Question Number	Scheme	Marks
1(a)	$\left(\dfrac{dy}{dx}=\right) \ldots x^2+\ldots x+\ldots x^{-2}$	M1
	$\left(\dfrac{dy}{dx}=\right) \dfrac{3}{4}x^2-2x-17x^{-2}$	A1A1
		(3)
(b)	$\left(\dfrac{dy}{dx}=\right) \dfrac{3}{4}(2)^2-2(2)-17(2)^{-2}=-\dfrac{21}{4}$	M1
	$y-\dfrac{13}{2}=\text{"}-\dfrac{21}{4}\text{"}(x-2)$	dM1
	$21x+4y-68=0$	A1
		(3)
		(6 marks)

(a)

M1 Reduces the power by 1 on any of the following terms $\ldots x^3 \to \ldots x^2$, $\ldots x^2 \to \ldots x^1$, $\ldots x^{-1} \to \ldots x^{-2}$. Be careful not to allow just sight of x^2. The index does not have to be processed for this mark.

A1 Two of $+\dfrac{3}{4}x^2, -2x, -17x^{-2}$ or exact unsimplified equivalent terms. Accept eg $\dfrac{-17}{x^2}$ but the indices must be processed. Double signs eg $+\dfrac{-17}{x^2}$ is fine.

A1 $\dfrac{3}{4}x^2-2x-17x^{-2}$ all on one line or exact simplified equivalent. Allow x^1. Withhold the final mark if they attempt to multiply all the terms by 4 for example or a $+c$ appears.

(b)

M1 Attempts to substitute $x=2$ into their $\dfrac{dy}{dx}$ which must be a changed function to find the gradient of the tangent at P

dM1 It is for the method of finding a line passing through $\left(2, \dfrac{13}{2}\right)$ using their $\dfrac{dy}{dx}$ at $x=2$ eg it cannot be the gradient of the normal.
Score for sight of $y-\dfrac{13}{2}=\text{"}-\dfrac{21}{4}\text{"}(x-2)$ with both coordinates substituted in correctly or if they use the form $y=mx+c$ they must proceed as far as $c=\ldots$ It is dependent on the previous method mark.

A1 $21x+4y-68=0$ or any equivalent multiple where the coefficients are integers and all terms are on one side of the equation. If they state values which contradict the equation then the equation takes precedence.

Question Number	Scheme	Marks
2(a)	$a=2$	B1
	$b=-3$	B1
		(2)
(b)	Any two term of $\int \frac{2x^3-3x^2-32x-15}{5\sqrt{x}}\,dx = \int \frac{2}{5}x^{\frac{5}{2}} - \frac{3}{5}x^{\frac{3}{2}} - \frac{32}{5}x^{\frac{1}{2}} - 3x^{-\frac{1}{2}}\,dx$	M1A1
	$x^n \to x^{n+1}$	M1
	$\frac{4}{35}x^{\frac{7}{2}} - \frac{6}{25}x^{\frac{5}{2}} - \frac{64}{15}x^{\frac{3}{2}} - 6x^{\frac{1}{2}} + c$	A1A1
		(5)
		(7 marks)

(a) If there is a contradiction between their stated values and the embedded values in a cubic expression then the embedded values take precedence.

B1 $a=2$ which may be embedded

B1 $b=-3$ which may be embedded

(b)

M1 Attempts to write as a sum of terms. Award for any term with a correct index from correct working. The index does not need to be processed.

A1 Any **two** correct unsimplified or simplified terms of the expression $\frac{2}{5}x^{\frac{5}{2}} - \frac{3}{5}x^{\frac{3}{2}} - \frac{32}{5}x^{\frac{1}{2}} - 3x^{-\frac{1}{2}}$ oe eg $0.4x^{\frac{5}{2}} - 0.6x^{\frac{3}{2}} - 6.4x^{\frac{1}{2}} - 3x^{-\frac{1}{2}}$ (indices must be processed)

M1 Increases the power of any of their non-integer terms by 1. ($x^n \to x^{n+1}$) This mark cannot be awarded for just increasing the power by 1 on a numerator or denominator term. The index does not need to be processed.

A1 Any two terms correct unsimplified or simplified (see below). May appear in a list or on separate lines.

A1 $\frac{4}{35}x^{\frac{7}{2}} - \frac{6}{25}x^{\frac{5}{2}} - \frac{64}{15}x^{\frac{3}{2}} - 6x^{\frac{1}{2}} + c$ all on one line (including the constant c and all simplified)

Allow exact equivalents but not rounded decimals so $\frac{4}{35}$ must be written as a fraction.

Accept $\frac{4}{35}x^{\frac{7}{2}} - 0.24x^{\frac{5}{2}} - 4.2\dot{6}x^{\frac{3}{2}} - 6x^{\frac{1}{2}} + c$. Also allow terms written as eg $\frac{4}{35}x^3\sqrt{x}$ Withhold this mark if the final answer has the integral sign and dx around it or any other spurious notation.

Question Number	Scheme	Marks
3(a)	$1.05 = 3p + q$ $1.65 = 5p + q$ e.g. $\Rightarrow 2p = 0.6$ or $\Rightarrow 1.05 = 3p + (1.65 - 5p)$ or $\Rightarrow 1.65 = 5p + (1.05 - 3p)$ $p = 0.3 \quad q = 0.15$	 M1 A1A1
		(3)
(b)	$2.5 = "0.3"T + "0.15" \Rightarrow T =$ $T = 7.8$	M1 A1
		(2)
		(5 marks)

(a)

M1 Forms two simultaneous equations (which may be in pence) and proceeds to find a value for p or q
May be implied by a correct p or q (allow sight of 30 or 15).
Also score for an attempt to calculate $\frac{1.65 - 1.05}{5 - 3}$ or equivalent.

A1 $p = 0.3$ or $q = 0.15$ oe

A1 $p = 0.3$ and $q = 0.15$ oe

(b)

M1 Uses their values for p and q with $V = 2.5$ and rearranges to find a value for T. It must come from $\frac{2.5 \pm q}{p}$ which you may need to check on your calculator, allowing for truncation or rounding (eg 8 following correct values for V, p and q)

A1 7.8 cao isw after sight of the correct answer.

Question Number	Scheme	Marks
4(a)	$x^2(2x+1)-15x \Rightarrow 2x^3+x^2-15x = x(2x^2+x-15)$	M1
	$x(2x-5)(x+3)=0 \Rightarrow x=...$	dM1
	Two of $x=0,\ \frac{5}{2},\ -3$	B1
	$x=0,\ \frac{5}{2},\ -3$	A1
		(4)
(b)	$y^{\frac{2}{3}}=\frac{5}{2} \Rightarrow y=\left(\frac{5}{2}\right)^{\frac{3}{2}}$	M1
	$\frac{5}{4}\sqrt{10}$	A1cso
		(2)
		(6 marks)

The question says "In this question you must show detailed reasoning. Solutions relying on calculator technology are not acceptable". Correct answers do not imply full marks.

(a)

M1 Multiplies out the bracket to achieve a cubic, takes out a linear factor or cancels the x leading to a quadratic factor (usually $2x^2+x-15$). Award for $...x(...x^2 \pm ...x \pm ...)$ or $...x(...x\pm...)(...x\pm...)$ May be implied by eg $x(2x-5)(x+3)$ May see $=0$ or may be implied.

dM1 Attempts to solve their quadratic either by factorising or using the quadratic formula or completing the square. They cannot just state the roots and the fully factorised version or values of a, b and c must match their quadratic. It is dependent on the previous method mark. The = 0 can be implied and the factorised quadratic may appear under their solutions.

B1 Two of $x=0,\ \frac{5}{2},\ -3$

A1 $x=0,\ \frac{5}{2},\ -3$ provided all previous marks have been scored. Check for $x=0$ in earlier work

Eg1 $2x^3+x^2-15x = x(2x-5)(x+3) \Rightarrow 0,\ \frac{5}{2},\ -3$ M1dM1B1A1

Eg2 $2x^3+x^2-15x=0 \Rightarrow x^3+\frac{1}{2}x^2-\frac{15}{2}x=0 \Rightarrow x\left(x-\frac{5}{2}\right)(x+3)=0 \Rightarrow 0,\ \frac{5}{2},\ -3$ M1dM1B1A1

Eg3 $2x^3+x^2-15x = x\left(x-\frac{5}{2}\right)(x+3) \Rightarrow 0,\ \frac{5}{2},\ -3$ M1dM0B1A0 (the cubic and factorised version are not equal to each other)

Eg4 $2x^3+x^2-15x = x(2x^2+x-15) \Rightarrow 0,\ \frac{5}{2},\ -3$ M1dM0B1A0 (no method seen to solve the quadratic)

Eg5 $0,\ \frac{5}{2},\ -3$ M0dM0B1A0 (no method seen at all)

This response below can score full marks.

(a). $f(x) = x^2(2x+1) - 15x$.

$0 = 2x^3 + x^2 - 15x$

$(2x-5)(x+3)(x+0)$.

$x = \frac{5}{2}$ $x = -3$ $x = 0$.

(b)

M1 $y^{\frac{2}{3}} = "\frac{5}{2}" \Rightarrow y = \left("\frac{5}{2}"\right)^{\frac{3}{2}}$ (or one of their positive solutions from part (a)). The question states a calculator cannot be used so do not award for an implied method if they have decimal solutions or the exact answer without the method to deal with the fractional power seen. No marks can be scored without a positive solution from (a) or they restart in (b).

Allow notation such as $y = \sqrt[\frac{2}{3}]{\frac{5}{2}}$ and you do not need to see $y = ...$

A1 $\frac{5}{4}\sqrt{10}$ or $1.25\sqrt{10}$ or $1\frac{1}{4}\sqrt{10}$ **only and no other solutions** cso

Eg1 $y^{\frac{2}{3}} = "\frac{5}{2}" \Rightarrow y = 3.95...$ is M0A0

Eg2 $y^{\frac{2}{3}} = "\frac{5}{2}" \Rightarrow y = \frac{5}{4}\sqrt{10}$ is M0A0

Eg3 $y^{\frac{2}{3}} = "\frac{5}{2}" \Rightarrow y^2 = \frac{125}{8} \Rightarrow y = \frac{5}{4}\sqrt{10}$ can score M1A1 as they have shown a method to deal with the factional power.

Question Number	Scheme	Marks
5(a)	$\text{f}'(x)=12x^{-\frac{1}{2}}+\frac{x}{3}-4$	
	One of $x^{-\frac{1}{2}}\to x^{\frac{1}{2}}$, $-4\to -4x$, $x\to x^2$	M1
	$\text{f}(x)=\int 12x^{-\frac{1}{2}}+\frac{x}{3}-4\,\text{d}x=24x^{\frac{1}{2}}+\frac{x^2}{6}-4x+c$	A1A1
	$8=24(9)^{\frac{1}{2}}+\frac{(9)^2}{6}-4(9)+c\Rightarrow c=...$	dM1
	$(\text{f}(x)=)\ 24x^{\frac{1}{2}}+\frac{x^2}{6}-4x-\frac{83}{2}$	A1
		(5)
(b)	$\text{f}'(9)=\frac{12}{\sqrt{9}}+\frac{9}{3}-4\quad(=3)$	M1
	$3\to -\frac{1}{3}$	dM1
	$y-8=\text{"}-\frac{1}{3}\text{"}(0-9)$	M1
	$(0, 11)$	A1
		(4)
		(9 marks)

(a)

M1 Integrates by raising the power on one of the terms (ie $x^{-\frac{1}{2}}\to x^{\frac{1}{2}}$, $-4\to -4x^1$, $x\to x^2$). The index does not need to be processed.

A1 Two terms correct of $24x^{\frac{1}{2}}+\frac{x^2}{6}-4x$ or unsimplified equivalent which may appear as a list. The indices must be processed. Allow x^1

A1 $24x^{\frac{1}{2}}+\frac{x^2}{6}-4x\ (+c)$ or unsimplified equivalent. Condone the lack of $+c$ for this mark. Allow x^1 and ignore any spurious notation including = 0

dM1 Attempts to substitute $x=9, y=8$ into their f(x) and proceeds to find c. It is dependent on the previous method mark. If they have no + c then this mark cannot be scored.

A1 $(\text{f}(x)=)\ 24x^{\frac{1}{2}}+\frac{x^2}{6}-4x-\frac{83}{2}$ or simplified equivalent. Withhold this mark if they attempt to make the coefficients integers. Do not accept rounded decimals such as $0.166x^2$. Also withhold this mark if spurious notation around the answer is seen such as the integral and dx or an = 0

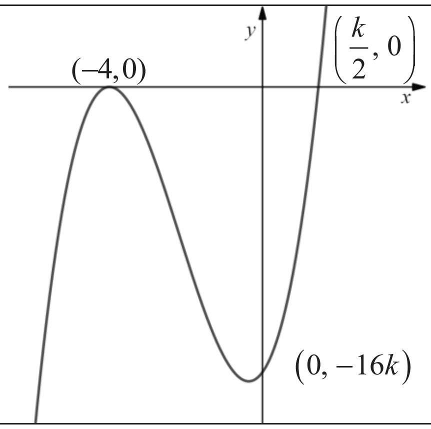
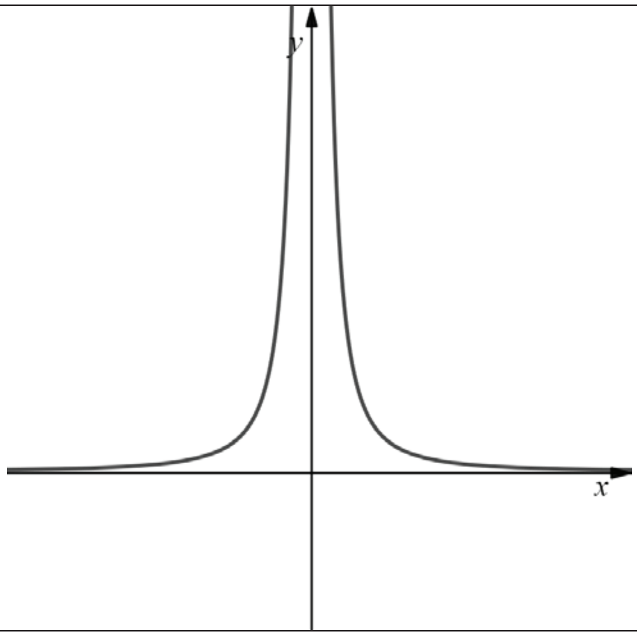
(b)

M1 Attempts to substitute $x = 9$ to find a value for $f'(9)$

dM1 Attempts to find the negative reciprocal to find the gradient of the normal. It is dependent on the previous method mark.

M1 It is for the attempt to find the normal line passing though $(9,8)$, using a changed gradient from $f'(9)$ and substituting $x = 0$. Alternatively, they may just use their gradient of the normal to determine where the line crosses the *y*-axis knowing that for every "3 units to the left it is 1 up". Condone a changed gradient from finding $f''(9)$ instead of from $f'(9)$ for this mark.

A1 $(0, 11)$ or allow it to be written as $x = 0,\ y = 11$

Question Number	Scheme	Marks
6(a)(i)		B1B1B1
		(3)
(a)(ii)		B1B1
		(2)
(b)	One root because the two graphs intersect each other once	B1
		(1)
		(6 marks)

(a)(i) If multiple attempts are made then mark the last attempt. Condone if (i) and (ii) are drawn on the same set of axes

B1 A positive cubic shape with a local maximum and a local minimum drawn anywhere on a set of axes. Do not be concerned regarding the location of the minimum. Mark of the intention to draw a cubic so condone aspects which may appear linear or slips of the pen.

B1 Intersects (not just meet) the *x*-axis at $x = \frac{k}{2}$ to the right of the *y*-axis and has a local maximum (or minimum) on $x = -4$ which must be to the left of the *y*-axis. If there is a contradiction between the labelling on the graph and values stated separately then the graph labels take precedence. Condone for example $(-4, 0)$ labelled as $(0, -4)$ as long as it is in the correct position on the axis

B1 *y*-intercept is $-16k$ (which must be below the *x*-axis) If there is a contradiction between the labelling on the graph and the *y*-intercept stated separately then the graph label takes precedence. Condone for example $(0, -16k)$ labelled as $(-16k, 0)$ as long as it is in the correct position on the axis

(a)(ii)

B1 Correct shaped curve in the first **or** second quadrant. It must not cross either axis. Do not be concerned by any labelled asymptotes or extra "branches" appearing in these quadrants. Mark the intention to draw a graph which does not have a clear turning point.

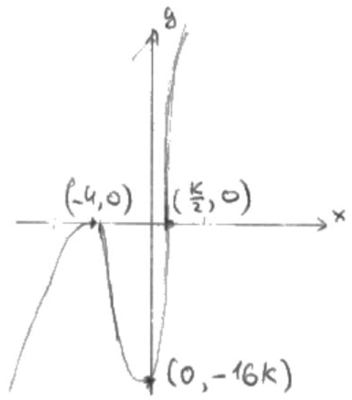
B1 Correct curves in the first **and** second quadrants and no other curves appearing in quadrants 3 and 4 (unless the cubic from (i) has been drawn on the same axes). Mark the intention to draw a graph tending towards the axes and does not have a clear turning point. If any asymptotes are labelled or indicated with dashed lines which are not the coordinate axes then withhold this mark.

(b) This mark can only be awarded provided both graphs are the correct shape and position in part (a) (the intercepts with the axes are not needed for this mark)

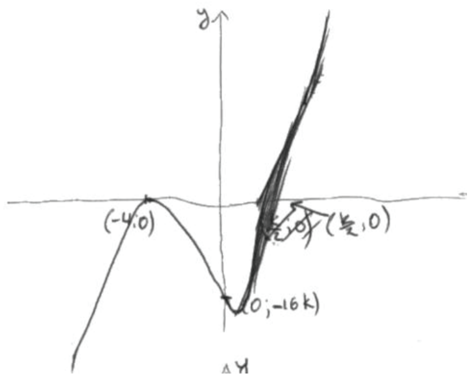
B1 One root because the two graphs intersect each other once (only). Condone alternative wording which implies they "meet" once. Do not allow references to intersecting the axes.

Examples for (a)(i)

B1B1B1

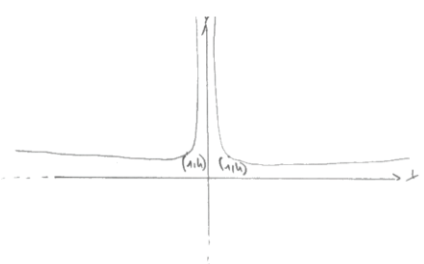


B1B1B1

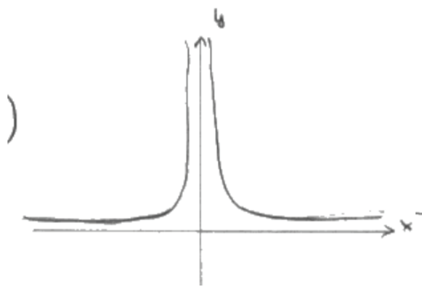


Examples for (a)(ii)

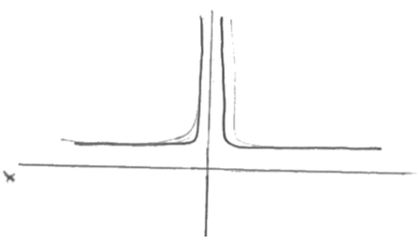
B1B1



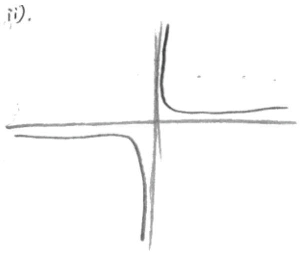
B1B1



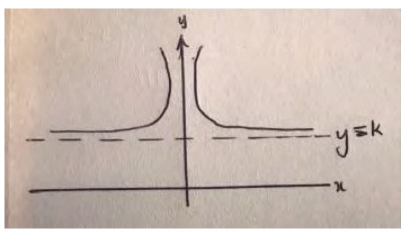
B1B1



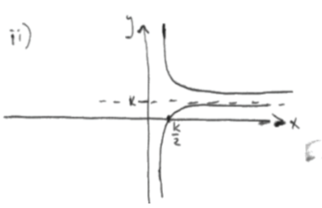
B1B0

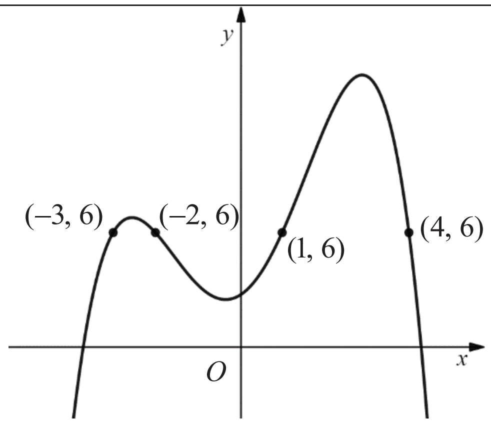


B1B0



B1B0



Question Number	Scheme	Marks
7(a)	$-1 < x < 2$ $x < -4,\ x > 3$	M1A1 B1
		(3)
(b)	$(x =)\ 1.5$	B1
		(1)
(c)(i) **(ii)**	 $-3 \leqslant x \leqslant -2$	B1B1B1 B1
		(4)
		(8 marks)

(a) Ignore any references to OR or AND (or equivalent use of set notation) between $-1 < x < 2$, $x > 3$, $x < -4$

M1 Requires one end of the inside region between -1 and 2. Score for $x > -1$ or $x < 2$, condoning use of $\leqslant$ … Must be in terms of x

A1 $-1 < x < 2$ or any equivalent notation such as $-1 < x \cap x < 2$, $(-1,\ 2)$ and also score for $2 > x > -1$. Do not allow just two separate inequalities for this mark without AND or equivalent.

B1 $x > 3$, $x < -4$

(b)

B1 1.5 or $\frac{3}{2}$ Condone $(1.5,\ 6)$ or $x = 1.5,\ y = 6$ only (the y-coordinate must be correct if stated)

(c)(i) **Check the figure at the start of the question. If there is a contradiction, then the sketch with labelled coordinates in the main body of working takes precedence. There must be a sketch to score any marks.**

B1 Sketch reflected in the y-axis with the intention to have the higher maximum turning point in quadrant 1 and the lower maximum turning point in quadrant 2. Do not be concerned which side of the y-axis the minimum turning point is located.

B1 Either two correct pairs of coordinates **or** all x coordinates correct **or** all y coordinates correct. Do not be concerned with the relative locations of the coordinates in relation to each other. The points must be in the correct quadrants, but may be stated separately. Do not be concerned with the labelling of *P*, *Q*, *R* and *S* and the associated coordinates if they are stated separately.

B1 All four correct coordinates (Do not penalise poor notation and may be listed as $x = ..., y = ...$) Do not be concerned with the relative locations of the coordinates in relation to each other. The points must be in the correct quadrants, but may be stated separately. Do not be concerned with the labelling of *P*, *Q*, *R* and *S* and the associated coordinates if they are stated separately.

(ii)

B1 $-3 \leqslant x \leqslant -2$ only or any equivalent notation such as $-3 \leqslant x \cap x \leqslant -2$, $-3 \leqslant x$ AND $x \leqslant -2$. [–3, 2] but do not accept use of OR or $\cup$ if set notation is used.
Do not accept $(-3, -2)$ or $-3 < x < -2$ Must be in terms of x
There may be several inequalities. Mark what appears to be their final answer.

Question Number	Scheme	Marks
8(a)(i)	$2\pi - \frac{2\pi}{3} = \frac{4\pi}{3}$	B1
	Area of sector $= \frac{1}{2} \times 3^2 \times "\frac{4}{3}\pi" = 6\pi \quad (\text{m}^2)$	M1A1
(ii)	Length of arc $= 3 \times "\frac{4}{3}\pi" \Rightarrow$ Perimeter $= 4\pi + 6$ (m)	M1A1
		(5)
(b)	$\frac{1}{2} \times 3^2 \times \sin\left(\frac{2}{3}\pi\right) = \frac{9\sqrt{3}}{4} \quad (\text{m}^2)$	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)	$\frac{\sin BAC}{8} = \frac{\sin\left(\frac{\pi}{6}\right)}{3\sqrt{3}} \Rightarrow \sin BAC = \text{....}$ or $BAC = \text{...}$	M1
	$\sin BAC = \text{awrt } \frac{4\sqrt{3}}{9}$ or $BAC = \text{awrt } 0.88 \quad (0.8785\ldots)$	A1
	Area $ABC = \frac{1}{2} \times 3\sqrt{3} \times 8 \times \sin(\pi - \frac{\pi}{6} - "0.88") \quad (= 20.4896....)$	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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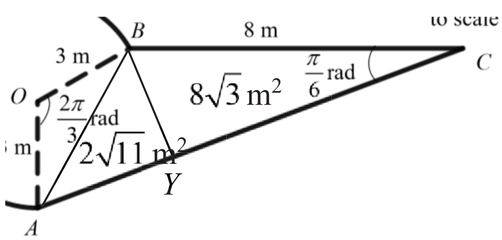
Alt (d) Forms two right angled triangles with the perpendicular to side AC from point B



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
	$\frac{1}{2}x^2-10x+22=\frac{1}{2}(x\pm 10)^2\pm...$ or states $a=\frac{1}{2}$ and $b=\pm 10$	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
	$\frac{\mathrm{d}y}{\mathrm{d}x}=x-10=8\Rightarrow x=...$	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 $\frac{1}{2}x^2-10x+22=\frac{1}{2}(x\pm 10)^2\pm...$ or states that $a=\frac{1}{2}$ & $b=\pm 10$ (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

(b)

B1ft One of the coordinates of $(10, -28)$ or follow through one of their $(-b, c)$ from (a).

B1ft $(10, -28)$ or follow through their $(-b, c)$ from (a). Accept $x = "10"$, $y = "-28"$. Condone lack of bracketing as long as the intention as to which coordinate is which is clear.

(c)(i)

B1 Gradient of tangent $= 8$ (stated or implied)

M1 Differentiates $\frac{1}{2}x^2 - 10x + 22$ to achieve a derivative of the form $px + q$ and sets equal to 8. They then proceed to find a value for *x*.
Alternatively, sets $8x + \alpha = \frac{1}{2}x^2 - 10x + 22$, proceeds to a quadratic in *x*, sets the discriminant = 0 and solves to find α. They then use this value of α in their original equation to solve and find *x*

A1 $x = 18$

A1 $y = 4$

(c)(ii)

dM1 Sets $k - \frac{1}{8} \times "18" = "4"$ and proceeds to find a value for *k*. It is dependent on the method mark in (i)

A1 $k = \frac{25}{4}$ oe

(d) **Ignore any references to OR or AND (or equivalent use of set notation)**

Note that $\frac{1}{2}x^2 - 10x + 22 \leq y \leq "\frac{25}{4}" - \frac{1}{8}x$ is acceptable and counts as two of the required inequalities in part (d)
Use of strict or inclusive inequalities must be consistent for all of their inequalities on the last mark only

B1ft One of $x \geq "10"$ (or $"10" \leq x \leq d$ where *d* is at least 18) or $y \leq "\frac{25}{4}" - \frac{1}{8}x$ or $y \geq \frac{1}{2}x^2 - 10x + 22$ follow through on their minimum point or their *k*. Allow if *l* is still in terms of *k*

B1ft Two of $x \geq "10"$ (or $10 \leq x \leq d$ where *d* is at least 18) or $y \leq "\frac{25}{4}" - \frac{1}{8}x$ or $y \geq \frac{1}{2}x^2 - 10x + 22$ follow through on their minimum point or their *k*. Allow if *l* is still in terms of *k*

B1 All three of $x \geq 10$ (or $10 \leq x \leq d$ where *d* is at least 18), $y \leq \frac{25}{4} - \frac{1}{8}x$ and $y \geq \frac{1}{2}x^2 - 10x + 22$. Condone the additional minimum interval (or greater) $-28 \leq y \leq 5$