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EDEXCEL INTERNATIONAL GCSE FURTHER PURE MATHS: QUESTIONS BY TOPIC

Coordinate Geometry (7)

International GCSE Further Pure Mathematics Topic 7

22 questions · 282 marks · Mark schemes included

Pearson Edexcel International GCSE (9–1) Further Pure Mathematics 4PM1, Papers 1, 1R, 2 & 2R, June 2019 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
6-MARK QUESTIONS		1 questions · 6 marks	4
1. Q2 <i>also Topic 3</i>	Paper 2R January 2020	6	5
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2. Q5	Paper 1 November 2020	7	7
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17-MARK QUESTIONS			4 questions · 68 marks	33
19. Q11	Paper 1R	June 2019	17	34
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QUESTIONS

22 questions · 282 marks · lowest tariff first



6-MARK QUESTIONS

1 question in this booklet



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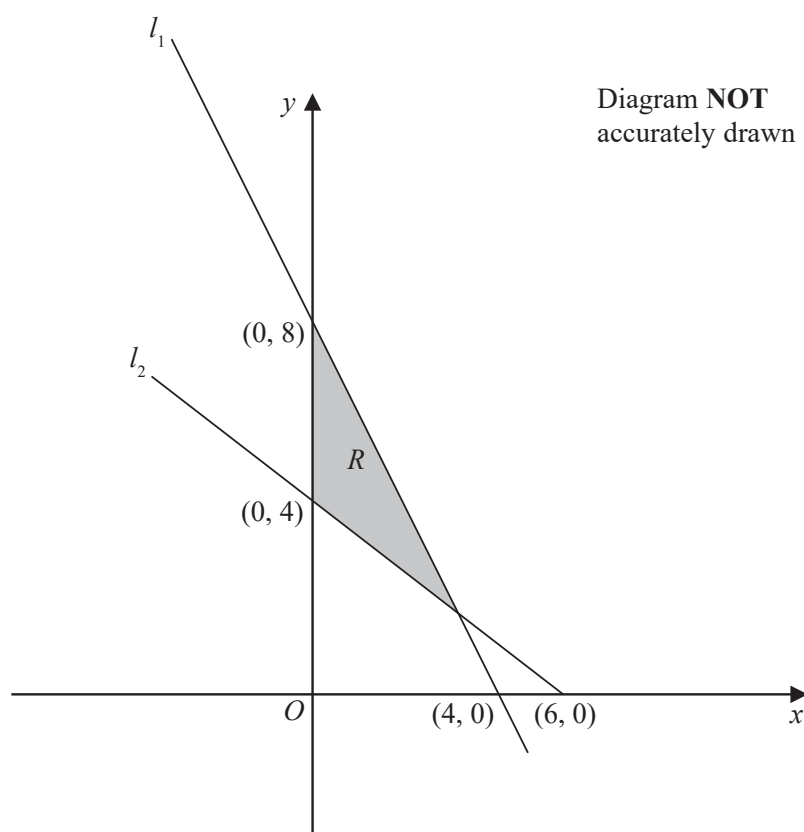


Figure 2

Figure 2 shows the shaded region R bounded by the line l_1 , the line l_2 and the y -axis.

The points with coordinates $(0, 8)$ and $(4, 0)$ lie on l_1

The points with coordinates $(0, 4)$ and $(6, 0)$ lie on l_2

(a) Find, in the form $ax + by = c$, where a , b and c integers, an equation of

(i) l_1

(ii) l_2

(3)

(b) Hence write down three inequalities that define the region R .

(3)

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7-MARK QUESTIONS

1 question in this booklet



5 The points P , Q , R and S have coordinates $(4, 7)$, $(3, 0)$, $(10, 1)$ and $(11, 8)$ respectively.

(a) Show, by calculation, that the lines PR and QS are perpendicular.

(3)

(b) Find the exact lengths of (i) PR (ii) QS

(2)

(c) Find the area of the quadrilateral $PQRS$

(2)

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8-MARK QUESTIONS

1 question in this booklet



2 The point A has coordinates $(-7, -1)$ and the point B has coordinates $(3, 4)$

(a) Find an equation of the line that passes through A and B

Give your answer in the form $ax + by + c = 0$ where a , b and c are integers.

(3)

The point C has coordinates $(-3, 7)$

Given that k is a constant such that $AB = kAC$

(b) find the value of k

(2)

The point D has coordinates $(3, p)$ where p is a constant.

Given that CD is perpendicular to AB

(c) find the value of p

(3)

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9-MARK QUESTIONS

1 question in this booklet



- 4 The point A with coordinates $(12, 14)$ and the point B with coordinates $(q, 2)$ where q is a constant, lie on the straight line with equation $3y - 2x - p = 0$ where p is a constant.

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

(3)

The line L is perpendicular to AB and passes through the point X , which lies on AB such that $AX : XB = 1 : 2$

- (b) Find an equation for L in the form $ax + by + c = 0$ where a , b and c are integers to be found.

(6)

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10-MARK QUESTIONS

2 questions in this booklet



- 3 The point A has coordinates $(1, 7)$ and the point B has coordinates $(9, 3)$

The line l is the perpendicular bisector of AB

- (a) Find an equation of l

(5)

The line l crosses the x -axis at the point C

- (b) Find the area of the triangle ABC

(5)

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- 2 The point P has coordinates $(-7, 3)$ and the point Q has coordinates $(3, 18)$

The point R divides the line PQ in the ratio $2:3$

The line l passes through R and is perpendicular to the line PQ

- (a) Find an equation of line l

Give your answer in the form $ay + bx + c = 0$ where a , b and c are integers.

(5)

The line l crosses the x -axis at the point S

- (b) Find the area of triangle QRS

(5)

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11-MARK QUESTIONS

2 questions in this booklet



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

(a) Find the exact length of

(i) AB (ii) BC (iii) AC

(4)

(b) Find the size of each angle of triangle ABC in degrees.

(3)

The points A , B and C lie on a circle with centre P .

(c) Find the coordinates of P .

(2)

(d) Find the exact length of the radius of the circle in the form $\sqrt{a}$, where a is an integer.

(2)

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- 5 The line l with gradient $-\frac{1}{12}$ passes through the points A and B with coordinates $(p, 10)$ and $(123, 0)$ respectively.

(a) Show that $p = 3$

(2)

(b) Find an equation for l in the form $rx + sy + t = 0$ where r, s and t are integers.

(2)

The line k is perpendicular to l and passes through the point A .

(c) Find an equation for k in the form $y = mx + c$

(3)

Line k intersects the x -axis at the point C .

(d) Find the exact area of triangle ABC .

(4)

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12-MARK QUESTIONS

2 questions in this booklet



- 9 The straight line L_1 passes through the point A with coordinates $(4, 7)$ and has gradient m , where $m < 0$

Another straight line L_2 is perpendicular to L_1 and passes through the point B with coordinates $(4, k)$ where $k \neq 7$

The lines L_1 and L_2 intersect at the point C .

Given that the y coordinate of C is Y

(a) show that $Y = \frac{7 + m^2k}{m^2 + 1}$ (7)

Given that the triangle ABC is isosceles,

(b) find the value of m (5)

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- 9 The point A has coordinates $(-4, 3)$ and the point B has coordinates $(6, 8)$
The points A and B lie on the line k

(a) Find an equation of k

(2)

The point C , on k , is such that $AC : CB = 4:1$

(b) Find the coordinates of point C

(2)

The point D with coordinates (p, q) , where $p < 0$, lies on the line l through C that is perpendicular to k

The length of CD is $8\sqrt{5}$

(c) Find the coordinates of D

(6)

(d) Find the area of triangle ACD

(2)

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13-MARK QUESTIONS

2 questions in this booklet



- 2 The point A has coordinates $(-5, 3)$, the point B has coordinates $(4, 0)$ and the point C has coordinates $(-1, 5)$.

The line l passes through C and is perpendicular to AB .

- (a) Find an equation of l .

Give your answer in the form $ax + by + c = 0$ where a , b and c are integers.

(4)

The line l intersects AB at the point D .

- (b) Show that the coordinates of D are $(-2, 2)$.

(3)

- (c) Show that l is not the perpendicular bisector of AB .

(2)

- (d) Find the value of $\tan \angle ABC$.

Give your answer in its simplest form.

(4)

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- 2 The point A has coordinates $(3, 2)$, the point B has coordinates $(8, 3)$ and the point C has coordinates $(4, 7)$

(a) Show that ABC is an isosceles triangle.

(2)

The midpoint of BC is M

(b) Find an equation of the line that passes through A and M

Give your answer in the form $y = mx + c$

(3)

The points A , C and D are collinear such that $AD = kAC$ ($k > 1$)

Given that $\angle ABD = 90^\circ$

(c) find the coordinates of D
Show your working clearly.

(8)

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14-MARK QUESTIONS

1 question in this booklet



- 6 The point A has coordinates $(3, 0)$ and the point B has coordinates $(2, 2)$.
The line L_1 passes through B and is perpendicular to AB .

(a) Find an equation of L_1

Give your answer in the form $ax + by + c = 0$

(5)

The line L_2 with equation $x - 7y - 3 = 0$ intersects the line L_1 at the point C .
The midpoint of AC is M .

(b) Find the coordinates of M .

(5)

(c) Find the area of the triangle ABM .

(4)

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15-MARK QUESTIONS

2 questions in this booklet



- 9 The line l_1 with equation $y + 2x - 4 = 0$ passes through the point P with coordinates $(a, 6)$ and the point Q with coordinates $(3, b)$.

(a) Find the value of a and the value of b .

(2)

The line l_2 passes through point P and is perpendicular to l_1

The point R , with coordinates (e, f) lies on l_2 such that $PR = 6\sqrt{5}$

(b) Find the two possible pairs of values of e and f .

(8)

Given that $e < 0$,

(c) find the area of triangle PQR .

(3)

The points P , Q and R lie on a circle C .

(d) Find the coordinates of the centre of C .

(2)

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11 The points A and B have coordinates $(-3, -5)$ and $(7, 5)$ respectively.

(a) Find an equation for the line AB

(2)

The point C has coordinates $(p, 1)$ where $p < 0$

Given that AC and BC are perpendicular,

(b) prove that $p = -5$

(7)

The point D , where BCD is a straight line, is such that C divides BD in the ratio $4:3$

(c) Find the coordinates of D

(2)

(d) (i) Find the exact length of AC

(ii) Hence, or otherwise, find the area of triangle ABD

(4)

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16-MARK QUESTIONS

3 questions in this booklet



- 4 The point A has coordinates $(-4, -10)$ and the point B has coordinates $(3, 11)$
The line l passes through A and B .

(a) Find an equation of l .

(2)

The point P lies on l such that $AP:PB = 3:4$

(b) Find the coordinates of P .

(2)

The point Q with coordinates (m, n) , where $m < 0$, lies on the line through P that is perpendicular to l .

Given that the length of PQ is $\sqrt{10}$

(c) find the coordinates of Q .

(6)

The point R has coordinates $(-11, -21)$

(d) Show that

(i) AB and RQ are equal in length,

(ii) AB and RQ are parallel.

(4)

(e) Find the area of the quadrilateral $ABQR$.

(2)

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8 The points A and B have coordinates $(1, 5)$ and $(9, 9)$ respectively.

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

(3)

The line l is perpendicular to AB and passes through the point X which lies on AB such that $AX : XB = 3:1$

- (b) Show that an equation of l is $y = -2x + 22$

(5)

The point C has coordinates $(6, p)$

Given that C lies on l

- (c) find the value of p

(1)

$ABCD$ is a parallelogram where the x coordinate of D is negative.

- (d) Find the coordinates of the point D

(3)

- (e) Find the area of the parallelogram $ABCD$

(4)

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- 6

The line l passes through the point A with coordinates $(-2, 2)$ and the point B with coordinates $(3, 12)$

The point C with coordinates (p, q) lies on l such that $AC : CB = 3 : 2$

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

(2)
- The line k is perpendicular to l and passes through the point C

(b) Show that an equation of k is $2y + x - 17 = 0$

(4)
- The line k crosses the x -axis at the point D

(c) Find the exact length of CD

(3)
- The point X with coordinates (m, n) lies on l such that

area of triangle $DXC = 80 \text{ units}^2$

Given that $m > 0$

(d) find the value of m and the value of n

(7)

17-MARK QUESTIONS

4 questions in this booklet



11 The points A and B have coordinates $(-1, 3)$ and $(5, 6)$ respectively.

(a) Find an equation for the line AB .

(2)

The point P divides AB in the ratio $2:1$

(b) Show that the coordinates of P are $(3, 5)$

(2)

The point C with coordinates (m, n) , where $m > 0$, is such that CP is perpendicular to the line AB .

Given that the radius of the circle which passes through A , P and C is 5

(c) find the value of m and the value of n .

(6)

The point D with coordinates (p, q) is such that the line AD is perpendicular to the line AB and the line DC is parallel to the line AB .

(d) Find the value of p and the value of q .

(3)

(e) Find the area of trapezium $ABCD$.

(4)

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10 The equation of the line L_1 is $y - 2x - 6 = 0$

The point P with coordinates $(2, a)$ lies on L_1

(a) Find the value of a

(1)

The line L_2 is perpendicular to L_1 and passes through P

(b) Show that an equation of L_2 is $x + 2y - 22 = 0$

(4)

Line L_1 crosses the x -axis at the point A and line L_2 crosses the x -axis at the point B

The point C has coordinates (m, n) such that $m > 0$ and $n < 0$

The length of AC is $5\sqrt{2}$ and the gradient of BC is $\frac{1}{4}$

(c) Find the value of m and the value of n

(9)

(d) Find the area of quadrilateral $ACBP$

(3)

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11 An equation of the straight line l is $y - 3x = 3$

The point A on l lies on the y -axis.

The point B on l has coordinates $(10, b)$, where b is an integer.

The point C divides AB in the ratio $2:3$

The straight line k passes through C and is perpendicular to l

(a) Show that an equation of k is

$$3y + x - 49 = 0 \quad (6)$$

The point D with coordinates (p, q) , where q is positive, is such that AD is parallel to k and the length of AD is $12\sqrt{10}$

(b) Find the coordinates of D (6)

The point E lies on k such that DE is parallel to the y -axis.

The point F lies on l such that DF is parallel to the y -axis.

(c) Find the exact area of triangle ECF . (5)

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8 The points A and B have coordinates $(-6, 8)$ and $(12, 2)$ respectively.

- (a) Find an equation of the straight line passing through A and B in the form $ax + by + c = 0$, where a , b and c are integers to be found.

(3)

- (b) Find the exact length of AB

(2)

The point X with coordinates (m, n) lies on AB such that $AX:XB = 1:2$

- (c) Find the value of m and the value of n

(2)

The line L passes through the point X and is perpendicular to AB

The point C with coordinates (p, q) lies on L where $p > 0$ and $q > 0$

Given that AB is a diameter of a circle and C also lies on the circumference of the circle,

- (d) find

(i) the exact value of p

(ii) the exact value of q

(7)

- (e) Find the exact area of triangle ABC

(3)

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MARK SCHEMES

official Pearson Edexcel mark schemes

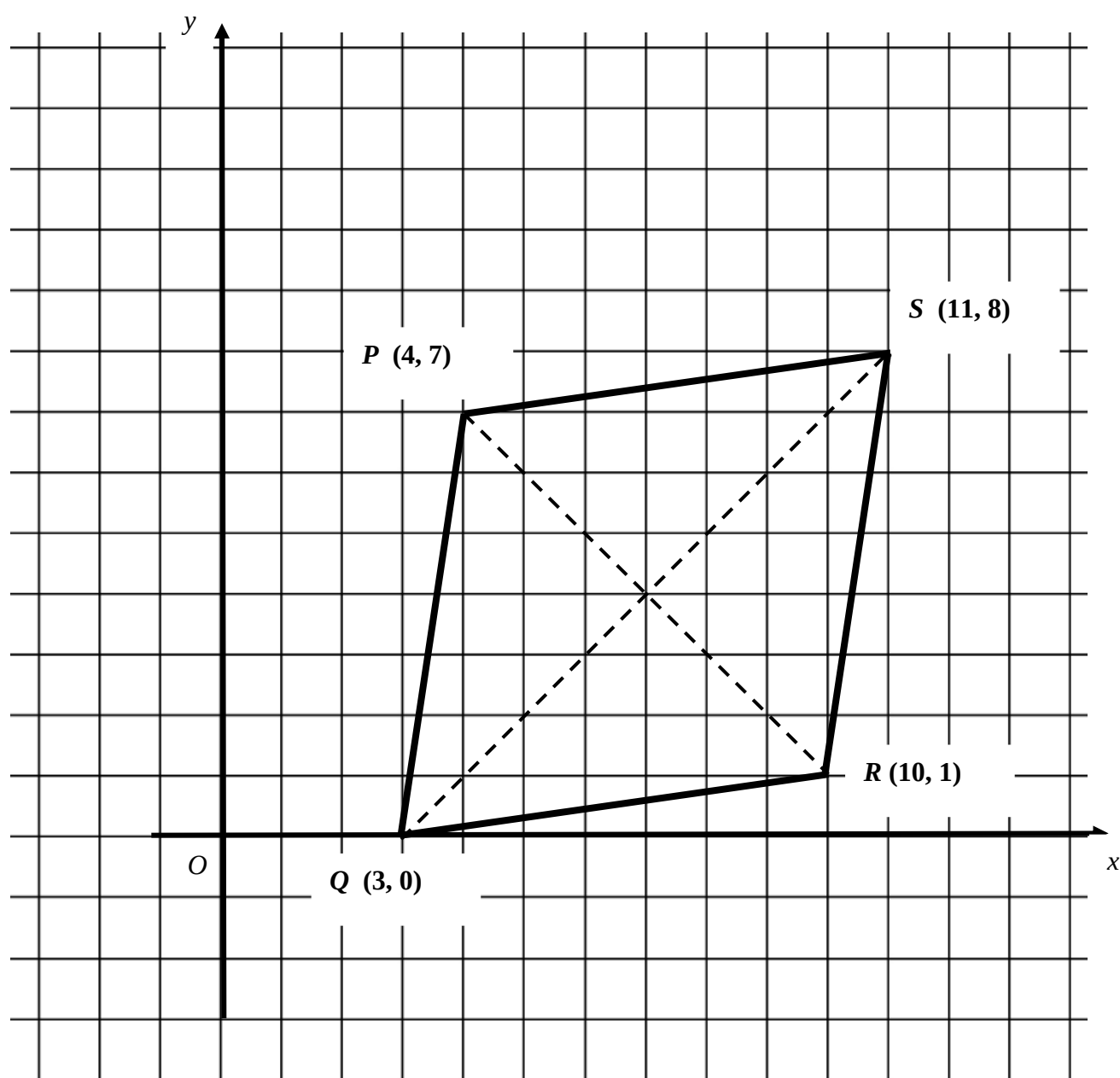


Question number	Scheme	Marks
2 (a)	Line l_1 $m = \frac{-8}{4} = -2$ $y - 8 = -2(x) \Rightarrow y + 2x = 8$ Line l_2 $m = \frac{-4}{6} = -\frac{2}{3}$ $y - 4 = -\frac{2}{3}(x) \Rightarrow 3y + 2x = 12$	M1A1 A1 [3]
(b)	$x \geq 0$ $y + 2x \leq 8$ $3y + 2x \geq 12$ Accept $<$ and $>$	B1B1ftB1ft [3]
Total 6 marks		
(a) M1 A1 A1	Calculating the gradient of either l_1 or l_2 $y + 2x = 8$ $3y + 2x = 12$ NB If both are correct but not in the form $ax + by = c$ then award A1A0	
(b) B1 B1ft B1ft	For all 3 marks accept $<$ and $>$ instead of $\leq$ and $\geq$ $x \geq 0$ $y + 2x \leq 8$ oe (ft l_1) $3y + 2x \geq 12$ oe (ft l_2)	

Question Number	Scheme	Marks
5(a)	Gradient $PR = \frac{6}{-6} = -1$, Gradient $QS = \frac{8}{8} = 1$ Product $= -1 \Rightarrow$ perpendicular	M1A1 A1 (3)
(b)	(i) $PR = \sqrt{6^2 + 6^2} = 6\sqrt{2} \left(= \sqrt{72} \right)$	M1
	(ii) $QS = \sqrt{8^2 + 8^2} = 8\sqrt{2} \left(= \sqrt{128} \right)$	A1 (2)
(c)	Area $= \frac{1}{2} "6\sqrt{2}" \times "8\sqrt{2}" = 48 \text{ (units}^2\text{)}$	M1A1 (2) [7]

Part	Mark	Notes
(a)	M1	Finds the gradient of PR and QS using a correct method. This may be on a diagram. Gradient $PR = \frac{7-1}{4-10} = \frac{6}{-6} = -1$, Gradient $QS = \frac{8-0}{11-3} = \frac{8}{8} = 1$
	A1	Both gradients correct Gradient $PR = -1$, Gradient $QS = 1$
	A1	Finds the product of the two gradients with a statements that as the product $= -1$ then the lines are perpendicular.
(b)	M1	For either $PR = \sqrt{6^2 + 6^2} = \sqrt{72}$ or $6\sqrt{2}$ OR $QS = \sqrt{8^2 + 8^2} = \sqrt{128}$ or $8\sqrt{2}$ correct
	A1	For both $PR = \sqrt{6^2 + 6^2} = \sqrt{72}$ or $6\sqrt{2}$ AND $QS = \sqrt{8^2 + 8^2} = \sqrt{128}$ or $8\sqrt{2}$ correct
(c)	M1	$PQRS$ is a kite so $= \frac{1}{2} "6\sqrt{2}" \times "8\sqrt{2}" = \dots$
	A1	Area $= 48 \text{ (units}^2\text{)}$
	ALT Uses determinants	
	M1	Area $= \frac{1}{2} \begin{vmatrix} 4 & 3 & 10 & 11 & 4 \\ 7 & 0 & 1 & 8 & 7 \end{vmatrix}$ $= \frac{1}{2} ([4 \times 0 + 3 \times 1 + 10 \times 8 + 11 \times 7] - [3 \times 7 + 10 \times 0 + 11 \times 1 + 4 \times 8])$ $= \dots$ Allow one slip in a product.
	A1	Area $= 48 \text{ (units}^2\text{)}$



USEFUL SKETCH

Question number	Scheme	Marks
2 (a)	$\text{Gradient} = \frac{4+1}{3+7} = \frac{1}{2}$	M1
	$y+1 = \frac{1}{2}(x+7)$	M1
	$x-2y+5=0$	A1
		(3)
	(b) $AB = \sqrt{10^2 + 5^2} = 5\sqrt{5}$	M1
	$AC = \sqrt{(-7--3)^2 + (7--1)^2} = 4\sqrt{5}$	
	$k = \frac{5}{4}$	A1
		(2)
	(c) $-2 = \frac{7-p}{-3-3}$	M1
	$12 = 7 - p$	dM1
	$p = -5$	A1
		(3)
Total 8 marks		

Part	Mark	Notes
(a)	M1	For finding the gradient of AB
	M1	For a fully correct method for finding the equation of a straight line. If $y = mx + c$ is used, then they must find a value for c for the award of this mark.
	A1	For $x - 2y + 5 = 0$ in the required form. Accept the terms in any order provided they are all on one side of the equation with the other = 0 e.g., $-2y + x + 5 = 0$ or $2y - x - 5 = 0$ etc
(b)	M1	For using Pythagoras to find both AB and AC $AB = \sqrt{(7--3)^2 + (4--1)^2} = 5\sqrt{5}$ and $AC = \sqrt{4^2 + 8^2} = 4\sqrt{5}$
	A1	For $k = \frac{5}{4}$
(c)	M1	Obtains an equation using the perpendicular of their gradient from (a) and the point (3, p) $-2 = \frac{7-p}{-3-3}$
	dM1	For a linear equation in p $12 = 7 - p$
	A1	For $p = -5$
	ALT	
	M1	Finds the equation of the perpendicular using their gradient from part (a) $y - 7 = -2(x + 3) \Rightarrow y = -2x + 1$
	dM1	Substitutes $x = 3$ into their equation of the perpendicular to find a value for y
	A1	For $p = -5$

Question	Scheme	Marks
4(a)	$(3 \times 14 - 2 \times 12 - p = 0 \Rightarrow) p = 18$ $3y - 2q - "18" = 0 \Rightarrow 3 \times 2 - 2q - "18" = 0 \Rightarrow q =$ $q = -6$	B1 M1 A1 [3]
(b)	$(X(x, y) =) \left(\frac{1 \times " - 6" + 2 \times 12}{3}, \frac{1 \times 2 + 2 \times 14}{3} \right) \text{ oe } (6, 10)$ $(\text{Gradient of } AB =) = \frac{2}{3} \text{ oe}$ $(\text{Gradient of } L =) -\frac{1}{\frac{2}{3}} \left(= -\frac{3}{2} \right)$ $y - "10" = -\frac{1}{\frac{2}{3}} (x - "6") \left(\Rightarrow y = -\frac{3}{2}x + 19 \right)$ $\Rightarrow 3x + 2y - 38 = 0 \text{ oe}$ Where a, b and c are integers.	B1B1 or M1A1 B1 B1ft M1 A1 [6]
Total 9 marks		

	Mark	Notes
(a)	B1	For $p = 18$
	M1	Uses their value of p and substitutes $y = 2$ and finds a value for q .
	A1	For the correct value of q .
First 2 marks of (b) – use the scheme which gives the most marks to candidates.		
(b)	B1 (M1 ePen)	For one correct value (6, 10).
	B1 (A1 ePen)	For both correct values (6, 10).
	or M1	Correct method for finding both coordinates, using their q . Look for any equivalent methods eg similar triangles.
	or A1	Both correct values.
	B1	For a fully correct unsimplified or simplified gradient of AB Note this mark is awarded for finding or stating the gradient and if simplified, it must be clear that $\frac{2}{3}$ is not a fraction from the given ratio. Accept $\frac{14-2}{12-6}$ This mark may be implied for a correct gradient of $-\frac{3}{2}$ used in further work.
	B1ft	For finding the negative reciprocal of their gradient – does not need to be simplified.
	M1	For a full and correct method to find the equation for the line L using their coordinates of X and their perpendicular gradient. This need not be simplified. If $y = mx + c$ is used, the correct value of c must be found for their coordinates and gradient. It must be clear the candidate is using their coordinates for X and not, for example simply the numbers from the coordinates of A and B
	A1	For the correct equation of the line in the required form – any equivalent where a, b and c are integers.

Question number	Scheme	Marks
3 (a)	(Midpoint of $AB = (5, 5)$)	B1
	(Gradient of $AB = \frac{3-7}{9-1} = \left(-\frac{1}{2}\right)$ oe	M1
	(Gradient of $l = -\left(\frac{1}{-\frac{1}{2}}\right) (= 2)$	A1ft
	$y - 5 = 2(x - 5)$ oe	M1 A1 (5)
ALT	Let $D(x, y)$ be any point on the line	
	$x - 1^2 + y - 7^2 = x - 9^2 + y - 3^2$	{B1}
	$x^2 - 2x + 1 + y^2 - 14y + 49 = x^2 - 18x + 81 + y^2 - 6y + 9$	{M1} {A1ft}
	$16x - 40 = 8y \rightarrow (y = 2x - 5)$	M1 A1
(b)	$x = \frac{5}{2}$	B1ft
	(length of C to midpoint of $AB = \sqrt{(5-0)^2 + (5-2.5)^2} \left(= \frac{5\sqrt{5}}{2}\right)$	M1
	(length of $AB = \sqrt{8^2 + 4^2} (= 4\sqrt{5})$	B1 (A1 on ePen)
	$\frac{1}{2} \times 4\sqrt{5} \times \frac{5\sqrt{5}}{2}$	M1
	25	A1 [5]
ALT1	Use of determinant	
	$x = \frac{5}{2}$	B1ft
	$\frac{1}{2} \begin{vmatrix} 1 & 9 & 2.5 & 1 \\ 2 & 7 & 0 & 7 \end{vmatrix}$	M1 A1
	$\left(\frac{1}{2}\right) \left (1 \times 3 + 9 \times 0 + 2.5 \times 7) - (1 \times 0 + 2.5 \times 3 + 9 \times 7) \right $ oe	M1
	25	A1 [5]
ALT2	Area of rectangle – (sum of areas of 3 triangles)	
	$x = \frac{5}{2}$	B1ft
	$\frac{1}{2} \times \left(\frac{5}{2} - 1\right) \times 7 + \frac{1}{2} \times \left(9 - \frac{5}{2}\right) \times 3 + \frac{1}{2} (9-1)(7-3)$ $\left(= \frac{21}{4} + \frac{39}{4} + 16 = 31\right)$	M1
	$(9-1) \times 7 = 56$	A1
	$56 - 31$	M1
	35	A1 [5]
Total 10 marks		



Part	Marks	Notes
(a)	B1	For midpoint of $AB = (5, 5)$
	M1	For correctly finding the unsimplified gradient of $AB = \frac{3-7}{9-1}$ oe
	A1ft	For correctly finding the unsimplified gradient of line l , use of their gradient for AB to find the negative reciprocal. $-\left(\frac{1}{-\frac{1}{2}}\right)$
	M1	For a correct method to find the equation of l using their midpoint and their gradient, which must have involved finding the negative reciprocal of the gradient of AB
	A1	For $y - 5 = 2(x - 5)$ ft oe
ALT	B1	For correctly equating the two expressions for AD^2 and AB^2 to give the equation shown
	M1	For an expansion of either their LHS or their RHS provided their equation is in the form. $x - a^2 + y - b^2 = x - c^2 + y - d^2$ Allow one numerical or algebraic slip.
	A1ft	For a correct expansion of both their LHS and their RHS provided their equation is in the form. $x - a^2 + y - b^2 = x - c^2 + y - d^2$
	M1	For simplifying leading to a linear equation
	A1	For $y = 2x - 5$ oe
(b)	B1ft	For $x = \frac{5}{2}$ ft their equation from part (a) with $y = 0$
	M1	For finding the unsimplified length of C to midpoint of $AB = \sqrt{("5"-0)^2 + ("5"-2.5)^2} \left(= \frac{5\sqrt{5}}{2} \right)$ Allow use of their (5, 5) and their C
	B1 (A1 on ePen)	For finding the unsimplified length of $AB = \sqrt{8^2 + 4^2} (= 4\sqrt{5})$
	M1	For area of triangle $= \frac{1}{2} \times 4\sqrt{5} \times \frac{5\sqrt{5}}{2}$
	A1	For 25
ALT1	B1ft	As main
	M1	For the determinant set up with their C
	A1	For the determinant set up fully correctly
	M1	For correctly evaluating their determinant, with their C , full working must be shown.
	A1	25
ALT2	B1ft	As main
	M1	For the correct calculation of the three areas using their C
	A1	For the correct rectangle area
	M1	For the correct calculation, using their values for the three areas
	A1	25



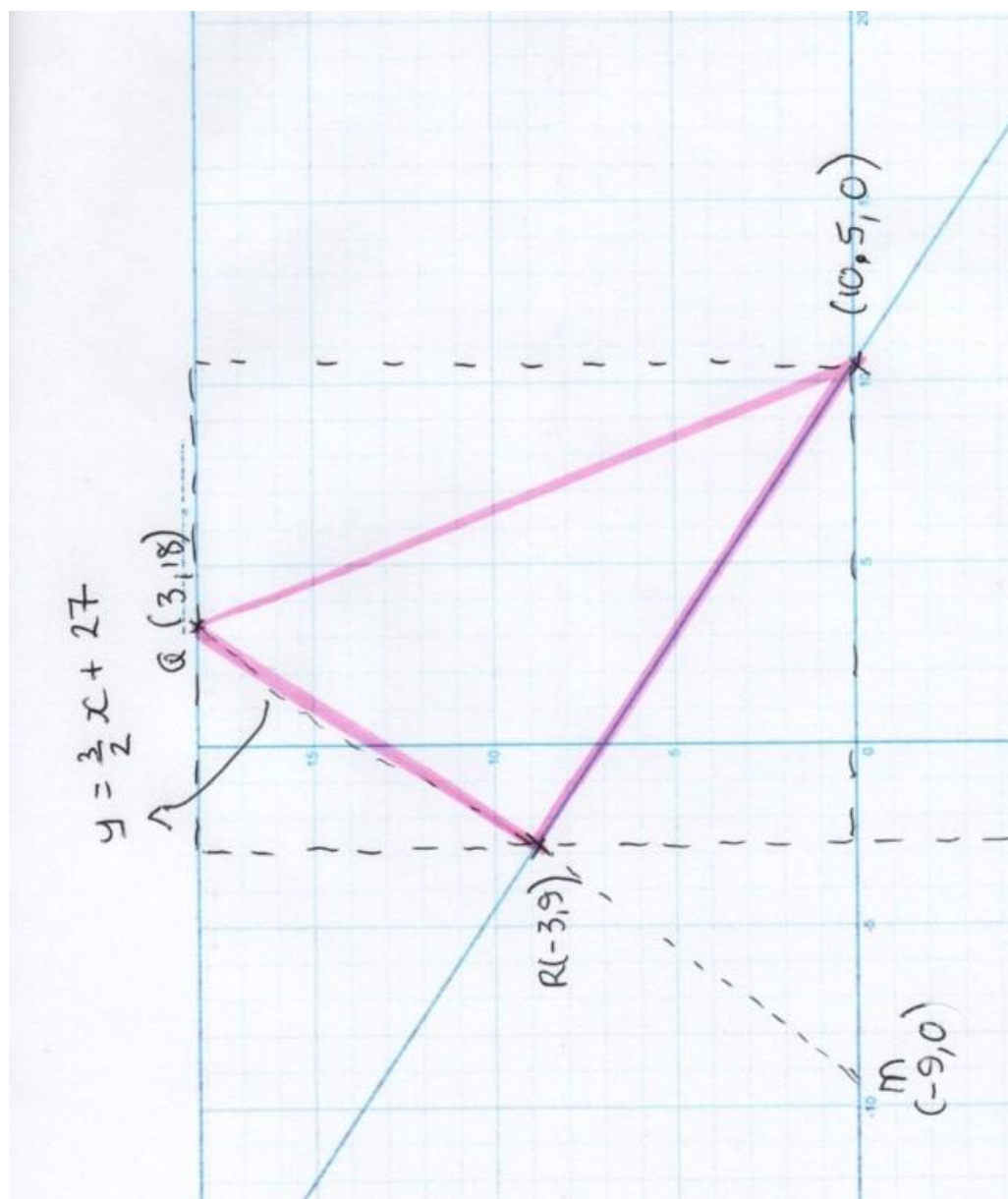
Question number	Scheme	Marks
2 (a)	$(-3, 9)$ $(m_{PQ} =) \frac{18-3}{3-7} \left(= \frac{3}{2} \right)$ oe $(m_l =) = -\frac{1}{\frac{18-3}{3-7}} = \left(-\frac{1}{\frac{3}{2}} \right) \left(= -\frac{2}{3} \right)$ oe $y - 9 = -\frac{2}{3}(x + 3)$ $3y + 2x - 21 = 0$ oe eg $-6y - 4x + 42 = 0$	B1 M1 M1 M1 A1 [5]
(b)	$3 \times 0 + 2x - 21 = 0 \Rightarrow x = (10.5)$ $(QR^2 =) (3 - (-3))^2 + (18 - 9)^2 (= 117)$ or $(QR =) \sqrt{(3 - (-3))^2 + (18 - 9)^2} (= 3\sqrt{13})$ $(RS^2 =) ((10.5 - (-3))^2 + (0 - 9)^2) \left(= \frac{1054}{4} \right)$ or $(RS =) \sqrt{((10.5 - (-3))^2 + (0 - 9)^2)} \left(= \frac{9\sqrt{13}}{2} \right)$ $\frac{1}{2} \times 3\sqrt{13} \times \frac{9\sqrt{13}}{2}$ $\frac{351}{4}$ oe (87.75)	M1 M1 M1 ddM1 A1 [5]
ALT1	$3 \times 0 + 2x - 21 = 0 \Rightarrow x = (10.5)$ $\left(\frac{1}{2} \right) \begin{vmatrix} 3 & -3 & 10.5 & 3 \\ 18 & 9 & 0 & 18 \end{vmatrix}$ oe eg $\left(\frac{1}{2} \right) \begin{vmatrix} 10.5 & -3 & 3 & 10.5 \\ 0 & 9 & 18 & 0 \end{vmatrix}$ oe $\frac{1}{2} ((3 \times 9 + -3 \times 0 + 10.5 \times 18) - (3 \times 0 + 10.5 \times 9 + -3 \times 8))$ oe $\frac{351}{4}$ oe (87.75)	M1 M1 M1 ddM1 A1
	Finding the area of a rectangle and subtracting area of triangles	
ALT2a	$3 \times 0 + 2x - 21 = 0 \Rightarrow x = 0$ $((10.5 - (-3)) \times 18 = 243)$ $\frac{1}{2} \times (18 - 9) \times (3 - (-3)) (= 27)$ $\frac{1}{2} \times ((10.5 - 3) \times (18 - 0)) \left(= \frac{135}{2} \right)$ $\frac{1}{2} \times ((10.5 - (-3)) \times (9 - 0)) \left(= \frac{243}{4} \right)$ $243 - 27 - \frac{135}{2} - \frac{243}{4}$ $\frac{351}{4}$ oe (87.75)	M1 M1 M1 M1 ddM1 A1

ALT2b	Let M be the intersection of PQ with the x-axis $3 \times 0 + 2x - 21 = 0 (\Rightarrow x = 10.5)$ $\left(y = \frac{3}{2}x + 13.5 \Rightarrow x = \right) - 9$ $(\text{Area of triangle } SQM =) \frac{1}{2} \times ("10.5" - "-9") \times 18 \left(= \frac{351}{2} \right)$ $(\text{Area of triangle } SRM =) \frac{1}{2} \times ("10.5" - "-9") \times 9 \left(= \frac{351}{4} \right)$ $"\frac{351}{2}" - "\frac{351}{4}"$ $\frac{351}{4} \text{ oe } (87.75)$	M1 M1 M1 M1 ddM1 A1
ALT3	Usually with a good diagram, the candidate can work out that triangles SRM and QRS are congruent (SAS) If spotting this, this is full marks or 0 marks (because without the correct coordinates, this is not so) $\frac{1}{2} \times 19.5 \times 9 = \frac{351}{4}$	M1M1 M1M1 ddM1A1
Total 10 marks		



Part	Mark	Additional Guidance
(a)	B1	For $(-3,9)$
	M1	For the method for gradient of PQ in unsimplified form
	M1	For finding the negative reciprocal of their gradient of PQ , does not need to be simplified. This mark is not dependent, so may be awarded for finding the negative reciprocal of any gradient believed to be their gradient of PQ
	M1	For a full and correct method to find the equation of the line. Doesn't need to be simplified. Ft their grad for l , so long as it involves a changed gradient from PQ and ft their point R . If using $y = mx + c$, a full method includes correct rearrangement to find c . If the equation is not the correct one and they're working with their values, this rearrangement must be shown or check their c is correct for their values. $c = 7$ implies this mark. Full equation needs to be seen.
	A1	For the equation shown oe integer coefficients.
(b)	M1	For substituting $y = 0$ into their equation for l and correctly solving to find a value of x This mark may be implied by $(x =) 10.5$
	M1	For a correct method to find QR or QR^2 using their coordinates for point R
	M1	For a correct method to find RS or RS^2 using their coordinates for point R and their value for the x coordinate of S
	ddM1	For a correct method to find the area of the triangle. Dependent on both previous method marks.
	A1	Correct answer as shown.
ALT1	M1	For substituting $y = 0$ into their equation for l and solving to find a value of x This mark may be implied by $(x =) 10.5$
	M1	For a correct matrix array, condone round or brackets, using their coordinates for R and their 10.5, the 0.5 doesn't need to be present. Be aware of all the equivalents, including reverse order or 'upside down'. May be implied by correct working
	M1	For a correct determinant array, using their coordinates for R and their 10.5, with 0.5 outside. May be implied correct working.
	ddM1	For a correct calculation of the determinant do need to see multiplication by 0.5. May be implied by a correct answer. If the candidate is using their values rather than the correct values, they must show the products (or at the minimum each product evaluated) and subtraction correctly. Dependent on both previous method marks.
	A1	Correct answer as shown.
ALT2a	M1	For substituting $y = 0$ into their equation for l and solving to find a value of x This mark may be implied by $(x =) 10.5$
	M1	For a correct method to find the area of the rectangle, using their R and their 10.5.
	M1	For a correct method to find the area of the surrounding triangles
	ddM1	For a correct method to find the area of triangle QRS
	A1	Correct answer as shown.
ALT2b	M1	For substituting $y = 0$ into their equation for l and solving to find a value of x This mark may be implied by $(x =) 10.5$
	M1	For -9 This is the intersection of PQ with the x -axis The mark is for the number not the method
	M1	For a correct method to find the area of triangle SQM
	ddM1	For a correct method to find the area of triangle SPM
	A1	Correct answer as shown.





Question Number	Scheme	Marks
8(a)	$AB^2 = 4^2 + 2^2$, $BC^2 = 2^2 + 6^2$, $AC^2 = 2^2 + 4^2$ (i) $AB = \sqrt{20}$ (ii) $BC = \sqrt{40}$ (iii) $AC = \sqrt{20}$ or equivalents (4.47) (6.32) (4.47)	M1 (any one) A1A1A1 (4)
(b)	Any complete method for finding one of the angles: eg $AB^2 + AC^2 = BC^2 \Rightarrow \angle A = 90^\circ$ or use trigonometry $\angle A = 90^\circ$, $\angle B = \angle C = 45^\circ$	M1 A1, A1 (3)
I	(centre at midpoint of BC) (5,5)	M1A1 (2)
(d)	Radius = $\frac{1}{2}BC = \frac{1}{2}\sqrt{40} = \sqrt{10}$ (Working for (d) may be seen in a previous part)	M1A1 (2) [11]
(a) M1 A1A1A1 SC: (b) M1 A1 A1 (c) M1 A1 (d) M1 A1 NB	Use Pythagoras with a plus sign to obtain AC^2, BC^2 or AB^2. If the answer is incorrect it must be clear that the correct coordinates have been used correctly. Award A1 for each correct length. Ignore labels (i), (ii) and (iii). Award M1A1A1A1 / M1A1A1A0 / M1A1A0A0 as appropriate. If there is no working shown but at least one length is correct, award M1 and deduct one A mark for each incorrect length. (no length correct and no working $\Rightarrow$ M0) If all 3 lengths are correct to at least 3 sf, award M1A1A1A0 If 2 are correct to at least 3 sf, award M1A1A0A0 Attempt to obtain any of the required angles. Method must be complete (ie reach a value for one angle) and formula used must be correct and values must be substituted into a correct formula. $\angle A = 90^\circ$ Any labelling given can be ignored. $\angle B = \angle C = 45^\circ$ All 3 correct w/o working scores M1A1A1 For indicating that the centre is at the midpoint of BC. This can be stated explicitly or used by attempting to find the midpoint. OR: Find equations for perpendicular bisectors of 2 of the sides and find the point of intersection Both coordinates correct. Correct answer written down w/o working scores M1A1 For indicating that the radius is half the length of BC. This can be stated explicitly or used by attempting to find half of their BC (not nec in the required form). Correct length of the radius, in the required form. If half the length of BC has been found earlier the marks for (d) can only be awarded if the length of the radius has been written in (d).	



Question	Scheme	Marks
5(a)	$-\frac{1}{12} = \frac{10-0}{p-123} \left[\text{or } -\frac{1}{12} = \frac{0-10}{123-p} \right]$ $\Rightarrow p-123 = -12 \times 10 \Rightarrow p = 3^*$	M1 A1 CSO [2]
(b)	$y-10 = -\frac{1}{12}(x-3) \Rightarrow 12y+x-123=0$	M1A1 [2]
(c)	$m_k = 12$ $y-10 = 12(x-3) \Rightarrow y = 12x-26$	B1 M1A1 [3]
(d)	At C : $y = 12x - 26$ when $y = 0$, $x = \frac{26}{12}$ oe $\text{Area}_{ABC} = \frac{1}{2} \times 10 \times \left(123 - \frac{13}{6}\right) = \frac{3625}{6}$ ALT $\text{Area} = \frac{1}{2} \begin{vmatrix} 3 & 123 & 13/6 & 3 \\ 10 & 0 & 0 & 10 \end{vmatrix} = \frac{3625}{6}$	M1A1 M1A1 [M1A1] [4]
Total 11 marks		



Question	Notes	Marks
5(a)	States a correct expression for the gradient in terms of p either $-\frac{1}{12} = \frac{10-0}{p-123}$ or $-\frac{1}{12} = \frac{0-10}{123-p}$ and attempts to solve their equation in p $p-123 = -12 \times 10 \Rightarrow p = \dots$	M1
	Finds the value of $p = 3^*$ Must show an intermediate step e.g. $k = p \pm c$ or $c = \frac{p}{k}$ or $c = kp$	A1 cso [2]
(b)	Forms an equation using either the formula or $y = mx + c$ with the given values $y-10 = -\frac{1}{12}(x-3)$ OR $y-0 = -\frac{1}{12}(x-123)$	M1
	For the correct equation in the required form $12y + x - 123 = 0$ Coefficients must be integers. Allow for $r = 1, s = 12, t = -123$	A1 [2]
(c)	For the gradient of the normal when $x = 3$ is 12	B1
	Forms an equation of the normal using either the formula or $y = mx + c$ with their values of the gradient of the normal. $y-12 = 12(x-3)$	M1
	For the correct equation in the required form. $y = 12x - 26$	A1 [3]
(d)	Attempts to find the x coordinate at point C $y = 12x - 26$ when $y = 0, x = \dots$ Their linear equation from (c) with $y = 0$ and attempt to solve.	M1
	For the correct value of x $x = \frac{26}{12}$ oe	A1
	For attempting to find the area of triangle ABC Area = $\frac{1}{2} \times 10 \times \left(123 - \frac{13}{6}\right) = \dots$ or Area = $\frac{1}{2} \begin{vmatrix} 3 & 123 & 13/6 & 3 \\ 10 & 0 & 0 & 10 \end{vmatrix}$	M1
	For the correct area of the triangle $\frac{3625}{6}$ oe isw rounding	A1 [4]
Total 11 marks		

Question number	Scheme	Marks
9 a	$L_1 : y - 7 = m(x - 4)$ Gradient of $L_2 = -\frac{1}{m}$ $L_2 : y - k = -\frac{1}{m}(x - 4)$ $x = \frac{y-7}{m} + 4$ $y - k = -\frac{1}{m}\left(\frac{y-7}{m} + 4 - 4\right)$ $m^2 y - m^2 k = 7 - y$ $y(m^2 + 1) = 7 + m^2 k$ $Y = \frac{7 + m^2 k}{m^2 + 1} *$	B1 M1 M1 M1 M1 dM1 A1 cso (7)
b	Midpoint of $AB = \left(4, \frac{k+7}{2}\right)$ So $\frac{k+7}{2} = \frac{7 + m^2 k}{m^2 + 1}$ $m^2 k + 7m^2 + k + 7 = 2m^2 k + 14$ $m^2(k - 7) = k - 7$ As $k \neq 7$ $m = \pm 1$ As $m < 0$ $m = -1$	B1 M1 M1 A1 A1 (5)
Total 12 marks		

Part	Mark	Notes
(a)	NOTE ; The algebra must be correct for the first three marks.	
	B1	For writing an equation for L_1 e.g., $y - 7 = m(x - 4)$ OR Uses $y = mx + c \Rightarrow y = mx + (7 - 4m)$
	M1	For the gradient of the perpendicular $\left(-\frac{1}{m}\right)$
	M1	For writing an equation for L_2 (ft a changed gradient) e.g., $y - k = -\frac{1}{m}(x - 4)$ OR Uses $y = mx + c \Rightarrow y = -\frac{1}{m}x + \left(k + \frac{4}{m}\right) \Rightarrow \left[y = \frac{-x + km + 4}{m}\right]$
	M1	For rearranging their equation of L_2 to make x the subject e.g., $x = \frac{y-7}{m} + 4$ or $x = km - ym + 4$ ALT 1 Rearranges either equation to make $(x - 4)$ the subject $x - 4 = \frac{y-7}{m}$ and/or $x - 4 = ym + km$ ALT 2 Eliminates y from their equations to obtain ' $x - 4m + 7 = \frac{-x + 4 + km}{m}$ ' $\Rightarrow x = \frac{4 + km + 4m^2 - 7m}{m^2 + 1}$ They must reach $x = \dots\dots$ for the award of this mark. Allow sign errors/slips at this stage.
	M1	Forming a linear equation in y No simplification is required at this stage. $y - k = -\frac{1}{m}\left(\frac{y-7}{m} + 4 - 4\right)$ ALT 1 $\frac{y-7}{m} = ym + km$ ALT 2 Forms a linear equation in y using their expression for x by substituting back into either L_1 or L_2 Allow sign errors/slips at this stage.
	dM1	For attempting to rearrange to obtain the required result. Allow sign errors but there must be no missing terms. You must check carefully.
	A1	For the required result with no errors seen. $Y = \frac{7 + m^2k}{m^2 + 1}$ allow $y = \frac{7 + m^2k}{m^2 + 1}$



(b)	B1	For identifying y coordinate of the midpoint of AB $\left(4, \frac{k+7}{2}\right)$ the x coordinate is not required for this mark.
	M1	Equating the y coordinate of C and y coordinate of the midpoint to give $\frac{k+7}{2} = \frac{7+m^2k}{m^2+1}$
	M1	For rearranging and factorising to attempt achieve $m^2(k-7) = k-7$ This mark can implied by the correct value for either m^2 or m
	A1	Concludes that $m = \pm 1$ $\left[m^2 = \frac{k-7}{k-7} = 1 \Rightarrow m = \pm 1\right]$ Again, this can be implied by the correct $m = -1$
	A1	For $m = -1$
	ALT 1	
		Let coordinates of C be (X, Y)
	B1	Sets: length $AC =$ length BC $(X-4)^2 + (Y-7)^2 = (X-4)^2 + (Y-k)^2 \Rightarrow (Y-7)^2 = (Y-k)^2$
	M1	Using the coordinates for C of (X, Y) or otherwise, performs the following algebraic manipulation. $(Y-7)^2 = (Y-k)^2 \Rightarrow Y^2 - 14Y + 49 = Y^2 - 2kY + k^2 \Rightarrow -14Y + 49 = -2kY + k^2$ $\Rightarrow 2Y(k-7) = (k+7)(k-7)$ $\Rightarrow 2Y = k+7$ NB: Allow sign slips, but not missing terms
	M1	Substitutes in the given expression for Y and attempts to obtain $m^2(k-7) = k-7$ $\frac{7+m^2k}{m^2+1} = \frac{k+7}{2}$ $\Rightarrow 14 + 2m^2k = km^2 + 7m^2 + k + 7 \Rightarrow 7 + km^2 = 7m^2 + k$ $\Rightarrow m^2(k-7) = k-7$ NB: Allow sign slips, but not missing terms
	A1	Concludes that $m = \pm 1$ $m^2 = \frac{k-7}{k-7} = 1 \Rightarrow m = \pm 1$
	A1	For $m = -1$
	ALT 2	
	If candidates deduces that $BAC = 45^\circ$ and concludes that the gradient must be $m = -1$ award B1M1M1A1A1	
	If they leave their answer as $m = \pm 1$ or just $m = 1$, withhold the final A mark	



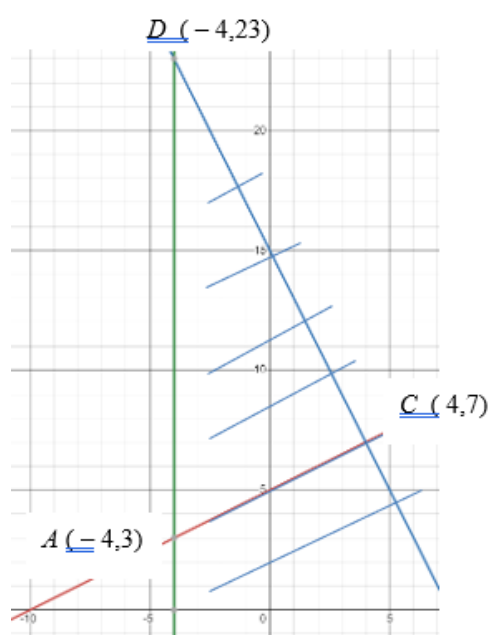
Question	Scheme	Marks
9(a)	$\frac{y-8}{8-3} = \frac{x-6}{6-4} \Rightarrow \frac{y-8}{5} = \frac{x-6}{10} \Rightarrow \left[y-8 = \frac{1}{2}(x-6) \right]$	M1A1 [2]
(b)	$C = \left(\frac{4 \times 6 + 1 \times -4}{4+1}, \frac{4 \times 8 + 1 \times 3}{4+1} \right) = (4, 7)$	B1,B1 [2]
(c)	$-2 = \frac{q-7}{p-4} \Rightarrow q = 15 - 2p$ $8\sqrt{5} = \sqrt{(4-p)^2 + (7-q)^2}$ $\Rightarrow 320 = (4-p)^2 + (2p-8)^2 \Rightarrow p^2 - 8p - 48 = 0$ $\Rightarrow (p+4)(p-12) = 0$ $\Rightarrow p = -4 \quad q = 15 - 2 \times -4 = 23 \Rightarrow D = (-4, 23)$	M1 M1 M1 M1 A1A1 [6]
(d)	Area of triangle $ACD = \frac{1}{2} \times (23-3) \times (4-(-4)) = 80$ [square units] ALT 1 $\frac{1}{2} \begin{vmatrix} -4 & 4 & -4 & -4 \\ 3 & 7 & 23 & 3 \end{vmatrix} = \frac{1}{2} [(-28+92-12)-(12-28-92)] = 80$ ALT 2 $A = \frac{1}{2} \times AC \times CD = \frac{1}{2} \times 4\sqrt{5} \times 8\sqrt{5} = 80$	M1A1 [2] [M1A1] [M1A1]
Total 12 marks		

Part	Mark	Notes
(a)	M1	For a complete method to find an equation of the line segment AB They must either use the formula shown Award M1A1 for $\frac{y-8}{5} = \frac{x-6}{10}$ (the denominators must be processed). OR They must find the gradient using a correct method and then use the formula $y - y_1 = m(x - x_1) \Rightarrow y - 8 = \frac{1}{2}(x - 6)$ or using $(-4, 3)$ OR They must find the gradient using a correct method and then using $y = mx + c$ they must find c and put an equation together to score this mark. $y = \frac{1}{2}x + 5$ Allow for example $k = \frac{1}{2}x + 5$ for this mark (M1) only.
	A1	For a correct equation in any form.[See above]



(b)	B1	For either correct coordinate of C (4, 7) This is an M mark in Epen
	B1	For both correct coordinates of C (4, 7) This is an M mark in Epen
(c)	Note: You must fit their coords of C in part (c)	
	M1	For using the perpendicular gradient of their equation in (a) to set up a correct equation in terms of p and q OR For finding the equation of the line CD using their point C (4, 7) The method must be complete for this mark. $\frac{y-7}{7-23} = \frac{x-4}{4--4} \Rightarrow y = -2x + 15$
	M1	For using the given length of CD to set up a second equation using Pythagoras theorem in terms of p and q $8\sqrt{5} = \sqrt{(4-p)^2 + (7-q)^2} \text{ oe}$
	M1	For combining their two equations in p and q to obtain a 3TQ
	M1	For solving their 3TQ (provided it is a 3TQ) by any acceptable method. If the 3TQ is incorrect, there must be evidence of a method to score this mark. If they use their calculator on a correct 3TQ and obtain the correct values, score M1.
	A1	For the correct value of p or q
(d)	A1	For the correct values of both p and q
	M1	For any correct method to find the area of triangle ACD , using their coordinates. If they use the determinant method, check their work carefully.
	A1	For the correct area of 80 [square units].

Useful sketch



Question number	Scheme	Marks
2 a	$(\text{Gradient of } AB =) \frac{0-3}{4+5} \left(= -\frac{1}{3} \right)$	M1
	$\text{Gradient of the perpendicular} = -\frac{1}{-\frac{1}{3}} (=3)$	M1
	$y-5 = -\frac{1}{-\frac{1}{3}}(x+1) \quad \text{or } y-5 = "3"(x+1) \text{ or } y=3x+8$	M1
	$3x-y+8=0 \text{ or } -3x+y-8=0 \text{ oe}$	A1 (4)
b	$(\text{Equation of } AB =) y-0 = "-\frac{1}{3}"(x-4) \text{ or } y = -\frac{1}{3}x + \frac{4}{3} \text{ oe}$	M1
	$\text{Solve } y-3x-8=0 \text{ and } y-0 = -\frac{1}{3}(x-4) \text{ oe simultaneously}$	M1
	$0 = \frac{10}{3}x + \frac{20}{3} \text{ oe}$	
	$x = -2 \quad y = 2 \text{ or } (-2, 2) *$	A1 cso (3)
	Alternative for final 2 marks (substitutes (-2, 2) into each equation)) Line l is $3x - y + 8 = 0$ When $x = -2$ and $y = 2$, $-6 - 2 + 8 = 0 \Rightarrow D$ lies on l	
	$AB \text{ is } y = -\frac{1}{3}x - 4$	{M1}
	$\text{When } x = -2 \text{ and } y = 2, \quad -\frac{1}{3}(-2) - 4 = 2 = y \Rightarrow D \text{ lies on } AB$	
	$\text{So } l \text{ and } AB \text{ intersect at } -2, 2 *$	{A1 cso} (3)
c	$\text{Midpoint of } AB = \left(\frac{-5+4}{2}, \frac{3(+0)}{2} \right) = \left(-\frac{1}{2}, \frac{3}{2} \right)$	B1 (M1 on ePen)
	$\neq (-2, 2) \text{ So not perpendicular bisector of } AB *$	B1 (A1 on ePen) cso (2)
ALT	$BD = \sqrt{(4-(-2))^2 + (0-2)^2} (= \sqrt{40}) \quad \text{or} \quad AD = \sqrt{(-5-(-2))^2 + (3-2)^2} (= \sqrt{10})$	M1
	$BD = \sqrt{40} (= 2\sqrt{10}) \quad \text{and} \quad AD = \sqrt{10}$	A1cso (2)
	$BD \neq AD \text{ so not the perpendicular bisector}$	

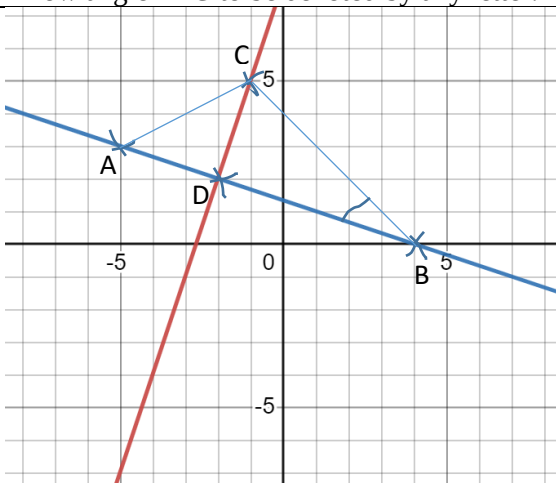


d ALT 1	$BD = \sqrt{(4 - -2)^2 + (0 - 2)^2} (= \sqrt{40}) \text{ oe}$ $CD = \sqrt{(-1 - -2)^2 + (5 - 2)^2} (= \sqrt{10}) \text{ oe}$ $(\tan \angle ABC =) \frac{\sqrt{(-1 - -2)^2 + (5 - 2)^2}}{\sqrt{(4 - -6)^2 + (0 - 2)^2}} \text{ or } \frac{\sqrt{10}}{\sqrt{40}}$ $= \frac{1}{2}$ Uses cosine rule in triangle ABC $AB = \sqrt{(-5 - 4)^2 + (3 - 0)^2} (= \sqrt{90} = 3\sqrt{10}) \text{ or } BC = \sqrt{(4 - -1)^2 + (0 - 5)^2} (= \sqrt{50} = 5\sqrt{2})$ or $AC = \sqrt{(-1 - -5)^2 + (5 - 3)^2} (= \sqrt{20} = 2\sqrt{5})$ may also find expressions for $(AB)^2, (BC)^2$ or $(AC)^2$ $AB = \sqrt{(-5 - 4)^2 + (3 - 0)^2} (= \sqrt{90} = 3\sqrt{10}) \text{ and } BC = \sqrt{(4 - -1)^2 + (0 - 5)^2} (= \sqrt{50} = 5\sqrt{2})$ and $AC = \sqrt{(-1 - -5)^2 + (5 - 3)^2} (= \sqrt{20} = 2\sqrt{5})$ may also find expressions for $(AB)^2, (BC)^2$ and $(AC)^2$ $(\cos ABC =) \frac{(\sqrt{50})^2 + (\sqrt{90})^2 - (\sqrt{20})^2}{2 \times \sqrt{50} \times \sqrt{90}} \left(= \frac{2}{\sqrt{5}} = \frac{2\sqrt{5}}{5} \right)$ $(\tan ABC) = \frac{1}{2}$	M1 M1 ddM1 A1 (4) M1 M1 ddM1 A1
Total 13 marks		

Part	Mark	Additional Guidance
(a)	M1	For correctly finding the gradient of AB , need not be simplified.
	M1	For finding the negative reciprocal of their gradient of AB , need not be simplified.
	M1	For a fully correct method using their negative reciprocal to find the equation of the straight line. Allow use of their $-\frac{1}{\text{"_1_"}}$ which can be unsimplified or processed incorrectly, but must follow from a clear attempt to have found the negative reciprocal of their gradient for AB . If $y = mx + c$ is used, there must be a fully correct substitution and a fully correct rearrangement to find c
	A1	For $3x - y + 8 = 0$ or $-3x + y - 8 = 0$ oe so long as integer coefficients and $= 0$.
(b)	M1	For writing the equation of AB , the equation need not be simplified, but must be fully correct.
	M1	For an attempt to solve their equations simultaneously, allow one processing error. Must eliminate one variable and arrive at a value for x or y .
	A1 cso*	For obtaining the required result, no errors.
	ALT	Final 2 marks
	M1	For writing the equation of AB , the equation need not be simplified, but must be fully correct.
	M1	For a fully correct substitution of $(-2, 2)$ into a correct equation for AB to show that D lies on AB OR a fully correct substitution of $(-2, 2)$ into their equation for line l
	A1 cso*	For a fully correct substitution of $(-2, 2)$ into a correct equation for AB to show that D lies on l AND a fully correct substitution of $(-2, 2)$ into a correct equation for line l to show that D lies on l . An appropriate (minimal) conclusion must also be written, this can be as simple as # or 'shown'. No errors.
(c)	B1 (M1 on ePen)	For either coordinate of the midpoint correct
	B1 (A1 on ePen) cso*	For both coordinates correct and an appropriate (minimal) conclusion, which must be correct, can be as simple as # or 'shown'.
ALT	M1	For a correct method to calculate AD or BD
	A1 cso*	For correct values for AD and BD , accept decimals and a (minimal) conclusion, can be as simple as # or 'shown'.
(d)	M1	For the correct method to calculate BD (May be seen in (c))
	M1	For the correct method to calculate CD
	ddM1	For $(\tan \angle ABC =) \frac{\sqrt{(-1 - -2)^2 + (5 - 2)^2}}{\sqrt{(4 - -6)^2 + (0 - 2)^2}}$ or $\frac{\sqrt{10}}{\sqrt{40}}$ allow their BD and CD . Dependent on the previous 2 method marks.
	A1	For $(\tan \angle ABC) = \frac{1}{2}$
If you see a method using the gradient of BC and $\tan(A - B)$ – PLEASE SEND TO REVIEW		

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ALT 1	M1	Correct method to calculate one of the required lengths
	M1	Correct method to calculate all of the required lengths
	ddM1	Correct substitution into the cosine rule to give the expression shown, allow use of their lengths. Must obtain a correct expression for $\cos ABC =$, using their values. Dependent on the previous 2 method marks.
	A1	For $(\tan \angle ABC) = \frac{1}{2}$
Because of the wording of the question, in not specifically asking for an exact value, we are going to allow a range for the value of $\tan \angle ABC$ as follows: $0.49989 \leq \tan \angle ABC \leq \frac{1}{2}$		
If you see the candidate using the ratio for a right angled triangle - but they are using the wrong pairing of lengths, (perhaps AB, BC or AC) then this is to be marked using the main scheme, and is unlikely to be awarded any marks unless they have correctly calculated BD or CD. To be clear - If the candidate states correct values for AB, BC or AC but goes onto to use a tan ratio - this cannot be awarded any marks using the ALT mark scheme, because they are not using the correct cosine rule and with the tan ratio they should be using at least one of the correct sides, BD or CD. If you see a clear attempt to use the cosine rule, please use this ALT marking scheme. A special case is when the candidate has not made it clear which route they were intending to take - tan ratio (right angled triangle ratio) or cosine rule. If they have all lengths stated correctly, they could be awarded M1 M1 using either scheme.		
Further ALTS		If you see a valid method, leading to a fully correct exact value for $\tan ABC$, please award 4 marks. If the value for $\tan ABC$ is incorrect or approximate and there is some partially correct working, PLEASE SEND TO REVIEW. Allow angle ABC to be denoted by any letter.
		 For reference $BD = \sqrt{40} (= 2\sqrt{10}) \quad AD = \sqrt{10} \quad AB = \sqrt{90} = 3\sqrt{10} \quad BC = \sqrt{50} = 5\sqrt{2}$ $\sin ABC = \frac{\sqrt{5}}{5} \quad \cos ABC = \frac{2\sqrt{5}}{5}$



Question number	Scheme	Marks
2(a)	$\sqrt{(8-3)^2 + (3-2)^2}$ or $\sqrt{(4-3)^2 + (7-2)^2}$ or $\sqrt{(8-4)^2 + (3-7)^2}$ $AB = AC = \sqrt{26}$ hence isosceles	M1 A1*cso [2]
(b)	Midpoint $M = (6, 5)$ or gradient of $AM = 1$ e.g. $y - 2 = \left[\frac{5-2}{6-3} \right] (x-3)$ or $y - 2 = '1' \times (x-3) \Rightarrow y = x - 1$	B1 M1A1 [3]
(c)	Equation of AC $y - 2 = \left(\frac{7-2}{4-3} \right) (x-3) \Rightarrow [y = 5x - 13]$ ----- Gradient of AB $m = \frac{3-2}{8-3} \left[= \frac{1}{5} \right]$ Gradient of DB $m_p = -\frac{1}{'1/5'} [= -5]$ Equation of BD $y - 3 = -5(x-8) \Rightarrow [y = -5x + 43]$ $5x - 13 = '-5x + 43'$ $\Rightarrow x = \dots$ or $y = \dots$ $\left(\frac{56}{10}, 15 \right)$ oe	M1A1 M1 M1 M1A1 dM1 A1 [8]
ALT I (c) Last 6 marks	$D(x, '5x - 13')$ $BD^2 = (x-8)^2 + (5x-13-3)^2$ or $AD^2 = (x-3)^2 + (5x-13-2)^2$ $26 + (x-8)^2 + (5x-13-3)^2 = (x-3)^2 + (5x-13-2)^2$ $26 - 16x + 64 - 160x + 256 = -6x + 9 - 150x + 225 \Rightarrow x = \dots$ $\left(\frac{56}{10}, 15 \right)$ oe	M1 M1 M1A1 dM1 A1

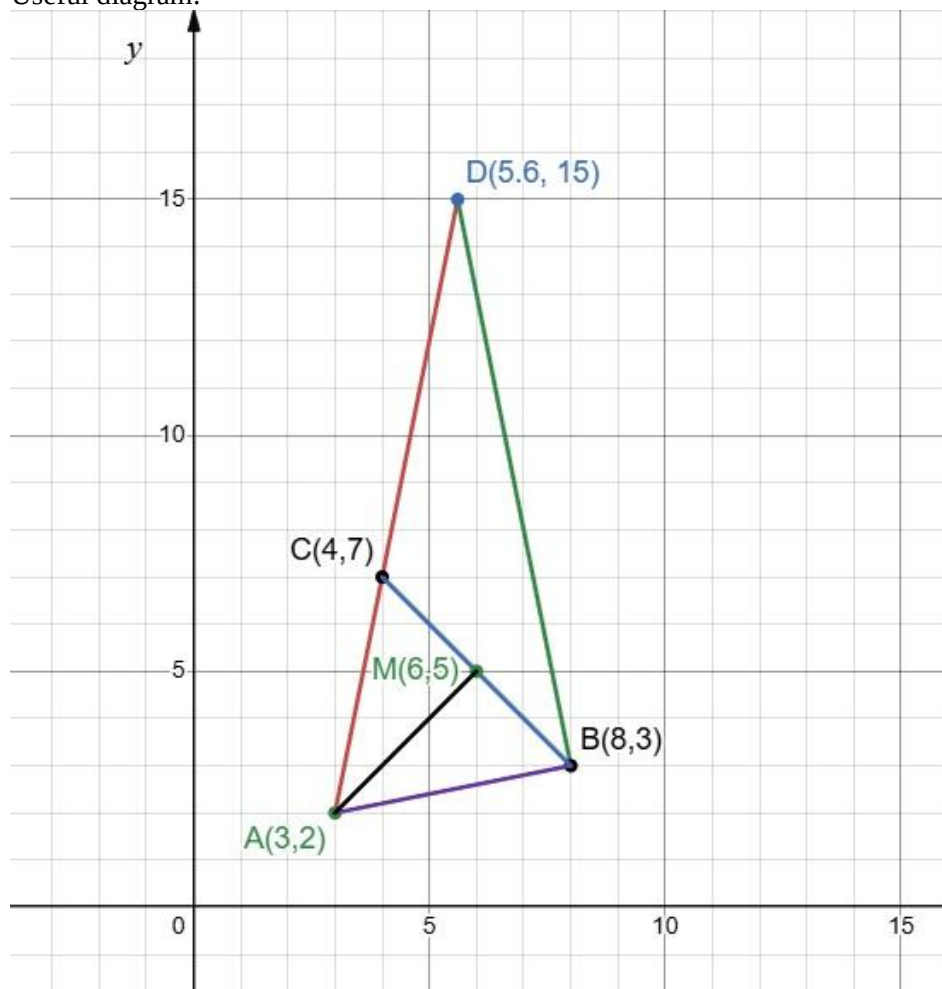
ALT II (c)	$y - 2 = \left(\frac{7-2}{4-3} \right) (x-3) \Rightarrow [y = 5x - 13]$ $\text{or } \overline{AC} = \begin{pmatrix} 1 \\ 5 \end{pmatrix} \text{ oe}$ $\left('4\sqrt{2}' \right)^2 = '\sqrt{26}'^2 + '\sqrt{26}'^2 - 2 \times '\sqrt{26}' \times '\sqrt{26}' \cos \angle BAC \Rightarrow \cos \angle BAC = \dots$ $\text{or } \sin \frac{\angle BAC}{2} = \frac{'2\sqrt{2}'}{'\sqrt{26}'}$ $\cos \angle BAC = \frac{5}{13} \text{ or } \angle BAC = 67.4(\text{awrt})$ $\frac{\sqrt{26}}{k\sqrt{26}} = \frac{5}{13} \text{ or } \cos 67.38\dots = \frac{\sqrt{26}}{k\sqrt{26}}$ $k = 2.6 \text{ exact}$ $3+1 \times '2.6' = \dots \text{ and } 2+5 \times '2.6' = \dots$ $\text{or } \sqrt{(x-3)^2 + ('5x-13'-2)^2} = '2.6\sqrt{26}' \Rightarrow x = \dots, y = \dots$ $(5.6, 15)$	M1A1 M1 M1 M1 A1 dM1 A1
Total 13 marks		

Part	Mark	Additional Guidance
(a)	M1	For correct use of Pythagoras' theorem to find the length / length ² of one of the sides. Must have a subtraction of x coordinates and a subtraction of y coordinates with appropriate substitution into Pythagoras' theorem. Or at least one correct vector for AC, AB, BC , or the other way around
	A1	For showing both AB and AC have length $=\sqrt{26}$ or length ² = 26 with conclusion that the triangle is isosceles. e.g. stating $AC=AB$ Correct vectors for AB and AC , followed by $ AC = AB $ oe Allow statements such as 'hence shown' or symbols to indicate conclusion of the demonstration such as QED, // or $\square$.
(b)	B1	For finding the midpoint M of line BC Or finds the correct gradient of $AM = 1$
	M1	For finding the equation of the line AM in any form using any correct valid method: e.g. $\begin{cases} 3m + c = 2 \\ '6'm + c = '5' \end{cases} \Rightarrow m = \dots, c = \dots \Rightarrow y = \dots$
	A1	For $y = x - 1$
(c)	M1	For correct method of finding the equation of line AC
	A1	For the correct equation of AC .
	M1	For attempting to find the gradient of AB
	M1	For negative reciprocal of their gradient AB
	M1	For attempting to find the equation of the line perpendicular to AB and passing through B , their gradient of BD might not be $-\frac{1}{m_{AB}}$, but must be a changed gradient
	A1	For the correct equation of BD .
	dM1	For attempting to solve their line BD and AC simultaneously. Minimum required for a correct method is to obtain an equation in either x or y (by elimination method or substitution method) and finds a value for x or y Dependent on the previous M mark only
	A1	For (5.6, 15) oe, accept given as $x = 5.6$ $y = 15$
ALT I (c) Last 6 marks	M1	Use the fact that D is on the line AC , sets up the coordinate of $D(x, '5x - 13')$ or $D(x, y)$ where y is replaced by their ' $5x - 13$ ' later
	M1	For correct attempt to find the length/length ² expression of BD or AD using $D(x, '5x - 13')$ or $D(x, y)$
	M1	For correct use of Pythagoras' theorem to set up equation $ AB ^2 + BD ^2 = AD ^2$ in terms of x only
	A1	Correct equation, simplified/ unsimplified
	dM1	For expanding and solving their equation to find $x = \dots$ Dependent on the previous M mark only
	A1	For (5.6, 15) oe accept given as $x = 5.6$ $y = 15$



ALT II (c)	M1	Correct method of finding the equation of line AC or Vector AC
	A1	Correct equation of AC or correct vector AC
	M1	Correct use of cosine rule or trigonometry to set up an equation involving angle BAC
	M1	Obtains a value of $\cos \angle BAC$ or $\angle BAC$ from a correct cosine rule or trigonometry equation
	M1	Correct equation in k
	A1	Correct k value, must be exact/rounded to 2.6
	dM1	Uses their k value to find $x = \dots$ and $y = \dots$ Dependent on the previous M mark only
	A1	Correct coordinates from an exact value of k found, not a rounded value

Useful diagram:



Question number	Scheme	Marks
6 (a)	$\frac{\text{Change in } y}{\text{Change in } x} = \frac{2-0}{2-3} = -2$ $2 = 1 + c$ $c = 1$ $x - 2y + 2 = 0$	M1 A1
(b)	$2y - 2 = 7y + 3$ $-5y = 5$ $y = -1$ When $y = -1$ $x = 2 \times -1 - 2 = -4$ So $C = (-4, -1)$	M1 A1 ft A1 (5) M1
(c)	$\left(\frac{3-4}{2}, \frac{0-1}{2}\right) = \left(-\frac{1}{2}, -\frac{1}{2}\right)$ $AB = \sqrt{5}$ $BC = \sqrt{45}$ $\text{Area} = \frac{1}{2} \times \sqrt{5} \times \sqrt{45} \times \frac{1}{2}$ 3.75 Alternative c $\pm \frac{1}{2} \begin{vmatrix} 3 & 0 & 1 \\ 2 & 2 & 1 \\ -4 & -1 & 1 \end{vmatrix}$ $\pm \frac{1}{2} \left[3 \begin{vmatrix} 2 & 1 \\ -1 & 1 \end{vmatrix} + 1 \begin{vmatrix} 2 & 2 \\ -4 & -1 \end{vmatrix} \right]$ $\pm \frac{1}{2} [3(2+1) + (-2+8)] \times \frac{1}{2}$ 3.75	M1A1 (5) M1 A1 M1 A1 (4) (14) M1 A1 M1 A1

Part	Mark	Additional Guidance
(a)	M1	For an attempt to find the gradient using the given coordinates and a correct attempt to find the perpendicular gradient. Accept either $\frac{2-0}{2-3} = (-2)$ or $\frac{0-2}{3-2} = (-2) \Rightarrow m_p = -\frac{1}{-2}$
	A1	For $m = \frac{1}{2}$
	dM1	For a correct method to find the equation of a line $y - 2 = \frac{1}{2}(x - 2)$ or $y - 0 = \frac{1}{2}(x - 3)$ The gradient must come from a correct attempt to find the gradient and the gradient of the perpendicular If $y = mx + c$ is used, then they must use the correct values of x and y and a value for c must be reached before this mark is awarded.
	A1	For the correct equation in any form $y - 2 = \frac{1}{2}(x - 2)$ or $y - 0 = \frac{1}{2}(x - 3)$ or $y = \frac{1}{2}x + 1$ oe

	A1	For the correct equation in the required form $x - 2y + 2 = 0$ oe arranged in any order but all one side (e.g. accept even $\frac{x}{2} - y + 1 = 0$)
(b)	M1	Sets $L_1 = L_2$ and attempts to solve for y or x
		$\begin{array}{l} 2y - 2 = 7y + 3 \\ -5y = 5 \Rightarrow y = \dots \end{array}$ $\frac{x+2}{2} = \frac{x-3}{7} \Rightarrow 7x+14 = 2x-6$ $5x = -20 \Rightarrow x = \dots$
	A1	$y = -1$ $x = -4$
	A1	$x = -4$ $y = -1$
	M1	For any correct method to find the coords of M using their values for C of x and y and the given coordinates of A (3, 0) $\left(\frac{3 + [-4]}{2}, \frac{0 + [-1]}{2} \right)$ This is a B mark in Epen
	A1	$\left(-\frac{1}{2}, -\frac{1}{2} \right)$ This is a B mark in Epen
(c)	M1	For attempting to find the length AB and BC $AB = \sqrt{(3-2)^2 + (0-2)^2} \text{ and } BC = \sqrt{(2-4)^2 + (2-1)^2}$ This is a B mark in Epen
	A1	For both $AB = \sqrt{5}$ and $BC = \sqrt{45}$ This is a B mark in Epen
	M1	$\frac{1}{2} (\sqrt{5} \times \sqrt{45}) \times \frac{1}{2}$ For using a correct method to find the area of the triangle using correct lengths. i.e. they must be using BC and AB
	A1	For $A = 3.75$
	ALT – using determinants	
	M1	For using a correct method with their coordinates for C in any order (it is a triangle), but they must start and finish with the same coordinates $A = \frac{1}{2} \begin{vmatrix} 3 & 2 & -\frac{1}{2} & 3 \\ 0 & 2 & -\frac{1}{2} & 0 \end{vmatrix}$ This is a B mark in Epen
	A1	For using the correct coordinates $A = \frac{1}{2} \begin{vmatrix} 3 & 2 & -\frac{1}{2} & 3 \\ 0 & 2 & -\frac{1}{2} & 0 \end{vmatrix}$ This is a B mark in Epen
	M1	For a correct evaluation using their coordinates $A = \frac{1}{2} \left(\left[3 \times 2 + 2 \times -\frac{1}{2} + -\frac{1}{2} \times 0 \right] - \left[2 \times 0 + -\frac{1}{2} \times 2 + 3 \times -\frac{1}{2} \right] \right) = \dots$



Question number	Scheme	Marks
9 (a)	$a = -1, b = -2$	B1,B1 [2]
(b)	Gradient of $l_1 = -2, \Rightarrow$ Gradient of $l_2 = \frac{1}{2}$ $180 = (x+1)^2 + (y-6)^2$ $\frac{1}{2} = \frac{y-6}{x+1} \Rightarrow x = 2y - 13$ Solves simultaneous equations; $180 = ([2y - 13] + 1)^2 + (y - 6)^2 \Rightarrow 0 = 5y^2 - 60y$ or $180 = (x+1)^2 + \left(\frac{1}{2}x + \frac{13}{2} - 6\right)^2 \Rightarrow 0 = x^2 + 2x - 143 = 0$ $y = 0, y = 12 \Rightarrow x = -13, x = 11 \quad \text{or} \quad x = -13, x = 11 \Rightarrow y = 0, y = 12$ Coordinates are $(-13, 0)$ and $(11, 12)$	B1,B1 M1 M1 M1M1 A1A1 [8]
(c)	Area of triangle PQR $PQ = \sqrt{(6+2)^2 + (-1-3)^2} = 4\sqrt{5}$ $\text{Area} = \frac{1}{2} \times 4\sqrt{5} \times 6\sqrt{5} = 60 \text{ (units)}^2$ ALT $\text{Area} = \frac{1}{2} \begin{vmatrix} -13 & -1 & 3 & -13 \\ 0 & 6 & -2 & 0 \end{vmatrix} = \frac{1}{2}(-78 + 2 + 0 - 0 - 18 - 26) = -60$ $\Rightarrow 60 \text{ (units)}^2$	M1 M1A1 [3] {M1} {M1} {A1} [3]
(d)	Coordinates of R required are $(-13, 0)$ $\angle RPQ = 90^\circ$ so RQ is a diameter $\left(\frac{-13+3}{2}, \frac{0-2}{2}\right) \Rightarrow (-5, -1)$	M1A1 [2]
Total 15 marks		
(a) B1 B1	$a = -1$ $b = -2$	

(b)	
B1	Gradient of $l_1 = -2$
B1	Gradient of $l_2 = \frac{1}{2}$
M1	Use of $PR = 6\sqrt{5}$ to obtain an equation
M1	Use of gradient of the perpendicular to obtain an equation
M1	Solves simultaneously
M1	Simplifies to $5y^2 - 60y = 0$ or $x^2 + 2x - 143 = 0$
A1	All 4 values identified 0, 12, -13, 11
A1	(11, 12) and (-13, 0) (must be paired correctly and if written as a coordinate then must be in the correct order)
(c)	
M1	$PQ = 4\sqrt{5}$
M1	Use of Area $= \frac{1}{2} \times PQ \times PR$
A1	60 (units) ²
ALT	
M1	Use of Area $= \frac{1}{2} \begin{pmatrix} -13 & -1 & 3 & -13 \\ 0 & 6 & -2 & 0 \end{pmatrix}$ ft R provided $e < 0$
M1	$\frac{1}{2}(-78 + 2 + 0 - 0 - 18 - 26)$ ft R provided $e < 0$
A1	60 (units) ²
(d)	
M1	$\left(\frac{-13+3}{2}, \frac{0-2}{2} \right)$ ft R provided $e < 0$
A1	(-5, -1)

Question number	Scheme	Marks
11 (a)	$\frac{y-5}{5-5} = \frac{x-7}{7-3} \quad [\Rightarrow y = x-2] \text{ oe}$	M1A1 [2]
(b)	$m_{BC} = \frac{5-1}{7-p} = \frac{4}{7-p}, m_{AC} = \frac{1-(-5)}{p-(-3)} = \frac{6}{p+3}$ $m_{BC} \times m_{AC} = -1 \Rightarrow \frac{4}{7-p} \times \frac{6}{p+3} = -1 \Rightarrow \frac{4}{7-p} = -\left(\frac{p+3}{6}\right)$ $\Rightarrow -24 = -p^2 + 4p + 21 \Rightarrow p^2 - 4p - 45 = 0$ $\Rightarrow (p-9)(p+5) = 0 \Rightarrow p = -5, (9)$	M1A1A1 M1 dM1 M1A1* [7]
(c)	Using formula; $\left(\frac{(7 \times -5) - (3 \times 7)}{7-3}, \frac{(7 \times 1) - (3 \times 5)}{7-3} \right) = (-14, -2)$	B1B1 [2]
(d) (i)	$AC = \sqrt{(1-[-5])^2 + (-5-[-3])^2} = \sqrt{40} = 2\sqrt{10}$	B1
(ii)	$BD = \sqrt{(7-[-14])^2 + (5-[-2])^2} = \sqrt{490} = 7\sqrt{10}$ $\text{Area} = \frac{1}{2} \times 2\sqrt{10} \times 7\sqrt{10} = 70 \text{ (units}^2\text{)}$	M1 M1A1 [4]
Total 15 marks		



Part	Mark	Notes
(a)	M1	For forming an equation of a straight line
	A1	Accept a correct line in any form following simplification of denominators; for example, accept $\frac{y-5}{10} = \frac{x-7}{10}$ or $y-5 = x-7$ or $y+5 = x+3$
(b)	M1	For attempting to find an expression for the gradient of <i>BC</i> or the gradient of <i>AC</i> $m_{BC} = \frac{5-1}{7-p}$ or $m_{AC} = \frac{1-(-5)}{p-(-3)}$ Accept maximum one slip in either expression for this mark.
	A1	For an expression for the gradient of <i>BC</i> or <i>AC</i> fully correct
	A1	For an expression for the gradient of <i>BC</i> and <i>AC</i> fully correct Need not be simplified in either case
	M1	For setting their gradient of <i>BC</i> = negative reciprocal of their gradient of <i>AC</i>
	dM1	For attempting to form a 3TQ in <i>p</i> : $[p^2 - 4p - 45 = 0]$ Dependent on the previous M mark.
	M1	For solving their 3TQ by any method. See General Guidance.
	A1*	For $p = -5$
(c)	B1	For either $x = -14$ or $y = -2$
	B1	Both coordinates correct $(-14, -2)$ given as coordinates only.
(d)(i)	B1	For the correct length of <i>AC</i> $[= 2\sqrt{10}]$
(ii)	M1	For the correct method to find length <i>BD</i> $[= 7\sqrt{10}]$ Ft their $x = -14$ or $y = -2$
	M1	For a correct method using $A = \frac{1}{2} \times \text{base} \times \text{height}$ using their <i>AC</i> and <i>BD</i>
	A1	For the correct area of 70 (units ²)
	ALT – Uses determinants	
	M1	For stating $A = \frac{1}{2} \begin{vmatrix} -3 & 7 & -14 & -3 \\ -5 & 5 & -2 & -5 \end{vmatrix}$ oe
	M1	For evaluating their determinant $A = \frac{1}{2} [(-3 \times 5 + 7 \times -2 + -14 \times -5) - [7 \times -5 + -14 \times 5 + -3 \times -2]]$ oe
	A1	Area = 70 (units ²) Which must be a positive value

Question number	Scheme	Marks
4 (a)	Gradient = $\frac{11+10}{3+4} = 3$ $y+10 = 3(x+4)$ or $y-11 = 3(x-3)$ oe	M1A1 (2)
(b)	e.g. $\left(\frac{4 \times -4 + 3 \times 3}{3+4}, \frac{4 \times -10 + 3 \times 11}{3+4}\right) = (-1, -1)$	M1 A1 (2)
ALT (b)	Using Vectors $\begin{pmatrix} -4 \\ -10 \end{pmatrix} + \frac{3}{7} \begin{pmatrix} 7 \\ 21 \end{pmatrix} = \begin{pmatrix} -1 \\ -1 \end{pmatrix}$ or $\begin{pmatrix} 3 \\ 11 \end{pmatrix} - \frac{4}{7} \begin{pmatrix} 7 \\ 21 \end{pmatrix} = \begin{pmatrix} -1 \\ -1 \end{pmatrix}$	{M1} {A1}
(c)	$-\frac{1}{3} = \frac{n+1}{m+1} \Rightarrow -\frac{1}{3}(m+1) = n+1$ $(\sqrt{10})^2 = (m+1)^2 + (n+1)^2$ $10 = (m+1)^2 + \frac{1}{9}(m+1)^2$ $9 = (m+1)^2$ $m = -4 \quad n = 0$	M1 M1 M1 M1 A1 A1 (6)
ALT (c)	Using Vectors $\vec{AB} = \begin{pmatrix} 7 \\ 21 \end{pmatrix}$ so perpendicular to $\vec{AB} = \begin{pmatrix} 21 \\ -7 \end{pmatrix}$ $ \vec{AB} = 7\sqrt{10} \Rightarrow \vec{AP} = 3\sqrt{10}$ $\vec{PQ} = \frac{\sqrt{10}}{7\sqrt{10}} \times \begin{pmatrix} 21 \\ -7 \end{pmatrix} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$ So $Q = (-1-3, -1-1)$ $Q = (-4, 0)$	{M1} {M1,M1} {M1} {A1} {A1}
(d)(i)	$AB = \sqrt{(3+4)^2 + (11+10)^2} = 7\sqrt{10}$ $RQ = \sqrt{(-11+4)^2 + (-21)^2} = 7\sqrt{10}$	M1 A1
(d)(ii)	Gradient of $RQ = \frac{-21-0}{-11+4} = 3$ So Gradient of $AB (=3) =$ Gradient of RQ	M1 A1 (4)

ALT (d)	Using Vectors $\vec{RQ} = \begin{pmatrix} -4 - (-11) \\ 0 - (-21) \end{pmatrix} = \begin{pmatrix} 7 \\ 21 \end{pmatrix}$ $\vec{AB} = \begin{pmatrix} 7 \\ 21 \end{pmatrix} = \vec{RQ}$ Because the vectors are the same they must be parallel and the same length	{M1} {A1}
(e)	Area = $7\sqrt{10} \times \sqrt{10} = 70$	M1 A1 (2)
ALT (e)	Using Vectors $\begin{array}{r rrrrr} 1 & 3 & -4 & -11 & -4 & 3 \\ \hline 2 & 11 & 10 & -21 & 0 & 11 \end{array}$ $= 70$	{M1} {A1}
Total is 16 marks		

Part	Mark	Guidance
(a)	M1	For a fully correct method of finding an equation of a straight line. $\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1} \Rightarrow \frac{y - (-10)}{11 - (-10)} = \frac{x - (-4)}{3 - (-4)}$ Or finds gradient $\frac{11+10}{3+4} = 3$ and uses $y + 10 = 3(x + 4)$ or $y - 11 = 3(x - 3)$ If $y = mx + c$ is used, they must find a complete equation for this mark. Allow one error only for the award of this mark.
	A1	For a correct line in any form. $y + 10 = 3(x + 4)$ or $y - 11 = 3(x - 3)$ or $y = 3x + 2$ or even $\frac{y+10}{21} = \frac{x+4}{7}$ but do not allow incomplete processing.
(b)	M1	For one correct from $x = -1$ or $y = -1$
	A1	For the correct coordinates of point P $(-1, -1)$ Accept $x = -1$ $y = -1$
(c)	M1	Uses the perpendicular gradient to set up an equation in m and n . $-\frac{1}{'3'} = \frac{n - '(-1)'}{m - '(-1)'} \Rightarrow -\frac{1}{'3'}(m + 1) = n + 1 \text{ or } n = -\frac{1}{3}m - \frac{4}{3}$ Ft their gradient in part (a) and their P from part (b) for this mark.
	M1	Uses Pythagoras theorem to set up an equation in m and n . $(\sqrt{10})^2 = (m - '(-1)')^2 + (n - '(-1)')^2$ Ft their coordinates of point P from part (b) for this mark.
	M1	Attempts to solve their two equations in n and m simultaneously and forms a quadratic equation in one variable only. $10 = (m + 1)^2 + \frac{1}{9}(m + 1)^2 \Rightarrow 9 = (m + 1)^2 \text{ or } 0 = m^2 + 2m - 8$ or $10 = 9(n + 1)^2 + (n + 1)^2 \Rightarrow 0 = 10n^2 + 20n$
	M1	For solving their either: $9 = (m + 1)^2 \Rightarrow m = \dots$ or $0 = 10n^2 + 20n \Rightarrow n = \dots$ which must be a quadratic equation.
	A1	For finding either $m = -4$ or $n = 0$ Condone the sight of $m = 2$ for this mark.
	A1	For finding both $m = -4$ and $n = 0 \Rightarrow (-4, 0)$ The final answer must be given as coordinates.
	ALT – using vectors – see main scheme.	
(d)(i)	M1	For finding either the length $AB = \sqrt{(3+4)^2 + (11+10)^2} = 7\sqrt{10}$ Or $RQ = \sqrt{(-11+4)^2 + (-21)^2} = 7\sqrt{10}$
	A1	For finding both the length $AB = \sqrt{(3+4)^2 + (11+10)^2} = 7\sqrt{10}$ And $RQ = \sqrt{(-11+4)^2 + (-21)^2} = 7\sqrt{10}$ and states they are equal
(d)(ii)	M1	The gradient of $RQ = \frac{-21 - '0'}{-11 - '(-4)'} = '3'$ Ft their coordinates from part (c)

Question	Scheme	Marks
8(a)	$\frac{y-5}{5-9} = \frac{x-1}{1-9}$ $\Rightarrow x-2y+9=0$	M1A1 A1 [3]
(b)	<u>Coordinates of point X</u> $\left(\frac{3 \times 9 + 1 \times 1}{3+1}, \frac{3 \times 9 + 1 \times 5}{3+1} \right) = (7, 8)$ The perpendicular gradient = $-\frac{1}{\frac{1}{2}} = -2$ Equation of l $y-8 = -2(x-7) \Rightarrow y = -2x + 22$ *	B1B1 B1ft M1A1 cso [5]
(c)	$y = -2(6) + 22 \Rightarrow p = 10$	B1 [1]
(d)	$\overrightarrow{BA} = \begin{pmatrix} 1-9 \\ 5-9 \end{pmatrix} = \begin{pmatrix} -8 \\ -4 \end{pmatrix} \Rightarrow \overrightarrow{CD} = \begin{pmatrix} 6-8 \\ 10-4 \end{pmatrix} = \begin{pmatrix} -2 \\ 6 \end{pmatrix}$ and coordinates of C are (6, 10) so coordinates of D are (-2, 6)	M1 A1A1 [3]
(e)	Length of AB (or CD) = $\sqrt{(9-5)^2 + (9-1)^2} = \sqrt{80}$ Length of CX = $\sqrt{(10-8)^2 + (7-6)^2} = \sqrt{5}$ Area of parallelogram $ABCD$ = $\sqrt{5} \times \sqrt{80} = \sqrt{400} = 20$ (units²)	B1 B1 M1A1 [4]
Total 16 marks		

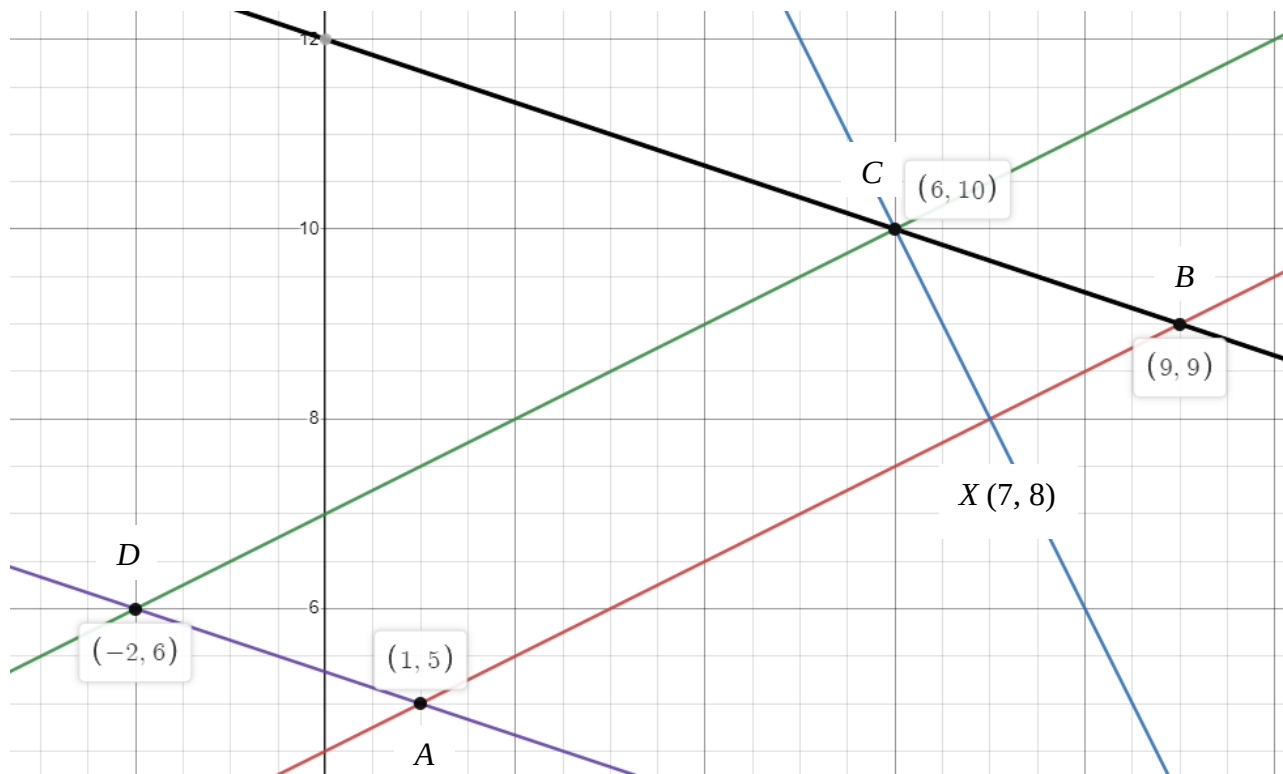
Part	Mark	Notes
(a)	M1	For using a correct method and the given coordinates of A and B to form the equation of AB . Do not score this mark until they find the gradient and form the equation of the line using a correct formula. If they use $y = mx + c$ do not allow this mark until they find c and form a complete equation. $\left[m = \frac{1}{2}, \quad c = \frac{9}{2} \quad y = \frac{x}{2} + \frac{9}{2} \right]$
	A1	For the correct equation of AB in any form.
	A1	For the correct equation of AB in the required form.



(b)	B1	For either x or y correct coordinates of point X NB This is an M mark in Epen
	B1	For both x and y correct coordinates of point X NB This is an A mark in Epen.
	B1ft	For writing down the inverse reciprocal of their gradient for AB Ft their gradient form part (a)
	M1	For forming an equation for l using their coordinates of X and their negative reciprocal gradient of AB $y - 8 = -2(x - 7) \Rightarrow y = -2x + 22$
	A1	For the correct equation of l as shown.
(c)	B1	For $y = 10$
(d)	M1	For a suitable method. Method 1 - Uses vectors: $\overrightarrow{BA} = \begin{pmatrix} 1-9 \\ 5-9 \end{pmatrix} = \begin{pmatrix} -8 \\ -4 \end{pmatrix} \Rightarrow \overrightarrow{CD} = \begin{pmatrix} 6+(-8) \\ 10+(-4) \end{pmatrix} \Rightarrow \begin{bmatrix} -2 \\ 6 \end{bmatrix}$ OR: $\overrightarrow{BC} = \begin{pmatrix} 6-9 \\ 9-10 \end{pmatrix} = \begin{pmatrix} -3 \\ -1 \end{pmatrix} \Rightarrow \overrightarrow{AD} = \begin{pmatrix} 1-3 \\ 5-(-1) \end{pmatrix} \Rightarrow \begin{bmatrix} -2 \\ 6 \end{bmatrix}$ Method 2 - Uses simultaneous equations: The equation of AD is $y = -\frac{x}{3} + \frac{16}{3}$ and of CD is $y = \frac{x}{2} + 7$ $-\frac{x}{3} + \frac{16}{3} = \frac{x}{2} + 7 \Rightarrow x = -2$ and $y = 6$ Method 3 - Uses the gradient and length of AB or CD $AB = CD = 4\sqrt{5} = \sqrt{(6-x)^2 + (y-10)^2}$ Gradient: $\frac{1}{2} = \frac{10-y}{6-x} \Rightarrow x = 2y - 14$ $(4\sqrt{5})^2 = (6 - (2y - 14))^2 + (y - 10)^2 \Rightarrow 5y^2 - 100y + 420 = 0$ $\Rightarrow y = 6, 14$ and $x = -2, 14$ Allow no more than one error in either method.
	A1	For either correct x or y coordinate of D $[(-2, 6)]$ NB this is an A mark in Epen
	A1	For both correct coordinates of D $(-2, 6)$

(e)	B1	For the correct length of either AB [CD] or CX These are given coordinates there is no ft
	B1	For the correct lengths of both AB [CD] and CX Ft their C and their X
	M1	For using a correct method to calculate the area of a parallelogram. $b \times h = CX \times AB = \sqrt{5} \times \sqrt{80} = \sqrt{400} = 20$ If their lengths are incorrect allow this mark provided their lengths are identified as base and perpendicular height. If they use AD as the base $[\sqrt{10}]$, the perpendicular height required is $2\sqrt{10}$ so base $\times$ height = $\sqrt{10} \times 2\sqrt{10} = \dots$
	A1	For the correct area of 20 [units ²]
	ALT – Using determinants	
	B1B1	For sight of the correct array which must use the coordinates of A, B, C and D ONLY . The coordinates (7, 8) seen in the array is B0B0 $\begin{pmatrix} 1 & 9 & '6' & '-2' & 1 \\ 5 & 9 & '10' & '6' & 5 \end{pmatrix}$ Award both marks for fully correct. Award B1 if there are no more than 2 errors but with none missing. There must be 5 sets of coordinates in the array with first and last the same. The coordinates must go in order around the parallelogram clockwise or anticlockwise.
	M1	For the correct evaluation of their 2×5 array. Allow this even if they have (7, 8) included instead of (9, 9) [which is a common error] $\frac{1}{2} \begin{pmatrix} 1 & 9 & 6 & -2 & 1 \\ 5 & 9 & 10 & 6 & 5 \end{pmatrix} = \frac{1}{2} [(9+90+36-10)-(45+54-20+6)] = \dots$
	A1	For the correct area of 20 [units ²]



Useful sketch

Question	Scheme	Marks
6 (a)	$p=1, q=8$	B1B1 [2]
(b)	$\left(\text{Gradient of } l = \frac{12-2}{3--2} = \right) 2$ (Gradient of the perpendicular $\Rightarrow -\frac{1}{"2"}$) Equation of k $y - "8" = -\frac{1}{2}(x - "1")$ $\Rightarrow 2y + x - 17 = 0 \quad *$	B1 B1ft M1 A1 cso [4]
(c)	When $y = 0$, $(2 \times 0 + x - 17 = 0 \Rightarrow) x = 17$ $(CD =) \sqrt{(0 - "8")^2 + ("17" - "1")^2} = \sqrt{320} = [8\sqrt{5}]$	B1 M1A1 [3]
(d)	(Length of $CX =) \frac{2 \times 80}{8\sqrt{5}} (= 4\sqrt{5})$ $("4\sqrt{5}")^2 = (m - "1")^2 + (n - "8")^2$ $"2" = \frac{n - "8"}{m - "1"} \Rightarrow [n = 2m + 6] \quad \text{oe or } y - 2 = "2"(x + 2) \Rightarrow [y = 2x + 6]$ or $y - 12 = "2"(x - 3) \Rightarrow [y = 2x + 6] \quad \text{oe}$ $\Rightarrow "80" = (m - "1")^2 + (2m + 6 - "8")^2 (\Rightarrow 0 = 5m^2 - 10m - 75 \text{ oe eg } 0 = m^2 - 2m - 15)$ $\Rightarrow (5m + 15)(m - 5) = 0 \text{ oe eg } (m + 3)(m - 5) = 0$ $m = 5, (-3)$ $n (= 2m + 6 = 2 \times 5 + 6) = 16$	B1 M1 M1 ddM1 M1 A1 A1 [7]
ALT1	(Length of $CX =) \frac{2 \times 80}{8\sqrt{5}} (= 4\sqrt{5})$ $(m - "17")^2 + (n)^2 = ("4\sqrt{5}")^2 + ("8\sqrt{5}")^2$ $"2" = \frac{n - "8"}{m - "1"} \Rightarrow [n = 2m + 6] \quad \text{oe or } y - 2 = "2"(x + 2) \Rightarrow [y = 2x + 6]$ or $y - 12 = "2"(x - 3) \Rightarrow [y = 2x + 6] \quad \text{oe}$ $\Rightarrow "400" = (m - "17")^2 + (2m + 6)^2 (\Rightarrow 0 = 5m^2 - 10m - 75 \text{ oe eg } 0 = m^2 - 2m - 15)$ $\Rightarrow (5m + 15)(m - 5) = 0 \text{ oe eg } (m + 3)(m - 5) = 0$ $m = 5, (-3)$ $n (= 2m + 6 = 2 \times 5 + 6) = 16$	B1 M1 M1 ddM1 M1 A1 A1 [7]



ALT2	(Length of $CX = \frac{2 \times 80}{8\sqrt{5}} (= 4\sqrt{5})$ Length of $AB = \sqrt{(12-2)^2 + (3--2)^2} (= 5\sqrt{5})$ Vector $\vec{AB} = \begin{bmatrix} 3--2 \\ 12-2 \end{bmatrix} (= 5 \begin{bmatrix} 1 \\ 2 \end{bmatrix})$ $(\vec{CX} = 4\sqrt{5} \Rightarrow \vec{CX} = 4 \begin{bmatrix} 1 \\ 2 \end{bmatrix} = \begin{bmatrix} 4 \\ 8 \end{bmatrix})$ $\Rightarrow$ Coordinates of X are $(1, 8) + (4, 8) = (5, 16)$ $(m = 5 \quad n = 16)$	B1 M1 M1 ddM1 M1A1 A1 [7]
ALT3	$\frac{1}{2} \begin{vmatrix} 17 & m & 1 & 17 \\ 0 & n & 8 & 0 \end{vmatrix}$ $\frac{1}{2} \begin{vmatrix} "17" & m & "1" & "17" \\ 0 & n & "8" & 0 \end{vmatrix} = 80 \Rightarrow \frac{1}{2} (17n + "8"m - ("136" + n)) = 80 (\Rightarrow 2n + m = 37)$ $"2" = \frac{n-8}{m-1} \Rightarrow [n = 2m + 6] \text{ oe or } y - 2 = "2"(x + 2) \Rightarrow [y = 2x + 6] \text{ oe}$ or $y - 12 = "2"(x - 3) \Rightarrow [y = 2x + 6] \text{ oe}$ $\frac{1}{2} \begin{vmatrix} "17" & m & "1" & "17" \\ 0 & "2m+6" & "8" & 0 \end{vmatrix} \text{ or } \frac{1}{2} (17("2m+6") + "8"m - ("136" + "2m+6")) = 80$ or $2("2m+6") + m = 37 \Rightarrow m =$ $m = 5, n = 16$	B1 M1 M1 ddM1 M1 A1A1 [7]
Total 16 marks		

Part	Mark	Notes
(a)	B1	For $p = 1$ OR $q = 8$ Allow anything that clearly implies these values eg (1, 8) or 1, 8
	B1	For $p = 1$ AND $q = 8$ Allow anything that clearly implies these values eg (1, 8) or 1, 8
(b)	B1	For the gradient of $l = 2$
	B1ft	For the gradient of $k = -\frac{1}{2}$. Ft their calculation of the gradient of l .
	M1	For the correct unsimplified equation for k , using their p and q and any changed gradient. If the candidate uses $y = mx + c$, a fully correct rearrangement to find c must be shown (this can be implied by a correct c for their equation) and concluded with the equation of the line written.
	A1 cso	For the equation of k in the required form. Minimum steps shown, no errors or omissions. This must from a correct p and q
Watch for methods using vectors. If the candidate arrives at the correct unsimplified equation with no obviously incorrect work, following vector work, allow B1 B1ft M1 and the final A1 if the equation is given in the correct form. (See example in Practice)		
(c)	B1	For the x coordinate of $D = 17$
	M1	For a correct method to find the length of CD using their p and q and their 17
	A1	For the correct length of $\sqrt{320}$ oe
(d)	B1	Any correct unsimplified calculation for CX
	M1	For correctly using Pythagoras to form an equation in terms of m and n or x and y . Follow through their CX (ie coming from correct calculation with their p , q , their point D).
	M1	For an unsimplified equation in terms of m and n or x and y correctly using the gradient of l . Follow through their gradient for l , their p and their q . Allow working in p , q or x , y . Note this work is sometimes being seen in (b). As long as it is used in part (d) , the equation found in (b) may be given credit.
	ddM1	For eliminating either m or n from either equation and forming a 3TQ. Allow errors in processing if an initial correct method following from 2 correct unsimplified equations to eliminate one of the variables is seen. Allow working in p , q or x , y . Dependent on both previous method marks. Note, the previous M mark is for the unsimplified equation, so if simplified incorrectly, this can be used here to gain this mark (general principle of marking).
	M1	For a minimally acceptable attempt to solve (see general guidance) their 3TQ. This mark can be implied from a correct value of $m = 5$. If the quadratic is not the correct quadratic, method must be shown.
	A1	For one of $m = 5$ or $n = 16$
	A1	For both $n = 16$ and $m = 5$
ALT1	First B, final 2 A marks – as main scheme	
	M1	For correctly using Pythagoras to form an equation in terms of m and n or x and y . Follow through their CX and CD (ie coming from correct calculation with their p , q , their point D).
	M1	For an unsimplified equation in terms of m and n or x and y correctly using the gradient of l . Follow through their gradient for l , their p and their q . Allow working in p , q or x , y . Note this work is sometimes being seen in (b). As long as it is used in part (d) , the equation found in (b) may be given credit.
	ddM1	For eliminating either m or n from either equation and forming a 3TQ. Allow errors in processing if an initial correct method following from 2 correct unsimplified equations to eliminate one of the variables is seen. Allow working in p , q or x , y . Dependent on both previous method marks. Note, the previous M mark is for the unsimplified equation, so if simplified incorrectly, this can be used here to gain this mark (general principle of marking).
	M1	For a minimally acceptable attempt to solve (see general guidance) their 3TQ. This mark can be implied from a correct value of $m = 5$. If the quadratic is not the correct quadratic, method must be shown.



ALT2	B1	Any correct unsimplified calculation for CX
	M1	Correct method to find the length of AB
	M1	Correct method to find vector AB
	ddM1	Correctly deduces the relationship between their vectors CX and AB Dependent on both previous method marks.
	M1	Correct method to find the coordinates of X using their vector work.
	A1	For one of $m = 5$ or $n = 16$
	A1	For both $n = 16$ and $m = 5$
ALT3	B1	For a fully correct array as shown oe
	M1	For placing their array (though ft their p and q and their “17”) = 80 and correctly multiplying out the discriminant to form an unsimplified equation in m and n
	M1	For an unsimplified equation in terms of m and n or x and y correctly using the gradient of l . Follow through their gradient for l , their p and their q . Allow working in p, q or x, y Note this work is sometimes being seen in (a). As long as it is used in part (d) , the equation found in (a) may be given credit.
	ddM1	For eliminating either m or n seen either in the array or in their equation formed. Allow errors in processing if an initial correct method following from 2 correct unsimplified equations to eliminate one of the variables is seen. Allow working in p, q or x, y Dependent on both previous method marks. Note, the previous M mark is for the unsimplified equation, so if simplified incorrectly, this can be used here to gain this mark (general principle of marking).
	M1	For solving their linear equation, allow one error in processing, leading to a value of m or n
	A1	For one of $m = 5$ or $n = 16$
	A1	For both $n = 16$ and $m = 5$
If a partial method is seen, with correct answers not from obvious incorrect working, marks may be given (general point of marking unless precluded from the mark scheme for a question). If a partial method is seen and marks cannot be fitted to the main or ALT schemes – send to review.		



Question number	Scheme	Marks
11 (a)	$\frac{y-6}{x-5} = \frac{6-3}{5--1} \Rightarrow 2y-12 = x-5$	M1A1 [2]
(b)	$\left(\frac{2 \times 5 + 1 \times -1}{2+1}, \frac{2 \times 6 + 1 \times 3}{3} \right) \Rightarrow (3, 5)^*$	M1A1 [2]
(a) M1 A1 (b) M1 A1	A fully correct method for finding the equation of a straight line e.g. $\frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$ $2y-12 = x-5$ oe Use of $\left(\frac{qx_1 + px_2}{p+q}, \frac{qy_1 + py_2}{p+q} \right)$ or $\begin{pmatrix} -1 \\ 3 \end{pmatrix} + \frac{2}{3} \times \begin{pmatrix} 6 \\ 3 \end{pmatrix}$ Obtains the given coordinates	

(c)	Gradient of perpendicular to $AB = -2$ $\frac{5-n}{3-m} = -2 \Rightarrow (11 = 2m + n)$ Radius = 5, so the length of $AC = 10$ $100 = (3-n)^2 + (-1-m)^2 \Rightarrow (90 = n^2 - 6n + m^2 + 2m)$ Solves simultaneous equations $90 = 121 - 44m + 4m^2 - 6(11 - 2m) + m^2 + 2m$ $35 = 5m^2 - 30m \Rightarrow m^2 - 6m - 7 = 0$ $(m-7)(m+1) = 0 \Rightarrow m = 7, n = -3$	B1 M1 M1 depM1 depM1 A1 [6]
ALT (c) using vectors		
(c)	$\overrightarrow{AB} = \begin{pmatrix} 5 \\ 6 \end{pmatrix} - \begin{pmatrix} -1 \\ 3 \end{pmatrix} = \begin{pmatrix} 6 \\ 3 \end{pmatrix} \Rightarrow \text{Perpendicular vector to } \overrightarrow{AB} = \begin{pmatrix} 3 \\ -6 \end{pmatrix}$ $ \overrightarrow{AB} = \sqrt{45} = 3\sqrt{5} \Rightarrow \overrightarrow{AP} = 2\sqrt{5} \quad \overrightarrow{AC} = 10$ Using Pythagoras $\overrightarrow{PC} = \sqrt{100 - 20} = \sqrt{80} = 4\sqrt{5}$ $\overrightarrow{PC} = \frac{4\sqrt{5}}{3\sqrt{5}} \times \begin{pmatrix} 3 \\ -6 \end{pmatrix} = \begin{pmatrix} 4 \\ -8 \end{pmatrix}$ $\Rightarrow$ Coordinates of C are $(3 + (4), 5 + (-8)) \Rightarrow (7, -3)$	B1 M1M1 depM1 depM1 A1 [6]
(c) B1 M1 M1 depM1 depM1 A1 ALT: B1 M1 M1 depM1 depM1 A1	Gradient of perpendicular to $AB = -2$ (Can be implied by M1) Obtains an equation using the gradient of the perpendicular and the points (m, n) and P (Condone if given in terms of x and y) Obtains a second equation using $AC = 10$ and the points A and C Solve simultaneously to obtain a 3 term quadratic Solve their 3 term quadratic $m = 7, n = -3$ Perpendicular vector to $\overrightarrow{AB} = \begin{pmatrix} 3 \\ -6 \end{pmatrix}$ Finds $\overrightarrow{AB}$ or $\overrightarrow{AP}$ or $\overrightarrow{PC} = \begin{pmatrix} 3 \\ 5 \end{pmatrix} + \lambda \begin{pmatrix} 3 \\ -6 \end{pmatrix}$ States $\overrightarrow{AC} = 10$ or $\lambda = \frac{4}{3}$ Use of Pythagoras to find $\overrightarrow{PC}$ or $\overrightarrow{PC} = \begin{pmatrix} 3 \\ 5 \end{pmatrix} + \frac{4}{3} \times \begin{pmatrix} 3 \\ -6 \end{pmatrix}$ Finds $\overrightarrow{PC}$ $m = 7, n = -3$	

(d)	$\frac{y-3}{x-7} = \frac{1}{2} \Rightarrow \left\{ y = \frac{x-13}{2} \right\}, \quad \frac{y-3}{x-1} = -2 \Rightarrow \{y = -2x+1\}$ Solving simultaneous equations by any method $\frac{x-13}{2} = -2x+1 \Rightarrow p = 3 \text{ and } q = -5$	M1 M1A1 [3]
ALT (d) using vectors		
(d)	$\overrightarrow{AD} = \overrightarrow{PC} = \begin{pmatrix} 4 \\ -8 \end{pmatrix}$ Coordinates of point D $\Rightarrow (-1+(4), 3+(-8)) = (3, -5)$	M1 M1A1 [3]
(e)	Length of AB $\sqrt{(6-3)^2 + (5-(-1))^2} = 3\sqrt{5}$ Length of CD $\sqrt{(-3-(-5))^2 + (7-3)^2} = \sqrt{20} = 2\sqrt{5}$ Area of trapezium $= \frac{1}{2}(3\sqrt{5} + 2\sqrt{5}) \times 4\sqrt{5} = 50 \text{ (units}^2\text{)}$	M1 A1 M1A1 [4]
ALT (e) using vectors		
	$\text{Area} = \frac{1}{2} \begin{vmatrix} -1 & 5 & 7 & 3 & -1 \\ 3 & 6 & -3 & -5 & 3 \end{vmatrix}$ $= \frac{1}{2} [(-6-15-35+9)-(15+42-9+5)] = 50$	M1A1 M1A1 [4]
Total 17 marks		
(d) M1 M1 A1 ALT: M1 M1 A1 (e) M1 A1 M1 A1 ALT: M1 A1 M1 A1	Obtains a linear equation using the given information Obtains a 2nd linear equation using the given information and solves simultaneously $p = 3$ and $q = -5$ NB A correct answer, no incorrect working scores 3 out of 3 Use $\overrightarrow{AD} = \overrightarrow{PC}$ Substitution of the point $(-1, 3)$ to find the coordinates of point D $p = 3$ and $q = -5$ Use Pythagoras to find either the length of AB or CD Both lengths correct Use of area of trapezium formula using their lengths 50 (units not required) Use of Area $= \frac{1}{2} \begin{vmatrix} a & c & e & g & a \\ b & d & f & h & b \end{vmatrix}$ with the coordinates of A, B, C and D Area $= \frac{1}{2} \begin{vmatrix} -1 & 5 & 7 & 3 & -1 \\ 3 & 6 & -3 & -5 & 3 \end{vmatrix}$ Attempt to evaluate the Area 50 (units not required)	

Question	Scheme	Marks
10 (a)	For the correct value of $a = 10$	B1 [1]
(b)	Gradient of line L_2 $m = -\frac{1}{2}$ $y - '10' = -\frac{1}{2}(x - 2)$ $y - 10 = -\frac{1}{2}(x - 2)$ oe $x + 2y - 22 = 0$ *	B1 M1 A1 A1 cso [4]
(c)	Coordinates of point A are $(-3, 0)$ Coordinates of point B are $(22, 0)$ Length of AC $(5\sqrt{2})^2 = (m - ' - 3')^2 + n^2$ [$\Rightarrow 50 = m^2 + 6m + 9 + n^2$] Gradient of BC $\frac{1}{4} = \frac{n}{m - '22'} \Rightarrow n = \frac{m - '22'}{4} \Rightarrow n^2 = \frac{m^2 - 44m + 484}{16}$ $50 = m^2 + 6m + 9 + \frac{m^2 - 44m + 484}{16}$ [or $50 = (22 + 4n)^2 + 6(22 + 4n) + 9 + n^2$] $17m^2 + 52m - 172 = 0$ OR $17n^2 + 200n + 575 = 0$ e.g. $m = \frac{-52 \pm \sqrt{52^2 - 4 \times 17 \times -172}}{2 \times 17} \Rightarrow m = 2, (-5.058...)$ $m = 2$ and $n = -5$	B1 B1 M1 M1 ddM1 A1 M1 A1A1 [9]
(d)	$\text{Area}_{APB} = \frac{1}{2}('10') \times ('22' - ' - 3') = (125)$ $\text{Area}_{ABC} = \frac{1}{2}('5') \times ('22' - ' - 3') = \left(\frac{125}{2}\right)$ $\text{Area of quadrilateral ACBP} = \frac{375}{2} \text{ (units)}^2$	M1 A1 A1 [3]
	ALT	
	$\text{Area}_{ACBP} = \frac{1}{2}('25') \times ('15') = ..$ $\text{Area of quadrilateral ACBP} = \frac{375}{2} \text{ (units)}^2$	[M1A1 A1]
	ALT	

	$A = \frac{1}{2} \begin{bmatrix} -3' & 2 & '22' & '2' & '-3' \\ 0 & '10' & 0 & '-5' & '0' \end{bmatrix}$	[M1]
	$A = \frac{1}{2} \left([(-3) \times 10 + 2 \times 0 + 22 \times (-5) + 2 \times 0] - [2 \times 0 + 22 \times 10 + 2 \times 0 + (-3) \times -5] \right) = \dots$	A1
	$\text{Area of quadrilateral } APBC = \frac{375}{2} \text{ (units)}^2$	A1]
Total 17 marks		

Part	Mark	Notes
(a)	B1	For the correct value of $a = 10$. Accept embedded i.e. $P = (2, 10)$
(b)	B1	For the correct gradient of line L_2 $m = -\frac{1}{2}$
	M1	For a correct attempt at the equation of line L_2 using their gradient and their value for a $y - '10' = -\frac{1}{2}(x - 2)$
	A1	For the correct equation in any form $y - 10 = -\frac{1}{2}(x - 4)$ oe
	A1 cs0	For the correct equation in the required form $x + 2y - 22 = 0$ * [Accept for example $22 - x - 2y = 0$ provided all terms on one side]
(c)	B1	Coordinates of point A are $(-3, 0)$
	B1	Coordinates of point B are $(22, 0)$
	M1	Length of AC $(5\sqrt{2})^2 = (m - '-3')^2 + n^2$ [$\Rightarrow 50 = m^2 + 6m + 9 + n^2$] Allow use of $'-3'$ provided this is an x-intercept i.e. $(-3, 0)$
	M1	Gradient of BC $\frac{1}{4} = \frac{n}{m - '22'}$ [$\Rightarrow n = \frac{m - '22'}{4} \Rightarrow n^2 = \frac{m^2 - 44m + 484}{16}$] Allow use of $'22'$ provided this is an x-intercept i.e. $(22, 0)$
	ddM1	For attempting to form an equation in m e.g. $50 = m^2 + 6m + 9 + \frac{m^2 - 44m + 484}{16}$
		OR, For attempting to form an equation in n e.g. $50 = (22 + 4n)^2 + 6(22 + 4n) + 9 + n^2$
	A1	For the correct 3TQ in either m or n $17m^2 + 52m - 172 = 0$ OR $17n^2 + 200n + 575 = 0$
	M1	For attempting to solve their 3TQ to find a value for m or n by any valid method e.g. $m = \frac{-52 \pm \sqrt{52^2 - 4 \times 17 \times -172}}{2 \times 17} \Rightarrow m = 2, (-5.058\dots)$ If a calculator is used with the incorrect 3TQ award only with a full method seen.
	A1	For the value of m or n $m = 2$ or $n = -5$ If a second value for m or n is seen then condone for this mark.
	A1	For the value of m and n $m = 2$ and $n = -5$

		Any other values of m and n must be rejected.
(d)	M1	For either area of triangle APB or ABC $\text{Area}_{APB} = \frac{1}{2}('10') \times ('22' - '-3') = (125) \quad \text{or} \quad \text{Area}_{ABC} = \frac{1}{2}('5') \times ('22' - '-3') = \left(\frac{125}{2}\right)$
	A1	Either area of triangle APB or ABC correct
	A1	Area of quadrilateral $ACBP = \frac{375}{2}$ (units) ²
ALT		
	M1A1	$\text{Area}_{ACBP} = \frac{1}{2}('25') \times ('15') = \dots$
	A1	Area of quadrilateral $ACBP = \frac{375}{2}$ (units) ²
ALT – determinant method		
	M1	For using the ‘determinant method’ e.g. $A = \frac{1}{2} \begin{vmatrix} '-3' & 2 & '22' & '2' & '-3' \\ 0 & '10' & 0 & '-5' & '0' \end{vmatrix}$
	A1	For a correct evaluation of their determinants using their values e.g. $A = \frac{1}{2} \left([(-3) \times 10 + 2 \times 0 + 22 \times (-5) + 2 \times 0] - [2 \times 0 + 22 \times 10 + 2 \times 0 + (-3) \times -5] \right) = \dots$
	A1	Area of quadrilateral $APBC = \frac{375}{2}$ (units) ²



Question number	Scheme	Marks
11 (a)	$b = 33$ $\left(\left(\frac{3 \times 0 + 2 \times 10}{5}, \frac{3 \times 3 + 2 \times 33}{5} \right) \right) = (4, 15)$ ALT Identifies the correct x coordinate of $x = 4$ using any method. $y = 3 \times '4' + 3 = \dots \Rightarrow y = 15$ For the gradient of line k $m = -\frac{1}{"3"}$ $y - "15" = -\frac{1}{"3"}(x - "4")$ $3y + x - 49 = 0^*$ cso	B1 B1 B1 B1 B1B1 M1 dM1 A1* cso [6]
(b)	$A = (0, 3)$ $-\frac{1}{"3"} = \frac{q - "3"}{p(-0)} (\Rightarrow p = -"3"(q - "3"))$ alt $y = -\frac{1}{3}x + 3 \Rightarrow q = -\frac{p}{3} + 3$ OR $p^2 + (q - "3")^2 = 1440$ Equation in q $10q^2 - 60q + 90 = 1440 \Rightarrow q^2 - 6q - 135 = 0$ oe $10(q - 3)^2 = 1440$ or $q^2 - 6q - 135 = 0$ Equation in p $1440 = p^2 + \left(3 - 3 - \frac{p}{3}\right)^2 \Rightarrow 1440 = \frac{10p^2}{9}$ And attempting to solve by any valid method, reaching a value for p $q - 3 = \pm\sqrt{144}$ or $(q - 15)(q + 9)$ or $\frac{- -6 \pm \sqrt{(-6)^2 - 4.(1).(-135)}}{2 \times 1}$ $q = 15, p = -36$ ALT $A = (0, 3)$ $a\sqrt{(-3)^2 + 1^2} (=12\sqrt{10})$ $\Rightarrow a = (12)$ $p = 0 - 3 \times "12"$ $q = 3 + 1 \times "12"$ $p = -36$ and $q = 15$ or D is $(-36, 15)$	B1 M1 dM1 ddM1 A1 A1 [6] [B1 M1 dM1 dM1 A1 A1]



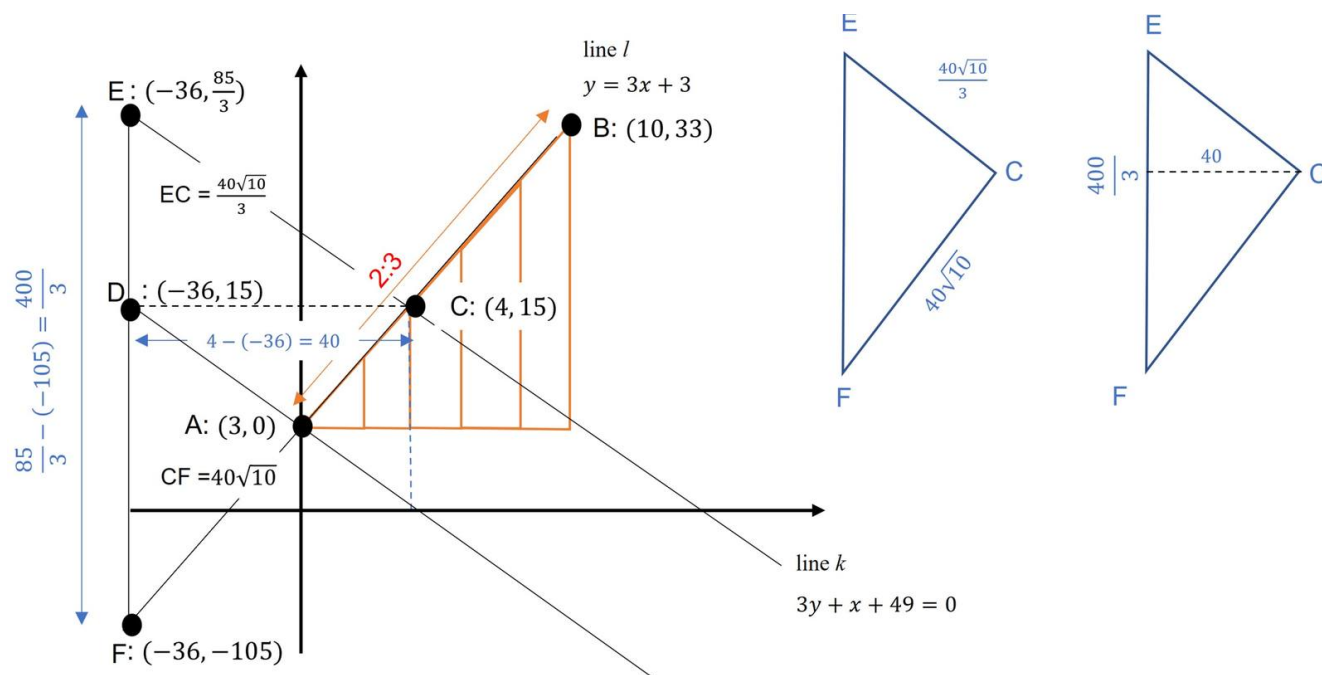
(c)	Finding the coordinates of points <i>E</i> and <i>F</i> (Finding <i>E</i> $x = -36$ $3y + x - 49 = 0$) $3y + (-36) - 49 = 0 \left(y = \frac{85}{3} \right)$ (Finding <i>F</i> $x = -36$ $y - 3x = 3$) $y - 3(-36) = 3 \quad (y = -105)$ Find the area of triangle <i>ECF</i> Method 1 $(CE =) \sqrt{("4" - "-36")^2 + \left(" \frac{85}{3}" - "15" \right)^2} = \left(\frac{40\sqrt{10}}{3} \right)$ Or $(CF =) \sqrt{("4" - "-36")^2 + ("15" - "-105")^2} = (40\sqrt{10})$ $(\text{Area triangle } ECF =) \frac{1}{2} \times \frac{40\sqrt{10}}{3} \times 40\sqrt{10} = \frac{8000}{3} \quad \text{oe}$	M1 M1 M1 M1A1 [5]
	Method 2 $\text{Area} = \frac{1}{2} \begin{vmatrix} "-36" & "4" & "-36" & "-36" \\ " \frac{85}{3}" & "15" & "-105" & " \frac{85}{3}" \end{vmatrix} \quad \text{oe}$ $\frac{1}{2} \left(\begin{vmatrix} "-36" \times "15" + "4" \times "-105" + "-36" \times " \frac{85}{3}" \\ - \left["-36" \times "-105" + "-36" \times "15" + "+4" \times " \frac{85}{3}" \right] \end{vmatrix} \right) = \left(\frac{10060}{3} - [-1980] \right) = \frac{8000}{3} \quad \text{oe}$	M1 M1A1
	Method 3 Finds the lengths: $DC = 4 - (-36) = 40$ and $EF = \frac{85}{3} - (-105) = \frac{400}{3}$ $\text{Area} = \frac{1}{2} \times 40 \times \frac{400}{3} = \frac{8000}{3} \quad \text{oe}$	M1 M1A1
	Total 17 marks	

Part	Mark	Additional Guidance
(a)	B1	Correct value of b . This may be embedded in a coordinate of $B(10, 33)$
	B1	For either $x = 4$ or $y = 15$
	B1	For $(4, 15)$ or both $x = 4$ and $y = 15$
	ALT (Without finding the value of b)	
	B1	For $x = 4$ [by any method]
	B1	Substitutes their value of $x = 4$ into the given equation of l $y = 3 \times 4 + 3 = \dots$
	B1	For $y = 15$
	M1	For identification of a gradient from the equation of l and use of $m = -\frac{1}{3}$
	dM1	For the correct use of any form of the equation of a line, if using $y = mx + c$, must reach $c = \dots$ Note that $c = \frac{49}{3}$ Use of their $(4, 15)$ which must have come from an attempt to find the midpoint of AB and their m . Note: Dependent upon the previous method mark.
(b)	A1	$3y + x - 49 = 0$ accept terms on one side in any order. Cso Note: This equation is given. Award this and the previous mark that has come from work without any errors or omissions.
	B1	Identifies the y intercept of line l $(0, 3)$. This can be implied by later correct work or accept seen in part (a) Look for this coordinate written on a sketch if it is not in the body of the work.
	M1	Equates $-\frac{1}{3}$ to a correct expression for the gradient in terms of p and q , using their values of $(0, 3)$ for the y intercept. OR for correct use of Pythagoras for the length of AD to form an equation in p and q , using their value of $(0, 3)$ for the y intercept.
	dM1	For forming a quadratic equation in either p or q which must come from using their expression for the gradient and the length. This is dependent on the first M mark in (b)
	ddM1	For solving their quadratic equation by any acceptable method. This is dependent on the previous two M marks in (b)
	A1	For a correct p or q .
	A1	For a correct p and q .
	ALT	
	B1	Identifies the y intercept of line l $(0, 3)$ This can be implied by later correct work or accept seen in part (a) Look for this coordinate written on a sketch if it is not in the body of the work.
	M1	Uses a correct method, scaling the gradient of $-\frac{1}{3}$ Must arrive at a scaling value (shown as a in the mark scheme), but it may not be the correct value. This mark may be implicit in work that follows.
	dM1	Uses their scaling factor, with the coordinates of A , to find a value for p or q This is dependent on the first M mark in (b)
	dM1	Uses their scaling factor, with the coordinates of A , to find a value for p and q This is dependent on the first M mark in (b)
	A1	First A1 for p or q
	A1	Second A1 for p and q
(c)	M1	Substitutes their value for -36 into the equation for line k to find the y coordinate of point E
	M1	Substitutes their value for -36 into the equation for line l to find the y coordinate of point F



Method 1	
M1	Uses Pythagoras with their values to find the length of CE and CF correctly.
M1	Correct method to find the area of the triangle, using their values.
A1	For $\frac{8000}{3}$ oe
Method 2	
M1	For a correct array using their values.
M1	Correct calculation shown, using their values, takes the modulus and multiplies by $\frac{1}{2}$
A1	$\frac{8000}{3}$ oe
Method 3	
M1	For finding the lengths DC and EF correctly using their values.
M1	Applies the correct formula for the area of a triangle using their values.
A1	For $\frac{8000}{3}$ oe

USEFUL SKETCH



Question	Scheme	Marks
8(a)	$(\text{Grad}_{AB}) = \frac{2-8}{12-(-6)} \quad \text{oe}$ $y-2 = \left(-\frac{1}{3}\right)(x-12) \quad \text{oe}$ $\Rightarrow x+3y-18=0 \quad \text{or} \quad -x-3y+18=0 \quad \text{oe}$	M1 dM1 (A1 on ePen) A1 [3]
(b)	$\text{Length} = \sqrt{(12-(-6))^2 + (2-8)^2} = 6\sqrt{10} \quad \text{eg} \quad \sqrt{360} \quad \text{oe}$	M1A1 [2]
(c)	$\left(\left(\frac{2 \times -6 + 1 \times 12}{1+2}, \frac{2 \times 8 + 1 \times 2}{1+2}\right)\right)$ $(0, 6) \text{ or } m=0, n=6$	B1 B1 (M1A1 on ePen) [2]
(d) Mark parts (i) and (ii) together	$\text{Gradient of } CA = \frac{q-8}{p+6} \quad \text{or} \quad \text{gradient of } CB = \frac{q-2}{p-12} \quad \text{oe}$ $\frac{q-8}{p+6} = -\frac{1}{\frac{q-2}{p-12}} = -\left(\frac{p-12}{q-2}\right) \Rightarrow q^2 - 10q + 16 = -p^2 + 6p + 72$ $\text{Gradient of } XC = -\frac{1}{\frac{1}{3}} \Rightarrow -\frac{1}{\frac{1}{3}} = \frac{q-6}{p-0} (\Rightarrow q = 3p+6)$ $(3p+6)^2 - 10(3p+6) + 16 = -p^2 + 6p + 72 \Rightarrow 10p^2 - 80 = 0$ $10p^2 - 80 = 0 \Rightarrow p = \sqrt{8} \quad \text{oe} \quad q = 3 \times \sqrt{8} + 6 = 6 + 6\sqrt{2} \quad \text{oe}$	M1 M1 B1ft ddM1A1 M1A1 [7]
ALT1 Mark parts (i) and (ii) together	$(\text{midpoint of } AB) = \left(\frac{-6+12}{2}, \frac{8+2}{2}\right) (= (3, 5))$ $(\text{radius of } C) = \frac{6\sqrt{10}}{2} \quad \text{oe}$ $\text{or } \sqrt{(-6-3)^2 + (8-5)^2} \quad \text{oe}$ $y = \frac{-1}{\frac{1}{3}}x + 6 \quad (y = 3x+6) \quad \text{oe}$ $(x-3)^2 + (y-5)^2 = \left(\frac{6\sqrt{10}}{2}\right)^2 \Rightarrow (x-3)^2 + (3x+6-5)^2 = \left(\frac{6\sqrt{10}}{2}\right)^2$ $10x^2 = 80 \quad \text{oe}$ $x = \sqrt{8} \quad \text{oe}$ $p = \sqrt{8}, q = 6 + 3\sqrt{8} \quad \text{oe}$	M1 M1 B1ft ddM1 A1 M1 A1 [7]



ALT2 Mark parts (i) and (ii) together	$\left((AC)^2 = (p-6)^2 + (q-8)^2 \text{ or } (AC = \sqrt{(p-6)^2 + (q-8)^2} \text{ oe}\right.$ $\left((BC)^2 = (p-12)^2 + (q-2)^2 \text{ or } (BC = \sqrt{(p-12)^2 + (q-2)^2} \text{ oe}\right.$ $q = 3p + 6$ $\left((AB)^2 = (AC)^2 + (BC)^2\right)$ $\left(6\sqrt{10}\right)^2 = (p-6)^2 + (3p+6-8)^2 + (p-12)^2 + (3p+6-2)^2$ $10p^2 = 80 \quad \text{oe}$ $p = \sqrt{8} \quad \text{oe}$ $p = \sqrt{8}, q = 6 + 3\sqrt{8} \quad \text{oe}$	M1 M1 B1ft ddM1A1 M1 A1 [7]
(e)	$\text{Length } CX = \sqrt{(\sqrt{8}-0)^2 + (6+6\sqrt{2}-6)^2} (=4\sqrt{5})$ $\text{Area of triangle } ABC = \frac{1}{2} \times 4\sqrt{5} \times 6\sqrt{10} = 60\sqrt{2} \quad \text{oe}$	M1 dM1 A1 [3]
ALT	$\frac{1}{2} \begin{vmatrix} -6 & 12 & \sqrt{8} & -6 \\ 8 & 2 & 6+3\sqrt{8} & 8 \end{vmatrix} \quad \text{oe}$ $\frac{1}{2} \left[(-6 \times 2 + 12 \times (6+3\sqrt{8}) + \sqrt{8} \times 8) - (-6 \times (6+3\sqrt{8}) + \sqrt{8} \times 2 + 12 \times 8) \right] \text{ oe}$ $60\sqrt{2} \quad \text{oe}$	M1 dM1 A1 [3]
Total 17 marks		

Part	Mark	Notes
(a)	M1	For correctly finding the gradient of AB in unsimplified form.
	dM1 (A1 on ePen)	For a full and correct attempt to find the equation of the line using their gradient. No simplification is required. If using $y = mx + c$, a value for c must be found.
	A1	For a correct equation in the required form.
(b)	M1	For using a correct method to find the length of line segment AB , in unsimplified form.
	A1	For the correct exact length.
(c)	B1 (M1 on ePen)	For either coordinate correct.
	B1 (A1 on ePen)	For both correct coordinates (0, 6) For part c the values of m and n can be explicitly identified or written in a coordinate.
In part (d) allow p to be interchangeable with x, q to be interchangeable with y throughout		
(d)	M1	For a correct statement of the gradient for either CA or CB
	M1	For using the negative perpendicular of either gradient and equating the gradients to form an equation in terms of p and q only.
	B1ft	For finding the negative reciprocal of their gradient of XC and placing this equal to a correct expression in p and q as shown.
	ddM1	For correctly substituting their linear expression for p or q into a quadratic equation in q or p to obtain an equation in one variable. Must use their $q = 3p + 6$ and is dependent on both previous method marks.
	A1	For the correct two term quadratic..
	M1	For correctly solving their quadratic to find a value for either p or q
	A1	For both p and q correct.
ALT1 (d)	M1	For the correct method to find the midpoint of AB
	M1	For the correct method to find the radius of C , ft their answer from part b if used.
	B1ft	For the equation of the line, unsimplified, ft their gradient of AB
	ddM1	For correctly substituting their $y = 3x + 6$ into the equation of a circle, using their midpoint of AB and their radius of C Must use their $y = 3x + 6$ and is dependent on both previous method marks.
	A1	Correct equation
	M1	For correctly solving their quadratic to find a value for either x or y
	A1	For both p and q correct.
ALT2 (d)	M1	For the correct method to find the length of AC or $(AC)^2$
	M1	For the correct method to find the length of BC or $(BC)^2$
	B1ft	For the equation of the line, unsimplified, ft their gradient of AB
	ddM1	For correctly substituting their lengths and their $q = 3p + 6$ into a correct Pythagorean equation, dependent on both previous method marks.
	A1	Correct equation
	M1	For correctly solving their quadratic to find a value for either p or q
	A1	For both p and q correct.



(e)	M1	For using a correct method to find the length of the perpendicular from AB to C
	dM1	For using their results from part (b) and their length of perpendicular from AB to C with the correct formula for the area of a triangle. Dependent on previous method mark.
	A1	For the correct area of $60\sqrt{2}$ or $30\sqrt{8}$ (units ²)
ALT	M1	For a correct statement for the area such as the one shown, using their values of p and q
	dM1	For the correct evaluation of their determinant Dependent on previous method mark.
	A1	For the correct area of $60\sqrt{2}$ or $30\sqrt{8}$ (units ²)

Useful Sketch for Parts c/d – look for any working on or near a sketch.

