Write your name, centre number and candidate number in the boxes below.

Surname	Other names

Centre number | | | | | |

Candidate number | | | | |

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Straight-line graphs

Time allowed: 2 hours 10 minutes

Subject code **0606**

Additional Mathematics

Questions from Paper 1 and Paper 2

You must have: a ruler marked in centimetres and millimetres, a protractor, compasses, a pen, an HB pencil and an eraser.
Questions 1-2, 4, 8, 10 (Paper 1): no calculator.
Questions 3, 5-7, 9 (Paper 2): calculator allowed.

Total marks

/ 84

Instructions

- Answer every question in the space provided on this paper.
- Write in black or dark blue ink. Pencil may be used for diagrams and graphs.
- Fill in your name, centre number and candidate number above.
- Show your working: a correct method can earn marks even if the answer is wrong.
- Unless a question says otherwise, give answers that are not exact to 3 significant figures, and angles in degrees to 1 decimal place.

Information

- This paper has 10 questions worth 84 marks in total.
- The marks for each question or part are shown in brackets, for example [3].

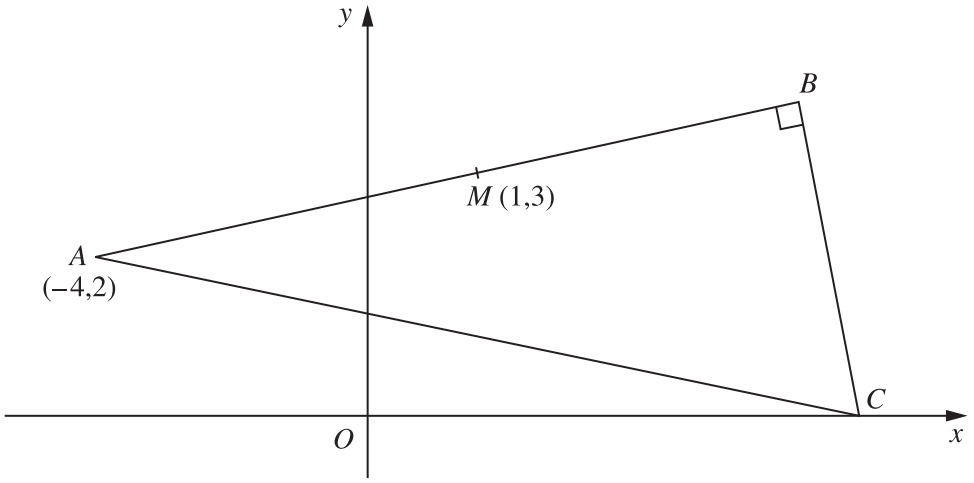
Advice

- Read every question through once before you write anything.
- Use the marks in brackets to judge how long to spend on each part.
- If you finish early, go back and check your working.

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Print at 100% (Actual size) so diagrams keep their real measurements.

1



The figure shows a right-angled triangle ABC, where the point A has coordinates $(-4,2)$, the angle B is 90° and the point C lies on the x-axis. The point $M(1,3)$ is the midpoint of AB. Find the area of the triangle ABC. [7]

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Coordinate geometry of straight lines Click for more variations

1	B (6, 4)	B1	
	grad $AM = \frac{1}{5}$ $\therefore$ grad $BC = -5$	M1	M1 for attempt at gradient of BC
	BC equation: $y - 4 = -5(x - 6)$	M1 A1	M1 for attempt at straight line equation A1 for correct equation in any form
	When $y = 0$, $x = 6.8$	√B1	Ft on their BC equation
	Area = 20.8	M1,A1 [7]	M1 for a correct method for area of triangle

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2 It is known that $y = A \times 10^{bx^2}$, where A and b are constants. When $\lg y$ is plotted against x^2, a straight line passing through the points (3.63, 5.25) and (4.83, 6.88) is obtained.

(a) Find the value of A and of b. [4]

Using your values of A and b, find

(b) the value of y when $x = 2$, [2]

(c) the positive value of x when $y = 4$. [2]

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Linear law (straight-line form) Click for more variations

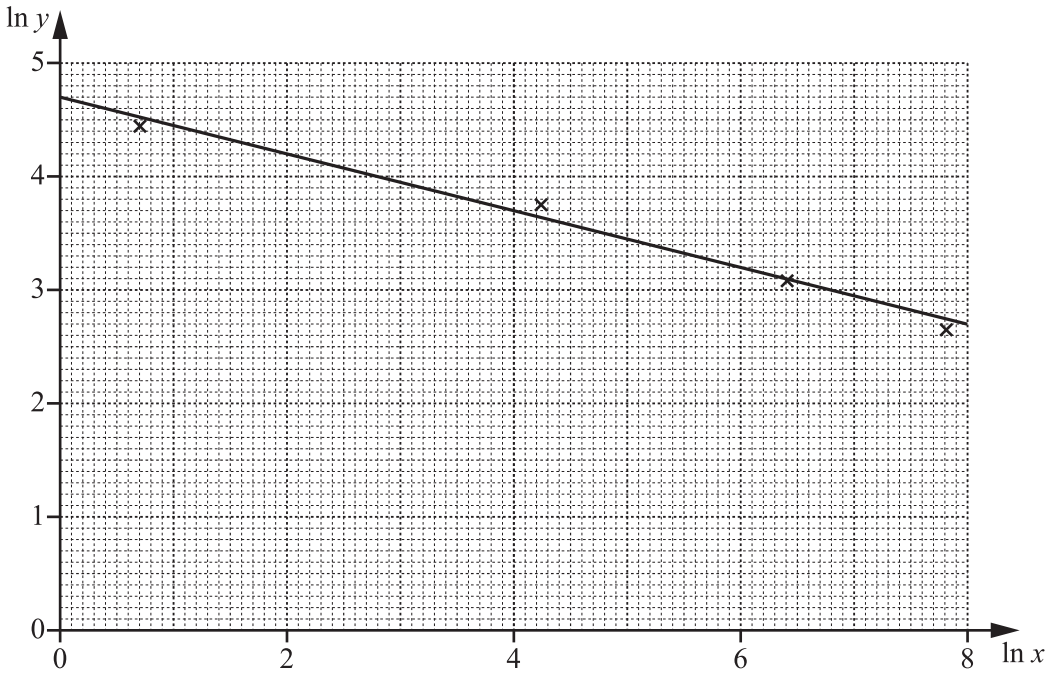
2(a)	$\lg y = \lg A + bx^2$	**B1**	Stated or may be implied by later work
	If using $\lg y = \lg A + bx^2$ as a starting point $5.25 = \lg A + 3.63b$ and $6.88 = \lg A + 4.83b$ or $5.25 = \lg A + 1.358(3.63)$ or $6.88 = \lg A + 1.358(4.83)$ OR If finding the equation of the straight line and then finding $\lg A$ and b by inspection $\lg y - 6.88 = 1.358(x^2 - 4.83)$ or $\lg y - 5.25 = 1.358(x^2 - 3.63)$ or $\lg y = 1.358x^2 + 0.31..$(or 0.32..)	**M1**	For correctly finding required equation(s)
	$b = 1.36,\ \frac{163}{120}$ or $1\frac{43}{120}$	**B1**	Must be b = and from correct working
	A in range 2.05 to 2.09	**A1**	
2(b)	$\lg y = 0.3132 + (4 \times 1.36)$ $y = 2.09 \times 10^{4 \times 1.36}$	**M1**	For $\lg y = (their\ \lg A) + 4(their\ b)$ or $y = (their\ A)(10^{4(their\ b)})$
	Allow 553 000 to 576 000	**A1**	
2 (c)	$4 = 2.09(10^{1.36x^2})$ or $\lg 4 = 0.3132 + 1.36x^2$	**M1**	$4 = (their\ A)(10^{their\ bx^2})$ or $\lg 4 = (their\ \lg A) + (their\ b)x^2$
	awrt 0.46	**A1**	

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3 An experiment was carried out recording values of y for certain values of x. The variables x and y are thought to be connected by the relationship $y = ax^n$, where a and n are constants.

(i) Transform the relationship $y = ax^n$ into straight line form. [2]

The values of $\ln y$ and $\ln x$ were plotted and a line of best fit drawn. This is shown in the diagram below.



(ii) Use the graph to find the value of a and of n, stating the coordinates of the points that you use. [3]

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(iii) Find the value of x when $y = 50$. [2]

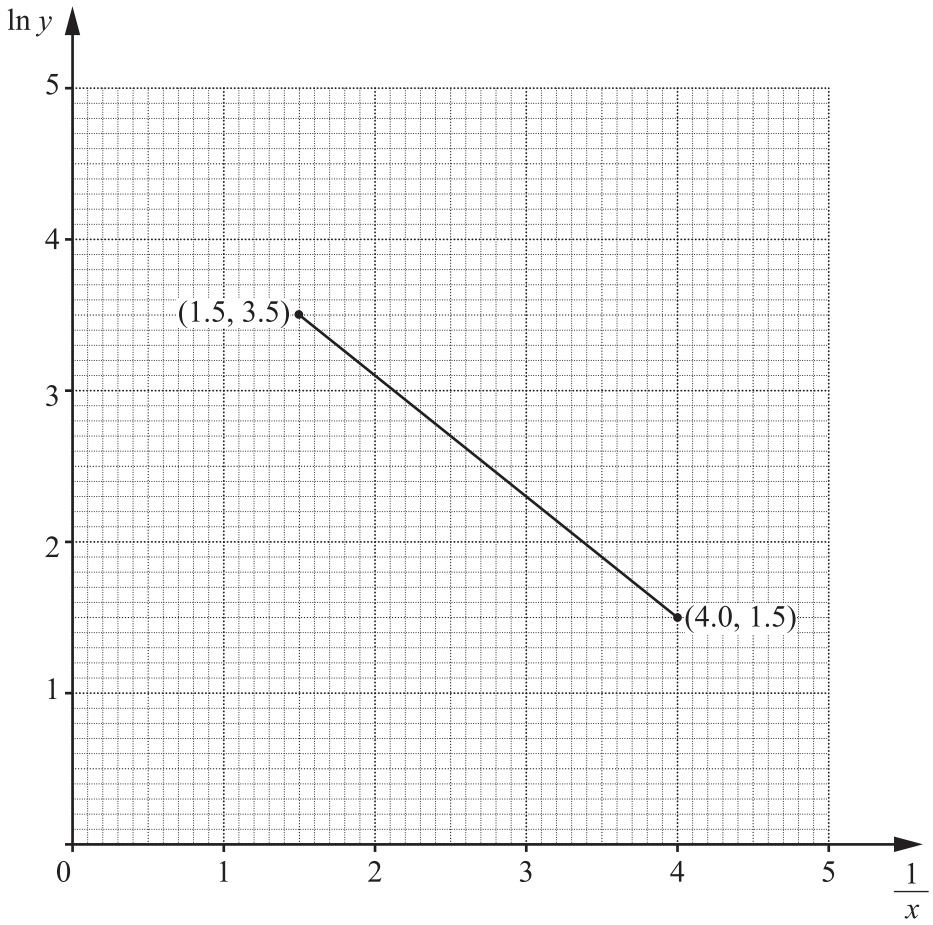
Linear law (straight-line form) Click for more variations

3(i)	Takes logs of both sides	**M1**	
	$\ln y = \ln a + n \ln x$ or $\lg y = \lg a + n \lg x$	**A1**	

3(ii)	$n =$ –0.2 to –0.3 nfww	**B1**	
	attempts to equate y-intercept to ln a or forms *their* ln equation with *their* gradient and a point on the line or uses two points on the line to form a pair of simultaneous equations	**M1**	
	$a = e^{4.7}$ isw or 110 or 109.9[47…]	**A1**	maximum of 2 marks if no coordinates stated
3(iii)	use of ln(50) and ln$x$ = 3 to 3.2	**M1**	or for $\frac{50}{theira} = x^{their\ n}$ or better or for $\ln 50 = \ln(theira) + (their\ n)\ln x$ oe
	awrt 22 or 23 to 2 significant figures	**A1**	implies **M1**

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4



The variables x and y are such that when $\ln y$ is plotted against $\frac{1}{x}$ the straight line graph shown above is obtained.

(i) Given that $y = Ae^{\frac{b}{x}}$, find the value of A and of b. [4]

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(ii) Find the value of y when $x = 0.32$. [2]

(iii) Find the value of x when $y = 20$. [2]

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Linear law (straight-line form) Click for more variations

4	**(i)**	$\ln y = \ln A + \dfrac{b}{x}$	**B1**	for equation, may be implied, must be using ln unless recovered
		Gradient: $b = -0.8$	**B1**	for $b = -0.8$ oe
		Intercept or use of equation: $\ln A = 4.7$ $A = 110$	**B1** **B1**	for ln A = 4.7 oe, allow 4.65 to 4.75 for A = 110, allow 105 to 116 Allow A in terms of e
		Alternative Method $3.5 = \ln A + 1.5b$ and $1.5 = \ln A + 4b$	**B1**	for one equation
		leading to $b = -0.8$ $\ln A = 4.7$ and $A = 110$	**B1** **B1** **B1**	for $b = -0.8$ for $\ln A = 4.7$ for $A = 110$ or $e^{4.7}$
		Alternative Method $e^{1.5} = Ae^{4b}$ $e^{3.5} = Ae^{1.5b}$	**B1** **B1**	for $e^{1.5} = Ae^{4b}$ or $4.48 = Ae^{4b}$ for $e^{3.5} = Ae^{1.5b}$ or $33.1 = Ae^{1.5b}$
		leading to $b = -0.8$ and $A = 110$	**B1** **B1**	for $b = -0.8$ for $A = 110$ or $e^{4.7}$
	(ii)	When $x = 0.32, \dfrac{1}{x} = 3.125, \ln y = 2.2$	**M1**	for a complete method to obtain y, using either the graph, using *their* values in the equation for ln$y$ or using *their* values in the equation for y.
		$y = 9$ (allow 8.5 to 9.5) or $e^{2.2}$	**A1**	
	(iii)	When $y = 20$, $\ln y = 3$, $\dfrac{1}{x} = 2.125$	**M1**	for a complete method to obtain x, using either the graph, using *their* values in the equation for ln$y$ or using *their* values in the equation for y.
		so $x = 0.47$ (allow 0.45 to 0.49)	**A1**	

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5 Solutions to this question by accurate drawing will not be accepted.

The points A and B have coordinates $(p, 3)$ and $(1, 4)$ respectively and the line L has equation $3x + y = 2$.

(i) Given that the gradient of AB is $\frac{1}{3}$, find the value of p. [2]

(ii) Show that L is the perpendicular bisector of AB. [3]

(iii) Given that $C(q, -10)$ lies on L, find the value of q. [1]

(iv) Find the area of triangle ABC. [2]

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Coordinate geometry of straight lines Click for more variations

5(i)	$\frac{4-3}{1-p}=\frac{1}{3}$ oe	**M1**	**ALT** uses $y=mx+c$ with A and B as far as an equation in p only
	-2	**A1**	
5(ii)	**Either:** Finds midpoint AB $\left(\frac{their\ p+1}{2}, \frac{3+4}{2}\right)$	**B1**	**FT** *their p*
	Verifies $(-0.5, 3.5)$ is on L	**B1**	
	$y=-3x+2$ therefore $m=-3$ oe **and** $\frac{1}{3}\times -3=-1$ oe	**B1**	
	Or: finds midpoint AB $\left(\frac{their\ p+1}{2}, \frac{3+4}{2}\right)$	**B1**	**FT** *their p*
	$\frac{1}{3}\times -3=-1$ oe	**B1**	
	$y-3.5=-3(x+0.5)$ **and** completion to $y=-3x+2$	**B1**	
5(iii)	$q=4$	**B1**	
5(iv)	22.5 nfww	**B2**	**B1** for correct method to find area using correct values e.g. $\frac{1}{2}\times AB\times MC$ where M is the midpoint of AB

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6 Points A and B have coordinates $(-2, 10)$ and $(4, 2)$ respectively. C is the mid-point of the line AB.

Point D is such that $\overrightarrow{CD} = \begin{pmatrix} 12 \\ 9 \end{pmatrix}$.

(i) Find the coordinates of C and of D. [3]

(ii) Show that CD is perpendicular to AB. [3]

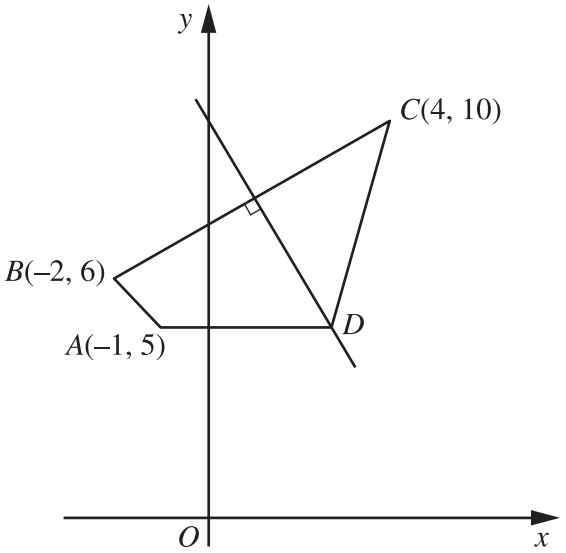
(iii) Find the area of triangle ABD. [2]

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Vectors: position, magnitude and geometry Click for more variations

6	**(i)**	C is (1, 6) D is $(1,6)+(12,9)$ $= (13, 15)$	**B1** **M1** **A1ft**	
	(ii)	gradient of $CD = \dfrac{15-6}{13-1}$ $\left(=\dfrac{3}{4}\right)$	**B1ft**	
		gradient of $AB = \dfrac{10-2}{-2-4}$ $\left(=\dfrac{8}{-6}=\dfrac{-4}{3}\right)$	**B1**	
		$\dfrac{3}{4}\times\dfrac{-4}{3}=-1$ lines are perpendicular	**B1**	correct completion www
	(iii)	area $= \dfrac{1}{2}\times AB\times CD=\dfrac{1}{2}\times 10\times 15$	**M1**	good attempt at two relevant lengths for $\frac{1}{2}$ base × height method
		=75 or array method	**A1**	

7 Solutions to this question by accurate drawing will not be accepted.



In the diagram the points $A(-1, 5)$, $B(-2, 6)$, $C(4, 10)$ and D are the vertices of a quadrilateral in which AD is parallel to the x-axis. The perpendicular bisector of BC passes through D. Find the area of the quadrilateral $ABCD$. [8]

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Coordinate geometry of straight lines Click for more variations

7	Midpoint (1, 8)	B1	
	Gradient BC = $\frac{2}{3}$	B1	
	Uses $m_1m_2 = -1$ and equation of perpendicular bisector	M1	
	$y-8=-\frac{3}{2}(x-1)$ or $3x + 2y = 19$	A1	
	Solve with $y = 5$	M1	
	D (3, 5)	A1	
	Complete method for area	M1	
	15	A1	[8]

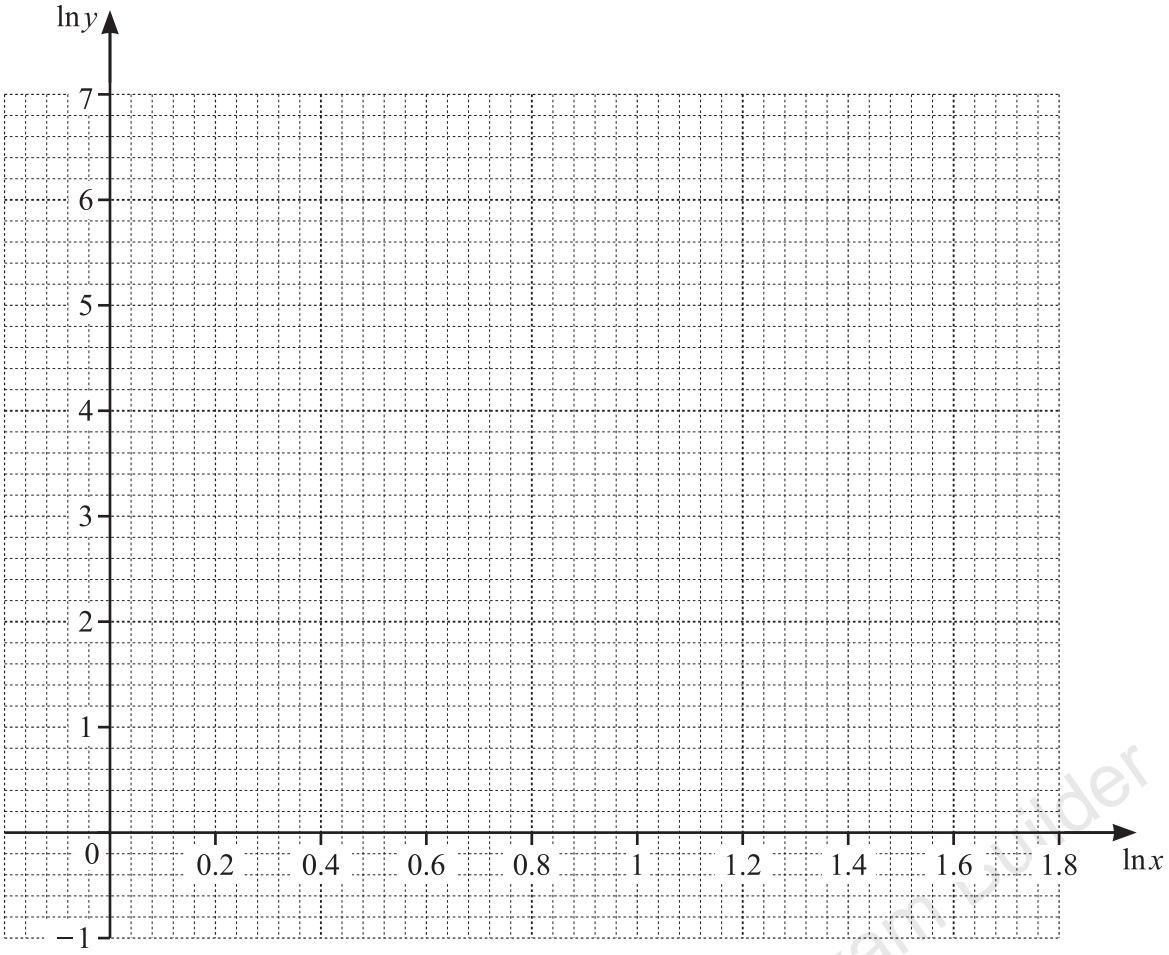
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8

x	1	2	3	4	5
y	20	57	104	160	224

The table shows values of the variables x and y, which are related by the equation $y = Ax^b$, where A and b are constants.

(a) Use the data to draw a straight line graph of $\ln y$ against $\ln x$. [3]



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(b) Use your graph to estimate the values of A and b. Give your answers correct to 2 significant figures. [4]

(c) Use your graph to estimate the value of y when $x = 3.5$. [2]

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Linear law (straight-line form) Click for more variations

8(a)	$\ln y = \ln A + b \ln x$ soi	**B1**	May be implied by parts **(b)** and **(c)**
	<table><tr><td>$\ln x$</td><td>0</td><td>0.69</td><td>1.1</td><td>1.4</td><td>1.6</td></tr><tr><td>$\ln y$</td><td>3</td><td>4</td><td>4.6</td><td>5.1</td><td>5.4</td></tr></table>	**2**	**M1** for attempt to plot a correct graph, allow one point error on the graph. **A1** All points correct on the graph.
8(b)	Vertical intercept = $\ln A \quad (=3)$	**M1**	**Dep** on a straight line graph
	20	**A1**	
	Gradient = b	**M1**	**Dep** on a straight line graph
	$b = 1.5$ (allow 1.4 to 1.6)	**A1**	
8(c)	Reading off graph for $\ln x = 1.25$ to obtain $\ln y$ or use of *their* equation	**M1**	**Dep** on a straight line graph
	$120 \leqslant y \leqslant 150$	**A1**	

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9 The table shows experimental values of two variables x and y.

x	1	2	3	4
y	9.41	1.29	−0.69	−1.77

It is known that x and y are related by the equation $y = \frac{a}{x^2} + bx$, where a and b are constants.

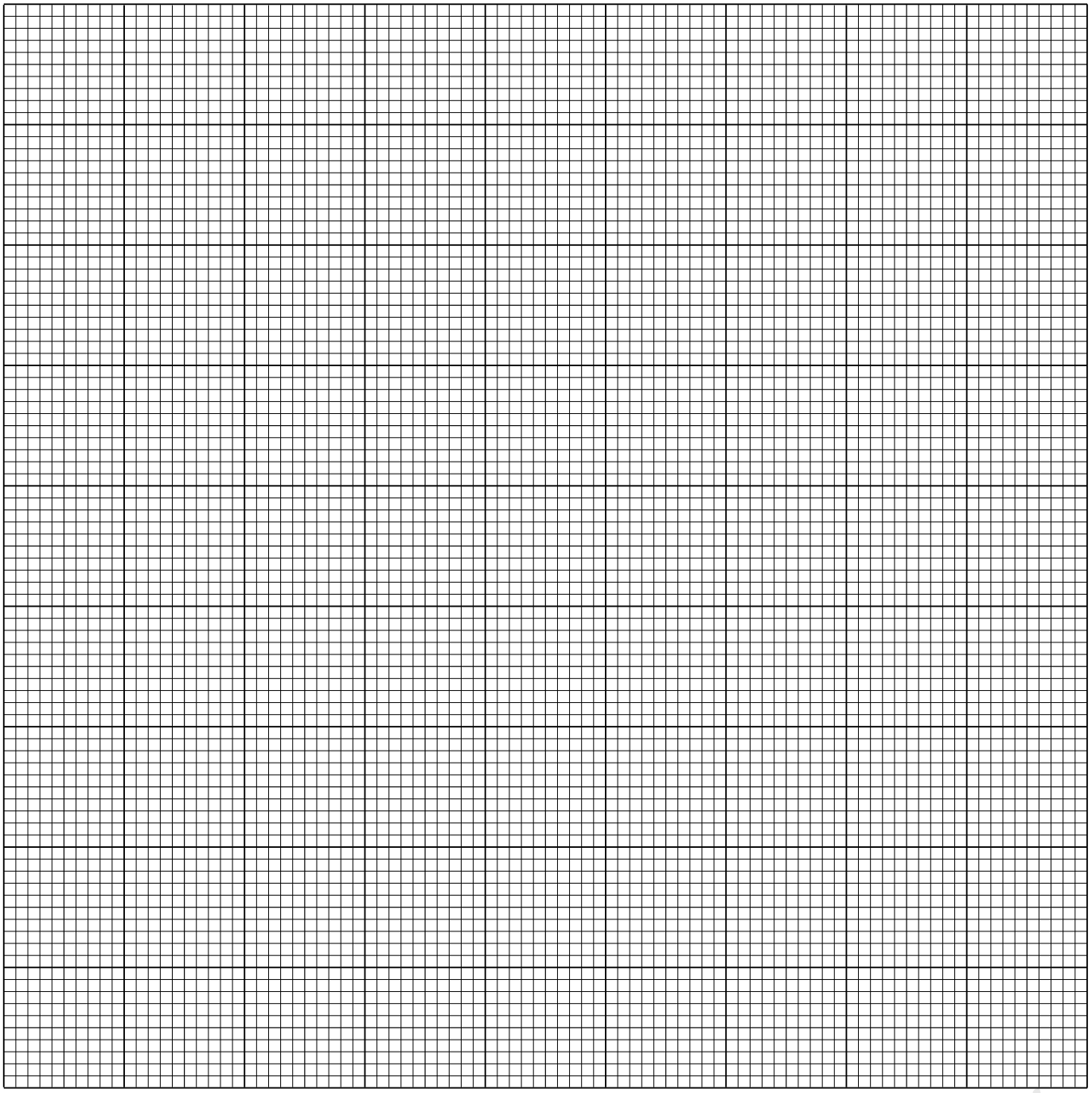
(i) A straight line graph is to be drawn to represent this information. Given that x^2y is plotted on the vertical axis, state the variable to be plotted on the horizontal axis. [1]

(ii) On the grid opposite, draw this straight line graph. [3]

(iii) Use your graph to estimate the value of a and of b. [3]

(iv) Estimate the value of y when x is 3.7. [2]

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Linear law (straight-line form) Click for more variations

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9 (i) x^3

B1 [1] correct answer

(ii)

x^3	1	8	27	64
x^2y	9.41	5.16	–6.21	–28.32

M1 graph of x^2y against x^3, linear axes
A2,1,0 [3] 4, 1–3, 0 points plotted correctly

(iii) $a = 9.5$ to 10.5

B1 correct answer

gradient = $\frac{y_2 - y_1}{x_2 - x_1}$

M1 finding numerical value for the gradient

$b = -0.6 \pm 0.01$

A1 [3] correct answer

(iv) $y = \frac{a}{13.69} + 3.7b$ or $13.69y = a + 50.653b$

M1 appropriate substitutions or read graph at 50.653 and divide value by 13.69

$= -1.48 \pm 0.04$

A1 [2] correct answer

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10 The straight line $y = 2x + 1$ intersects the curve $y + xy + 3x^2 = 15$ at the points A and B. The point C with coordinates $\left(\frac{21}{10}, k\right)$ lies on the perpendicular bisector of AB.

(a) Find the exact value of k. [8]

(b) The point D lies on the perpendicular bisector of AB such that its perpendicular distance from AB is twice that of the point C from AB. Find the possible coordinates of D. [4]

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Coordinate geometry of straight lines Click for more variations

10(a)	$5x^2+3x-14=0$ or $5y^2-4y-57=0$	**M1**	soi
	$x=\frac{7}{5},\ y=\frac{19}{5}$ $x=-2,\ y=-3$	**3**	**M1** for attempt to solve *their* quadratic to obtain either x = ... or y = … **A1** for one correct pair both x or both y or one correct (x, y) point
	Midpoint $\left(-\frac{3}{10},\ \frac{2}{5}\right)$	**B1**	Must be correct midpoint
	Gradient of perpendicular $-\frac{1}{2}$	**B1**	Must be correct
	Perp bisector: $y-\frac{2}{5}=-\frac{1}{2}\left(x+\frac{3}{10}\right)$	**M1**	Must be using *their* midpoint and a gradient $=-\frac{1}{2}$
	$k=-\frac{4}{5}$	**A1**	

10(b)	$\left(\frac{9}{2},\ -2\right)$	**2**	**B1** for one correct **FT** on $2\times(\textit{their } k)-\textit{their}\,\frac{2}{5}$
	$\left(-\frac{51}{10},\ \frac{14}{5}\right)$	**2**	**B1** for one correct **FT** on $\left[\left(3\times\textit{their}\ \frac{2}{5}\right)-(2\times\textit{their } k)\right]$

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