Mark Scheme (Results)

Summer 2026

Pearson Edexcel International GCSE
In Further Pure Mathematics (4PM1)
Paper 02

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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.

- **Types of mark**
    - M marks: method marks
    - A marks: accuracy marks – can only be awarded when relevant M marks have been gained
    - B marks: unconditional accuracy marks (independent of M marks)

- **Abbreviations**
    - cao – correct answer only
    - cso – correct solution only
    - ft – follow through
    - isw – ignore subsequent working
    - SC - special case
    - oe – or equivalent (and appropriate)
    - dep – dependent
    - indep – independent
    - awrt – answer which rounds to
    - eeoo – each error or omission

- **No working**
  If no working is shown then correct answers may score full marks
  If no working is shown then incorrect (even though nearly correct) answers score no marks.

- **With working**

If it is clear from the working that the “correct” answer has been obtained from incorrect working, award 0 marks.

If a candidate misreads a number from the question: eg. uses 252 instead of 255; follow through their working and deduct 2A marks from any gained provided the work has not been simplified. (Do not deduct any M marks gained.)

If there is a choice of methods shown, then award the lowest mark, unless the subsequent working makes clear the method that has been used

Examiners should send any instance of a suspected misread to review (but see above for simple misreads).

- **Ignoring subsequent work**
  It is appropriate to ignore subsequent work when the additional work does not change the answer in a way that is inappropriate for the question: eg. incorrect cancelling of a fraction that would otherwise be correct.

  It is not appropriate to ignore subsequent work when the additional work essentially makes the answer incorrect eg algebra.

- **Parts of questions**
  Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded to another.

General Principles for Further Pure Mathematics Marking
(but note that specific mark schemes may sometimes override these general principles)

Method mark for solving a 3 term quadratic equation:

1. Factorisation:

$$\left(x^2+bx+c\right)=\left(x+p\right)\left(x+q\right),\text{ where }|pq|=|c|\text{ leading to }x=\ldots.$$

$$\left(ax^2+bx+c\right)=\left(mx+p\right)\left(nx+q\right)\text{ where }|pq|=|c|\text{ and }|mn|=|a|\text{ leading to }x=\ldots.$$

2. Formula:

Attempt to use the **correct** formula (shown explicitly or implied by working) with values for *a*, *b* and *c*, leading to $x=\ldots.$

3. Completing the square:

$$x^2+bx+c=0:\ \left(x\pm\tfrac{b}{2}\right)^2\pm q\pm c=0,\quad q\neq 0\qquad\text{leading to }x=\ldots.$$

Method marks for differentiation and integration:

1. Differentiation

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

2. Integration:

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

Use of a formula:

Generally, the method mark is gained by **either**

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

or, where the formula is <u>not</u> quoted, the method mark can be gained by implication

from the substitution of <u>correct</u> values and then proceeding to a solution.

Answers without working:

The rubric states "Without sufficient working, correct answers <u>may</u> be awarded no marks".

General policy is that if it could be done "in your head" detailed working would not be required. (Mark schemes may override this eg in a case of "prove or show...."

Exact answers:

When a question demands an exact answer, all the working must also be exact. Once a candidate loses exactness by resorting to decimals the exactness cannot be regained.

Rounding answers (where accuracy is specified in the question)

Penalise only once per question for failing to round as instructed - ie giving more digits in the answers. Answers with fewer digits are automatically incorrect, but the is rule may allow the mark to be awarded before the final answer is given.

Question number	Scheme	Marks
1	$[a=]5,[d=]3,[L=]65$	B1, B1
	$[S_n=]\frac{21}{2}(2\times"5"+(21-1)\times"3")$ or $[S_n=]\frac{20}{2}(2\times"5"+(20-1)\times"3")$ or $\frac{21}{2}("5"+"65")$ or $\frac{20}{2}("5"+"65")$	M1
	735	A1 [4]
	$[a=]8,[d=]3$ **Use this ALT only if you see use of $a = 8$**	B1, B1
	$[S_n=]\frac{20}{2}(2\times"8"+(20-1)\times"3")[=730]$ or $[S_n=]\frac{19}{2}(2\times"8"+(19-1)\times"3")$	M1
	735	A1 [4]
	730 (from listing or on its own)	SC3
	735 (from listing or on its own)	SC4
		Total 4 marks

Part	Mark	Additional Guidance
	B1 B1	For any one of $a = 5$ or $d = 3$ or $L = 65$ For $a = 5$ **and** $d = 3$ **or** $a = 5$ **and** $L = 65$ These may be seen explicitly or use implicitly in working.
	M1	For correct substitution into the formula for S_n using their values for a and d or a and L with either $n = 21$ or $n = 20$ Allow any a or d or L that they believe are the first term and common difference. The minimum working we must see, if working with the incorrect values is $[S_n=]10.5("10"+20\times"3")$ or $[S_n=]10("10"+19\times"3")$ $[S_n=]10.5("70")$ or $[S_n=]10("70")$
	A1	For 735
ALT	B1 B1	For $a = 8$ or $d = 3$ For $a = 8$ and $d = 3$ These may be seen explicitly or use implicitly in working.
	M1	For correct substitution into the formula for S_n **using a = 8** and their value for d either $n = 20$ or $n = 19$ The minimum working we must see, if incorrect final answer or don't see 730 $[S_n=]10(16+19\times"3")$ or $[S_n=]9.5(16+18\times"3")$
	A1	For 735
	SC3	No part marks – mark as M1 M1 M1
	SC4	No part marks – mark as M1 M1 M1 A1

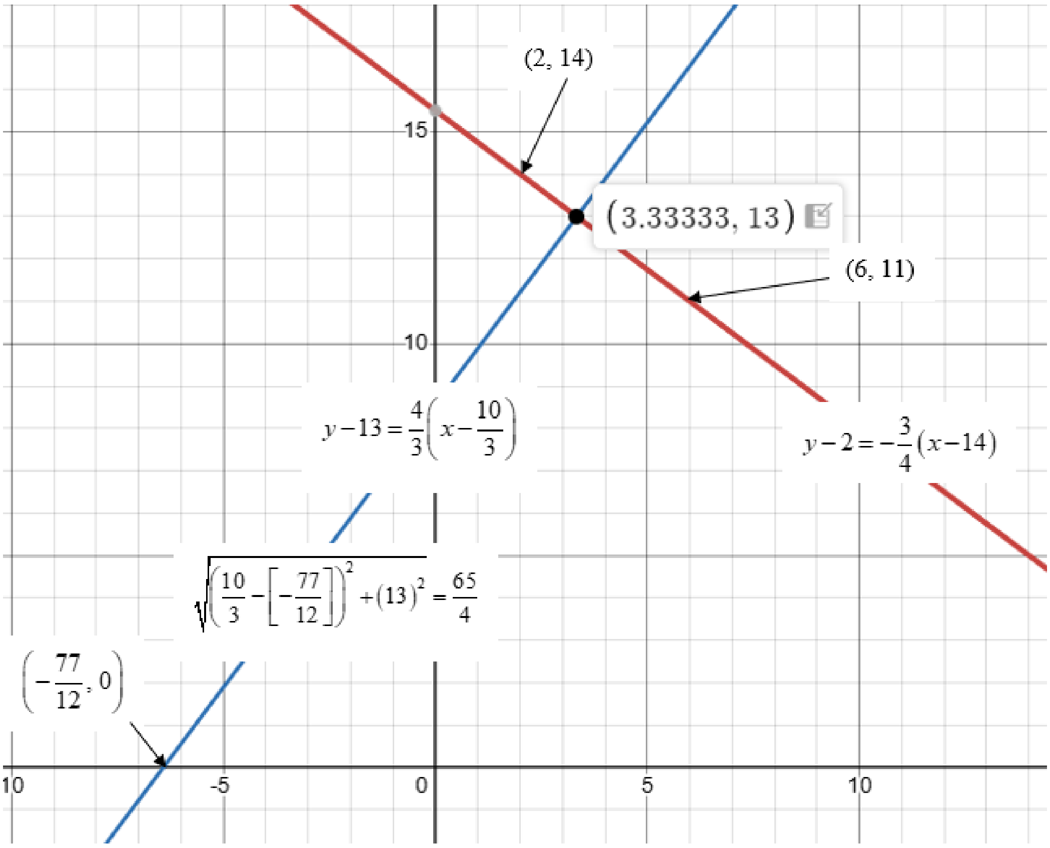
Question number	Scheme	Marks
2	$\frac{1}{2}\times\left(8-2\sqrt{3}\right)\times x=4\sqrt{3}-6$ oe	M1
	$\frac{4\sqrt{3}-6}{4-\sqrt{3}}$ oe multiple or $\frac{4\sqrt{3}-6}{8-2\sqrt{3}}$ oe multiple	M1
	$\frac{4\sqrt{3}-6}{4-\sqrt{3}}\times\frac{4+\sqrt{3}}{4+\sqrt{3}}=\frac{16\sqrt{3}+12-24-6\sqrt{3}}{4\times4-\left(\sqrt{3}\right)^2}$ oe allow as minimum eg $\frac{10\sqrt{3}+12-24}{13}$ or $\frac{4\sqrt{3}-6}{8-2\sqrt{3}}\times\frac{8+2\sqrt{3}}{8+2\sqrt{3}}=\frac{32\sqrt{3}+24-48-12\sqrt{3}}{8\times8-\left(2\sqrt{3}\right)^2}$ oe allow as minimum eg $\frac{32\sqrt{3}-24-12\sqrt{3}}{52}$	dM1
	$\frac{10\sqrt{3}-12}{13}$	A1 [4]
		Total 4 marks

Part	Mark	Additional Guidance
	M1	$\frac{1}{2}\times\left(8-2\sqrt{3}\right)\times x=4\sqrt{3}-6$ oe eg $\left(8-2\sqrt{3}\right)\times x=2\times\left(4\sqrt{3}-6\right)$ or $8\sqrt{3}-12$ eg Any correct equation (ignore any processing errors once correct equation seen)
	M1	For $\frac{4\sqrt{3}-6}{4-\sqrt{3}}$ oe multiple or $\frac{4\sqrt{3}-6}{8-2\sqrt{3}}$ oe multiple Allow this mark to imply the previous method mark if you see a fully correct fraction for x $[x=]\frac{4\sqrt{3}-6}{4-\sqrt{3}}$ oe eg $[x=]\frac{4\sqrt{3}-6}{\left(\frac{1}{2}\right)\left(8-2\sqrt{3}\right)}$ or $[x=]\frac{2\left(4\sqrt{3}-6\right)}{4-\sqrt{3}}$
	dM1	For stating $\frac{4\sqrt{3}-6}{4-\sqrt{3}}\times\frac{4+\sqrt{3}}{4+\sqrt{3}}$ oe eg $\frac{8\sqrt{3}-12}{8-2\sqrt{3}}\times\frac{8+2\sqrt{3}}{8+2\sqrt{3}}$ or $\frac{4\sqrt{3}-6}{8-2\sqrt{3}}\times\frac{8+2\sqrt{3}}{8+2\sqrt{3}}$ oe **and** correctly multiplying out the terms • allow 2 terms to be simplified correctly without shown explicitly, the other 2 terms must be explicitly seen. ie there must be a minimum of 3 correct terms shown • correct denominator (processed to be a single number or unprocessed) Dependent on previous method mark
	A1	For the correct answer. Must see working from 3rd M Missing brackets may be recovered.

Question number	Scheme	Marks
3	$\frac{14-11}{2-6}\left[=-\frac{3}{4}\right]$ oe	M1
	$\left(m_{norm}=\right)-\frac{1}{"-\frac{3}{4}"}\left[=\frac{4}{3}\right]$	M1
	$\left(\frac{10}{3},13\right)$ oe eg $\left(\frac{10}{3},\frac{39}{3}\right)$	B1 B1
	$y-"13"=-\frac{1}{"-\frac{3}{4}"}\left(x-"\frac{10}{3}"\right)$ oe $\left[y=\frac{4}{3}x+\frac{77}{9}\right]$	M1
	$\left(y=0,x=\right)-\frac{77}{12}$ oe	A1 (M1 on ePen)
	$\sqrt{("\frac{10}{3}"-"-\frac{77}{12}")^2+("13"[-0])^2}$	ddM1
	$=\frac{65}{4}$ oe	A1 [8]
		Total 8 marks

Part	Mark	Additional Guidance
	M1	For the correct unsimplified **method** to find the gradient. (May also be totally processed)
	M1	For finding the negative reciprocal of their gradient. May or may not be fully processed. Not dependent but must be the negative reciprocal Cannot be $-\frac{3}{4}$ or $\frac{3}{4}$
	B1	For one correct value for the coordinates of D Allow $x=$ or $y=$
	B1	For both correct values for coordinates of D Allow $x=$ and $y=$
	M1	For a fully correct and complete method to find the equation of the line, using their changed gradient and their midpoint. Any obviously changed gradient used will be awarded this mark. If students use substitution into $y=mx+c$ They must correctly substitute and correctly rearrange after substitution to find c If they are not using the correct D or gradient, you must see this sub and rearrangement.
	A1 (M1 on ePen)	For $-\frac{77}{12}$ or equivalent The correct value can imply any previous marks.
	ddM1	Correct full method to find the length of the line, using their values. Dep on any 2 previous M marks. The minimum working that must be showing if not using correct values must be, for example, using $\left(\frac{10}{3},13\right)$ and $\left("-\frac{10}{3}",0\right)$ is $\sqrt{("\frac{20}{3}")^2+("13"[-0])^2}$ Candidates must be using an x intercept ie one coordinate with $y=0$ They may not use $\left("\frac{10}{3}",0\right)$
	A1	$\frac{65}{4}$ oe The correct answer can imply any previous marks. (General principle unless precluded by the MS for a question or if a ‘show’ question).

USEFUL SKETCH



<table>
<tr><th>Question number</th><th colspan="2">Scheme</th><th>Marks</th></tr>
<tr><td>4 (a)</td><td colspan="2">$\left(\mathrm{f}(x) = \mathrm{e}^{2x}(x^2+1)\right)$
$\left(\mathrm{f}'(x) =\right) 2\mathrm{e}^{2x}(x^2+1) + \mathrm{e}^{2x}(2x)$
$= 2\mathrm{e}^{2x}\left(x^2+x+1\right)$</td><td>M1 A1

A1*cso
[3]</td></tr>
<tr><td>(b)</td><td>$\left[\Rightarrow x^2+x+1=0\right]$ oe
$1^2 - 4\times1\times1\left[=-3\right]$

$-3<0$ (or $\sqrt{-3}$ has no solutions or roots)
or $1^2-4\times1\times1<0$
(or $\sqrt{1^2-4\times1\times1}$ has no solutions or roots)
or you cannot square root a negative number
and
$2\mathrm{e}^{2x}\neq0$ or $2\mathrm{e}^{2x}>0$ therefore no solutions</td><td>$\left[\Rightarrow x^2+x+1=0\right]$ oe
$\left(x+\frac{1}{2}\right)^2 - \frac{1}{4}+1$ or $\left(x+\frac{1}{2}\right)^2+\frac{3}{4}$

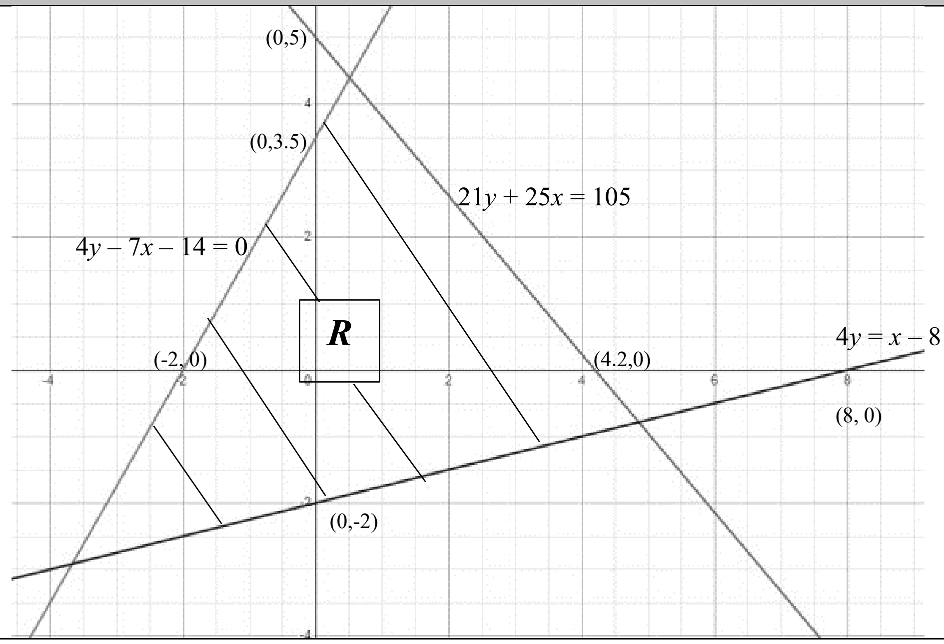
$\left(x+\frac{1}{2}\right)^2 \geqslant 0$
$\Rightarrow \left(x+\frac{1}{2}\right)^2 - \frac{1}{4}+1>0$
or $\left(x+\frac{1}{2}\right)^2+\frac{3}{4}>0$
and $2\mathrm{e}^{2x}\neq0$
or $2\mathrm{e}^{2x}>0$ therefore no solutions</td><td>M1

A1

[2]</td></tr>
<tr><td colspan="4" align="right">Total 5 marks</td></tr>
</table>

<table>
<tr><th>Part</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td rowspan="3">(a)</td><td>M1</td><td>For $a\mathrm{e}^{2x}(x^2+1)+\mathrm{e}^{2x}(bx)$ $a,b\neq0,1$
Brackets may be missing for this mark.</td></tr>
<tr><td>A1</td><td>For $a\mathrm{e}^{2x}(x^2+1)+\mathrm{e}^{2x}(2x)$ or $2\mathrm{e}^{2x}(x^2+1)+\mathrm{e}^{2x}(bx)$ $a,b\neq0,1$
Brackets must not be missing for this mark.</td></tr>
<tr><td>A1*cso</td><td>For fully correct work, no errors/omissions, minimum steps shown to get the given result.
$2\mathrm{e}^{2x}(x^2+1)+\mathrm{e}^{2x}(2x)\Rightarrow 2\mathrm{e}^{2x}\left(x^2+x+1\right)$
Extra steps to be checked.</td></tr>
<tr><td rowspan="2">(b)</td><td>M1</td><td>For correct calculation of discriminant or correct completion of square
Allow discriminant to be stated as – 3 or written as 1 – 4 to imply this mark
This may be seen in the use of the quadratic formula or in a square root</td></tr>
<tr><td>A1</td><td>For fully correct work throughout and full conclusion drawn.
Full conclusion includes some way of explaining $2\mathrm{e}^{2x}\neq0$
Can also state
• $\sqrt{b^2-4ac}<0$ if – 3 or the correct calculation seen
– 3 does not have to be calculated if the calculation is seen, but must be correct if calculated.
An individual conclusion for each part, will be seen as an overall conclusion.</td></tr>
<tr><td></td><td colspan="2">If candidates solve and give complex numbers, send to Review</td></tr>
</table>

<table>
<tr><th>Question number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>5 (a)

and (b)</td><td>


</td><td>B1

B1

B1

B1ft

[4]</td></tr>
<tr><td>(c)</td><td>The following tables are examples</td><td>M1
M1
A1
[3]</td></tr>
</table>

	A	B	C	D
x	1	3	2	4
y	3	1	2	0
P	$4\times3+3\times1$ $=15$	$4\times1+3\times3$ $=13$	$4\times2+3\times2$ $=14$	$4\times0+3\times4$ $=12$

Total 7 marks

Part	Mark	Additional Guidance
Tolerance for this question is **half a square** and each line must as a **minimum** pass through the x & y axes		
(a)	B1	For one of the lines correctly drawn to within tolerance (as a minimum, examiners should check intersections with axes, but candidates do not need to mark these).
	B1	For two of the lines correctly drawn to within tolerance (as a minimum, examiners should check intersections with axes, but candidates do not need to mark these).
	B1	For all three of the lines correctly drawn to within tolerance (as a minimum, examiners should check intersections with axes, but candidates do not need to mark these).
(b)	B1ft	For the correct **enclosed** region, shaded in or out or for R clearly labelled. The B1ft can be awarded for the enclosed shaded region (or indicated R) between any 3 lines drawn on the grid.
(c)	M1	For correctly using any pair of non-negative values (doesn't have to be integer) from **their region** by substituting into $4y + 3x$ Candidates may solve equations and test at the intersections of the lines. For reference relevant values are: x: 1085/247 = 4.3927.. allow 4.4 y: 126/247 = 0.5101…condone 0.52
	M1	For correctly using at least one pair of integer values for x and y shown in the table above and substituting into $4y + 3x$
	A1	For (Q) = 15 The correct answer may imply previous method marks.

Question number	Scheme	Marks
6 (a) (i)	$1+\left(-\frac{1}{2}\right)\left(\frac{x}{4}\right)+\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)}{2!}\left(\frac{x}{4}\right)^2+\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)\left(-\frac{1}{2}-2\right)}{3!}\left(\frac{x}{4}\right)^3$	M1 A1
	$1-\frac{1}{8}x+\frac{3}{128}x^2-\frac{5}{1024}x^3$	A1 [3]
(ii)	$-4<x\leqslant 4$ allow $\lvert x\rvert<4$ or $-4<x<4$	B1 [1]
(b)	$1+\frac{1}{8}x+\frac{3}{128}x^2+\frac{5}{1024}x^3$	B1ft [1]
(c)	$\frac{1}{4}\left(1-\frac{1}{8}x+\frac{3}{128}x^2....\right)\left(1-\frac{1}{8}x+\frac{3}{128}x^2....\right)$ or $\frac{1}{2}\left(1-\frac{1}{8}x+\frac{3}{128}x^2....\right)\frac{1}{2}\left(1-\frac{1}{8}x+\frac{3}{128}x^2....\right)$ or $4^{-\frac{1}{2}}\left(1-\frac{1}{8}x+\frac{3}{128}x^2....\right)4^{-\frac{1}{2}}\left(1-\frac{1}{8}x+\frac{3}{128}x^2....\right)$ or $\left(\frac{1}{2}-\frac{1}{16}x+\frac{3}{256}x^2....\right)\left(\frac{1}{2}-\frac{1}{16}x+\frac{3}{256}x^2.....\right)$ oe	M1
	$\left(\text{"}\frac{1}{4}\text{"}\right)\left(1-\frac{1}{8}x+\frac{3}{128}x^2-\frac{1}{8}x+\frac{1}{64}x^2+\frac{3}{128}x^2....\right)$ or $\frac{1}{4}-\frac{1}{32}x+\frac{3}{512}x^2-\frac{1}{32}x+\frac{1}{256}x^2+\frac{3}{512}x^2$	dM1
	$\frac{1}{4}-\frac{1}{16}x+\frac{1}{64}x^2$	A1 [3]
(d)	$\left(\int_{(0)}^{(0.2)}\left(\frac{1}{4}-\frac{1}{16}x+\frac{1}{64}x^2\right)\mathrm{d}x\right)=\left[\frac{x}{4}-\frac{1}{16\times 2}x^2+\frac{1}{(3)(64)}x^3\right]_{(0)}^{(0.2)}$	B1ft
	$\frac{0.2}{4}-\frac{1}{16\times 2}(0.2)^2+\frac{1}{(3)(64)}(0.2)^3$	M1
	awrt 0.048791667	A1 [3]
		Total 11 marks

Part	Mark	Additional Guidance
(a) (i)	M1	For applying a correct binomial expansion in unsimplified (or simplified) form. Minimum required: • The expansion begins with 1 • The term in x is correct • The powers of $\frac{x}{4}$ must be correct eg $\left(\frac{x}{4}\right)^2$ • The denominators are correct. Do not allow missing brackets unless recovered later – this is a general point of marking. Ignore any terms with powers higher than 3. Allow a misread of $\frac{1}{2}$ for $-\frac{1}{2}$ and mark accordingly, but do not allow any other misreads. In general, misreads should be sent to Review.
	A1	Following M1 (this is a general point of marking, A marks can only follow M marks*). All conditions above met, must see $1-\frac{1}{8}x$ **and** at least the term in x^2 or x^3 correct and simplified. Ignore any terms with powers higher than 3. * unless final answer fully correct, not from incorrect working or the MS states otherwise.
	A1	A fully correct and simplified expansion. Ignore any terms with powers higher than 3.
(b)	B1ft	For $1+\frac{1}{8}x+\frac{3}{128}x^2+\frac{5}{1024}x^3$ ft any expression from (a) of the form $1\pm ax\pm bx^2\pm cx^3$ to $1\mp ax\pm bx^2\mp cx^3$, i.e. the signs of the coefficients of the odd powers of x changed. Ignore any binomial expansion redone
(c)	M1	Any expression which states multiplying their expression from (a) by itself with either the correct factor of $4^{-\frac{1}{2}}$ factorised as shown or each of their terms in the bracket multiplied by this correct factor. Watch for any other equivalences. Follow through their expression for (a) of the form $1\pm ax\pm bx^2$ Ignore terms with powers higher than 2.
	dM1	Any two terms in their unsimplified expansion correct (do not need to be simplified) Dep on previous M mark
	A1	For $\frac{1}{4}-\frac{1}{16}x+\frac{1}{64}x^2$
	SC1	For $1-\frac{1}{4}x+\frac{1}{16}x^2$ mark as M1 M0 A0 May be contained in other working.
	SC2	For $\frac{1}{4}-\frac{1}{16}x+\frac{1}{64}x^2$ not using their answer to part (a) mark as M1 M1 A0
(d)	B1ft	For correctly integrating their expression from part (c), provided it has at least one constant term and at least one algebraic term or at least two algebraic terms. If an expression with more than 3 terms, for correct integration of any 3 terms. Terms do not need to be simplified. Limits do not need to be present. May not be implied by a correct answer as candidates are told to use integration.
	M1	For correct substitution of limits into their changed expression. Do not need to see substitution of 0 if gives a 0 answer. Must be a minimum of 2 terms. May be implied by a correct answer if first B gained.
	A1	For awrt 0.048791667 Note calculator value is 0.04879016417

Question number	Scheme	Marks
7 (a)	$[18=]l+l+\frac{1}{2}\pi w+\frac{1}{2}\pi w$ oe eg $[18=]2l+\pi w$	B1
	$\frac{18-\pi w}{2}=l$ oe eg $l=9-\frac{1}{2}\pi w$	M1
	$[A=\ ]lw+\frac{1}{2}\pi\left(\frac{w}{2}\right)^2+\frac{1}{2}\pi\left(\frac{w}{2}\right)^2$ oe eg $[A=\ ]lw+\frac{1}{2}\pi\frac{w^2}{4}+\frac{1}{2}\pi\frac{w^2}{4}$ $[A=\ ]lw+\pi\left(\frac{w}{2}\right)^2$ $[A=\ ]lw+\frac{\pi w^2}{4}$	B1
	$[A=]w\left(\text{"}\frac{18-\pi w}{2}\text{"}\right)+\frac{\pi w^2}{4}\left[=9w-\frac{\pi w^2}{2}+\frac{\pi w^2}{4}\right]$ oe	dM1
	$A=9w-\frac{\pi w^2}{4}$ *	A1*cso [5]
(b) (i)	$\left[A=9w-\frac{\pi w^2}{4}\right]\Rightarrow\left[\frac{dA}{dw}=\right]9-\frac{\pi w}{2}$	M1
	$\text{"}9-\frac{\pi w}{2}\text{"}=0\Rightarrow w=$	M1
	$[w=]\frac{18}{\pi}$	A1
	$\left[A=9\left(\frac{18}{\pi}\right)-\frac{\pi\left(\frac{18}{\pi}\right)^2}{4}=\right]\frac{81}{\pi}$	A1cso [4]
(ii)	[When $w=\frac{18}{\pi}$] $[l=]\frac{18-\pi\left(\frac{18}{\pi}\right)}{2}=0$	B1 [1]
ALT1	Finds the area of the two semicircles and shows that it is $\frac{81}{\pi}$ Eg $\frac{\pi\left(\frac{18}{\pi}\right)^2}{4}=\frac{81}{\pi}$ or $\pi\left(\frac{9}{\pi}\right)^2=\frac{81}{\pi}$	B1 [1]
ALT2	Shows the Perimeter of the semicircles is 18 $2\pi\times\frac{9}{\pi}=18$ or $\pi\times\frac{18}{\pi}=18$	B1 [1]
(iii)	$\frac{18}{\pi}$	B1 [1]
(c)	$\left[\frac{d^2A}{dw^2}=\right]-\frac{\pi}{2}<0$ Therefore a maximum	B1 [1]
		Total 12 marks

Part	Mark	Additional Guidance
(a)	B1	For the correct expression for P
	M1	For placing an expression of the form $2l + a\pi w$ equal to 18 **and** correctly rearranging to make l the subject (this doesn't need to be simplified)
	B1	For the correct expression for the area. Does not to be = A at this point, does not need to be simplified. May be implied by substitution of l into a correct expression.
	dM1	For substitution of their expression for l into their expression for area of the form $lw + dw^2 \quad d \neq 0,1$ Does not need to be = A at this point. Dependent on first M mark.
	A1*cso	For fully correct work, no errors, minimum steps shown as shown in the MS. Extra steps must be checked and must not be incorrect. This mark cannot be awarded if not place = A at some point in the working. Condone Area =
(b) (i)	M1	For differentiating the given expression for A. See general guidance, no power of w to increase and for this mark, one term must be differentiated fully correctly.
	M1	For placing their derivative = 0 and attempting to rearrange to find w Must be a changed function
	A1	For $\frac{18}{\pi}$ As candidates have been told to use calculus, we must see the first 2 M marks for this mark to be awarded.
	A1cso	For $\frac{81}{\pi}$ As candidates have been told to use calculus, we must see the first 2 M marks for this mark to be awarded.
(ii)	B1	For the work shown in the MS for any option.
(iii)	B1	For stating the diameter
(c)	B1	For the work shown. Must state < 0 and short conclusion that can be as simple as # or 'shown'

Question number	Scheme	Marks
8 (a) (i)	$\left[\cos 2A = \cos(A+A) =\right]\cos A\cos A - \sin A\sin A$ or $\cos^2 A - \sin^2 A$ $= \cos^2 A - (1-\cos^2 A)$ oe eg $\cos^2 A - 1 + \cos^2 A = 2\cos^2 A - 1$ *	M1 A1*cso [2]
(ii)	$\sin 2A = \sin A\cos A + \sin A\cos A = 2\sin A\cos A$	B1 [1]
(b)	$\cos 3A\left(=\cos(2A+A)\right) = \cos 2A\cos A - \sin 2A\sin A$ $= (2\cos^2 A - 1)\cos A - 2\sin A\cos A\sin A$ $= 2\cos^3 A - \cos A - 2\sin^2 A\cos A = 2\cos^3 A - \cos A - 2\left(1-\cos^2 A\right)\cos A$ $= 2\cos^3 A - \cos A - 2\cos A + 2\cos^3 A = 4\cos^3 A - 3\cos A$	M1 M1 M1 dddM1 A1*cso [5]
(c)	$-3\cos 3A - 2 = 0$ oe $\cos 3A = -\dfrac{2}{3}$ $3A = 2.30(0523983), 3.98(2661324), -2.30(0523983), -3.98(2661324), -8.58(37)$ $A = -0.8, -1.3, -2.9$	B1 M1 A1 A1 [4]
(d)	$\left(\int_0^{\frac{\pi}{6}} \cos^3\theta \,\mathrm{d}\theta =\right)\dfrac{1}{4}\int_0^{\frac{\pi}{6}}\left(\cos 3\theta + 3\cos\theta\right)\mathrm{d}\theta$ oe $\left(\dfrac{1}{4}\right)\left[\dfrac{\sin 3\theta}{3} + 3\sin\theta\right]_0^{\frac{\pi}{6}}$ $\left(\dfrac{1}{4}\right)\left(\dfrac{\sin 3\left(\frac{\pi}{6}\right)}{3} + 3\sin\left(\dfrac{\pi}{6}\right) \quad [-0]\right)$ $= \dfrac{11}{24}$	B1 M1 M1 A1 [4]
ALT	**The following approach uses knowledge not on the Specification, but has been seen.** $\left(\int_0^{\frac{\pi}{6}} \cos^3\theta \,\mathrm{d}\theta =\right)\int_0^{\frac{\pi}{6}}\left(1-\sin^2\theta\right)\cos\theta \,\mathrm{d}\theta$ oe eg $\int_0^{\frac{\pi}{6}}\left(\cos\theta - \cos\theta\sin^2\theta\right)\mathrm{d}\theta$ $\left[\sin\theta - \dfrac{\sin^3\theta}{3}\right]_0^{\frac{\pi}{6}}$ **or** $\left[u = \sin\theta \Rightarrow \mathrm{d}u = \cos\theta\,\mathrm{d}\theta \Rightarrow \int_0^{0.5}\left(1-u^2\right)\mathrm{d}u \Rightarrow\right]\left[u - \dfrac{u^3}{3}\right]_0^{0.5}$ $\left(\sin\dfrac{\pi}{6} - \dfrac{\sin^3\frac{\pi}{6}}{3}\right)[-0]$ **or** $\left(0.5 - \dfrac{0.5^3}{3}\right)[-0]$ $= \dfrac{11}{24}$	B1 M1 M1 A1 [4]
		Total 16 marks

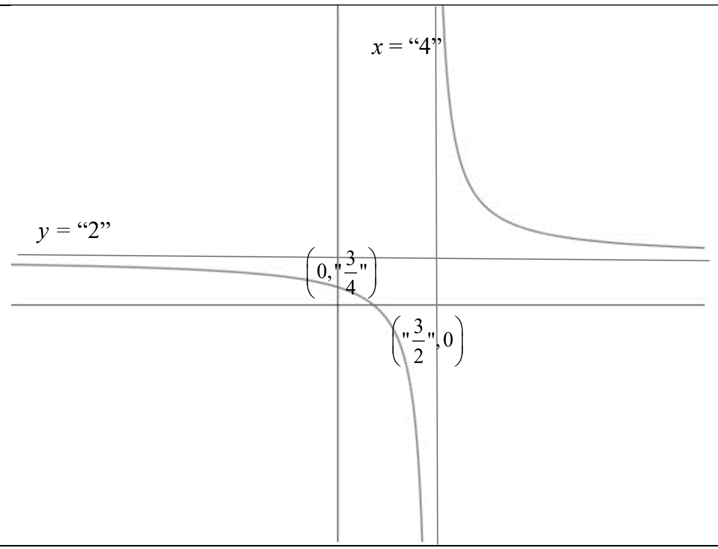
Part	Mark	Additional Guidance
(a) (i)	M1	For $\cos A\cos A-\sin A\sin A$ or $\cos^2 A-\sin^2 A$
	A1*cso	For correctly using $\sin^2 A=1-\cos^2 A$ and obtaining the correct result with the minimum steps as shown, no errors seen.
(ii)	B1	For the correct result with the minimum steps as shown, no errors seen
(b)	M1	For $\cos 3A=\cos 2A\cos A-\sin 2A\sin A$
	M1	For replacing cos2A with the result from (a)(i)
	M1	For replacing sin2A with their result from (a)(ii)
	dddM1	For correctly multiplying out the brackets in their expression and correctly using $\sin^2 A=1-\cos^2 A$ Dependent on the 3 previous method marks.
	A1*cso	For a fully correct solution, no errors (allow missing brackets to be recovered), minimum steps shown as in mark scheme.
(c)	B1	For the correct equation shown. Implied by $\cos 3A=-\frac{2}{3}$ or any other equivalent
	M1	For correctly rearranging their equation of the form $q\cos 3A-2=0$ $q\neq 0$ to get $\cos 3A=\frac{2}{q}$
	A1	For any 2 of the correct values shown for 3A or any correct value for A
	A1	For all 3 correct values, awrt – 0.8, – 1.3. –2.9 Ignore extra values out of range. A0 if extra values in range. Answers only (potentially from a graphical calculator) scores B0 M0 A0 A0 without working.
(d) Main Scheme and ALTS	Allow candidates to work in A or θ or a mix if intention is clear	
	B1	For replacing $\cos^3\theta$ with one of the correct expressions Limits don't need to be present
	M1	For correctly integrating any expression of the form $a\cos 3\theta+b\cos\theta$ $a,b\neq 0$ or correctly integration of $\cos\theta-\cos\theta\sin^2\theta$ **or** $1-u^2$ Limits don't need to be present
	M1	For correct substitution of correct limits into a changed expression. Substitution of the limit of 0 need not be seen, if the substitution would give an answer of 0. This is not dependent on the previous mark, but must see substitution of the correct limits into a changed expression with minimum 2 terms. This mark may be implied if both a correct integration and correct final answer is seen.
	A1	Cao must see B1 and first M1 A correct answer can imply 2nd M mark.
	Accept work in A or θ or a mixture of both, if intention is clear.	

Question number	Scheme	Marks
9(a)(i)	$8y-10x+15=0$ intersects the x-axis at $\left(\frac{3}{2},0\right)$	B1
	$\dfrac{p\times"\frac{3}{2}"-3}{\left["\frac{3}{2}"-q\right]}=0\Rightarrow p=$	M1
	$p=2$ *	A1*cso [3]
ALT1	$[px-3=0]\Rightarrow x=\dfrac{3}{p}$	B1
	$8\times0-10\times\dfrac{3}{p}+15=0$ oe eg $0=\dfrac{5}{4}\times\dfrac{3}{p}-\dfrac{15}{8}\Rightarrow p=$	M1
	$p=2$ *	A1*cso [3]
ALT2	$x=\dfrac{3}{2}$	B1
	Indicates for C or curve x-intercept is $\dfrac{3}{p}$ or states $\left(\dfrac{3}{p},0\right)$ **or** $px-3=0$ and $x=\dfrac{3}{p}$	M1
	and $p=2$ Must be an indication that each intercept is for curve and line	A1*cso [1]
(ii)	$\left[y=\dfrac{5}{4}x-\dfrac{15}{8}\right]$[Gradient of normal =] $-\dfrac{4}{5}$ oe	B1
	$\left(\dfrac{dy}{dx}=\right)\dfrac{2(x-q)-1(2x-3)}{(x-q)^2}\left[=\dfrac{3-2q}{(x-q)^2}\right]$ oe	M1 A1 A1
	$=\dfrac{2\left("\frac{3}{2}"-q\right)-[1]\left(2\times"\frac{3}{2}"-3\right)}{\left("\frac{3}{2}"-q\right)^2}\left[=-\dfrac{1}{"\frac{5}{4}"}\left(\left(\dfrac{2}{\left("\frac{3}{2}"-q\right)}=-\dfrac{4}{5}\right)\right)\right]$ oe eg $\left[=\dfrac{3-2q}{\left("\frac{3}{2}"-q\right)^2}=-\dfrac{4}{5}\right]$	dM1
	$10=-4\left("\frac{3}{2}"-q\right)$ oe eg $10=-6+4q$ eg $3-2q=-\dfrac{4}{5}\left(\dfrac{3}{2}-q\right)^2$ eg $15-10q=-4\left(\dfrac{9}{4}-3q+q^2\right)$ eg $4q^2-22q+24[=0]$ eg $(2q-3)(q-4)[=0]$	M1
	$q=4$ *	A1*cso [7]

ALT Use of product rule for M1 A1 A1	$\left[(2x-3)(x-q)^{-1}\right]$ $2(x-q)^{-1}+(-1)(2x-3)(x-q)^{-2}$ oe eg $\frac{2}{(x-q)}-\frac{(2x-3)}{(x-q)^2}$		M1 A1 A1
(b) (i)	$y=2$	In all questions, but particularly in this question for these parts, look carefully for work next to the text of the question on the first page.	B1 [1]
(ii)	$x=4$		B1 [1]
(c)	$\left(0,\frac{3}{4}\right)$ or $[x=0]$ $y=\frac{3}{4}$ or or $x=0$ $[y=]$ $\frac{3}{4}$		B1 [1]

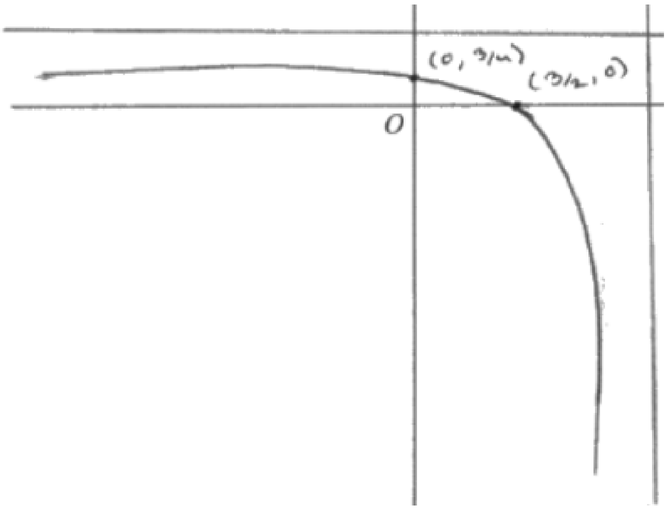
Part	Mark	Additional Guidance
(a) (i)	B1	Identification of $x=\frac{3}{2}$ at A This may be explicitly stated or implicitly used.
	M1	For $\frac{p\times"\frac{3}{2}"-3}{"\frac{3}{2}"-q}=0$ or $p\times"\frac{3}{2}"-3=0$ using their value of x May use their $\frac{3}{2}$ if there is nothing to contradict that this is what they believe to be the x-intercept.
	A1*cso	$p=2$ Must show the minimum correct working from the M mark, no errors. Extra steps must be checked.
ALT1	B1	For $x=\frac{3}{p}$ This may be explicitly stated or implicitly used.
	M1	For a correct substitution of into the equation $x=\frac{3}{p}$ for line n
	A1*cso	$p=2$ Must show the minimum correct working from the M mark, no errors. Extra steps must be checked.
ALT2	B1	For $x=\frac{3}{2}$
	M1	For a clear indication that the x-intercept of the curve or C is $\frac{3}{p}$ or $\left(\frac{3}{p},0\right)$ stated It is not enough to just write down $\frac{3}{p}$, it must be matched to the curve. **or** for $px-3=0$ and $x=\frac{3}{p}$
	A1*cso	$p=2$

(ii)	B1	Correct value for gradient of normal. May be seen from a manipulation of the equation anywhere in part (i) or (ii) of (a) May be seen as part of an equation eg $y = -\frac{4}{5}x$........
	M1	For an expression of the form $\frac{a(x-q)-b(2x-3)}{(x-q)^2}$ $a \neq 0, b > 0$ For this mark, it may be awarded if they've not substituted $p = 2$ ie $\frac{a(x-q)-b(px-3)}{(x-q)^2}$ $a \neq 0, b > 0$
	A1	For an expression of the form $\frac{a(x-q)-b(2x-3)}{(x-q)^2}$ $a \neq 0, b > 0$ with one of a or b correct
	A1	For $\frac{2(x-q)-[1](2x-3)}{(x-q)^2}$ a correct simplified expression with no obvious incorrect working may imply M1 A1 A1 $\frac{3-2q}{(x-q)^2}$
	For both A marks – if they have not substituted *p* at this stage, look for it in later working, as this mark may be recovered, if substituted later.	
	dM1	For equating their gradient function **in terms of *q* only** to $-\frac{1}{"\frac{5}{4}"}$. Dep on previous M mark (allow to be processed incorrectly) Allow follow through of a gradient which has come from a manipulation of line *n.* Do not allow $\pm\frac{1}{"10"}$
	M1	For any **correct** linear or quadratic equation with algebraic denominators removed – there are other equivalents to watch out for.
	A1*cso	For $q = 4$, with no incorrect steps and minimal working for M marks seen
ALT Use of product rule for M1 A1 A1	M1	$c(x-q)^{-1} - d(2x-3)(x-q)^{-2}$ oe eg $\frac{c}{(x-q)} - \frac{d(2x-3)}{(x-q)^2}$ $c \neq 0, d > 0$ For this mark, it may be awarded if they've not substituted $p = 2$ ie $c(x-q)^{-1} - d(px-3)(x-q)^{-2}$ $c \neq 0, d > 0$
	A1	For an expression of the form $c(x-q)^{-1} - d(2x-3)(x-q)^{-2}$ oe $c \neq 0, d > 0$ with one of c or d correct
	A1	For $2(x-q)^{-1} + (-1)(2x-3)(x-q)^{-2}$ oe eg $\frac{2}{(x-q)} - \frac{(2x-3)}{(x-q)^2}$ $\frac{2(x-q)-[1](2x-3)}{(x-q)^2}$ a correct simplified expression with no obvious incorrect working may imply M1 A1 A1 $\frac{3-2q}{(x-q)^2}$

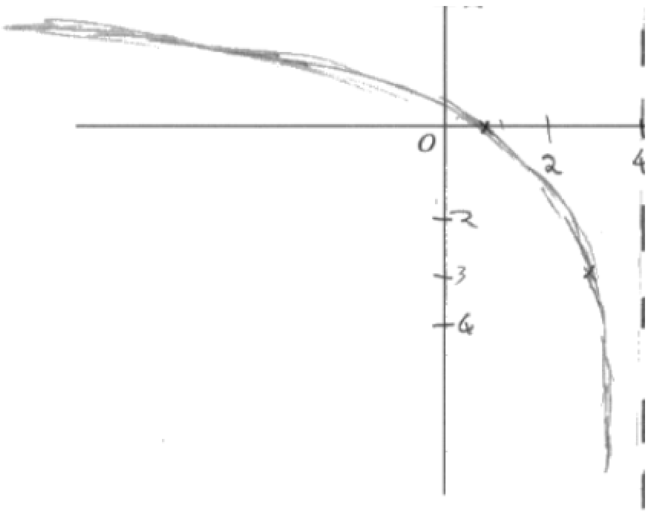
(d)			B1ft B1ft B1ft [3]
Total 16 marks			

(b) (i)	B1	$y = 2$ must be an equation, cannot be recovered from part (d)
(ii)	B1	$x = 4$ must be an equation, cannot be recovered from part (d)
(c)	B1	For one of the options shown in the MS
(d)	B1ft	For a positive reciprocal curve drawn anywhere in the grid – there must be two branches present, they must not cross or touch any asymptotes drawn or implied and must not obviously 'bend back' on themselves. Mark intention.
	B1ft	For the asymptotes drawn, follow through their (b)(i) and (ii). There must be at least one branch of a positive reciprocal curve present in the correct place for their work in (a), (b) and (c), tending towards asymptotes, which must not cross, touch or obviously bend back from the asymptotes. Mark intention. The asymptotes must be labelled with their equation or shown as passing through 4 on the *x*-axis and 2 on the y-axis, both clearly labelled. Ignore any other branch/curve/line drawn if there is one branch fulfilling these conditions.
	B1ft	Single curve (or even line) passing through $\left(0, "\frac{3}{4}"\right)$ and $\left("\frac{3}{2}", 0\right)$ marked clearly on the graph as coordinates or crossing points on the axis. Ignore any other branch/curve/line present. Allow follow through of their x intercept from (a) and their y intercept from (c)
If labelling is missing, allow answers presented in the correct order to imply the marks If there is ambiguity about order – do not award the marks.		

An example of the limit of what we'd accept for B1
"mark intention, asymptotes not obviously bending back":



An example of 'mark intention' re the curve – B1.



Question number	Scheme	Marks
10 (a)	$\sqrt{1+p^2}=\sqrt{17}$ oe eg $1+p^2=17$ eg $p^2=16 \Rightarrow p=$	M1
	$p=4$	A1
	$\overrightarrow{AD}=\overrightarrow{AC}+\overrightarrow{CD}$ or $\overrightarrow{DA}=\overrightarrow{DC}+\overrightarrow{CA}$	M1
	$=7\mathbf{a}-6\mathbf{b}+2\mathbf{a}-9\mathbf{b}\left(=9\mathbf{a}-15\mathbf{b}\right)$ $=-2\mathbf{a}+9\mathbf{b}-7\mathbf{a}+6\mathbf{b}\left(=-9\mathbf{a}+15\mathbf{b}\right)$	M1
	$\overrightarrow{BC}=\overrightarrow{BA}+\overrightarrow{AC}$ or $\overrightarrow{CB}=\overrightarrow{CA}+\overrightarrow{AB}$	M1
	$=-\mathbf{a}-\text{"}4\text{"}\mathbf{b}+7\mathbf{a}-6\mathbf{b}\left(=6\mathbf{a}-10\mathbf{b}\right)$ $=-7\mathbf{a}+6\mathbf{b}+\mathbf{a}+\text{"}4\text{"}\mathbf{b}\left(=-6\mathbf{a}+10\mathbf{b}\right)$	M1
	eg $6\mathbf{a}-10\mathbf{b}=\frac{2}{3}\left(9\mathbf{a}-15\mathbf{b}\right)$ eg $3\left(6\mathbf{a}-10\mathbf{b}\right)=2\left(9\mathbf{a}-15\mathbf{b}\right)$	
	eg $\frac{3}{2}\overrightarrow{BC}=\overrightarrow{AD}$ eg $\overrightarrow{CB}=-\frac{2}{3}\overrightarrow{AD}$	A1*cso
	$\left[\overrightarrow{AD}\text{ parallel } to\ \overrightarrow{BC}\right]$ therefore trapezium	[7]
(b)	$\left[\overrightarrow{AX}=\lambda\overrightarrow{AC}=\right]\lambda\left(7\mathbf{a}-6\mathbf{b}\right)$ oe eg $\left[\lambda\overrightarrow{CA}=\right]\lambda\left(-7\mathbf{a}+6\mathbf{b}\right)$	M1
	$\overrightarrow{BD}\left(=\overrightarrow{BA}+\text{"}\overrightarrow{AD}\text{"}\right)=-\mathbf{a}-\text{"}4\text{"}\mathbf{b}+\text{"}9\mathbf{a}-15\mathbf{b}\text{"}\left(=8\mathbf{a}-19\mathbf{b}\right)$oe	M1
	eg $\overrightarrow{BD}\left(=\text{"}\overrightarrow{BC}\text{"}+\overrightarrow{CD}\right)=\text{"}6\mathbf{a}-10\mathbf{b}\text{"}+2\mathbf{a}-9\mathbf{b}\left(=8\mathbf{a}-19\mathbf{b}\right)$	
	$\overrightarrow{AX}=\overrightarrow{AB}+\mu\overrightarrow{BD}=\mathbf{a}+\text{"}4\text{"}\mathbf{b}+\mu\left(\text{"}8\mathbf{a}-19\mathbf{b}\text{"}\right)$ oe	dM1
	eg $\overrightarrow{AX}=\overrightarrow{AB}+\mu\overrightarrow{DB}=\mathbf{a}+\text{"}4\text{"}\mathbf{b}+\mu\left(\text{"}-8\mathbf{a}+19\mathbf{b}\text{"}\right)$	dddM1
	$1+8\mu=7\lambda$ $4-19\mu=-6\lambda$	A1
	$\lambda=\frac{3}{5}$ or $\mu=\frac{2}{5}$	A1 cso
	$3:2$ oe	[6]
ALT1	$\left[\overrightarrow{DX}=\overrightarrow{DA}+\alpha\overrightarrow{AC}=\right]-\left(\text{"}9\mathbf{a}-15\mathbf{b}\text{"}\right)+\alpha\left(7\mathbf{a}-6\mathbf{b}\right)$ oe	M1
	eg $\left[\overrightarrow{DX}=\overrightarrow{DA}+\alpha\overrightarrow{CA}=\right]-\left(\text{"}9\mathbf{a}-15\mathbf{b}\text{"}\right)+\alpha\left(-7\mathbf{a}+6\mathbf{b}\right)$	
	$\overrightarrow{DB}\left(=\overrightarrow{DA}+\text{"}\overrightarrow{AB}\text{"}\right)=-\left(\text{"}9\mathbf{a}-15\mathbf{b}\text{"}\right)+\mathbf{a}+\text{"}4\text{"}\mathbf{b}\left(=-8\mathbf{a}+19\mathbf{b}\right)$	M1
	$\overrightarrow{DX}=\beta\overrightarrow{DB}=\beta\left(\text{"}-8\mathbf{a}+19\mathbf{b}\text{"}\right)$	dM1
	$-8\alpha=7\beta-9$ $19\alpha=15-6\beta$	dddM1
	$\alpha=\frac{3}{5}$ or $\beta=\frac{3}{5}$	A1
	$3:2$ oe	A1 cso [6]

Part	Mark	Additional Guidance
(a)	M1	For $\sqrt{1+p^2}=\sqrt{17}$ oe , leading to $p=$
	A1	$p=4$
	M1	For a correct vector path stated for $\overrightarrow{AD}$ or $\overrightarrow{DA}$ May be implied by the next method mark. May not be implied by **only** a correct simplified vector.
	M1	For the correct unsimplified vector $\overrightarrow{AD}$ or $\overrightarrow{DA}$ Some candidates calculate $\overrightarrow{BC}$ first and then use to find $\overrightarrow{AD}$. Follow through their p and any misprocessing from correct method. May not be implied by **only** a correct simplified vector.
	M1	For a correct vector path stated for $\overrightarrow{BC}$ or $\overrightarrow{CB}$ May be implied by the next method mark. May not be implied by **only** a correct simplified vector.
	M1	For the correct unsimplified vector $\overrightarrow{BC}$ or $\overrightarrow{CB}$ using their value of p May not be implied by **only** a correct simplified vector.
	A1*cso	Correct simplified vectors $\overrightarrow{AD}$ and $\overrightarrow{BC}$, $\overrightarrow{BC}=\frac{2}{3}\overrightarrow{AD}$ oe and stating (therefore) trapezium or shown or # - some conclusion. Must see as a minimum 2 vector paths with 2 correct simplified vectors (implies 3rd and 5th M marks) **or** 2 correct unsimplified vectors with 2 correct simplified vectors (implies 2nd and 4th M marks) 1 vector path with 1 correct simplified vector **and** 1 correct unsimplified vector with 1 correct simplified vector All cases will imply all method marks, with no errors. Allow students to state what they're looking for at the beginning. Dividing by constants and then stating $\overrightarrow{AD}=\overrightarrow{BC}$ is not acceptable for this mark
(b)	M1	For stating $\lambda(7\mathbf{a}-6\mathbf{b})$ use of any parameter
	M1	For correctly adding $\overrightarrow{BA}+"\overrightarrow{AD}"$ using their value of p for $\overrightarrow{AD}$ in the form $\mathbf{a}+"p"\mathbf{b}$ from part (a) to find $\overrightarrow{BD}$ or $\overrightarrow{BD}="\overrightarrow{BC}"+\overrightarrow{CD}$ using their $\overrightarrow{BC}$ from part (a) Can also find $\overrightarrow{DB}$
	dM1	For correctly adding $\overrightarrow{AX}=\overrightarrow{AB}+\mu\overrightarrow{BD}$ use of any second distinct parameter, use of their p and their $\overrightarrow{BD}$, Dependent on previous method mark.
	dddM1	Correctly equate coefficients for their vectors, in 2 distinct parameters. Dependent on all 3 previous method marks.
	A1	$\lambda=\frac{3}{5}$ or $\mu=\frac{2}{5}$ note if using eg $\overrightarrow{DB}$ $\mu=-\frac{2}{5}$
	A1 cso	3:2 oe – dependent on using a vector method.
ALT1	M1	For stating $-("9\mathbf{a}-15\mathbf{b}")+\alpha(7\mathbf{a}-6\mathbf{b})$ using their $\overrightarrow{AD}$ and any parameter
	M1	For correctly adding $\overrightarrow{DA}+"\overrightarrow{AB}"$ using their value for $-\overrightarrow{AD}$ in the form $-(\mathbf{a}+"p"\mathbf{b})$ from part (a) to find $\overrightarrow{DB}$ or $\overrightarrow{DB}=\overrightarrow{DC}+"\overrightarrow{CB}"$ using their $\overrightarrow{BC}$ from part (a) Can also find $\overrightarrow{BD}$
	dM1	For $\beta("-8\mathbf{a}+19\mathbf{b}")$ Dependent on previous method mark
	dddM1	Correctly equate coefficients for their vectors, in 2 distinct parameters. Dependent on all 3 previous method marks.
	A1	$\alpha=\frac{3}{5}$ or $\beta=\frac{3}{5}$ note if using eg $\overrightarrow{BD}$ $\beta=-\frac{3}{5}$
	A1 cso	3:2 oe – dependent on using a vector method.

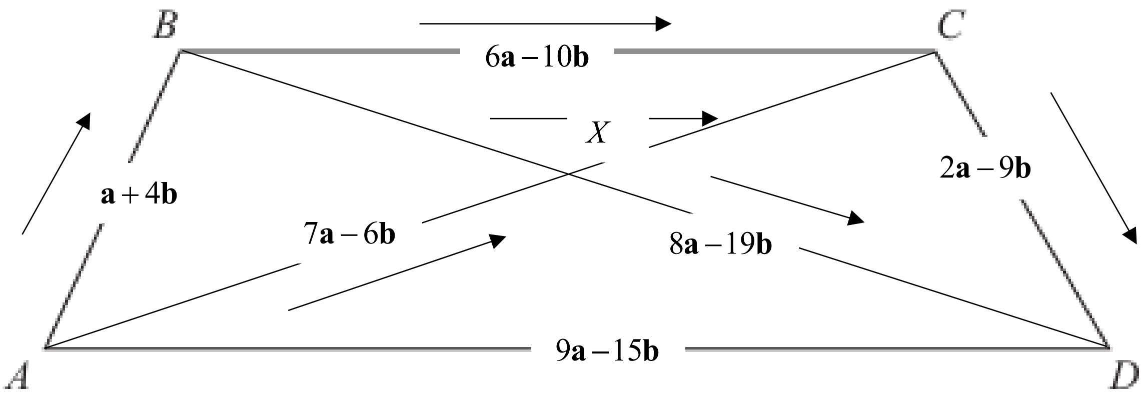
ALT2	$\left[\overrightarrow{AX} = \delta\ \overrightarrow{AC} = \right]\delta(7\mathbf{a}-6\mathbf{b})$ oe eg $\left[\delta\ \overrightarrow{CA} = \right]\delta(-7\mathbf{a}+6\mathbf{b})$	M1
	$\overrightarrow{DB}\left(= \overrightarrow{DA} + "\ \overrightarrow{AB}"\right) = -("9\mathbf{a}-15\mathbf{b}") + \mathbf{a} + "4"\mathbf{b}\,(=-8\mathbf{a}+19\mathbf{b})$	M1
	$\overrightarrow{AX} = \overrightarrow{AD} + \eta\ \overrightarrow{DB} = 9\mathbf{a}-15\mathbf{b}+\eta("-8\mathbf{a}+19\mathbf{b}")$ oe eg $\overrightarrow{AX} = \overrightarrow{AB} + \kappa\ \overrightarrow{BD} = \mathbf{a} + "4"\mathbf{b} + \kappa("8\mathbf{a}-19\mathbf{b}")$	dM1
	$9-8\eta = 7\delta$ and $19\eta - 15 = -6\delta$ or $1+8\kappa = 7\delta$ and $4-19\kappa = -6\delta$	dddM1
	$\eta = \frac{3}{5}$ or $\delta = \frac{3}{5}$ or $\kappa = \frac{2}{5}$ $3:2$ oe	A1 A1 cso [6]

ALT2	M1	For stating $\delta(7\mathbf{a}-6\mathbf{b})$ use of any parameter
	M1	For correctly adding $\overrightarrow{DA} + "\ \overrightarrow{AB}"$ using their value for $-\overrightarrow{AD}$ in the form $-(\mathbf{a}+"p"\mathbf{b})$ from part (a) to find $\overrightarrow{DB}$ or $\overrightarrow{DB} = \overrightarrow{DC} + "\overrightarrow{CB}"$ using their $\overrightarrow{BC}$ from part (a) Can also find $\overrightarrow{BD}$
	dM1	For correctly adding $\overrightarrow{AX} = \overrightarrow{AD} + \eta\ \overrightarrow{DB}$ use of any second distinct parameter, use of their p and their $\overrightarrow{DB}$, Dependent on previous method mark.
	dddM1	Correctly equate coefficients for their vectors, in 2 distinct parameters. Dependent on all 3 previous method marks.
	A1	$\delta = \frac{3}{5}$ or $\eta = \frac{2}{5}$ note if using eg $\overrightarrow{BD}$ $\eta = -\frac{2}{5}$
	A1 cso	3:2 oe – dependent on using a vector method.

Vectors questions notoriously have different methods.
Note, correct method can include the opposite signs in vectors multiplied by a parameter, as the parameter will just be the opposite sign when calculated and a fully correct solution is possible.

Correct answer, not from obviously incorrect working, full marks may be awarded **if method is shown.**
(This is because the demand of this question says students must use a vector method).
Minimum method **must** involve finding two correct different distinct relevant paths, with parameters.
If in doubt – send to Review please.

USEFUL SKETCH



(c) Eg 1	$\frac{CXD}{BCD}=\frac{3}{5}$ oe $\frac{BCD}{ABCD}=\frac{2}{5}$ oe $\frac{CXD}{BCD}\times\frac{BCD}{ABCD}=\frac{3}{5}\times\frac{2}{5}=\frac{6}{25}\text{oe}\Rightarrow K=\frac{6}{25}$ oe	M1 M1 ddM1A1 [4]
Eg 2	$\frac{CXD}{ACD}=\frac{2}{5}$ oe $\frac{ACD}{ABCD}=\frac{3}{5}$ oe $\frac{CXD}{ACD}\times\frac{ACD}{ABCD}=\frac{2}{5}\times\frac{3}{5}=\frac{6}{25}\text{oe}\Rightarrow K=\frac{6}{25}$ oe	M1 M1 ddM1A1 [4]
		Total 17 marks

(c)	M1	For the correct ratio of area of two triangles, which will lead to a correct final ratio The ratio must be clearly assigned to the triangle (ie not just a fraction or ratio on its own)
	M1	For the correct ratio of area of a triangle to the trapezium, which will lead to a correct final ratio The ratio must be clearly assigned (ie not just a fraction or ratio on its own)
	ddM1	Dep on previous 2 method marks For combining areas correctly
	A1	For the correct value of K K Must not be from obviously incorrect work. If a candidate reaches the correct value of K from incomplete work or if unsure of method used, send to Review

If you see the following method for b), with anything other than fully correct work – **please send to Review.**

10b) Let $AX : XC = 1 : \lambda$, $BX : XD = 1 : m$

$\vec{AX} = \frac{1}{\lambda+1}\vec{AC} = \frac{1}{\lambda+1}(7\vec{a} - 6\vec{b})$

$\vec{AX} = \vec{AB} + \frac{1}{m+1}\vec{BD} = (a+4b) + \frac{1}{m+1}(8a-19b)$

$\vec{BD} = (9a-11b) - (a+4b)$ [$\vec{BA} + \vec{Ab}$]

$= 8a - 19b$ //

$\frac{7}{\lambda+1} = 1 + \frac{8}{m+1}$

$\frac{7}{\lambda+1} = \frac{m+9}{m+1}$

$7m+7 = (\lambda+1)(m+9) = \lambda m + 9\lambda + m + 9$

$7m - 2 - m = \lambda(m+9)$

$\frac{6m-2}{m+9} = \lambda$ //

$4 - \frac{19}{m+1} = -6\frac{1}{\left(\frac{6m-2}{m+9}\right)+1}$

$\frac{4m+4-19}{m+1} = \frac{-6}{\left(\frac{6m-2}{m+9}\right)+1}$

$(4m-15)\left(\frac{6m-2}{m+9}+1\right) = -6m-6$

$(4m-15)(7m+7) = (-6m-6)(m+9)$

$28m^2 + 28m - 105m - 105 = -6m^2 - 54m - 6m - 54$

$34m^2 - 17m - 51 = 0$

$17(2m^2 - m - 3) = 0$

$(2m^2 - m - 3) = 0$

$m = -1, 1.5$

reject as $m > 0$

$m = 1.5$ //

[$BX : XD = 2 : 3$]

$\therefore \lambda = \frac{6(1.5)-2}{1.5+9}$

$= \frac{2}{3}$ //

$\therefore AX : XC = 3 : 2$ //

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