Pearson

Mark Scheme (Results)

January 2026

Pearson Edexcel International Advanced Level in
Pure Mathematics P1
WMA11/01A

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL IAL MATHEMATICS
General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

   - **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - **B** marks are unconditional accuracy marks (independent of M marks)

   Marks should not be subdivided.

3. Abbreviations

   These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN:

   - bod – benefit of doubt
   - ft – follow through
     - the symbol $\sqrt{}$ will be used for correct ft
   - cao – correct answer only
   - cso – correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC – special case
   - oe – or equivalent (and appropriate)
   - d… or dep – dependent
   - indep – independent
   - dp – decimal places
   - sf – significant figures
   - ∗ – The answer is printed on the paper or ag- answer given

- ⌊ or d… – The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected. If you are using the annotation facility on ePEN, indicate this action by 'MR' in the body of the script.

6. If a candidate makes more than one attempt at any question:
   a) If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   b) If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

General Principles for Pure Mathematics Marking

(NB specific mark schemes may sometimes override these general principles)

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$ leading to $x = \ldots$

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$ leading to $x = \ldots$

2. Formula

Attempt to use correct formula (with values for a, b and c)

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c, \quad q \neq 0$ leading to $x = \ldots$

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1 ($x^n \to x^{n-1}$)

2. Integration

Power of at least one term increased by 1 ($x^n \to x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are small mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Answers without working

The rubric says that these may not gain full credit. Individual mark schemes will give details of what happens in particular cases. General policy is that if it could be done "in your head", detailed working would not be required. Most candidates do show working, but there are occasional awkward cases and if the mark scheme does not cover this, please contact your team leader for advice.

Question Number	Scheme	Marks
1(a)	$4(x-5)<2x-9 \Rightarrow 4x-20<2x-9 \Rightarrow x<...$	M1
	$\Rightarrow x<\frac{11}{2}$	A1
		(2)
(b)	$2x^2-5x-63=0 \Rightarrow (2x+9)(x-7)=0 \Rightarrow x=-\frac{9}{2},7$	M1
	$-\frac{9}{2} \leqslant x \leqslant 7$	**d**M1 A1
		(3)
(c)	$-\frac{9}{2} \leqslant x<\frac{11}{2}$	B1
		(1)
		(6 marks)

Notes

(a)

M1: Attempts to expand the brackets or e.g. divide by 4, collect terms and proceeds to $x\square...$ where $\square$ is any inequality or "=".

A1: $x<\frac{11}{2}$ oe e.g. $x<5.5, (-\infty, 5.5)$ Apply isw once a correct answer is seen.

(b)

M1: Multiplies out the brackets, rearranges and attempts to solve a 3TQ by any **non-calculator** means. Apply the general guidance for solving a 3TQ by factorisation, formula or completing the square. If roots are just written down, this scores M0

Note that e.g. $2x^2-5x-63=0 \Rightarrow x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=-\frac{9}{2},7$ scores M0

But $2x^2-5x-63=0 \Rightarrow x=\frac{5\pm\sqrt{5^2-4(-63)(2)}}{2\times 2}$ or $\frac{5\pm 23}{4}=-\frac{9}{2},7$ scores M1

dM1: Chooses the inside region for their critical values found via a non-calculator method.

Condone strict inequalities e.g. $-\frac{9}{2}<x<7$ or e.g. $x>-\frac{9}{2}, x<7$

Depends on the previous mark.

A1: $-\frac{9}{2} \leqslant x \leqslant 7$ Allow "$x \geqslant -\frac{9}{2}$ **and** $x \leqslant 7$" or $\left[-\frac{9}{2}, 7\right]$ or $7 \geqslant x \geqslant -\frac{9}{2}$

but **not** "$x \geqslant -\frac{9}{2}$ or $x \leqslant 7$" and not "$x \geqslant -\frac{9}{2}, x \leqslant 7$"

Apply isw once a correct answer is seen but there must be no contradictory inequalities.

(c)

B1: $-\frac{9}{2} \leqslant x<\frac{11}{2}$ Allow "$x \geqslant -\frac{9}{2}$ **and** $x<\frac{11}{2}$" or $\left[-\frac{9}{2}, \frac{11}{2}\right)$ or $\frac{11}{2}>x \geqslant -\frac{9}{2}$

but **not** "$x \geqslant -\frac{9}{2}$ or $x<\frac{11}{2}$" and not "$x \geqslant -\frac{9}{2}, x<\frac{11}{2}$"

Apply isw once a correct answer is seen but there must be no extra inequalities.

Question Number	Scheme	Marks
2(i)	Uses a correct law of indices on 4^{2y+1} or 32^{4y} The possibilities are endless but some more common examples are: **For** 4^{2y+1} **:** $4^{2y}\times 4,\quad 2^{2(2y+1)},\quad \left(2^2\right)^{2y}\times 2^2$ **For** 32^{4y} **:** $\left(2^5\right)^{4y},\quad 2^{5\times 4y},\quad 2^{20y},\quad \left(4^{\frac{5}{2}}\right)^{4y},\quad 4^{10y}$	M1
	e.g. $2^{4y+2}=\dfrac{2^{20y}}{2}\Rightarrow 2^{4y+3}=2^{20y}\Rightarrow 4y+3=20y\Rightarrow y=...$ or e.g. $4^{2y+1}=\dfrac{4^{10y}}{2}\Rightarrow 4^{2y+1}=4^{10y-\frac{1}{2}}\Rightarrow 2y+1=10y-\dfrac{1}{2}\Rightarrow y=...$	**d**M1
	$y=\dfrac{3}{16}$	A1
		(3)

(i) Notes

This part of the question can be solved in many different ways.

If you are unsure if a particular approach deserves credit, seek advice from your TL

M1: This is effectively a B mark and is for applying a correct law of indices on 4^{2y+1} or 32^{4y}
This may be seen in isolation i.e. not necessarily within the equation but not just e.g. $4=2^2$
See scheme for some examples.

dM1: Reaches a value for y condoning arithmetic slips but with no incorrect index work e.g.
$2\times 4^{2y}=8^{2y}$ or e.g. $\dfrac{4^{10y}}{2}=2^{10y}$ or e.g. $\dfrac{32^{4y}}{2}=16^{4y}$
See main scheme for examples of acceptable work.
See also supplementary document for some example responses with marks.
Depends on the first method mark.

A1: Fully correct work leading to $y=\dfrac{3}{16}$ oe e.g. $y=\dfrac{6}{32}$ or 0.1875 following award of both Method marks.

Correct answers with no working in (i) score no marks.

See extra document for some examples.

(ii)	$$x\sqrt{27}+21=\frac{6x}{\sqrt{3}}$$	
	E.g. $\sqrt{27}=3\sqrt{3}$, $\frac{6}{\sqrt{3}}=\frac{6\sqrt{3}}{3}$ or $2\sqrt{3}$, $\sqrt{27}\times\sqrt{3}=9$	B1
	$\left(3\sqrt{3}-2\sqrt{3}\right)x=-21$ or e.g. $3x=-21\sqrt{3}$	M1
	$x=-\frac{21}{\sqrt{3}}=-7\sqrt{3}$	**d**M1 A1
		(4)
		(7 marks)

(ii) Notes

B1: Correct surd work seen. E.g. $\sqrt{27}=3\sqrt{3}$, $\frac{6}{\sqrt{3}}=\frac{6\sqrt{3}}{3}$ or $2\sqrt{3}$, $\sqrt{27}\times\sqrt{3}=9$

M1: Attempts to collect terms in x

dM1: Attempts to write the answer in the form $a\sqrt{b}$ where $\sqrt{b}$ is irrational. **Depends on the previous method mark.**

A1: cso $x=-7\sqrt{3}$

Correct answers with no working in (ii) score no marks.

Question Number	Scheme	Marks
3(a)	$\mathrm{f}(x)=\dfrac{16+24\sqrt{x}+9x}{x}$	
	$=16x^{-1}+24x^{-\frac{1}{2}}+9$	M1 A1
	$\left(\mathrm{f}'(x)=\right)-16x^{-2}-12x^{-\frac{3}{2}}$	M1 A1 A1cso
		(5)

(a) Notes

M1: Expands the numerator into a **3 or 4 term** quadratic expression in $\sqrt{x}$ **and** attempts to divide each term by x.

Award this mark for $\left(4+3\sqrt{x}\right)^2 \to p+q\sqrt{x}+rx\left(\text{or}\left(\sqrt{x}\right)^2\right)$, $p,q,r\neq 0$ followed by at least one of,

$\dfrac{p}{x}$ or $\dfrac{q}{\sqrt{x}}$ oe or r.

A1: Correct expression e.g. $16x^{-1}+24x^{-\frac{1}{2}}+9$ or equivalent e.g. $\dfrac{16}{x}$ for $16x^{-1}$ or $\dfrac{12}{\sqrt{x}}+\dfrac{12}{\sqrt{x}}$ for $24x^{-\frac{1}{2}}$

M1: Reduces a **correct index of *x*** by 1 when differentiating.

It is for one of $...x^{-1}\to ...x^{-2}$ or $...x^{-\frac{1}{2}}\to ...x^{-\frac{3}{2}}$ or $...x^{-1}\to ...x^{-1-1}$ or $...x^{-\frac{1}{2}}\to ...x^{-\frac{1}{2}-1}$

A1: One correct simplified term.

It is for $-16x^{-2}$ oe e.g. $-\dfrac{16}{x^2}$ or for $-12x^{-\frac{3}{2}}$ oe e.g. $-\dfrac{12}{x^{\frac{3}{2}}}$

Apply isw once a correct simplified term is seen.

A1cso: Fully correct and simplified expression $-16x^{-2}-12x^{-\frac{3}{2}}$ oe e.g. $-\dfrac{16}{x^2}-\dfrac{12}{x^{\frac{3}{2}}}$

Do not allow e.g. $-\dfrac{16}{x^2}+-\dfrac{12}{x^{\frac{3}{2}}}$ and do not allow $-\dfrac{16}{x^2}-\dfrac{12}{x^{\frac{3}{2}}}+c$

Apply isw once a correct simplified expression is seen. "$\mathrm{f}'(x)=$" is not required.

See next page for attempts to use the product or quotient rule.

<u>Special case:</u>

It is possible to obtain a correct derivative with an incorrect expansion in the numerator e.g.

$$\mathrm{f}(x)=\frac{16+24\sqrt{x}+kx}{x}=\frac{16}{x}+24x^{-\frac{1}{2}}+k\Rightarrow\left(\mathrm{f}'(x)=\right)-16x^{-2}-12x^{-\frac{3}{2}}$$

If *k* is incorrect, this scores SC M1A0M1A1A0 in (a) but allow full recovery in (b)

(b)	$\mathrm{f}'(4) = -1 - \dfrac{12}{8} = -2\tfrac{1}{2}$	M1
	$y - 25 = -\dfrac{5}{2}(x-4) \Rightarrow y = -\dfrac{5}{2}x + 35$ or $y = -\dfrac{5}{2}x + c \Rightarrow 25 = -\dfrac{5}{2}\times 4 + c \Rightarrow c = ...$ $\Rightarrow y = -\dfrac{5}{2}x + 35$	**d**M1 A1
		(3)
		8 marks

(b) Notes

M1: Substitutes $x = 4$ into their $\mathrm{f}'(x)$ from part (a) to find a value which may be implied. There must have been an attempt to differentiate so do not allow for finding e.g. $\mathrm{f}(4)$. If no substitution is seen and their value is incorrect for their derivative (you may need to check) then score M0

dM1: Attempts an equation of the tangent (**not the normal**) at (4, 25) using a correct method with the values correctly placed. If using $y = mx + c$ must reach as far as finding a value for c. **Depends on the first method mark.**

A1: $y = -\dfrac{5}{2}x + 35$ oe e.g. $y = -2.5x + 35$

<u>Part (a) Using quotient rule:</u>

$$\mathrm{f}(x) = \frac{\left(4+3\sqrt{x}\right)^2}{x} \Rightarrow \mathrm{f}'(x) = \frac{x \times 2\left(4+3\sqrt{x}\right)\times \tfrac{3}{2}x^{-\frac{1}{2}} - \left(4+3\sqrt{x}\right)^2}{x^2}$$

M1 for $\mathrm{f}'(x) = \dfrac{...x\left(4+3\sqrt{x}\right)\times x^{-\frac{1}{2}} - \left(4+3\sqrt{x}\right)^2}{x^2}$

A1 can then be scored for fully correct differentiation

Then,

M1 for an attempt to expand, collect terms and simplify to obtain $\dfrac{...x^{\frac{1}{2}} + ...}{x^2}$

A1 for $\dfrac{-12x^{\frac{1}{2}} - 16}{x^2}$

A1 for $-\dfrac{16}{x^2} - \dfrac{12}{x^{\frac{3}{2}}}$

<u>Part (a) Using product rule:</u>

$$\mathrm{f}(x) = \frac{\left(4+3\sqrt{x}\right)^2}{x} = x^{-1}\left(4+3\sqrt{x}\right)^2 \Rightarrow \mathrm{f}'(x) = x^{-1}\times 2\left(4+3\sqrt{x}\right)\times \tfrac{3}{2}x^{-\frac{1}{2}} + \left(4+3\sqrt{x}\right)^2 \times -x^{-2}$$

M1 for $\mathrm{f}'(x) = ...x^{-1}\left(4+3\sqrt{x}\right)\times x^{-\frac{1}{2}} + ...\left(4+3\sqrt{x}\right)^2 x^{-2}$

A1 can then be scored for fully correct differentiation

Then,

M1 for an attempt to expand, collect terms and simplify to obtain $...x^{-\frac{3}{2}}$ or $...x^{-2}$

Then the **A** marks as in the main scheme.

Question Number	Scheme	Marks
4(a)(i)	$(0, 4)$	B1
(ii)	$(6, 13)$	B1

(a) Notes

(i)

B1: Allow the coordinates to be written separately as $x = \ldots, y = \ldots$ and allow $y = 4$ as long as there is no suggestion that x is anything other than 0.

Condone missing brackets e.g. $0, 4$ or unusual punctuation e.g. $(0;4)$ or a vector e.g. $\begin{pmatrix} 0 \\ 4 \end{pmatrix}$

Do **not** allow coordinates the wrong way round unless the correct answer is seen previously then apply isw.

Condone $\frac{8}{2}$ for 4.

Do not allow $P = 4$

(ii)

B1: Allow the coordinates to be written separately as $x = \ldots, y = \ldots$

Condone missing brackets e.g. $6, 13$ or unusual punctuation e.g. $(6;13)$ or a vector e.g. $\begin{pmatrix} 6 \\ 13 \end{pmatrix}$

Do **not** allow coordinates the wrong way round unless the correct answer is seen previously then apply isw.

Condone $\frac{26}{2}$ for 13.

Allow work that implies the correct coordinates e.g. $x = 6 \rightarrow 2y = 18 + 8 = 26 \rightarrow y = 13$

(b)	The gradient of line $l_1 = \frac{3}{2}$ oe	B1
	Perpendicular gradient $"-\frac{2}{3}"$	M1
	$y-"13"="-\frac{2}{3}"(x-6)$ or $y="-\frac{2}{3}"x+c \Rightarrow "13"="-\frac{2}{3}"\times 6+c \Rightarrow c=...$	M1
	$2x+3y-51=0$	A1
		(4)
(c)	$y=0 \Rightarrow 2x-51=0 \Rightarrow x=...\left(\frac{51}{2}\right)$	M1
	Full and correct method of finding required area e.g. trapezium + triangle: $\frac{6}{2}("4"+"13")+\frac{1}{2}\times"13"\times\left("\frac{51}{2}"-6\right)$	**d**M1
	= 177.75	A1
		(3)
		(9 marks)

Notes

(b)

B1: The gradient of line $l_1 = \frac{3}{2}$ oe which may be implied.

M1: Attempts $l_2 = -\frac{1}{\text{their gradient of } l_1}$ which may be implied.

M1: Uses $x = 6$ and their y coordinate of Q with a changed $"\frac{3}{2}"$ in an attempt to find an equation for l_2 using a correct method with the values correctly placed.

If using $y = mx + c$ must reach as far as finding a value for c.

A1: $2x+3y-51=0$ or any integer multiple of this equation. (Allow terms in any order).

(c)

M1: Substitutes $y = 0$ into their equation from part (b) to find the x coordinate of R.

dM1: For a full and correct method using their values to find the area of shape $OPQR$

e.g. trapezium + triangle. (See scheme)

e.g. rectangle + triangle + triangle $"4"\times 6+\frac{6}{2}("13"-"4")+\frac{1}{2}\times"13"\times\left("\frac{51}{2}"-6\right)$

e.g. triangle PQR + triangle OPR $\frac{1}{2}\sqrt{\left(6-"\frac{51}{2}"\right)^2+"13"^2}\times\sqrt{6^2+("13"-"4")^2}+\frac{1}{2}\times"\frac{51}{2}"\times"4"$

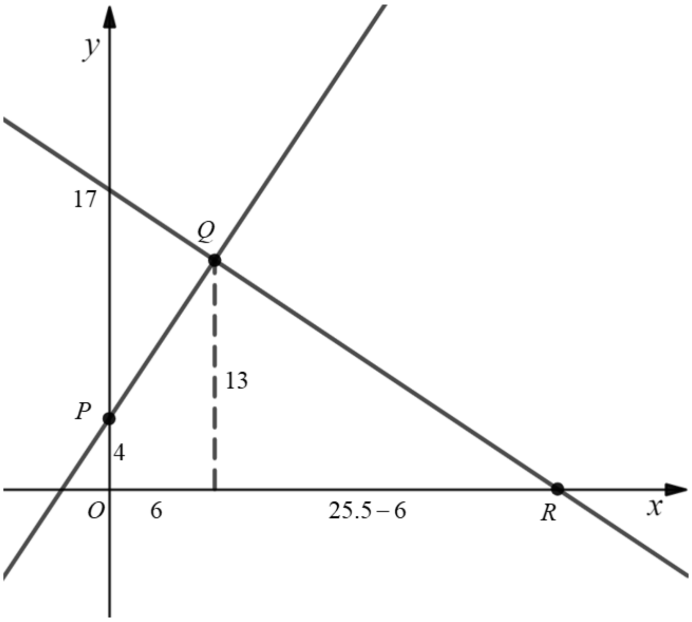
e.g. rectangle + triangle − triangle $6\times"13"-\frac{1}{2}("13"-"4")\times 6+\frac{1}{2}\times"13"\times\left("\frac{51}{2}"-6\right)$

May see shoelace method for areas e.g. for PQR: $\frac{1}{2}\begin{vmatrix} 0 & \frac{51}{2} & 6 & 0 \\ 4 & 0 & 13 & 4 \end{vmatrix} = \frac{1}{2}\left(\frac{51}{2}\times 13+6\times 4-\frac{51}{2}\times 4\right)$

Depends on the first method mark.

A1: 177.75 oe e.g. $\frac{711}{4}$

4(c) Further guidance:



There are lots of different methods to find the total area so look carefully at their work.

e.g. triangle – triangle: $\frac{1}{2}\times 17\times 25.5-\frac{1}{2}(17-4)\times 6$

An unusual one is triangle *OPQ* + triangle *OQR* = $\frac{1}{2}\times 4\times 6+\frac{1}{2}\times 25.5\times 13$

Allow integration attempts e.g. $\int_0^6\left(\frac{3}{2}x+4\right)\mathrm{d}x+\int_6^{\frac{51}{2}}\left(17-\frac{2}{3}x\right)\mathrm{d}x=...$

In this case, an attempt to evaluate the expression as shown is fine for the method mark and allow A1 if correctly evaluated on a calculator.

If you are unsure if a particular method deserves credit then use Review.

Question Number	Scheme	Marks
5(a)	(8, 5)	B1
		(1)
(b)	$y=7$	B1
		(1)
(c)	$5<k<10$	M1A1
		(2)

Notes

(a)

B1: Accept (8, 5) or $x = 8, y = 5$ or a sketch of $y=\mathrm{f}\left(\frac{1}{4}x\right)$ with a minimum point marked at (8, 5)

Condone missing brackets e.g. 8, 5 or unusual punctuation e.g. $(8;\,5)$ or a vector e.g. $\begin{pmatrix}8\\5\end{pmatrix}$

Do **not** allow coordinates the wrong way round unless the correct form is seen previously then apply isw.

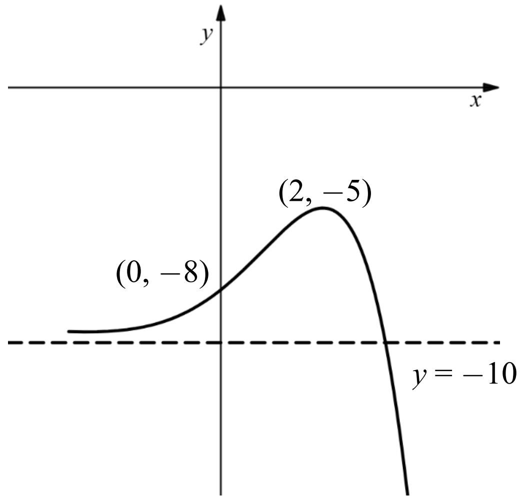
(b)

B1: $y=7$. It must be an equation and not just '7'

(c)

M1: For one "end" of the interval condoning strictness so allow for $k > 5$, $k\geqslant 5$, $k < 10$, $k\leqslant 10$
Condone use of x or y rather than k for this mark.

A1: cao $5<k<10$. Allow "$k>5$ **and** $k< 10$", $(5, 10)$, $\{k\in\mathbb{R}:5<k<10\}$
Must be in terms of k.
Do not allow "$k > 5$ **or** $k < 10$" or "$k > 5$, $k < 10$"

(d)		Shape	B1
		(0, −8) and (2, −5)	B1
		Asymptote	B1
			(3)
			(7 marks)

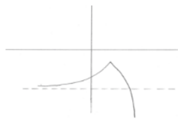
(d) Notes

There must be a sketch to score any marks.

If the original curve is included on their sketch it can be ignored.

If more than 1 sketch is given, mark the final attempt.

B1: For a reflection of the original curve in the x-axis.
The curve must be in quadrants 3 and 4 only.
There should be a maximum in quadrant 4.

Condone a maximum that is cusp-like e.g.  as long as the intention is clear.

The right hand tail should be below the left hand tail i.e. must at least touch the asymptote if it was drawn.
Condone a right hand tail that starts to bend to the right as long as it does not head back towards the x-axis to create a clear minimum.
The coordinates of the y intercept, the maximum and the position of the asymptote can be ignored for this mark.

B1: For the intercept of (0, −8) and the maximum point (2, −5) correctly labelled that correspond with the sketch.
Allow −8 marked in the correct place and condone $(-8, 0)$ as long as it is the correct place.
Allow the $(2, -5)$ to be indicated by the labels 2 and −5 on the appropriate axes.
Allow to appear away from the sketch but they must be fully correct.
If there is any ambiguity, the sketch takes precedence.

B1: For the asymptote equation of $y = -10$ that corresponds with their sketch.
It must be an **equation** i.e. not just −10 marked on the y-axis.
The curve must be asymptotic to $y = -10$ from above for one of the branches.

See extra document for some example sketches.

Question Number	Scheme	Marks
6(a)	$\frac{\sin DAO}{1.8}=\frac{\sin 0.84}{3.9}\Rightarrow DAO=\text{awrt }0.351$ (NB sin DAO = 0.343681…)	M1A1
		(2)
(b)	Angle $ADO=\pi-0.84-\text{'}0.351\text{'}=(1.95)$	M1
	Uses $AO^2=1.8^2+3.9^2-2\times1.8\times3.9\cos\text{'}1.95\text{'}\Rightarrow AO=...$	M1
	$AO=$ awrt 4.86 (m)	A1
		(3)
	(b) Alternative 1	
	$3.9^2=1.8^2+AO^2-2\times1.8\times AO\cos0.84$	M1
	$AO^2-2.41AO-11.97=0\Rightarrow AO=4.86,$ ~~-2.46~~	M1A1
	(b) Alternative 2	
	$1.8^2=3.9^2+AO^2-2\times3.9\times AO\cos\text{"}0.351\text{"}$	M1
	$AO^2-7.32AO+11.97=0\Rightarrow AO=4.86,$ ~~2.46~~	M1A1
	(b) Alternative 3	
	$ON=1.8\cos0.84$ or $AN=3.9\cos\text{"}0.351\text{"}$ (See diagram below for position of N)	M1
	$AO=1.8\cos0.84+3.9\cos\text{"}0.351\text{"}=...$	M1
	$AO=$ awrt 4.86 (m)	A1

Notes

(a)

M1: Uses the sine rule in an attempt to find angle DAO which is not their sin DAO.
The sides and angles must be in the correct position within the formula.

A1: Proceeds correctly to obtain $DAO=$ awrt 0.351

Do not be concerned with incorrect labels or notation e.g. $AOD=$ awrt 0.351 if the intention is clear.

For the rest of the question, allow the method marks for the use of what they think is angle *DAO* e.g. even if they use 0.3436…

(b)

M1: States or uses angle $ADO=\pi-0.84-$ their 0.351 (Must be seen in (b))
May be implied by ADO = awrt 1.95 (rads) or by their value.

M1: Uses $AO^2=1.8^2+3.9^2-2\times1.8\times3.9\cos(k\pi-0.84-\text{their }0.351)$ or

$$\frac{AO}{\sin(k\pi-0.84-\text{their }0.351)}=\frac{3.9}{\sin0.84}$$ with k = 1 or 2 in an attempt to find a value for AO.

A1: For $AO=$ awrt 4.86 (m) Units are not required but if any are given they must be correct.

Alternative 1:

M1: Sets up a correct quadratic equation in AO using the cosine rule with angle AOD.

M1: Collects terms, simplifies and solves a 3TQ in AO or their variable.

A1: For $AO=$ awrt 4.86 (m) Units are not required but if any are given they must be correct.

Alternative 2:

M1: Sets up a correct quadratic equation in AO using the cosine rule with angle DAO.

M1: Collects terms, simplifies and solves a 3TQ in AO or their variable.

A1: For $AO=$ awrt 4.86 (m) Units are not required but if any are given they must be correct.

Alternative 3:

M1: Correct attempt at either ON or AN

M1:	Complete method to find a value for AO
A1:	For $AO =$ awrt 4.86 (m) Units are not required but if any are given they must be correct.
Must come from correct work in part (a) unless they re-start.	

(c)	Area of sector $=\frac{1}{2}\times1.8^2\times(2\pi-0.84)$ $(=\text{awrt } 8.8)$ (NB $2\pi-0.84=5.44318...$) **or** Area of triangle $=\frac{1}{2}\times1.8\times\text{"4.9"}\times\sin0.84$ $(=\text{awrt } 3.3)$ Or Area of triangle $=\frac{1}{2}\times1.8\times3.9\times\sin(\pi-0.84-\text{"0.351"})$ $(=\text{awrt } 3.3)$	M1
	Total Area $=\frac{1}{2}\times1.8^2\times(2\pi-0.84)+\frac{1}{2}\times1.8\times\text{"4.9"}\times\sin0.84=...$	**d**M1
	= 12.1 (m^2)	A1
		(3)
(d)	Arc *BCD* = $1.8\times(2\pi-0.84)$ $(=9.8)$	M1
	$\text{'9.8'}+3.9+\text{"4.86"}-1.8=...$ or e.g. $2\pi\times1.8-0.84\times1.8+\text{"4.86"}-1.8+3.9=...$	**d**M1
	Perimeter of shop sign = 16.8 (m)	A1
		(3)
		(11 marks)

Notes

(c)

M1: Correct attempt at the area of sector *DOBCD* **or** the area of triangle *ADO* following through their *AO* from part (b). There may be other methods seen for these areas e.g.

The area of the sector may be seen as $\pi\times1.8^2-\frac{1}{2}\times1.8^2\times0.84$

The area of the triangle may be seen as $\frac{1}{2}\times1.8\times3.9\times\sin(\pi-0.84-\text{"0.351"})$ or

$\frac{1}{2}\times(1.8\cos0.84+3.9\cos\text{"0.351"})\times1.8\sin0.84$ or $=\frac{1}{2}\times3.9\times\text{"4.86"}\times\sin\text{"0.351"}$

dM1: Complete and correct attempt at the area of the shop sign e.g.

$\frac{1}{2}\times1.8^2\times(2\pi-0.84)+\frac{1}{2}\times1.8\times\text{"4.9"}\times\sin0.84$

Depends on the previous mark.

A1: For awrt 12.1 Units are not required but if any are given they must be correct.

Note that it is also possible via Circle + Triangle – Minor sector

$$\text{e.g. } \pi\times1.8^2+\frac{1}{2}\times1.8\times\text{"4.9"}\times\sin0.84-\frac{1}{2}\times1.8^2\times0.84$$

In these cases, the scheme can be applied in the same way i.e. M1 for area of Circle – Minor sector or area of triangle and **d**M1 for a complete and correct method Circle + Triangle – Minor sector

Must come from correct work in part (a) unless they re-start.

(d)

M1: Attempt to find the length of the major arc using a correct method.

Accept $1.8\times(2\pi-0.84)$ or equivalent e.g. $2\pi\times1.8-0.84\times1.8$

dM1: Complete and correct method for the perimeter.

A1: Awrt 16.8 Units are not required but if any are given they must be correct.

Must come from correct work in parts (a) and (b) unless they re-start.

Attempts using **degrees** are acceptable and values and example working are as follows:

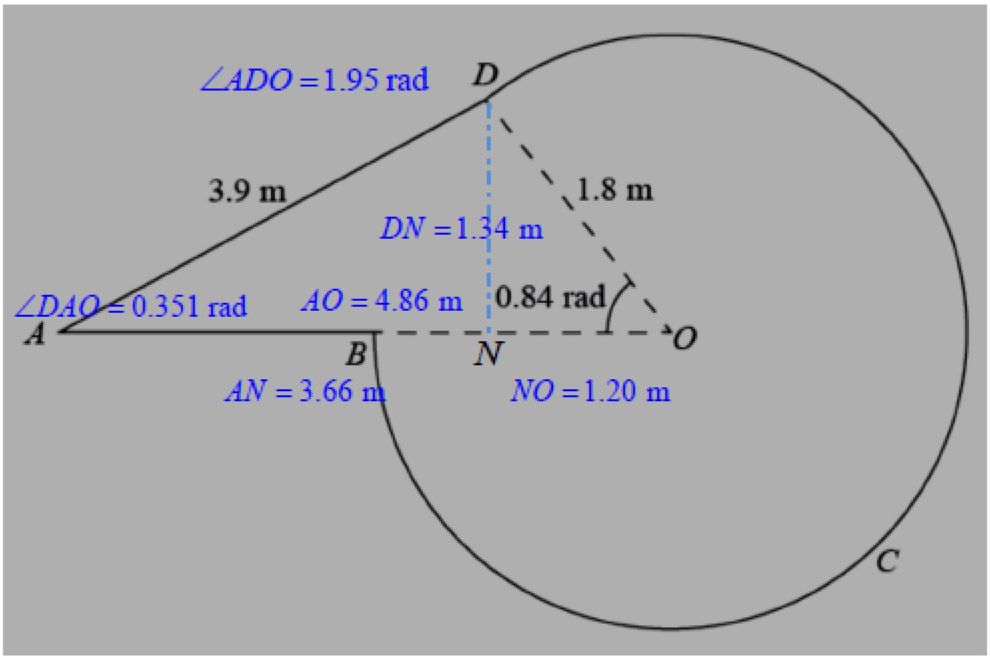
(a) M1: $\frac{\sin DAO}{1.8} = \frac{\sin 48}{3.9}$ A1: $DAO = 20.1^\circ$ = awrt 0.351

(b) M1: $ADO = \pi - 48^\circ -$ their 20.1° M1: $AO^2 = 1.8^2 + 3.9^2 - 2\times 1.8\times 3.9\cos "111.8^\circ"$

(c) M1: $\frac{360^\circ - 48^\circ}{360}\times\pi\times 1.8^2$ **or** $\frac{1}{2}\times 1.8\times 4.9\sin 48^\circ$ dM1 $\frac{360^\circ - 48^\circ}{360}\times\pi\times 1.8^2 + \frac{1}{2}\times 1.8\times 4.9\sin 48^\circ$

(d) M1: Arc length $\frac{360^\circ - 48^\circ}{360}\times 2\pi\times 1.8$

Diagram for reference:



Question Number	Scheme	Marks
7(a)	$\left(\mathrm{f}(x)=\right)\int\left(3\sqrt{x}-\frac{9}{x\sqrt{x}}+\frac{4}{3}\right)\mathrm{d}x=\int\left(3x^{\frac{1}{2}}-9x^{-\frac{3}{2}}+\frac{4}{3}\right)\mathrm{d}x$ $=\frac{3x^{\frac{3}{2}}}{\frac{3}{2}}-\frac{9x^{-\frac{1}{2}}}{-\frac{1}{2}}+\frac{4}{3}x\ \ (+c)$	M1 A1 A1
	$x=9, y=20\rightarrow 20=\frac{3(9)^{\frac{3}{2}}}{\frac{3}{2}}-\frac{9(9)^{-\frac{1}{2}}}{-\frac{1}{2}}+\frac{4}{3}(9)+c\Rightarrow c=...$	**d**M1
	$\left(\mathrm{f}(x)=\right)2x^{\frac{3}{2}}+18x^{-\frac{1}{2}}+\frac{4}{3}x\ -52$	A1
		(5)

(a) Notes

M1: Evidence of integration, so $x^n\rightarrow x^{n+1}$ at least once on a correct index.

It is for $3\sqrt{x}\rightarrow ...x^{\frac{3}{2}}$ or $\frac{9}{x\sqrt{x}}\rightarrow ...x^{-\frac{1}{2}}$ or $\frac{4}{3}\rightarrow\frac{4}{3}x$

Allow unprocessed indices e.g. $3\sqrt{x}\rightarrow ...x^{\frac{1}{2}+1}$ or $\frac{9}{x\sqrt{x}}\rightarrow ...x^{-\frac{3}{2}+1}$ or $\frac{4}{3}\rightarrow\frac{4}{3}x^{0+1}$

A1: One correct term which may be unsimplified but indices must be processed.

A1: Fully correct unsimplified or simplified expression.
The "+ c" is not required and f(x) = is not required.
Ignore any spurious notation e.g. integral symbols.

dM1: Uses x = 9 and y = 20 in a changed expression to find their c.
Dependent upon the first method mark.

A1: $\left(\mathrm{f}(x)=\right)2x^{\frac{3}{2}}+18x^{-\frac{1}{2}}+\frac{4}{3}x\ -52$

Allow simplified equivalents e.g. $\left(\mathrm{f}(x)=\right)2x\sqrt{x}+\frac{18}{\sqrt{x}}+\frac{4}{3}x\ -52$

f(x) = is not required so just look for the correct expression.
Apply isw once a correct expression is seen.

If they find their constant in (b), allow the marks for that work to be scored here.

(b)	$f'(9) = 10$	B1
	Gradient of normal is $-\dfrac{1}{f'(9)}$	M1
	$(y-20) = "-\dfrac{1}{10}"(x-9)$ or $y = "-\dfrac{1}{10}"x + c \Rightarrow 20 = "-\dfrac{1}{10}" \times 9 + c \Rightarrow c = \ldots$	**d**M1
	$x + 10y - 209 = 0$	A1
		(4)
		9 marks

(b) Notes

B1: For $f'(9) = 10$ which may be implied by the gradient of normal = $-\dfrac{1}{10}$

M1: For gradient of normal = $-\dfrac{1}{\text{their } f'(9)}$ where $f'(9)$ is an attempt to substitute $x = 9$ into the given $f'(x)$

dM1: Correct method for the equation of the normal using $x = 9$, $y = 20$ and a changed $f'(9)$ with the values correctly placed.
If they use $y = mx + c$ they must proceed as far as finding a value for c.
Dependent upon the previous method mark.

A1: cso $x + 10y - 209 = 0$ or any integer multiple of this equation in the required form.

Question Number	Scheme	Marks
8	$kx^2+8x+2(k+7)=0$	
	$b^2-4ac=8^2-4k\times 2(k+7)$	M1
	$8^2-4k\times 2(k+7)=64-8k^2-56k$	A1
	Attempts to solve $b^2-4ac...0 \Rightarrow k^2+7k-8...0 \Rightarrow k=$	**d**M1
	Critical values of 1 and -8	A1
	$k>1$ or $k<-8$	**dd**M1 A1
		(6)
		6 marks

Notes

M1: Attempts b^2-4ac with $a=k$, $b=8$ and $c=2(k+7)$

Condone slips with the $2(k+7)$ e.g. uses $2k+7$ or $k+7$ and condone missing brackets e.g. $b^2-4ac=8^2-4k\times 2k+14$

May be seen embedded in an attempt to use the quadratic formula.

May also be seen in an attempt at an equation or inequality e.g. $b^2-4ac...0$ or $b^2<4ac$ or e.g. $b^2>4ac$

A1: Correct 3 term quadratic expression seen e.g. $64-56k-8k^2$ which may be seen as an inequality or an equation e.g. $64<56k+8k^2$ or $64=56k+8k^2$ or $8-7k-k^2$. Allow 8^2 for 64.

Any brackets must be removed.

dM1: Attempts to find the critical values from a 3 term quadratic equation or inequality resulting from $b^2-4ac...0$ or equivalent where … can be any inequality or equality via **non calculator** methods.

Depends on the first method mark.

Do not allow for quoting the quadratic formula quoted followed by values e.g.

$$8k^2+56k-64=0 \Rightarrow k=\frac{-b\pm\sqrt{b^2-4ac}}{2a}=1,-8 \text{ is M0}$$

But allow e.g. $8k^2+56k-64=0 \Rightarrow k=\dfrac{-56\pm\sqrt{56^2-4\times 8\times(-64)}}{2\times 8}=1,-8$ is M1

Do not allow obvious use of a calculator where the factors do not correspond with their 3TQ e.g. $8k^2+56k-64=0 \Rightarrow (k-1)(k+8)=0 \Rightarrow k=1,\ -8$ is M0

but allow e.g. $8k^2+56k-64=0 \Rightarrow 8(k-1)(k+8)=0 \Rightarrow k=1,\ -8$ is M1

A1: Correct critical values. May be implied by e.g. $k^2+7k-8>0 \Rightarrow (k-1)(k+8)>0 \Rightarrow k>1,\ k<-8$

ddM1: Chooses the outside region for their critical values. Condone e.g. $1<k<-8$ for this mark.

Condone the boundaries being included in the inequality and condone the use of x rather than k.

The evidence for choosing the outside region must be taken from what they write down and not from e.g. a sketch.

It is dependent upon both previous Method marks.

A1: CSO $k>1$ or $k<-8$ o.e. Must be in terms of k.

The following are acceptable:

$k>1,\ k<-8$	$k>1$ and $k<-8$	$k>1$ or $k<-8$	$k>1 \cup k<-8$
$(0,-8),(1,\infty)$	$\{k: k>1,\ k<-8\}$	$k>1 \quad k<-8$	

Question Number	Scheme	Marks
9(a)	2	B1
		(1)
(b)	1	B1
		(1)
(c)	200	B1
		(1)
(d)	0	B1
		(1)
		4 marks

Notes

You may see diagrams, calculations etc, BUT you are looking for the final answers of:

(a)
B1: 2 or equivalent e.g. "two"
(b)
B1: 1 or equivalent e.g. "one"
(c)
B1: 200 or equivalent e.g. "two hundred"
(d)
B1: 0 or equivalent e.g. "none", "no solutions", "no real solutions"

If more than one answer is given in any part, mark the final answer.

Question Number	Scheme	Marks
10(a)	$(\text{f}(x)=)k(x+1)(x-4)^2$	M1 A1
	Uses $(0,12) \Rightarrow 12=16k \Rightarrow k=...$ $(\text{f}(x)=)\frac{3}{4}(x+1)(x-4)^2$	**d**M1 A1
		(4)
	(a) Alternative 1 by simultaneous equations	
	$(\text{f}(x)=)ax^3+bx^2+cx+d$ $(0,\ 12)\to d=12$ $(-1,\ 0)\to 0=-a+b-c+12$ $(4,\ 0)\to 0=64a+16b+4c+12$ $\text{f}'(x)=3ax^2+2bx+c\to 0=48a+8b+c$	M1 A1
	$a=\frac{3}{4}, b=-\frac{21}{4}, c=6\to(\text{f}(x)=)\frac{3}{4}x^3-\frac{21}{4}x^2+6x+12$	**d**M1 A1
	(a) Alternative 2 using roots	
	$(\text{f}(x)=)ax^3+bx^2+cx+d$ $(0,\ 12)\to d=12$ Sum: $4+4-1=-\frac{b}{a}$, Pair sum: $-4-4+16=\frac{c}{a}$, product: $-16=-\frac{12}{a}$	M1 A1
	$a=\frac{3}{4}, b=-\frac{21}{4}, c=6\to(\text{f}(x)=)\frac{3}{4}x^3-\frac{21}{4}x^2+6x+12$	**d**M1 A1

(a) Notes

In part (a) "f(x) =" is not required so just look the correct expression.

M1: States or implies that $(\text{f}(x)=)k(x\pm1)(x\pm4)^2$ allowing for $k=1$

A1: States or implies that $(\text{f}(x)=)k(x+1)(x-4)^2$ allowing for $k=1$

dM1: Uses $(0,12)$ in $(\text{f}(x)=)k(x\pm1)(x\pm4)^2$ to find a value for k

Depends upon the first method mark.

A1: $(\text{f}(x)=)\frac{3}{4}(x+1)(x-4)^2$ oe e.g. $(\text{f}(x)=)\frac{3}{4}(x+1)(4-x)^2$

Condone a spurious "= 0" e.g. $(\text{f}(x)=)\frac{3}{4}(x+1)(x-4)^2=0$ Apply isw once a correct answer is seen.

Alternative 1:

M1: Starts with a general cubic and uses the given information to produce 3 equations in 3 unknowns.

A1: Correct equations including $d = 12$.

dM1: Solves to find all unknowns. You do not need to check the working as long as all values are found.

A1: $(\text{f}(x)=)\frac{3}{4}x^3-\frac{21}{4}x^2+6x+12$ oe. Condone a spurious "= 0" e.g. $(\text{f}(x)=)\frac{3}{4}x^3-\frac{21}{4}x^2+6x+12=0$

Apply isw once a correct answer is seen.

Alternative 2:

M1: Starts with a general cubic and uses the correct roots to produce 3 equations in 3 unknowns.

A1: Correct equations including $d = 12$.

dM1: Solves to find all unknowns. You do not need to check the working as long as all values are found.

A1: $(\text{f}(x)=)\frac{3}{4}x^3-\frac{21}{4}x^2+6x+12$ oe. Condone a spurious "= 0" e.g. $(\text{f}(x)=)\frac{3}{4}x^3-\frac{21}{4}x^2+6x+12=0$

Apply isw once a correct answer is seen.

A correct function with no working scores 4/4 in (a)

(b)	$x=-1$	B1
	$\frac{3}{4}\cancel{(x+1)}(x-4)^2=6\cancel{(x+1)}(x-2)\Rightarrow x^2-16x+32=0$	M1
	$x^2-16x+32=0\Rightarrow(x-8)^2=32\Rightarrow x=8\pm4\sqrt{2}$	**d**M1 A1
		(4)
	(b) Alternative by expanding.	
	$x=-1$	B1
	$\frac{3}{4}x^3-\frac{21}{4}x^2+6x+12=6(x+1)(x-2)=6x^2-6x-12$ $\Rightarrow\frac{3}{4}x^3-\frac{45}{4}x^2+12x+24=0$	M1
	$\frac{3}{4}x^3-\frac{45}{4}x^2+12x+24=0\Rightarrow(x+1)\left(\frac{3}{4}x^2-12x+24\right)=0$ $\frac{3}{4}x^2-12x+24=0\Rightarrow x=\frac{12\pm\sqrt{12^2-4\times\frac{3}{4}\times24}}{2\times\frac{3}{4}}=8\pm4\sqrt{2}$	**d**M1 A1
		8 marks

(b) Notes

(b)

B1: States $x=-1$ Condone $(-1, 0)$ You do not need to be concerned where this comes from.

M1: Sets their $\frac{3}{4}\cancel{(x+1)}(x-4)^2=6\cancel{(x+1)}(x-2)$ cancels $(x+1)$ and proceeds to a 3TQ

or factorises out $(x+1)$ to obtain a 3 term quadratic factor which must be seen and it cannot be implied by their final answer(s).

It is dependent upon having achieved $f(x)=k(x+1)(x-4)^2 \quad k\neq1$

dM1: Dependent upon the previous method mark, it is for a **non-calculator** method for solving their 3TQ leading to at least one value for *x*.

A1: $x=8\pm4\sqrt{2}$ o.e.

Alternative:

B1: States $x=-1$ Condone $(-1, 0)$ You do not need to be concerned where this comes from.

M1: Expands both sides and collects terms to one side to obtain a 4 term cubic equation and then uses the factor $(x + 1)$ to find a 3 term quadratic factor which must be seen and it cannot be implied by their final answer(s).

It is dependent upon having achieved $f(x)=k(x+1)(x-4)^2 \quad k\neq1$ **from the main scheme or** $f(x)=ax^3+bx^2+cx+d, \quad a\neq1$ **from alternatives 1 and 2**

dM1: Dependent upon the previous method mark, it is for a **non-calculator** method for solving their 3TQ leading to at least one value for *x*.

A1: $x=8\pm4\sqrt{2}$ o.e.