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EDEXCEL INTERNATIONAL A LEVEL MATHS: QUESTIONS BY TOPIC

Straight-Line Graphs (P1.5)

International A Level Mathematics · P1: Pure Mathematics 1 (WMA11)

17 questions · 125 marks · Mark schemes included

Past papers January 2019 - January 2025 · 3 sub-topics

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HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.

A gold bar in the left margin marks exactly where the question sits on the original page.

Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.

Each question is filed under its main topic; longer questions may also test skills from other topics.

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QUESTIONS

17 questions · 125 marks · 3 sub-topics

SUB-TOPIC P1.5a

EQUATIONS OF STRAIGHT LINES & GRADIENTS

Sub-topic P1.5a · 11 questions · 79 marks · lowest tariff first



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2. A tree was planted in the ground.

Exactly 2 years after it was planted, the height of the tree was 1.85 m.

Exactly 7 years after it was planted, the height of the tree was 3.45 m.

Given that the height, H metres, of the tree, t years after it was planted in the ground, can be modelled by the equation

$$H = at + b$$

where a and b are constants,

- (a) find the value of a and the value of b .

(4)

- (b) State, according to the model, the height of the tree when it was planted.

(1)

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Q2

3. The share price of a company is monitored.

Exactly 3 years after monitoring began, the share price was £1.05

Exactly 5 years after monitoring began, the share price was £1.65

The share price, $\pounds V$, of the company is modelled by the equation

$$V = pt + q$$

where t is the number of years after monitoring began and p and q are constants.

- (a) Find the value of p and the value of q .

(3)

Exactly T years after monitoring began, the share price was £2.50

- (b) Find the value of T , according to the model, giving your answer to one decimal place.

(2)

Question 3 continued

Lined area for writing the answer to Question 3.

(Total for Question 3 is 5 marks)

(Total for Question 2 is 5 marks)



Question 3 continued





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Question 2 continued

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Question 2 continued

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Q2

(Total 6 marks)



- (a) Find an equation for l_1 giving your answer in the form $y = mx + c$, where m and c are constants.

The line l_2 is perpendicular to l_1 and passes through the midpoint of AB

- (b) Find an equation for l_2 giving your answer in the form $px + qy + r = 0$, where p , q and r are integers.



Question 1 continued

(Total for Question 1 is 6 marks)



Question 4 continued

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Question 4 continued

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Q4

(Total 8 marks)



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Q8

10.

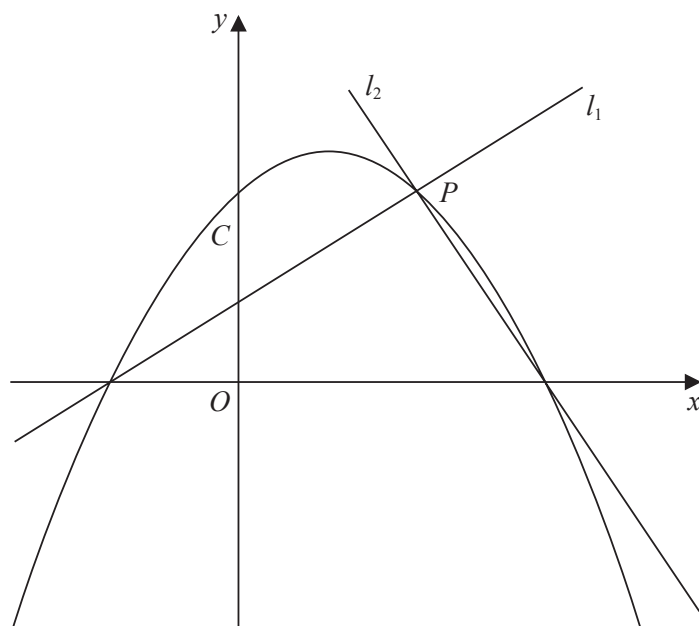


Figure 5

Figure 5 shows a sketch of the quadratic curve C with equation

$$y = -\frac{1}{4}(x+2)(x-b) \quad \text{where } b \text{ is a positive constant}$$

The line l_1 also shown in Figure 5,

- has gradient $\frac{1}{2}$
- intersects C on the negative x -axis and at the point P

(a) (i) Write down an equation for l_1

(1)

(ii) Find, in terms of b , the coordinates of P

(3)

Given that the line l_2 is perpendicular to l_1 and intersects C on the positive x -axis,

(b) find, in terms of b , an equation for l_2

(2)

Given also that l_2 intersects C at the point P

(c) show that another equation for l_2 is

$$y = -2x + \frac{5b}{2} - 4$$

(2)

(d) Hence, or otherwise, find the value of b

(2)



Question 10 continued

Lined area for writing the answer to Question 10.



Question 10 continued

Lined area for writing the answer to Question 10.



Question 10 continued

Lined area for writing the answer to Question 10.



Question 10 continued

Lined area for writing the answer to Question 10.

(Total for Question 10 is 10 marks)

TOTAL FOR PAPER IS 75 MARKS



5.

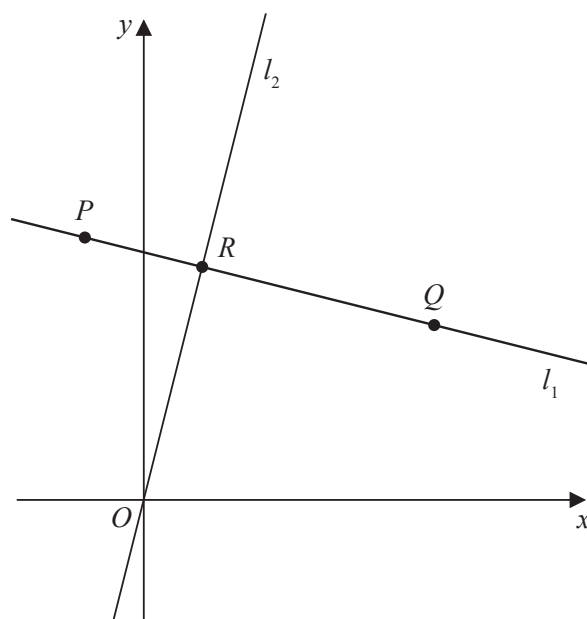


Figure 1

In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

The straight line l_1 , shown in Figure 1, passes through the points $P(-2, 9)$ and $Q(10, 6)$.

- (a) Find the equation of l_1 , giving your answer in the form $y = mx + c$, where m and c are constants to be found.

(3)

The straight line l_2 passes through the origin O and is perpendicular to l_1 .

The lines l_1 and l_2 meet at the point R as shown in Figure 1.

- (b) Find the coordinates of R

(4)

- (c) Find the exact area of triangle OPQ .

(3)



Question 5 continued



Question 5 continued

Lined area for writing the answer to Question 5.

(Total for Question 5 is 10 marks)



7.

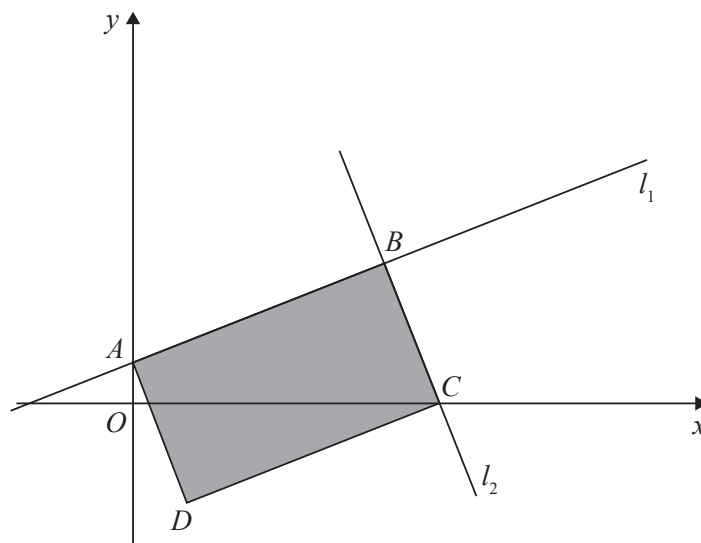


Figure 2

The straight line l_1 shown in Figure 2 has equation $5y = 2x + 10$

The points A and B lie on l_1 such that

- point A lies on the y -axis
- point B has x coordinate 10

(a) Find the distance AB writing your answer as a fully simplified surd.

(3)

The straight line l_2 also shown in Figure 2

- passes through B
- is perpendicular to l_1

(b) Find an equation for l_2 writing your answer in the form $ax + by + c = 0$, where a , b and c are integers.

(4)

Line l_2 crosses the x -axis at the point C .

Point D is such that the points A , B , C and D form the vertices of a rectangle, shown shaded in Figure 2.

(c) Find the area of rectangle $ABCD$.

(3)

Question 7 continued

Lined area for writing the answer to Question 7 continued.



Question 7 continued

Lined area for writing the answer to Question 7 continued.



Question 7 continued

Lined area for writing the answer to Question 7.

(Total for Question 7 is 10 marks)



SUB-TOPIC P1.5b

PARALLEL & PERPENDICULAR LINES

Sub-topic P1.5b · 4 questions · 26 marks · lowest tariff first



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3. The line l_1 has equation $3x + 5y - 7 = 0$

(a) Find the gradient of l_1

(2)

The line l_2 is perpendicular to l_1 and passes through the point $(6, -2)$.

(b) Find the equation of l_2 in the form $y = mx + c$, where m and c are constants.

(3)

Question 3 continued

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Q3

(Total 5 marks)



- (3)

(2)



(Total for Question 2 is 5 marks)



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6. The line l_1 has equation $3x - 4y + 20 = 0$

The line l_2 cuts the x -axis at $R(8,0)$ and is parallel to l_1

- (a) Find the equation of l_2 , writing your answer in the form $ax + by + c = 0$, where a , b and c are integers to be found.

(3)

The line l_1 cuts the x -axis at P and the y -axis at Q .

Given that $PQRS$ is a parallelogram, find

- (b) the area of $PQRS$,

(3)

- (c) the coordinates of S .

(2)

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Question 6 continued

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Handwriting practice lines for the answer to Question 6.



Question 6 continued

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Lined area for writing the answer to Question 6.

(Total 8 marks)

Q6

Mark box for Q6.



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5. The line l_1 has equation $3y - 2x = 30$

The line l_2 passes through the point $A(24, 0)$ and is perpendicular to l_1

Lines l_1 and l_2 meet at the point P

- (a) Find, using algebra and showing your working, the coordinates of P .

(5)

Given that l_1 meets the x -axis at the point B ,

- (b) find the area of triangle BPA .

(3)

Question 5 continued

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Handwriting practice area with 30 horizontal lines.



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Question 5 continued

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Lined area for writing the answer to Question 5.

(Total 8 marks)

Q5



SUB-TOPIC P1.5c

LENGTHS, MIDPOINTS & AREAS

Sub-topic P1.5c · 2 questions · 20 marks · lowest tariff first



Question 9 continued

Lined area for writing the answer to Question 9.



Question 9 continued

Lined area for writing the answer to Question 9.



Question 9 continued

Lined area for writing the answer to Question 9.

(Total for Question 9 is 9 marks)



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6. The point A has coordinates $(-4, 11)$ and the point B has coordinates $(8, 2)$.

- (a) Find the gradient of the line AB , giving your answer as a fully simplified fraction. (2)

The point M is the midpoint of AB . The line l passes through M and is perpendicular to AB .

- (b) Find an equation for l , giving your answer in the form $px + qy + r = 0$ where p , q and r are integers to be found.
- (4)**

The point C lies on l such that the area of triangle ABC is 37.5 square units.

- (c) Find the two possible pairs of coordinates of point C . (5)



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Question 6 continued

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Lined area for writing the answer to Question 6 continued.



Question 6 continued

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(Total 11 marks)

Q6



MARK SCHEMES

official mark schemes, in the same order as the questions



General Principles for Core Mathematics Marking

(But note that 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 $x = \dots$

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

2. Formula

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

3. Completing the square

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

Method marks for differentiation and integration:1. Differentiation

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

2. Integration

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

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.



General Principles for Pure Mathematics Marking

(But note that 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 $x = \dots$

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

2. Formula

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

3. Completing the square

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

Method marks for differentiation and integration:

1. Differentiation

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

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

(a)

M1 Reduces the power by 1 on any of the following terms

$\dots x^3 \rightarrow \dots x^2$, $\dots x^2 \rightarrow \dots x^1$, $\dots x^{-1} \rightarrow \dots x^{-2}$. Be careful not to allow just sight of x^2 . The index does not have to be processed for this mark.

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

A1 $\frac{3}{4}x^2 - 2x - 17x^{-2}$ 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 $\frac{dy}{dx}$ 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 $\left(2, \frac{13}{2}\right)$ using their $\frac{dy}{dx}$ at $x = 2$ eg it cannot be the gradient of the normal.

Score for sight of $y - \frac{13}{2} = -\frac{21}{4}(x - 2)$ with both coordinates substituted in correctly or if they use the form $y = mx + c$ they must proceed as far as $c = \dots$. 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.



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 $x = \dots$

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

2. Formula

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

3. Completing the square

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

Method marks for differentiation and integration:

1. Differentiation

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

2. Integration

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

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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	$\int \left(8x^3 - 6\sqrt{x} - \frac{2}{5x^3} \right) dx = 2x^4 - 4x^{\frac{3}{2}} + \frac{1}{5x^2} + c$	M1 A1A1A1
		(4 marks)

M1 Increases the power by one on one of the terms in x

Must be for any one of $x^3 \rightarrow x^4$ $x^{\frac{1}{2}} \rightarrow x^{\frac{3}{2}}$ $x^{-3} \rightarrow x^{-2}$. Indices do not need to be processed for this mark. e.g. $x^3 \rightarrow x^{3+1}$ is fine.

A1 One term of $2x^4 - 4x^{\frac{3}{2}} + \frac{1}{5x^2}$ (may be unsimplified but indices must be processed)

A1 Any two terms of $2x^4 - 4x^{\frac{3}{2}} + \frac{1}{5x^2}$ (may be unsimplified but indices must be processed). Terms may appear as a list or be on different lines.

A1 $2x^4 - 4x^{\frac{3}{2}} + \frac{1}{5x^2} + c$ or simplified equivalent (including the constant of integration) all on one line.

e.g. accept $2x^4 - 4(\sqrt{x})^3 + 0.2x^{-2} + c$ but do not accept $\frac{0.2}{x^2}$ or $\frac{\frac{1}{5}}{x^2}$ for $\frac{1}{5x^2}$

isw once a correct answer is seen but withhold if there is any spurious notation e.g. an integral sign or dx



General Principles for Pure Mathematics Marking

(But note that 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 $x = \dots$

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

2. Formula

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

3. Completing the square

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

Method marks for differentiation and integration:

1. Differentiation

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

2. Integration

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

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Exact answers

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Answers without working

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

2. Formula

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

3. Completing the square

Solving $x^2 + bx + c = 0$: $(x \pm \frac{b}{2})^2 \pm q \pm c$, $q \neq 0$ leading to $x = \dots$ **Method marks for differentiation and integration:**

1. Differentiation

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

2. Integration

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

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Question Number	Scheme	Marks
3. (a)(i)	$P(-180, -4)$	B1, B1
(ii)	$Q(450, 0)$	B1
(b)	$R(360, 7)$	B1, B1
		(3)
		(2)
		(5 marks)

For all parts condone missing brackets and check the graph/next to the question for answers.

Condone use of the degree symbol for their x values eg $(-180^\circ, \dots)$ instead of $(-180, \dots)$

(a)(i)

B1 $(-180, \dots)$ or $(\dots, -4)$ or $x = -180$ or $y = -4$ condone x in radians

B1 $(-180, -4)$ or $x = -180, y = -4$ Must be in degrees

SC1 $(-4, -180)$ (on EPEN this would be scored B1B0)

(a)(ii)

B1 $(450, 0)$ or $x = 450, y = 0$ condone $\left(\frac{5}{2}\pi, 0\right)$

(b)

B1 $(360, \dots)$ or $(\dots, 7)$ $x = 360$ or $y = 7$ condone x in radians

B1 $(360, 7)$ or $x = 360, y = 7$ Must be in degrees. Ignore any reference to $(0, 7)$

SC1 $(7, 360)$ (on EPEN this would be scored B1B0)

Note if radians used throughout then max score:

(a)(i) $(-\pi, -4)$ B1B0 **(a)(ii)** $\left(\frac{5}{2}\pi, 0\right)$ B1 **(b)** $(2\pi, 7)$ B1B0



Question Number	Scheme	Marks
4.(a)	Gradient $PQ = -3$ Attempts to find equation of l Eg. $y - 13 = -3(x + 2)$ $y = -3x + 7$	B1 M1 A1 (3)
(b)	Attempts to use minimum is $(4, -5)$ Eg $y = \dots(x - 4)^2 - 5$ Attempts to use $(-2, 13)$ with $y = a(x - 4)^2 - 5 \Rightarrow a = \dots$ $\Rightarrow y = \frac{1}{2}(x - 4)^2 - 5$ or $y = \frac{1}{2}x^2 - 4x + 3$ oe	M1 dM1 A1 (3)
(c)	Two of $y > -3x + 7$, $y < \frac{1}{2}(x - 4)^2 - 5$ $x < -2$ All three of $y > -3x + 7$, $y < \frac{1}{2}(x - 4)^2 - 5$ $x < -2$	M1 A1 (2)
		(8 marks)

(a)B1 Finds the gradient of l to be -3 If simultaneous equations are used then it would be scored for $m = -3$

M1 Attempts to find the equation of the line using their gradient for PQ and one of the points. Sight of embedded values eg $(y - -5) = "-3"(x - 4)$ is sufficient (allow one sign slip on one of the brackets) or if they use $y = mx + c$ they must proceed as far as $c = \dots$

If the perpendicular gradient is used it is M0.

A simultaneous method, eg solving $13 = -2m + c$ and $-5 = 4m + c$ must reach values for m and c .A1 $y = -3x + 7$ cso Condone $m = -3$, $c = 7$ **(b)**M1 Attempts to use the **minimum point** $(4, -5)$ to form a valid equation**Way One:** e.g. $(y =) A(x - 4)^2 - 5$ (condoning A to be 1). Condone**Way Two:** Letting $y = ax^2 + bx + c$ and either:

- finding $\frac{dy}{dx}$ and setting $2a \times 4 + b = 0$
- uses the minimum point and symmetry starting with $-\frac{b}{2a} = 4$ ($\Rightarrow -b = 8a \Rightarrow 8a + b = 0$)
- uses symmetry about the minimum point to identify the point $(10, 13)$ and form the equation $13 = 100a + 10b + c$

Do not award for only substituting the minimum point into a linear equation.



Question Number	Scheme	Marks
7(a)	$4 \times -2 \times -9 = 72$ $p = "72" - 50$	M1
	$(p =) 22$	A1
		(2)
(b)	$(q =) -4, 2, 4.5$	B1B1
		(2)
(c)	$f(x) = (x+4)(x-2)(2x-9)$ $f(x) = (x^2 + 2x - 8)(2x - 9) = \dots x^3 \pm \dots x^2 \pm \dots x (\pm \dots)$	M1
	$= 2x^3 - 5x^2 - 34x (+72)$	A1
	$(f'(x) =) 6x^2 - 10x - 34$	M1A1
		(4)
(d)	$"6x^2 - 10x - 34" = -18$ $"6x^2 - 10x - 16" = 0 \Rightarrow x = \dots \left(-1, \frac{8}{3}\right)$	M1
	$-1 < x < \frac{8}{3}$	dM1A1
		(3)
		Total 11

(a)

M1: Correct method for p . Condone sign slips in finding the product of $4 \times -2 \times -9$
Alternatively multiplies out to achieve a cubic (eg ± 72) and subtracts 50 from their constant. $50 - 72 (= -22)$ is M0.

A1: 22 cao (22 with no working is M1A1) In the alternative method they must identify p as 22.
Check for answer next to question. If there is a contradiction then the answer in the main body of working takes precedence.
Accept $y = f(x) - 22$ but do not accept contradictions such as $f(x) - 22 \Rightarrow p = -22$ (M1A0)

(b) Check next to the question (ignore any references to x)

B1: Any 1 correct value of $-4, 2, 4.5$ in their final answer. If they proceed to changing the sign on the value then B0.

B1: $-4, 2, 4.5$ cao but if they exclude any of these then withhold this mark. If there is a contradiction, then the answer in the main body of working takes precedence and if they state the correct values followed by $4, -2, -4.5$ then withhold this mark.



(c) The expansion may be seen in (a) or (b) which is acceptable to score the first two marks.

M1: Correct method used to expand and achieve a cubic $ax^3 + bx^2 + cx (+d)$ where a, b, c are all non zero. Terms do not need to be collected.

A1: $2x^3 - 5x^2 - 34x$ (simplified or unsimplified). Do not be concerned with the value of d

M1: $x^n \rightarrow x^{n-1}$ on at least one term for their cubic.

A1: $6x^2 - 10x - 34$ following a correct expansion of the cubic (+72 may be omitted). If the constant term is incorrect (not just omitted) then A0
isw eg $6x^2 - 10x - 34 = 0$ can still score A1.

(d)

M1: Sets their $f'(x) = \pm 18$, collects terms and attempts to solve their 3TQ by factorising, quadratic formula or completing the square. They may just write down their critical values which is acceptable, but you may need to check these on your calculator. Condone slips in their rearrangement.

dM1: Attempts “inside” region for their values. Do not be concerned as to whether the inequalities are $<$ or $\leq$ for this mark. It is dependent on the previous method mark.

A1: $-1 < x < \frac{8}{3}$ or other equivalent expressions such as $\left\{ x \in \mathbb{R} : -1 < x < \frac{8}{3} \right\}$ $x > -1 \cap x < \frac{8}{3}$ or

$x > -1$ and $x < \frac{8}{3}$, $\frac{8}{3} > x > -1$ or $x > -1, x < \frac{8}{3}$. Some minimal working must be seen.

Condone other attempts at set notation where there is the same intention.

Do not accept “ $x > -1$ or $x < \frac{8}{3}$ ” or “ $x > -1 \cup x < \frac{8}{3}$ ”

Question Number	Scheme	Marks
8(a)	$\frac{2}{5}$ or decimal equivalent	B1
		(1)
(b)	$m_N = -1 \div \frac{2}{5}$	M1
	$y + 2 = -\frac{5}{2}(x - 6)$	M1
	$y = -\frac{5}{2}x + 13$	A1
		(3)
(c)	$-\frac{5}{2}x + 13 = \frac{2}{5}x + \frac{7}{5} \Rightarrow \frac{29}{10}x = \frac{58}{5} \Rightarrow x = \dots (= 4)$ or $\frac{5}{2}y - \frac{7}{2} = -\frac{2}{5}y + \frac{26}{5} \Rightarrow \frac{29}{10}y = \frac{87}{10} \Rightarrow y = \dots (= 3)$	M1
	$x = "4" \Rightarrow y = \dots$ or $y = "3" \Rightarrow x = \dots$	dM1
	$(4, 3)$	A1
		(3)
(d)	$(2, 8)$	B1B1
		(2)
		Total 9

(a)

B1: $\frac{2}{5}$ or decimal equivalent. It must be identified so do not just extract it from a rearranged equation into the form $y = \frac{2}{5}x + \dots$ and do not allow $\frac{2}{5}x$. Must be seen in (a). Do not be concerned with the working to achieve $\frac{2}{5}$. Do not accept $\frac{-2}{-5}$

(b)

M1: Correct application of the perpendicular gradient rule

M1: Correct straight-line method with their “changed” gradient. Eg $(y + 2) = -\frac{5}{2}(x - 6)$. Allow one sign slip in the brackets. If they use $y = mx + c$ they must proceed as far as $c = \dots$

A1: $y = -\frac{5}{2}x + 13$ oe

(c) Coordinates found with no algebraic working scores 0

M1: A correct method to solve for x or y for their l_1 and l_2 . Do not be concerned by the mechanics of their rearrangement. Do not penalise if decimals appear in their working.



dM1: Finds the value of the other variable. It is dependent on the previous method mark.

A1: $(4,3)$ or $x = 4, y = 3$ Condone lack of brackets around the coordinates.

(d) **Note on EPEN this is M1A1 we are marking this B1B1**

B1: One of $x = 2$ or $y = 8$ May be seen within a pair of coordinates.

B1: $(2,8)$ or $x = 2, y = 8$ Condone lack of brackets around the coordinates.

Special Case: $(8,2)$ or $\begin{pmatrix} 2 \\ 8 \end{pmatrix}$ score B1B0

Question	Scheme	Marks
7(a)	$0 = 10 - 2x \Rightarrow x = 5$ or $y = 2, y = 10 - 2x \Rightarrow x = 4$	B1
	Examples: $\frac{1}{2} \times 2(5 + 4 - a) = \frac{27}{4} \text{ or } \frac{1}{2} \times 2\left(5 + 4 - \frac{2}{k}\right) = \frac{27}{4}$ Trapezium or $\frac{1}{2} \times 2a + \frac{1}{2} \times 2(5 - a + 4 - a) = \frac{27}{4} \text{ or } \frac{1}{2} \times 2 \times \frac{2}{k} + \frac{1}{2} \times 2\left(5 - \frac{2}{k} + 4 - \frac{2}{k}\right) = \frac{27}{4}$ Triangle + Trapezium or $\frac{1}{2} \times 2a + 2(4 - a) + \frac{1}{2} \times 1 \times 2 = \frac{27}{4} \text{ or } \frac{1}{2} \times 2 \times \frac{2}{k} + 2\left(4 - \frac{2}{k}\right) + \frac{1}{2} \times 1 \times 2 = \frac{27}{4}$ Triangle + Rectangle + Triangle or $\frac{1}{2} \times 5 \times 2 + \frac{1}{2}(4 - a) \times 2 = \frac{27}{4} \text{ or } \frac{1}{2} \times 5 \times 2 + \frac{1}{2}\left(4 - \frac{2}{k}\right) \times 2 = \frac{27}{4}$ 2 Triangles	M1
	$\Rightarrow k = \frac{8}{9}, a = \frac{9}{4}$	A1 A1ft
		(4)
(b)	Two of $y \geq \frac{8}{9}x, y \leq 10 - 2x, x > \frac{9}{4}$	M1
	All three of $y \geq \frac{8}{9}x, y \leq 10 - 2x, x > \frac{9}{4}$	A1
		(2)
(6 marks)		
Notes:		
(a) B1: Correct x intercept for $y = 10 - 2x$ or correct x coordinate for intersection of $y = 2$ with $y = 10 - 2x$. May be seen on the diagram or in a sketch or implied by their working. M1: Correct method for area and sets equal to $\frac{27}{4}$ to form an equation in a or k. The $2 \times \frac{1}{2}$ may be implied. May use e.g. trapezium, triangle + trapezium, triangle + rectangle + triangle or 2 triangles. See above for some examples. Note that with a correct “5” and “4” the area is $9 - a$ or $9 - \frac{2}{k}$. A1: Correct value for a or k as a single value not a calculation. A1ft: Correct values for a and k. Correct values or follow through using $ak = 2$ from their first value to the second provided the M1 is scored. Allow exact equivalents or exact ft equivalents so if correct allow e.g. $k = 0.\dot{8}$, $a = 2.25$ or $2\frac{1}{4}$		

(b)

M1: Any two of the three correct inequalities with their k and/or their a or the letters a and k . Note inequalities in y may be combined in to one so " $\frac{8}{9}$ " $x < y < 10 - 2x$ would count as two correct inequalities. Inequalities must be in the correct direction but accept with $<$ or $\leq$ for the M. Do not allow incorrect notation such as $R_2 \geq \frac{8}{9}x$, $R_2 \leq 10 - 2x$

A1: All three correct with the correct values of a and k – **there is no follow though for this mark.**

Note inequalities in y may be combined in to one as above.

Note that there may be an upper limit on the x inequality which is fine provided it is in an acceptable range and consistent.

Note that $y = \frac{8}{9}x$ and $y = 10 - 2x$ intersect when $x = \frac{45}{13}$ so the upper limit may be this value or greater. In general the following are acceptable:

$$y \geq \frac{8}{9}x, y \leq 10 - 2x, \frac{9}{4} < x \leq \alpha \text{ if } \alpha \geq \frac{45}{13} \text{ or } y \geq \frac{8}{9}x, y \leq 10 - 2x, \frac{9}{4} < x < \alpha \text{ if } \alpha > \frac{45}{13}$$

The following examples would score both marks,

$$y \geq \frac{8}{9}x, y \leq 10 - 2x, \frac{9}{4} < x \leq \frac{45}{13}$$

$$y \geq \frac{8}{9}x, y \leq 10 - 2x, \frac{9}{4} < x < 5$$

Note that some candidates are also including limits on y and this is acceptable provided the values are in the correct range. Allow strict or non strict inequalities e.g.

$$y > 2, y \geq 2, 2 < y < \frac{11}{2}, 2 \leq y \leq \frac{11}{2} \text{ but e.g. } y < 2, y \leq 2 \text{ scores A0}$$



Question 8 – General Guidance for marking

Note that some candidates are misreading the $x^{-\frac{1}{2}}$ as $x^{\frac{1}{2}}$ in part (a) and/or part (b)

In the majority of cases it will be clear if this is the case as candidates often write down the expression before they differentiate in part (a) or integrate in part (b)

If it is clear that a candidate thinks the expression is $\frac{1}{4}x^3 - 8x^{\frac{1}{2}}$ in either or both parts then **FULL** marks should be awarded for correct work – details are below. We are condoning the fact that

$$P(4,12) \text{ does not lie on } y = \frac{1}{4}x^3 - 8x^{\frac{1}{2}}$$

If candidates do not write down the original expression (in (a) or (b)) then evidence of misreading or not can be taken from their derivative or integral.

Note:

If candidates integrate in (a) and differentiate in (b) then the maximum marks available are:

(a) M0A0M1dM1A0 (b) M0A0dM0A0

If parts are not labelled then you should assume that the first attempt is part (a) and the second attempt is part (b).



8. Scheme - No Misread

Question	Scheme	Marks
8(a)	$y = \frac{1}{4}x^3 - 8x^{-\frac{1}{2}} \Rightarrow \left(\frac{dy}{dx}\right) = \frac{1}{4} \times 3x^2 - 8 \times -\frac{1}{2}x^{-\frac{3}{2}}$	M1 A1
	$\frac{dy}{dx}\bigg _{x=4} = \dots \left(\frac{25}{2}\right)$	M1
	$y - 12 = \frac{25}{2}(x - 4)$	dM1
	$25x - 2y - 76 = 0$ oe e.g. $-25x + 2y + 76 = 0$	A1
		(5)
(b)	$(f(x) =) \int \frac{1}{4}x^3 - 8x^{-\frac{1}{2}} dx = \frac{1}{4} \frac{x^4}{4} - \frac{8x^{\frac{1}{2}}}{\frac{1}{2}} (+c)$	M1 A1
	$f(4) = 12 \Rightarrow 16 - 32 + c = 12 \Rightarrow c = \dots(28)$	dM1 A1
	So $(f(x) =) \frac{x^4}{16} - 16\sqrt{x} + 28$	A1ft
		(5)
(10 marks)		

Notes:**(a)****M1:** Correct method of differentiation, at least one power reduced by 1.Award for $\frac{1}{4}x^3 \rightarrow \dots x^2$ or $-8x^{-\frac{1}{2}} \rightarrow \dots x^{-\frac{3}{2}}$ **A1:** Correct differentiation, need not be simplified.**M1:** Finds $\frac{dy}{dx}$ at $x = 4$. Requires the substitution of $x = 4$ into a “changed” function to find a value.

Note that some candidates are using the “12” in some way to find the gradient e.g.

$$12 = \frac{1}{4} \times 3(4)^2 - 8 \times -\frac{1}{2}(4)^{-\frac{3}{2}} + c \Rightarrow c = 2 \Rightarrow m = 2 \text{ and this scores M0}$$

dM1: Depends on previous M. Correct method for the tangent **not** the normal. Uses their $\frac{dy}{dx}$ at $x = 4$ with $y = 12$ and $x = 4$ correctly placed. If using $y = mx + c$ they must proceed as far as finding a value for c .**A1:** Correct equation in the required form including “= 0” or any non-zero integer multiple of it.**(b)****M1:** Attempts to integrate $f(x)$, look for power increased by 1 on at least one term.Award for $\frac{1}{4}x^3 \rightarrow \dots x^4$ or $-\frac{1}{8}x^{-\frac{1}{2}} \rightarrow \dots x^{\frac{1}{2}}$ **A1:** Correct integration, need not be simplified. (no need for constant for this mark).**dM1:** Depends on first M. Sets $f(4) = 12$ and proceeds to find a value for c - must have a constant of integration to score this mark.**A1:** Correct value for c found.**A1ft:** Correct answer following through their c only i.e. the algebraic part must be correct.

Accept with fractional index rather than square root. Allow $0.0625x^4$ for $\frac{x^4}{16}$. **Depends on the previous method mark.**

The “ $f(x) =$ ” is **not** required so just look for the correct expression. Apply isw if necessary, e.g. correct work leading to $(f(x) =) \frac{x^4}{16} - 16x^{\frac{1}{2}} + 28$ followed by $(f(x) =) x^4 - 256x^{\frac{1}{2}} + 448$ can score full marks in (b).

Condone poor notation e.g. leaving the final answer as $(f(x) =) \int \frac{x^4}{16} - 16x^{\frac{1}{2}} + 28$



8. Scheme – Misread in (a) and/or (b)

Question	Scheme	Marks
8(a)	$y = \frac{1}{4}x^3 - 8x^{\frac{1}{2}} \Rightarrow \left(\frac{dy}{dx}\right) = \frac{1}{4} \times 3x^2 - 8 \times \frac{1}{2}x^{-\frac{1}{2}}$	M1 A1
	$\frac{dy}{dx}\bigg _{x=4} = \dots (10)$	M1
	$y - 12 = "10"(x - 4)$	dM1
	$10x - y - 28 = 0$ oe e.g. $-10x + y + 28 = 0$	A1
		(5)
(b)	$(f(x) =) \int \frac{1}{4}x^3 - 8x^{\frac{1}{2}} dx = \frac{1}{4} \frac{x^4}{4} - \frac{8x^{\frac{3}{2}}}{\frac{3}{2}} (+c)$	M1 A1
	$f(4) = 12 \Rightarrow 16 - \frac{128}{3} + c = 12 \Rightarrow c = \dots \left(\frac{116}{3}\right)$	dM1 A1
	So $(f(x) =) \frac{x^4}{16} - \frac{16}{3}x^{\frac{3}{2}} + \frac{116}{3}$	A1ft
		(5)
(10 marks)		

Notes:**(a)****M1:** Correct method of differentiation, at least one power reduced by 1.Award for $\frac{1}{4}x^3 \rightarrow \dots x^2$ or $-8x^{\frac{1}{2}} \rightarrow \dots x^{-\frac{1}{2}}$ **A1:** Correct differentiation, need not be simplified. Ignore any spurious “= 0”.**M1:** Finds $\frac{dy}{dx}$ at $x = 4$. Requires the substitution of $x = 4$ into a “changed” function to find a value.

Note that some candidates are using the “12” in some way to find the gradient e.g.

$$12 = \frac{1}{4} \times 3(4)^2 - 8 \times -\frac{1}{2}(4)^{-\frac{1}{2}} + c \Rightarrow c = 2 \Rightarrow m = 2 \text{ and this scores M0}$$

dM1: Depends on previous M. Correct method for the tangent **not** the normal. Uses their $\frac{dy}{dx}$ at $x = 4$ with $y = 12$ and $x = 4$ correctly placed. If using $y = mx + c$ they must proceed as far as finding a value for c .**A1:** Correct equation in the required form including “= 0” or any non-zero integer multiple of it.**(b)****M1:** Attempts to integrate $f(x)$, look for power increased by 1 on at least one term.Award for $\frac{1}{4}x^3 \rightarrow \dots x^4$ or $-\frac{1}{2}x^{\frac{1}{2}} \rightarrow \dots x^{\frac{3}{2}}$ **A1:** Correct integration, need not be simplified. (no need for constant for this mark).**dM1: Depends on first M.** Sets $f(4) = 12$ and proceeds to find a value for c - must have a constant of integration to score this mark.**A1:** Correct value for c found.

A1ft: Correct answer following through their c only i.e. the algebraic part must be correct. Accept with fractional index rather than square root. Allow $0.0625x^4$ for $\frac{x^4}{16}$ and equivalent mixed

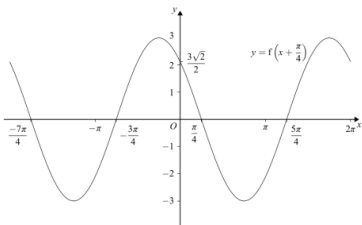
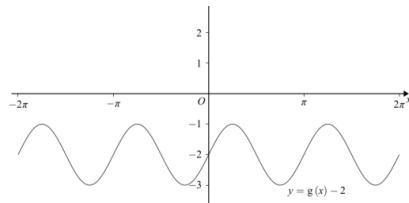
fractions for $\frac{16}{3}$ and $\frac{116}{3}$. **Depends on the previous method mark.**

The “ $f(x) =$ ” is **not** required so just look for the correct (or correct ft) expression. Apply isw if

necessary e.g. correct work leading to $(f(x) =) \frac{x^4}{16} - \frac{16}{3}x^{\frac{3}{2}} + \frac{116}{3}$ followed by

$(f(x) =) 3x^4 - 256x^{\frac{3}{2}} + 1856$ can score full marks in (b).

Condone poor notation e.g. leaving the final answer as $(f(x) =) \int \frac{x^4}{16} - \frac{16}{3}x^{\frac{3}{2}} + \frac{116}{3}$

Question	Scheme	Marks	
9(i)(a)	$(y =) 3\cos(x)$	M1 A1 (2)	
(b)		Same shape translated left or right	B1
		All x intercepts labelled correctly.	B1
		Correct y intercept $\frac{3\sqrt{2}}{2}$	B1
			(3)
(ii)(a)	$(y =) \sin(2x)$	M1 A1 (2)	
(b)		Same shape translated down below the x-axis.	B1
		Correct y intercept -2 labelled.	B1
			(2)
	(9 marks)		

Notes:

(i)(a) Remember to check the first page – (i)(a) is often attempted against the question.

M1: Identifies the curve as a cosine function of the form $\alpha \cos(\beta x)$.

Also allow for a sine function of the form $\alpha \sin\left(\beta x + \frac{\pi}{2}\right)$ oe.

A1: For a fully correct expression as shown or any equivalent. There is no requirement for $y = \dots$ or $f(x) = \dots$. Allow e.g. $3\cos\theta$

(b) There must be a sketch to score the marks in (i)(b) which may be done on Figure 3

B1: Applies a horizontal translation $y = f(x)$, either direction. The maximum at $(0, 3)$ must have moved to the left or to the right of the y-axis. There should also be one minimum to the left of the y-axis and one minimum to the right of the y-axis. Ignore any scale on the y-axis.

B1: All x intercepts labelled correctly. These must be the only x intercepts and the curve must pass through these points. Allow even if there is still a maximum on the y-axis. Allow as shown or as coordinate pairs e.g. $\left(-\frac{7\pi}{4}, 0\right)$ and allow e.g. $\left(0, -\frac{7\pi}{4}\right)$ as long as the intercepts are in the correct

positions. Condone 3sf decimal answers: Awrt -5.50 (or -5.5), -2.36 , 0.785 , 3.93

Condone use of degrees: -315° , -135° , 45° , 225° (with or without the degrees symbol)

B1: Correct exact y intercept labelled. Allow as shown or as e.g. $\left(0, \frac{3\sqrt{2}}{2}\right)$ and allow e.g. $\left(\frac{3\sqrt{2}}{2}, 0\right)$

as long as it is in the correct position. It must not be a clear maximum.



(ii)(a) Remember to check the first page – (ii)(a) is often attempted against the question

M1: Identifies the curve as a sine function of the form $\alpha \sin(\beta x)$.

Allow also for a cosine function of the form $\alpha \cos\left(\beta x \pm \frac{\pi}{2}\right)$ oe

A1: Any correct expression. There is no requirement for $y = \dots$ or $g(x) = \dots$. Allow e.g. $\sin 2\theta$

(b) There must be a sketch to score the marks in (ii)(b) which may be done on Figure 4

B1: Applies a vertical translation down to $y = g(x)$. It must have the same number of cycles as $g(x)$ and look the same as $g(x)$ and must lie entirely below the x -axis. Do not allow a clear “zig-zag” shape with cusps. Ignore any scale on the x -axis, correct or otherwise.

B1: Correct y intercept. Allow as shown or as e.g. $(0, -2)$ and allow e.g. $(-2, 0)$ as long as it is in the correct position and allow it to be shown by the intercept passing through the line with equation $y = -2$.



Question	Scheme	Marks
10(a)(i)	Equation is $y = \frac{1}{2}(x+2)$	B1
		(1)
(ii)	l_1 intersect parabola $\Rightarrow -\frac{1}{4}(x+2)(x-b) = \frac{1}{2}(x+2) \Rightarrow x = \dots$	M1
	$x = b - 2$	A1
	$y = \frac{1}{2}b$	A1
		(3)
(b)	l_2 passes through $(b, 0)$ and has gradient $-2 \Rightarrow y = \dots$	M1
	$y - 0 = -2(x - b)$	A1
		(2)
(c)	So equation is $y - \frac{1}{2}b = -2(x - b - 2)$	M1
	$y - \frac{1}{2}b = -2x + 2b - 4 \Rightarrow y = -2x + \frac{5}{2}b - 4^*$	A1*
		(2)
(d)	$y = -2x + 2b = -2x + \frac{5}{2}b - 4 \Rightarrow 2b = \frac{5}{2}b - 4 \Rightarrow b = \dots$ or $y = -2x + \frac{5}{2}b - 4, x = b, y = 0 \Rightarrow 0 = -2b + \frac{5}{2}b - 4 \Rightarrow b = \dots$ or $-\frac{1}{4}(x+2)(x-b) = -2(x-b) \Rightarrow x = \dots(6) \Rightarrow b - 2 = 6 \Rightarrow b = \dots$	M1
	$b = 8$	A1
		(2)
		(10 marks)

Notes:**(a)(i)**

B1: Correct equation in any form e.g. $y - 0 = \frac{1}{2}(x+2)$, $y = \frac{1}{2}x + 1$, $y = \frac{1}{2}(x - -2)$. Do not allow e.g.

$l_1 = \frac{1}{2}x + 1$. Apply isw if necessary, so allow e.g. $y = \frac{1}{2}(x+2)$ if followed by $y = \frac{1}{2}x + 2$

(a)(ii) Allow the marks for (a)(ii) to appear anywhere in their solution provided they are solving their l_1 with the given parabola.

Do not allow methods in (a)(ii) that assume that the y coordinate of P is the same as the y intercept of C unless this is justified by further work.

M1: Sets $-\frac{1}{4}(x+2)(x-b) = \frac{1}{2}(x+2)$ and makes some attempt to solve for x (or y) however

poor – e.g. allow if there is a slip in the use of the quadratic formula. Condone copying errors provided the intention is clear. Note that some candidates do not spot the cancelling of $(x+2)$ and end up solving a quadratic equation.

A1: Correct simplified x



A1: Correct simplified y

(b) Allow the work for (b) to appear anywhere in their solution

M1: Uses a gradient of -2 and the point $(b, 0)$ in an attempt to find the equation of l_2 .

If using $y = mx + c$ they must proceed as far as finding c in terms of b . The coordinates $(b, 0)$ must be correctly placed.

A1: Any correct equation. E.g. $y - 0 = -2(x - b)$, $y = -2(x - b)$, $y = -2x + 2b$. Apply isw if necessary.

(c) Allow the work for (c) to appear anywhere in their solution including in part (b) provided they have attempted part (a)(ii) and have coordinates for P .

M1: Uses a gradient of -2 and their coordinates of P in terms of b from (a) in an attempt to find the equation of l_2 . If using $y = mx + c$ they must proceed as far as finding c in terms of b . The coordinates of P must be correctly placed.

A1*: Correct equation reached from fully correct working with full marks in (a)(ii).

(d)

M1: Equates intercepts in the two equations for the line l_2 and solves for b . They must use the **given equation** in (c) and their attempt at the equation using $(b, 0)$ (however labelled) or uses the equation from (c) with $x = b$ when $y = 0$ to find b or equates the parabola to the line $y = -2(x - b)$, solves for x , equates to their x coordinate for P and then solves for b .

A1: $b = 8$

Correct answer only in (d) scores both marks.

Question Number	Scheme	Marks
3.(a)	$y = \frac{5x^3 - 8}{2x^2} = \frac{5}{2}x - 4x^{-2}$ $\frac{dy}{dx} = \frac{5}{2} + 8x^{-3}$	M1 dM1 A1 A1 (4)
(b)	Substitutes $x = 2$ into their $\frac{dy}{dx} = \frac{5}{2} + \frac{8}{x^3} \Rightarrow \frac{dy}{dx} = \frac{7}{2}$ Uses their $\frac{7}{2}$ and $(2, 4) \Rightarrow y - 4 = \frac{7}{2}(x - 2)$ $\Rightarrow 7x - 2y - 6 = 0$	M1 M1 A1 (3) (7 marks)

(a)

M1: Attempts to write y as **a sum of two terms** and achieves at least one term with the correct index.Award for $Px + Qx^k$ or $Px^k + Qx^{-2}$. Condone $Qx^{-2} \leftrightarrow \frac{Q}{x^2}$

dM1: Requires both

- the given expression to be written as a sum of two terms with both indices correct
- correct differentiation applied to the indices $Px + Qx^{-2} \rightarrow A + Bx^{-3}$ o.e

A1: One correct term which need not be simplified. Condone $\frac{5}{2}x^0$

Note that 1010 is possible where candidates only form one of the two correct terms and differentiate that correctly

A1: $\left(\frac{dy}{dx}\right) = \frac{5}{2} + 8x^{-3}$ or simplified equivalent such as $\frac{1}{2}\left(5 + \frac{16}{x^3}\right)$. There is no need to have the $\frac{dy}{dx}$

(b)

M1: Substitutes $x = 2$ into their $\frac{dy}{dx}$ and attempts its value. Their $\frac{dy}{dx}$ cannot be the same as their "y"Score for sight of embedded 2's in their $\frac{dy}{dx}$ followed by a value or it may be implied for a correctvalue for their $\frac{dy}{dx}$

M1: Correct method for finding the equation of a tangent.

Look for a correct use of their $\frac{dy}{dx}\bigg|_{x=2}$ and the point $(2, 4)$ to form equation $y - 4 = \frac{7}{2}(x - 2)$.If the form $y = mx + c$ is used it must proceed as far as $c = \dots$ Award this mark if they achieve $\frac{dy}{dx} = \frac{5}{2}$ in part (a) and correctly form the equation using $m = \frac{5}{2}$ and $(2, 4)$. They cannot score the previous mark.A1: $7x - 2y - 6 = 0$ or any multiple thereof

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Question Number	Scheme	Marks
7 (a)	States or implies that B is $(10, 6)$ $(AB^2) = (10-0)^2 + ("6"-2)^2 \Rightarrow AB = 2\sqrt{29}$	B1 M1, A1 (3)
(b)	States or implies that $\text{grad } AB = \frac{2}{5}$ Uses perpendicular gradient rule $\Rightarrow \text{grad } l_2 = -\frac{5}{2}$ $y - "6" = -\frac{5}{2}(x-10) \Rightarrow 5x + 2y - 62 = 0$	B1 M1 dM1, A1 (4)
(c)	C is $\left(\frac{62}{5}, 0\right)$ $(BC^2) = \left(\frac{62}{5}-10\right)^2 + ("6"-0)^2 \Rightarrow BC = \frac{6\sqrt{29}}{5} = (6.46)$ Area $ABCD = 69.6$	B1 ft M1, A1 (3) (10 marks)

(a)

B1: States or implies that B is $(10, 6)$. May be awarded for sight of $x=10, y=6$ without reference to " B "It is implied via sight of $(10-0)^2 + (6-p)^2$. Also be aware the answer may be on the FigureM1: Attempts AB or $(AB)^2$ between $(0, 2)$ and their $(10, "6")$ **This must be in part (a) and not in part (c).**Award for $\sqrt{(10-0)^2 + ("6"-2)^2}$ or $(10-0)^2 + ("6"-2)^2$ It is implied by $AB = \sqrt{116}$ or $AB^2 = 116$ There are other methods including $BH - AH = \sqrt{15^2 + 6^2} - \sqrt{5^2 + 2^2}$ where H is the x intercept of l_1 A1: $AB = 2\sqrt{29}$. This isn't a non-calculator question so minimal working is condoned/allowed.

(b)

B1: States or implies that $\text{grad } l_1 = \frac{2}{5}$ o.e such as $0.4, \frac{6}{15}$ It is implied by $\text{grad } l_2 = -\frac{5}{2}$ It cannot be awarded for just writing the equation of l_1 as $y = \frac{2}{5}x + \dots$

Candidates must know which part of the equation is the gradient

M1: Uses perpendicular gradient rule $\Rightarrow \text{grad } l_2 = -\frac{1}{\text{grad } l_1}$ dM1: Full attempt at equation of line l_2 $y - "6" = -\frac{5}{2}(x-10)$

For this to be awarded

- the gradient of l_2 must be either $-\frac{1}{\text{their grad } l_1}$ or if that was not attempted $-\frac{5}{2}$ or $-\frac{1}{0.4}$

- the point used must be $x=10$ and their $y=6$ (see part (a) for their B)

If the form $y = mx + k$ is used then the method must proceed as far as $k = \dots$ A1: $5x + 2y - 62 = 0$ or any integer multiple of this

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Special case in (b)

As the equation for l_1 is given as $5y = 2x + 10$ some candidates will assume the gradient is 2.

These candidates should get the equation of l_2 as $y - 6 = -\frac{1}{2}(x - 10)$

Such a candidate can score B0, M1, dM1, A0

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(c)

B1ft: States or implies that C is $\left(\frac{62}{5}, 0\right)$ o.e but follow through on their $-\frac{c}{a}$ from their $ax + by + c = 0$

M1: Attempts full method to find area $ABCD$. E.g $AB \times BC$ with a full attempt at BC using a correct method via Pythagoras' theorem. Follow through on their length AB from part (a)

If A , B and C are correct score for $AB = \text{awrt } 10.77$, $BC = 6.46$ followed by 10.77×6.46

A1: Exact answer is 69.6 or $\frac{348}{5}$ o.e. but accept awrt 69.6

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Other methods will be seen here, so look carefully at what is attempted.

E.g. The Shoelace Method

For example using $ABCD$ which requires all 4 coordinates

$$\frac{1}{2} \times \begin{vmatrix} 0 & 10 & 12.4 & 2.4 & 0 \\ 2 & 6 & 0 & -4 & 2 \end{vmatrix} = \frac{1}{2} \times |0 \times 6 + 10 \times 0 + 12.4 \times -4 + 2.4 \times 2 - 10 \times 2 - 12.4 \times 6 - 2.4 \times 0 - 0 \times -4|$$

$$= \frac{1}{2} \times 139.2 = 69.6$$

B1ft: For C as in the main method

M1: Correct method for coordinate D (usually using vectors with $\overrightarrow{AD} = \overrightarrow{BC}$) followed by a full application of the method with correct signs. Score for an unsimplified expression following through on their C

A1: AWRT 69.6

Or more easily by doubling area triangle ABC which does not use coordinate D

$$2 \times \frac{1}{2} \times \begin{vmatrix} 0 & 10 & 12.4 & 0 \\ 2 & 6 & 0 & 2 \end{vmatrix} = |0 \times 6 + 10 \times 0 + 12.4 \times 2 - 10 \times 2 - 12.4 \times 6 - 0 \times 0|$$

$$= 69.6$$

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General Principles for Pure Mathematics Marking

(But note that 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 $x = \dots$

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

2. Formula

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

3. Completing the square

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

Method marks for differentiation and integration:

1. Differentiation

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

2. Integration

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



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 errors 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.

Question Number	Scheme	Marks
1	$y = 2 + 10x^{\frac{1}{2}} - 2x^{\frac{3}{2}}$	
(a)	$\frac{dy}{dx} = 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}}$	M1 A1 A1
		(3)
(b)	$x = 2 \Rightarrow \frac{dy}{dx} = \frac{5}{\sqrt{2}} - 3\sqrt{2}$	M1
	$\frac{5}{\sqrt{2}} - 3\sqrt{2} = \frac{5}{2}\sqrt{2} - 3\sqrt{2} = -\frac{1}{2}\sqrt{2}$	A1
		(2)
		(5 marks)

(a) Mark (a) and (b) together.

M1: For ANY one of: $10x^{\frac{1}{2}} \rightarrow \dots x^{-\frac{1}{2}}$ or $-2x^{\frac{3}{2}} \rightarrow \dots x^{\frac{1}{2}}$ or $2 \rightarrow 0$

A1: For one simplified term e.g. either $10x^{\frac{1}{2}} \rightarrow 5x^{-\frac{1}{2}}$ or $-2x^{\frac{3}{2}} \rightarrow -3x^{\frac{1}{2}}$

A1: $\left(\frac{dy}{dx} = \right) 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}}$. Allow e.g. $\left(\frac{dy}{dx} = \right) \frac{5}{\sqrt{x}} - 3\sqrt{x}$. The “ $\frac{dy}{dx} =$ ” is not required. Condone “+ 0” as part of their answer.

There must be no other terms e.g. “+ c” or e.g. $\left(\frac{dy}{dx} = \right) 2 + 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}}$ but apply isw if possible once a correct simplified derivative with no extra terms is seen.

(b)

M1: For an attempt to substitute $x = 2$ fully into their $\frac{dy}{dx}$ which is not y e.g. it must be a “changed” function which could even come from integration.

All that is required is the substitution so allow for e.g. $5(2)^{-\frac{1}{2}} - 3(2)^{\frac{1}{2}}$

This mark may be implied by their answer or e.g. a decimal answer of awrt -0.7 following a correct derivative.

Do **not** allow this mark if they have e.g. $\left(\frac{dy}{dx} = \right) 5x^{-\frac{1}{2}} - 3x^{\frac{1}{2}} + c$ in part (a) **AND** subsequently go on to try and establish a value for “c” using $x = 2$.

A1: $-\frac{1}{2}\sqrt{2}$ or exact simplified equivalent e.g. $-\frac{1}{\sqrt{2}}$, $-0.5\sqrt{2}$, $-2^{-\frac{1}{2}}$, $-2^{-0.5}$ **following at least one intermediate line of working.**

E.g. $\frac{5}{\sqrt{x}} - 3\sqrt{x} = \frac{5}{\sqrt{2}} - 3\sqrt{2} = -\frac{1}{\sqrt{2}}$ scores M1A0

Question Number	Scheme	Marks
2 (a)	$3^{3x} = (3^x)^3 = y^3$	B1 (1)
(b)	$\frac{1}{3^{x-2}} = \frac{1}{3^x \times 3^{-2}} = \frac{9}{y}$	M1 A1 (2)
(c)	$\frac{81}{9^{2-3x}} = \frac{9^2}{9^{2-3x}} = 9^{2-(2-3x)} = 9^{3x} = 3^{6x} = y^6$	M1 A1 (2)
		(5 marks)

Note: Correct answer in any part implies full marks for that part

(a)

B1 y^3 Condone $(y)^3$. Ignore once correct answer seen.

(b)

M1 For correct application of the addition/subtraction law so award for eg:

$$\frac{1}{3^x \times 3^{-2}} \text{ or } \frac{1}{3^x \div 3^2} \text{ or } \frac{1}{\left(\frac{3^x}{3^2}\right)} \text{ or } \frac{1}{y \times 3^{-2}} \text{ or } \frac{3^2}{3^x} \text{ or sight of } 9 \text{ or } \frac{1}{y} \text{ oe}$$

A1 For $\frac{9}{y}$ or $9y^{-1}$ but NOT expressions that still contain $\div$ or fractions within fractions or $3^2 y^{-1}$. Ignore once correct answer seen.

(c)

M1 For simplifying the indices to expressions of the form $9^{\dots}$ or $3^{\dots}$ (not as a denominator) so award for 9^{3x} , $(9^x)^3$, 3^{6x} , $(3^x)^6$, or $k \times y^6$, $k \neq 0$ which must come from correct working. Also allow unsimplified equivalent expressions of the final answer eg $\frac{1}{y^{-6}}$ as long as it is in terms of y

A1 y^6 only (not eg $\frac{1}{y^{-6}}$). Ignore once correct answer seen. Condon $(y)^6$

Note: In all parts they may work from $y = 3^x$ and manipulate both sides to the given answer which is acceptable.

Eg part (b): $y = 3^x \Rightarrow y \times 3^{-2} = 3^{x-2}$ (M1) $\Rightarrow \frac{1}{y \times 3^{-2}} = \frac{1}{3^{x-2}} \Rightarrow \frac{9}{y} = \frac{1}{3^{x-2}}$ (A1)

Eg part (c): $y = 3^x \Rightarrow y^{-6} = 3^{-6x} \Rightarrow 81y^{-6} = 3^{4-6x}$ (M1) $\Rightarrow 81y^{-6} = 9^{2-3x} \Rightarrow \frac{81}{9^{2-3x}} = y^6$ (A1)



Question Number	Scheme	Marks
3.(a)	Attempts $\left(\frac{dy}{dx} = \right) 2x + 3$ at $x = 3$ At $x = 3$ gradient of tangent = 9	M1 A1 (2)
(b)	$(y_Q =) (3+h)^2 + 3(3+h) - 2$ Gradient $PQ = \frac{(3+h)^2 + 3(3+h) - 2 - 16}{3+h-3} = \frac{9h+h^2}{h} = 9+h$	B1 M1 A1 (3)
(c)	States as $h \rightarrow 0$ Gradient $PQ \rightarrow 9 =$ Gradient of tangent	B1 (1) (6 marks)

(a)

M1 Attempts to find the value of $\left(\frac{dy}{dx} = \right) ax + 3$, $a > 0$ at $x = 3$. Look for 3 to be substituted into the expression and proceeding to a value.

A1 9 (Answer only scores both marks)

(b)

B1 $(y_Q =) (3+h)^2 + 3(3+h) - 2$ (seen or implied)

M1 Attempts $\pm \frac{y_Q - 16}{x_Q - 3}$ condoning slips, but must be a genuine attempt at y_Q . Condone lack of brackets if implied by later working.

A1 $9+h$ with no errors seen and not originating from methods in calculus. This expression may immediately follow a correct simplified expression of $y_Q = h^2 + 9h + 16$

(c)

B1 States as $h \rightarrow 0$ Gradient $PQ \rightarrow 9 =$ Gradient of tangent (oe)

They must have achieved $9+h$ in (b) and 9 in (a)

There should be reference to “limit” or “as h tends to 0” (words or symbols) and linked to part (a) (so same gradient, or showing the answers agree). But be generous with the explanation beyond these constraints.

Question Number	Scheme	Marks
4 (a)	States or uses $\cos AOD = \frac{4}{12} \Rightarrow \text{angle } AOD = 1.231^*$	M1 A1* (2)
(b)	Attempts $\frac{1}{2}r^2\theta$ with $r=12$ and $\theta = \pi \pm 1.231$ or 1.231 Attempts area $AOD = \frac{1}{2} \times 4 \times \sqrt{12^2 - 4^2}$ oe (22.627...) Attempts sector – triangle = $\frac{1}{2} \times 12^2 \times (\pi + 1.231) - \frac{1}{2} \times 4 \times \sqrt{12^2 - 4^2}$ (314.8....) – (22.627...) or Attempts circle-sector-triangle $\pi \times 12^2 - \frac{1}{2} \times 12^2 \times (\pi - 1.231) - \frac{1}{2} \times 4 \times \sqrt{12^2 - 4^2}$ 452.38... – 137.562.... – 22.627..... = awrt 292.2 (m ²)	M1 M1 ddM1 A1 (4)
(c)	Attempts $s = r\theta$ with $r=12$ and $\theta = \pi \pm 1.231$ or 1.231 Attempts $P = 16 + \sqrt{12^2 - 4^2} + 12(\pi + 1.231)$ oe = awrt 79.8 (m)	M1 dM1 A1 (3)
(9 marks)		
Alt(a)	$AD = \sqrt{12^2 - 4^2} = 8\sqrt{2}$ $\cos AOD = \frac{12^2 + 4^2 - (8\sqrt{2})^2}{2 \times 12 \times 4} \Rightarrow \text{angle } AOD = \cos^{-1}\left(\frac{1}{3}\right) = 1.231$	M1A1*

(a)

M1 Attempts $\cos AOD = \frac{4}{12} \Rightarrow \text{angle } AOD = \dots$ via a correct method.

Alternatively attempts to find AD using Pythagoras' theorem correctly **and** uses the appropriate sine or tangent. They may attempt to use the cosine rule with all three side (see alt(a)).

Other candidates are finding angle OAD and using angles in a triangle to find angle AOD .

Do not award this mark for candidates who attempt to use 1.231 and compare with $\frac{4}{12}$

A1* Achieves angle $AOD = 1.231$ following a valid method and at least one step of working shown.

Minimum acceptable $\cos^{-1}\left(\frac{4}{12}\right) = 1.231$ or $\cos AOD = \frac{4}{12} \Rightarrow \text{angle } AOD = 1.231$

Only withhold this mark if

- awrt 1.231 radians is not achieved following a correct method. FYI sight of 1.23095... is likely to imply both marks)
- they work in degrees but fail to achieve awrt 70.5° **before** proceeding to 1.231 radians

We are going to condone on this occasion any rounding that may be written as part of their intermediate steps as long as they achieve awrt 1.231. Ignore any omission of brackets.



(b)

 M1 Attempts $\frac{1}{2}r^2\theta$ with $r=12$ and an allowable θ . ($\theta = \pi \pm 1.231$ or 1.231).
 $\angle AOC = \text{awrt } 1.911$ which may appear as $(\pi - 1.231)$ or $(2\pi - (\pi + 1.231))$ (minor sector)

 $\angle AOC = \text{awrt } 4.373$ which may appear as $(\pi + 1.231)$ or $(2\pi - (\pi - 1.231))$ (major sector)

The embedded values in an expression is sufficient for this mark. (awrt 315, awrt 88.6 or awrt 138 also implies this mark. Condone candidates who round 1.231 or use eg awrt 4.4 or awrt 1.9 radians.

 M1 Correct method to find area of triangle AOD . Eg $\frac{1}{2} \times 4 \times \sqrt{12^2 - 4^2}$, $\frac{1}{2} \times 4 \times 12 \sin 1.231$, awrt 22.6 .

The angle may be in degrees (70.5....) and condone using awrt 1.2 radians.

 Also allow an alternative method finding the area of the rectangle – area of trapezium. Allow errors in their method to finding “4” but r must be 12.

 ddM1 Full method to find the correct area $\frac{1}{2} \times 12^2 \times (\pi + 1.231) - \frac{1}{2} \times 4 \times \sqrt{12^2 - 4^2}$ oe. The embedded values in an expression is sufficient for this mark and the angle may be awrt 4.4. It is dependent on the two previous method marks.

Alternatively they may find the area by

Area of circle – area of minor sector – area of triangle

$$\pi \times 12^2 - \frac{1}{2} \times 12^2 \times (\pi - 1.231) - \frac{1}{2} \times 4 \times \sqrt{12^2 - 4^2}$$

 A1 awrt 292.2 (m^2)

(c)

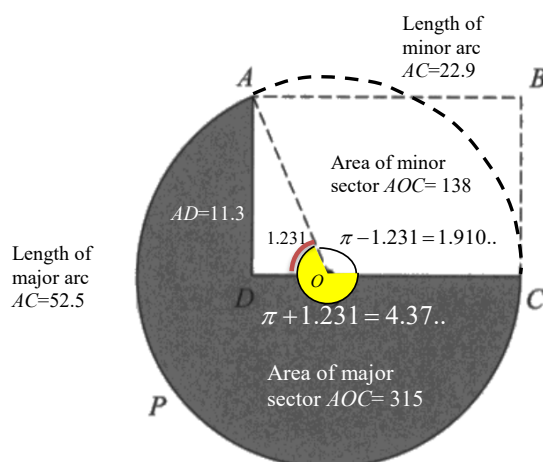
 M1 Attempts $s = r\theta$ with $r=12$ and an allowable θ . ($\theta = \pi \pm 1.231$ or 1.231 as above in part (b)). The embedded values in an expression is sufficient for this mark. (awrt 52.5 or awrt 14.8 or awrt 22.9 can imply this mark. Condone candidates who round 1.231 or use eg awrt 4.4 or awrt 1.9 radians).

 dM1 Full method to find the perimeter $P = 16 + \sqrt{12^2 - 4^2} + 12(\pi + 1.231)$ oe . The embedded values in an expression is sufficient for this mark and the angle may be awrt 4.4 or awrt 1.9.

 Alternatively they may find the perimeter P via circumference – minor arc + $16 + 8\sqrt{2}$

$$P = 16 + \sqrt{12^2 - 4^2} + 24\pi - 12(\pi - 1.231)$$

A1 awrt 79.8 (m)



Question Number	Scheme	Marks
5. (a)	$20x^3 - 50x^2 - 30x = 0 \Rightarrow 10x(2x^2 - 5x - 3) = 0$ $\Rightarrow 10x(2x+1)(x-3) = 0$ $\Rightarrow x = 0, -\frac{1}{2}, 3$	M1 A1, A1 (3)
(b)	Sets or implies $(y+3)^{\frac{1}{2}} = 0$ or $-\frac{1}{2}$ or 3 Full method to find y $y = 6$ $y = -3, 6$	B1ft M1 A1ft, A1 (4) (7 marks)

(a) **Note the question says using algebra so answers only scores 0 marks.**

M1 For attempting to factorise. They may do this by cancelling/factorising out ...x to achieve an expression of the form $Dx(Ax^2 + Bx + C)$ where $A, B, C \neq 0$ (but could be 1) and $D = 1, 2, 5$ or 10
If they only have the resulting quadratic $(2x+1)(x-3)$ they must state somewhere that $x = 0$ (usually as one of their answers)

Equally they may proceed straight to a fully factorised form eg. $x(2x+1)(x-3) (=0)$

We will condone on this occasion $x(x+\frac{1}{2})(x-3)$

A1 Two of $x = 0, -\frac{1}{2}, 3$ **following M1 awarded.**

A1 All of $x = 0, -\frac{1}{2}, 3$ They do not have to be stated on one line together. Withhold if any additional solutions.

(b)

B1ft Sets $(y+3)^{\frac{1}{2}} =$ any of their solutions from (a) or this may be implied by later work on one of their solutions from (a). Note $(y+3) = 0 \Rightarrow y = -3$ is insufficient for the B mark but is acceptable for the final A mark (see below)

M1 Full method to find a value for y from a non-zero solution for x.
 Scored for **squaring** and **subtracting 3**
 Allow this to be scored for squaring and subtracting 3 from a negative value as well

A1ft $y = 6$. Follow through on their positive solution from part (a)



A1 Both of $y = -3, 6$ with no incorrect working seen. If the solution $-\frac{11}{4}$ is found it must be discounted by the candidate (eg crossed out/rejected).

Beware that part (b) is hence so they must use their solutions from (a) and be careful regarding the -3 solution.

$(y+3)^{\frac{1}{2}} = 0 \Rightarrow y = -3$ and $(y+3) = 0 \Rightarrow y = -3$ is acceptable for the final A mark BUT

$(y+3)^{\frac{1}{2}} = 0 \Rightarrow y+3 = \sqrt{0} \Rightarrow y = -3$ is an incorrect method so A0

Give benefit of the doubt where it is unclear but send to review if unsure.



Question Number	Scheme	Marks
6.(a)	Attempts to find the gradient of $3x - 4y + 20 = 0 \Rightarrow y = \frac{3}{4}x + 5$	M1
	Equation l_2 is $y - 0 = \frac{3}{4}(x - 8) \Rightarrow 3x - 4y - 24 = 0$ oe	M1, A1 (3)
(b)	$P = \left(-\frac{20}{3}, 0\right), Q = (0, 5)$	B1
	Area $PQRS = PR \times OQ = \left(8 + \frac{20}{3}\right) \times 5 = \frac{220}{3}$	M1, A1 (3)
(c)	$\overrightarrow{QR} = \begin{pmatrix} 8 \\ -5 \end{pmatrix} \Rightarrow S = \left(-\frac{20}{3} + 8, 0 - 5\right) = \left(\frac{4}{3}, -5\right)$	M1, A1 (2) (8 marks)
Alt(c)	Solve their $y = \frac{3}{4}x - 6$ with their $y = -\frac{5}{8}\left(x + \frac{20}{3}\right)$	
	$\frac{3}{4}x - 6 = -\frac{5}{8}\left(x + \frac{20}{3}\right) \Rightarrow \frac{11}{8}x = \frac{11}{6} \Rightarrow x = \dots$	M1
	$S = \left(\frac{4}{3}, -5\right)$	A1 (2)

If you see any unusual approaches which may involve vectors and matrices then please send to review if you are unsure how to mark.

(a)

M1 For an attempt to find the gradient of $3x - 4y + 20 = 0$

Look for an attempt to rearrange $3x - 4y + 20 = 0$ and make y the subject.

Expect to see $\pm 4y = \dots$ **followed by** $y = \dots$ **or equivalent** if they do not achieve the correct value.

M1 For using the same gradient as their gradient of l_1 with $R(8, 0)$ to form a linear equation.

If they use $y = mx + c$ they must proceed as far as $c = \dots$ starting from a correct equation with their gradient of l_1 and the coordinates correctly substituted in.

Some candidates may set $3x - 4y + c = 0$ and substitute $(8, 0)$ to find c which is M1M1.

A1 $3x - 4y - 24 = 0$ or any integer multiple. All terms must be on one side of an equation $= 0$.

Correct equation implies full marks and it must be seen in (a) to score the A mark. (They may make errors in the manipulation of l_1 which is condoned).



Mark parts (b) and (c) together.

(b)

B1 $P = \left(-\frac{20}{3}, 0\right), Q = (0, 5)$. This may be implied by subsequent calculations or seen on a diagram

M1 A full attempt to find the area of parallelogram $PQRS = PR \times OQ = \left(8 + \frac{20}{3}\right) \times 5$ using their P and their Q and proceeding to find a value for the area. Condone attempts which appear to be calculating parallelogram $PQSR$.

Candidates may use the “Shoelace” algorithm i.e. $2 \times \frac{1}{2} \begin{vmatrix} 8 & 0 \\ 0 & 5 \\ -\frac{20}{3} & 0 \\ 8 & 0 \end{vmatrix} = 2 \times \frac{1}{2} \times \left(8 \times 5 - \frac{20}{3} \times 5\right)$

Candidates may attempt to find the area of the parallelogram using the determinant

eg $\frac{20}{3}\underline{i} + 5\underline{j}$ and $8\underline{i} - 5\underline{j}$ Area = $\left| \det \begin{bmatrix} \frac{20}{3} & 5 \\ 8 & -5 \end{bmatrix} \right| = \left| \frac{20}{3} \times -5 - 8 \times 5 \right| = \left| -\frac{220}{3} \right| \Rightarrow \text{Area} = \frac{220}{3}$

A1 $\frac{220}{3}$ oe (condone awrt 73.3)

(SC Sign slip on the coordinate Q to give $P = \left(-\frac{20}{3}, 0\right), Q = (0, -5) \Rightarrow$ Area of parallelogram = $\frac{220}{3}$ scores 011)

Some candidates who do part c) and form parallelogram $PQSR$ to find $S = \left(\frac{44}{3}, 5\right)$ may then attempt b) and proceed to the correct answer. This can still score M1 A1 in (b)

(c)

M1 A full attempt to find both the coordinates of S . Examples include:

- $\overrightarrow{OP} + \overrightarrow{QR}$ or equivalent using a vector approach.
- An attempt to solve their $y = \frac{3}{4}x - 6$ with their $y = -\frac{5}{8}\left(x + \frac{20}{3}\right)$
- An attempt to equate the length RS with PQ (or PS with RQ) to produce an equation that is solved simultaneously with l_2 or with each other (see next page)
- $y_s = -5$ from rotational symmetry consideration and proceeds to finding x
- It is also acceptable to score full marks following a sketch. Send to review if you find any which you think are credit-worthy.

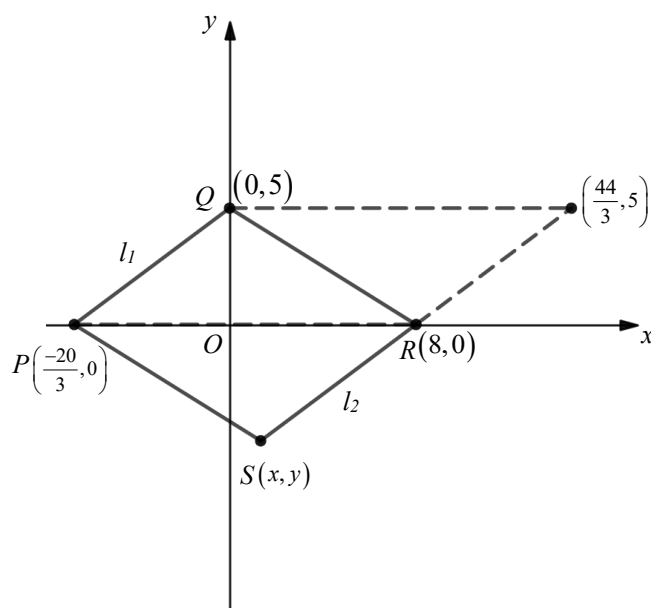
In all cases they should proceed to find the coordinates of S but condone arithmetical slips in their working. If in doubt send to review.

A1 $\left(\frac{4}{3}, -5\right)$. Allow alternatives eg $x = \dots, y = \dots$ Condone (awrt 1.33, 5)

SC: For those students who find $S = \left(\frac{44}{3}, 5\right)$ score SC 10



Additional guidance: some examples of methods for (c) using the lengths between points



1. Equating RS : $(8, 0)$ to (x, y) with PQ : $\left(-\frac{20}{3}, 0\right)$ to $(0, 5)$ and solving simultaneously with l_2

Look for $(x-8)^2 + y^2 = \frac{625}{9}$ and $3x - 4y - 24 = 0$ proceeding to $x = \frac{4}{3}$, $y = -5$

2. Equating PS : $\left(-\frac{20}{3}, 0\right)$ to (x, y) with RQ : $(8, 0)$ to $(0, 5)$ and solving simultaneously with l_2

Look for $(x + \frac{20}{3})^2 + y^2 = 89$ and $3x - 4y - 24 = 0$ proceeding to $x = \frac{4}{3}$, $y = -5$

3. Equating RS : $(8, 0)$ to (x, y) with PQ : $\left(-\frac{20}{3}, 0\right)$ to $(0, 5)$ and equating PS : $\left(-\frac{20}{3}, 0\right)$ to (x, y) with RQ : $(8, 0)$ to $(0, 5)$ and solving simultaneously

Look for $(x-8)^2 + y^2 = \frac{625}{9}$ and $(x + \frac{20}{3})^2 + y^2 = 89$ which proceeds to

$$9x^2 - 144x + 9y^2 - 49 = 0 \text{ and } 9x^2 + 120x + 9y^2 - 401 = 0 \Rightarrow 264x = 352 \Rightarrow x = \frac{4}{3}, y = -5$$



Question Number	Scheme	Marks
2.	$y = 3x^5 + 4x^3 - x + 5 \Rightarrow \left(\frac{dy}{dx} = \right) 15x^4 + 12x^2 - 1$	M1 A1
	$15x^4 + 12x^2 - 1 = 2 \Rightarrow 15x^4 + 12x^2 - 3 = 0$	dM1
	$\Rightarrow 3(5x^2 - 1)(x^2 + 1) = 0$ o.e	ddM1
	$\Rightarrow x = \pm \frac{1}{\sqrt{5}}$ o.e.	A1
		(5)
		(5 marks)

M1 Attempts to differentiate with $x^n \rightarrow x^{n-1}$ for one correct power

Allow for $x^5 \rightarrow x^4$ or $x^3 \rightarrow x^2$ or $x \rightarrow 1$

A1 $\left(\frac{dy}{dx} = \right) 15x^4 + 12x^2 - 1$ which may be left unsimplified. Just look for a correct expression

i.e. no need to see $\frac{dy}{dx} = \dots$

dM1 Sets their $\frac{dy}{dx} = 2$ and collects terms to one side to obtain a 3TQ in x^2

Depends on first method mark.

ddM1 Correct attempt to solve 3TQ in x^2 . This may be by factorising, using the quadratic formula, or completing the square (see general guidance). The attempt to factorise must be consistent with their 3TQ.

The correct quadratic with the correct answers just written down scores M0

Must be solving for x^2 not x to obtain at least one value for x^2 .

Depends on both previous method marks.

A1 $x = \pm \frac{1}{\sqrt{5}}$ or exact equivalent such as $\pm \frac{\sqrt{5}}{5}$, $\pm \sqrt{\frac{3}{15}}$ and isw once the correct answers are seen.

Must see both values so $x = \frac{1}{\sqrt{5}}$ is A0.

Ignore any attempts to find the y coordinates.



Question Number	Scheme	Marks
3.(i)	$\frac{3}{x} > 4 \Rightarrow 3x > 4x^2 \Rightarrow x(4x-3) < 0 \Rightarrow 0, \frac{3}{4}$	B1
	$0 < x < \frac{3}{4}$	M1 A1
		(3)
(ii)	$y-0=3(x+5)$	B1
	E.g. $y < 2x^2 - 50, y > 3x + 15$	M1
	E.g. $y < 2x^2 - 50, y > 3x + 15, x < -5$	A1
		(3)
		(6 marks)

(i)

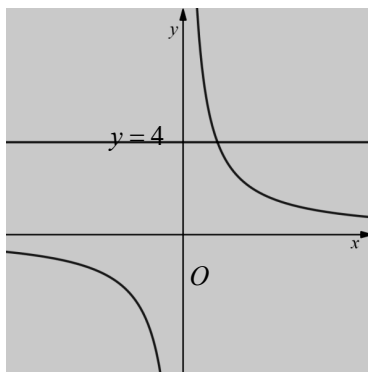
B1 For the two critical values 0 and $\frac{3}{4}$

M1 Chooses the inside region for their critical values

A1 $0 < x < \frac{3}{4}$ Award for exact equivalents such as $x > 0$ and $x < \frac{3}{4}$ or

$$\left\{ x : x > 0 \cap x < \frac{3}{4} \right\}$$

(Note they may deduce that $x > 0$ as $\frac{3}{x} > 4$ then solve to find $x < \frac{3}{4}$ which combined gives $0 < x < \frac{3}{4}$)



B1: Sketches BOTH graphs. May only see right hand branch of hyperbola.

M1: Chooses the inside region between 0 and their solution to $\frac{3}{x} = 4$

A1: $0 < x < \frac{3}{4}$

Special Case which is very common:

B1: States $x < \frac{3}{4}$ only

(ii)

B1 Correct equation for l E.g. $y - 0 = 3(x + 5)$. This may be implied by e.g. sight of $y > 3x + 15$ or e.g. $y = 3x + k$ and $k = 15$

M1 Two of $y < 2x^2 - 50$, $y > 3x + 15$, $x < a$ where $-5 \leq a \leq 6.5$
 Follow through their straight line provided it has a gradient of 3 with a numerical "15".
 Also allow two of $y \leq 2x^2 - 50$, $y \geq 3x + 15$, $x \leq a$ where $-5 \leq a \leq 6.5$
 Also allow $3x + 15 < y < 2x^2 - 50$ or $3x + 15 \leq y \leq 2x^2 - 50$ as 2 inequalities.
 Do **not** allow inequalities in terms of R e.g. $R < 2x^2 - 50$, $R > 3x + 15$. This scores M0.

A1 Fully defines region. E.g. $y < 2x^2 - 50$, $y > 3x + 15$, $x < a$ where $-5 \leq a \leq 6.5$
 Also allow $y \leq 2x^2 - 50$, $y \geq 3x + 15$, $x \leq a$ where $-5 \leq a \leq 6.5$
 If set notation is used, then they must use " $\cap$ " between any of their inequalities rather than " $\cup$ ".
 Condone attempts as long as the intention is clear.
 E.g.
 $\{x, y \in \mathbb{R} : y < 2x^2 - 50 \cap y > 3x + 15 \cap x < a\}, \{x, y \in \mathbb{R} : y < 2x^2 - 50, y > 3x + 15, x < a\}$
 are acceptable.

Note regarding consistency for the A1 if -5 is used:

$y < 2x^2 - 50$, $y > 3x + 15$ must go with $x < -5$

$y \leq 2x^2 - 50$, $y \geq 3x + 15$ must go with $x \leq -5$

If $-5 < a \leq 6.5$ is used then $x < a$ or $x \leq a$ is acceptable.



Question Number	Scheme	Marks
4.(a)(i)	$(90, -1)$	B1 B1
(ii)	225	B1
		(3)
(b)	One of $-1 < p < 0$, $p = 1$	M1
	Both $-1 < p < 0$, $p = 1$	A1
		(2)
		(5 marks)

(a) (i)

B1 One coordinate correct in the correct position. E.g $(180, -1)$ Award for $x = 90$ or $y = -1$. Condone $x = 90^\circ$ and condone for $\frac{180}{2}$ for 90B1 Fully correct $(90, -1)$ with or without brackets.Award for $x = 90$ and $y = -1$. Condone $x = 90^\circ$ and condone for $\frac{180}{2}$ for 90**Special Case:** If they give $(-1, 90)$ or $\left(-1, \frac{\pi}{2}\right)$ rather than $(90, -1)$ allow B1B0but e.g. $(-1, 180)$ scores B0B0 (2 errors)**Special case:** If the 90 and -1 are clearly indicated on the axes for Q on the sketch, score B1B0

(a)(ii)

B1 225 Condone 225° . Also allow $(225, 0)$ or $(225^\circ, 0)$ or 225 or 225° marked at R on the diagram but if there is any ambiguity, the body of the script takes precedence.**For candidates who use radians in part (a), penalise this once on the first occurrence so e.g.**(a)(i) $\left(\frac{\pi}{2}, -1\right)$ (a)(ii) $\frac{5\pi}{4}$ scores B1B0 B1(a)(i) $\left(-1, \frac{\pi}{2}\right)$ (a)(ii) $\frac{5\pi}{4}$ scores B0B0 B1 (2 errors)

(b)

M1 One of the "correct" pair, but fit on -1 from (a).For example if they believe that (a)(i) is $(180, -2)$ M1 can be awarded for either $-2 < p < 0$ or $p = 2$ Condone the use of y rather than p for this method mark e.g. condone $-1 < y < 0$ or $y = 1$ A1 Fully correct in terms of p **A significant number of candidates are writing their answers within the question so be sure to check answers appearing there.**

Question Number	Scheme	Marks
5(a)	$3y - 2x = 30 \Rightarrow m = \frac{2}{3}$	B1
	$y = -\frac{3}{2}(x - 24), y = -\frac{3}{2}x + 36, 2y + 3x = 72, \frac{y-0}{x-24} = -\frac{3}{2}$	M1 A1ft
	Full method to find one co-ordinate of P E.g. Solves $\frac{2}{3}x + 10 = -\frac{3}{2}(x - 24)$	M1
	Coordinates of P (12,18)	A1
		(5)
(b)	$y = 0, 3y - 2x = 30 \Rightarrow x = \dots$	M1 (B1 on EPEN)
	Area $BPA = \frac{1}{2} \times (24 + "15") \times "18" = 351$	dM1 A1 cso
		(3)
		(8 marks)

(a)

B1 Gradient of $l_1 = \frac{2}{3}$ seen or impliedM1 Full method for equation of l_2 . This involves an equation using the point (24,0) with a gradient using the negative reciprocal of their $\frac{2}{3}$. If they use $y = mx + c$ then must reach as far as $c = \dots$ A1ft Correct equation of normal in any form e.g. $y = -\frac{3}{2}(x - 24)$ but condone poor notation here and allow e.g. $l_2 = -\frac{3}{2}(x - 24)$ provided this is used appropriately to solve simultaneously. Follow through their negative reciprocal gradient.M1 Full method to find one coordinate of P Note that we allow a calculator to be used here e.g.
 $3y - 2x = 30, 2y + 3x = 72 \Rightarrow x = \dots$ or $y = \dots$ A1 Coordinates of P (12, 18) or $x = 12, y = 18$ **Alt (a)**

Note that the first three marks can be scored via

B1 Attempts l_2 via $2y + 3x = c$ M1 Full method for equation of l_2 . This involves an equation using the point (24,0) and $2y + 3x = c$ A1 $2y + 3x = 72$ 

(b)

M1(B1 on EPEN): Uses $y = 0$ in l_1 in an attempt to find the x coordinate of B .
 Checking any working for this mark but it may be implied by $x = \pm 15$

dM1 Correct attempt at area BPA using their -15 and 18 . This requires

$$\frac{1}{2} \times (24 + "15") \times "18" \text{ or equivalent}$$

$$\text{correct work with their values e.g. } \frac{1}{2} \times \sqrt{(24-12)^2 + 18^2} \times \sqrt{(12+15)^2 + 18^2}$$

Or e.g. "shoelace method"

$$\frac{1}{2} \begin{vmatrix} -15 & 24 & 12 & -15 \\ 0 & 0 & 18 & 0 \end{vmatrix} = \frac{1}{2} |0 + 24 \times 18 + 0 - 0 - 0 + 15 \times 18|$$

Depends on the first mark and depends on their B being a point on the x -axis.

The working for the area takes precedence over any diagrams they have drawn so if the working is correct but e.g. their diagram has points in the wrong positions, award the marks.

There may be other methods e.g. Hero's formula or use of trigonometry – if you are unsure if such attempts deserve credit, use review.

A1 351 cso

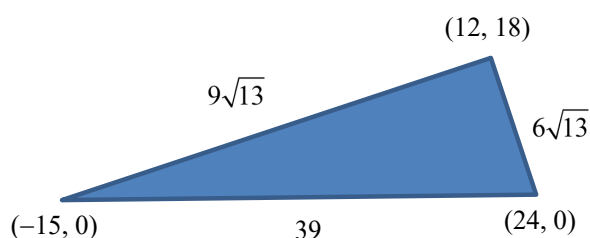
Common errors seen in marking:

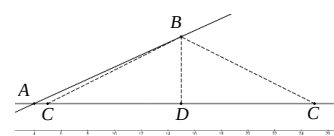
$$3y - 2x = 30 \Rightarrow l_1 : m = \frac{3}{2} \rightarrow l_2 : y = -\frac{2}{3}(x - 24) \rightarrow P\left(\frac{36}{13}, \frac{184}{13}\right), B\left(-\frac{20}{3}, 0\right)$$

$$3y - 2x = 30 \Rightarrow l_1 : m = -\frac{2}{3} \rightarrow l_2 : y = \frac{3}{2}(x - 24) \rightarrow P\left(\frac{276}{13}, -\frac{54}{13}\right), B(15, 0)$$

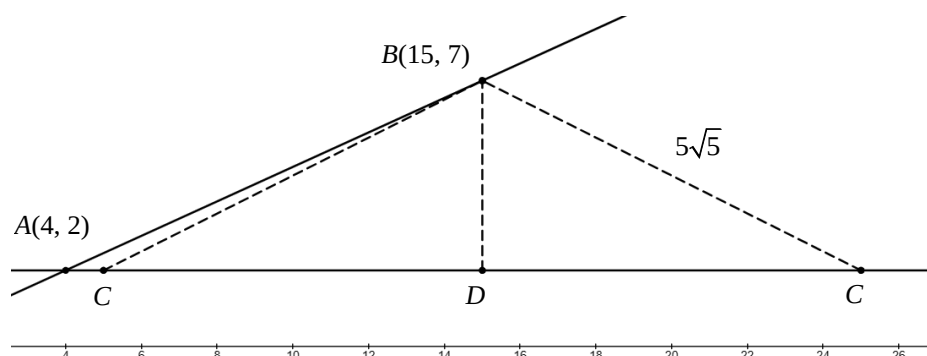
With a correct triangle area method such attempts will often score (a) B0M1A1ftM1A0 (b) M1M1A0

Triangle for reference:



Question	Scheme	Marks	
9(a)	$m = \frac{7-2}{15-4} \left(= \frac{5}{11} \right)$	M1	
	$y-2 = \frac{5}{11}(x-4) \quad \text{or} \quad y-7 = \frac{5}{11}(x-15)$ $\text{or } y = \frac{5}{11}x + c \Rightarrow 2 = \frac{5}{11} \times 4 + c \Rightarrow c = \dots \left(\frac{2}{11} \right)$	M1	
	$5x - 11y + 2 = 0$	A1	
		(3)	
(a) ALT	$y = mx + c \Rightarrow \begin{matrix} 2 = 4m + c \\ 7 = 15m + c \end{matrix}$	M1	
	$\begin{matrix} 2 = 4m + c \\ 7 = 15m + c \end{matrix} \Rightarrow m = \dots \left(\frac{5}{11} \right), \quad c = \dots \left(\frac{2}{11} \right)$	M1	
	$5x - 11y + 2 = 0$	A1	
(b)	$(15-x)^2 + (7-2)^2 = (5\sqrt{5})^2$ or e.g. $\sqrt{(15-x)^2 + (7-2)^2} = 5\sqrt{5}$ or e.g. $(5\sqrt{5})^2 = 5^2 + CD^2 \text{ oe}$		M1
	Way 1: $(15-x)^2 + 25 = 125 \Rightarrow (15-x)^2 = 100 \Rightarrow x = \dots$ or e.g. Way 2: $125 = 25 + CD^2 \Rightarrow CD^2 = 100 \Rightarrow CD = 10 \Rightarrow x = \dots$		M1
	$(5, 2) \text{ or } (25, 2)$		A1
	$(5, 2) \text{ and } (25, 2)$		A1
			(4)
	(c)	$\text{Area} = \frac{1}{2} ("5"-4) \times 5$	M1
$= \frac{5}{2}$		A1	
			(2)
		Total 9	

Notes:**(a)****M1:** Correct method for the gradient**M1:** For a correct straight line method using their gradient and point A or point B with x and y correctly placed.Alternatively uses $y = mx + c$ and reaches $c = \dots$ Note that $\frac{y-2}{7-2} = \frac{x-4}{15-4}$ scores both M marks.**A1:** Correct equation in the required form including the “= 0”. Allow any integer multiple of this equation.**ALT****M1:** Substitutes $x = 4, y = 2$ and $x = 15, y = 7$ into the general equation $y = mx + c$ to obtain 2 equations in m and c .**M1:** Solves 2 equations of the form $\alpha = m\beta + c$ to find values for m and c .**A1:** Correct equation in the required form including the “= 0”. Allow any integer multiple of this equation.



(b)

M1: Correct application of Pythagoras for triangle BCD (see diagram above)

The statements shown are sufficient for this mark but condone missing brackets e.g. $5\sqrt{5}^2$ for $(5\sqrt{5})^2$ as long as the intention is clear.

M1: A complete, correct and full method to obtain at least **one** x coordinate for C .

For **Way 1** this mark is for processing an equation of the form: $(15-x)^2 + \alpha^2 = (5\sqrt{5})^2$ where $0 < \alpha^2 < 125$ to obtain at least one value for x .

For **Way 2** this mark is for processing an equation of the form: $(5\sqrt{5})^2 = CD^2 + \alpha^2$ where $0 < \alpha^2 < 125$ to obtain at least one value for CD and then attempts at least one value of x either $15 - CD$ or $15 + CD$. Condone the use of x (or any other letter) for CD .

The work for this mark must be correct so e.g. $\sqrt{(15-x)^2 + (7-2)^2} = 5\sqrt{5} \Rightarrow (15-x) + (7-2) = 5\sqrt{5}$

or e.g. $(5\sqrt{5})^2 = CD^2 + \alpha^2 \Rightarrow 5\sqrt{5} = CD + \alpha$ scores M0. If a 3TQ is being solved, the usual rules apply.

A1: At least one correct position for C .

May be seen as a coordinate pair with or without brackets or as e.g. $x = 5, y = 2$

A1: Both correct pairs of coordinates.

May be seen as coordinate pairs with or without brackets or as e.g. $x = 5, y = 2$

Note that some candidates think the equation for l_2 is $y = 4$ rather than $y = 2$. This scores a maximum of 1 mark in part (b) and will look like this:

$$(15-x)^2 + (7-4)^2 = (5\sqrt{5})^2 \Rightarrow (15-x)^2 + (7-4)^2 = 125 - 9 = 116$$

$$(15-x) = \pm 2\sqrt{29} \Rightarrow x = 15 \pm 2\sqrt{29}$$

or

$$(5\sqrt{5})^2 = 3^2 + CD^2 \Rightarrow CD^2 = 116 \Rightarrow CD = 2\sqrt{29}$$

$$\Rightarrow x = 15 \pm 2\sqrt{29}$$

This scores M0M1A0A0

(c)

M1: Applies a correct triangle area for one of their points of the form $(k, 2)$, $k \neq 15$. May be implied.

This mark is for e.g. $\frac{1}{2}(k-4) \times 5$ where k is one of their calculated x coordinates from part (b)

or for $\frac{1}{2}(11 \pm CD) \times 5$ where CD is their calculated value from part (b)

May see shoelace method: $\frac{1}{2} \begin{vmatrix} 4 & 15 & "5" & 4 \\ 2 & 7 & 2 & 2 \end{vmatrix} = \frac{1}{2} |4 \times 7 + 15 \times 2 + "5" \times 2 - 2 \times 4 - 7 \times "5" - 2 \times 15|$

Allow other correct methods for the area e.g. using trigonometry.

Their C must be of the form $(k, 2)$ and a correct formula used or implied.

A1: Correct minimum area. Must be 2.5 **not** awrt 2.5 (e.g. if they use trigonometry and get an inexact answer)

Question	Scheme	Marks
6(a)	$\text{E.g. } m = \frac{2-11}{8+4} \text{ or } m = \frac{11-2}{-4-8}$ $m = -\frac{3}{4}$	M1 A1
		(2)
(b)	$M \text{ is } \left(2, \frac{13}{2}\right)$ $m_N = -1 \div -\frac{3}{4}$ $y - \frac{13}{2} = \frac{4}{3}(x - 2)$ $8x - 6y + 23 = 0$	B1 M1 M1 A1
		(4)
(c)	$AB = \sqrt{(-4-8)^2 + (11-2)^2} (=15) \text{ or } AB^2 = (-4-8)^2 + (11-2)^2 (=225)$ $\frac{1}{2} \times MC \times AB = 37.5 \Rightarrow MC = \frac{75}{15} (=5) \text{ or } MC^2 = 25$ $m_N = \frac{4}{3}, MC = 5 \Rightarrow C \text{ is } \left(2-3, \frac{13}{2}-4\right) \text{ or } \left(2+3, \frac{13}{2}+4\right)$ $(-1, 2.5) \text{ or } (5, 10.5) \text{ or } x = -1, x = 5 \text{ or } y = 2.5, y = 10.5$ $(-1, 2.5) \text{ and } (5, 10.5)$	M1 M1 dM1 A1 A1
		(5)
		(11 marks)

Notes

(a)

M1 Correct gradient method. Method must be correct for **both** the numerator and denominator.
 Could also be solved by setting up two simultaneous equations and solving correctly.
 ie $11 = -4m + c$ $2 = 8m + c \Rightarrow 9 = -12m \Rightarrow m = \dots$ (M1)

A1 Correct fraction or decimal (allow $-\frac{3}{4}$ or $\frac{3}{-4}$ or -0.75). If they find the equation of the line then they must identify $-\frac{3}{4}$ as the gradient.



(b)

B1 Correct midpoint. Allow unsimplified e.g. $\left(\frac{-4+8}{2}, \frac{11+2}{2}\right)$. Coordinates can be just stated, seen in their working or they may appear on the diagram. Condone lack of brackets.

M1 Applies the perpendicular gradient rule to their gradient from part (a)

M1 Correct straight line method using their midpoint and a “changed” gradient. If using $y = mx + c$, must reach as far as $c = \dots$

A1 Allow any integer multiple

(c)

M1 Correct application of Pythagoras using the points A and B (or $\frac{1}{2}AB$ using M)

M1 Uses their AB and 37.5 correctly to find MC or MC^2 . This may be implied by their working to find eg AM or BM

dM1 **Correct strategy** to find both x coordinates, or both y coordinates or a coordinate pair for the possible point C . To score this mark, look for sight of a linear or quadratic equation in one variable that would find either an x or a y coordinate for one of the possible pairs of coordinates for C . Condone slips in their rearrangements and they do not need to reach a value for either x or y for this mark.

Usually look for:

- Recognising that a distance of “5” for MC means by Pythagoras that $x = "2" \pm 3$ or $y = "\frac{13}{2}" \pm 4$. Alternatively, C is $\left("2"-3, "\frac{13}{2}"-4\right)$ or $\left("2"+3, "\frac{13}{2}" + 4\right)$
(If MC is not 5 look for application of Pythagoras.)
- Forming an equation of a circle with radius “5” from a point C and solving simultaneously with their l eg
 $(x - "2")^2 + (y - "\frac{13}{2}")^2 = "25"$ and $"8x - 6y + 23 = 0" \Rightarrow (x - 2)^2 + (\frac{4}{3}x + \frac{23}{6} - \frac{13}{2})^2 = 25$ or
(they may form an equation in y).
- Shoelace method:

$$\begin{vmatrix} -4 & 11 \\ x & \frac{4}{3}x + \frac{23}{6} \\ 8 & 2 \\ -4 & 11 \end{vmatrix} = \frac{1}{2}(-4(\frac{4}{3}x + \frac{23}{6}) + 2x + 88) - (11x + 8(\frac{4}{3}x + \frac{23}{6}) - 8) = 37.5$$

It is dependent on **both of the previous method marks**. There may be other credit worthy methods so if unsure then send to review.

A1 $(-1, 2.5)$ or $(5, 10.5)$ (does not have to be written as coordinates)
or $x = -1, x = 5$ or $y = 2.5, y = 10.5$

A1 $(-1, 2.5)$ and $(5, 10.5)$. Condone lack of brackets.
They may state the values for x and y but the coordinates must be paired correctly.

