=\frac{1}{2}(x-10)^2-28$ (cannot just be the stated values). Do not isw if for example they attempt to multiply by 2 to achieve integer values

This may also be done by equating coefficients using the expanded form $a(x+b)^2+c=ax^2+2abx+ab^2+c$ but the marks can be applied in the same way