



eClassroom

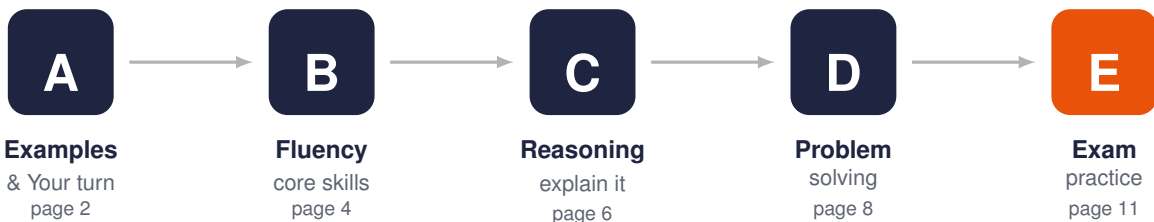
A-LEVEL MATHEMATICS • PURE 1

Straight Line Graphs

Worksheet

Pearson Edexcel International A Level (WMA11) & A Level (9MA0) • Calculator allowed: show every step

Free Straight Line Graphs worksheet for A-Level and International A-Level Maths, with full worked solutions



Tap a section to jump straight to it

By the end of this worksheet you can: find gradients and write lines as $y = mx + c$ and $ax + by + c = 0$ • find the equation of a line through given points • use parallel and perpendicular gradients, midpoints and perpendicular bisectors • find lengths and areas from coordinates • *Stretch:* fix a constant from a right angle, find every possible position of a point and prove geometric properties.

Which questions are for me?

CORE The methods every A-level student must secure. Start here.

STRETCH Lines with a parameter, perpendicular heights, every position of a point from a given length or area, and proof.

Every section has both, clearly labelled. Questions get harder as you go, and every skill in Sections A to D is needed in Section E.

Track your progress

Section	B	C	D	E
Core marks	23	10	13	11
Stretch marks	16	14	17	8
My score				

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A**Worked examples & Your turn**

Read each example carefully. Cover it up, then answer the question beside it using the same method.

CORE

Secure the method

Worked example A1

Find an equation of the line through $(-2, 5)$ and $(4, 1)$, in the form $ax + by + c = 0$, where a , b and c are integers.

$$m = \frac{1 - 5}{4 - (-2)} = -\frac{2}{3}$$

$$y - 5 = -\frac{2}{3}(x + 2)$$

Multiply by 3 to clear the fraction, then collect everything on one side.

$$2x + 3y - 11 = 0$$

Your turn A1

Find an equation of the line through $(3, -1)$ and $(-1, 5)$, in the form $ax + by + c = 0$, where a , b and c are integers.

Worked example A2

Find an equation of the line perpendicular to $4x - 3y + 6 = 0$ that passes through $(2, -1)$

Rearrange to read the gradient: $y = \frac{4}{3}x + 2$, so $m = \frac{4}{3}$

Perpendicular: the negative reciprocal, $-\frac{3}{4}$

$$y + 1 = -\frac{3}{4}(x - 2)$$

$$3x + 4y - 2 = 0$$

Your turn A2

Find an equation of the line perpendicular to $5x + 2y = 7$ that passes through $(-5, 3)$

Worked example A3

$A(1, 2)$ and $B(7, 10)$. Find the length of AB and the coordinates of its midpoint.

$$AB = \sqrt{6^2 + 8^2} = \sqrt{100}$$

Midpoint: add the coordinates and halve.

$$\left(\frac{1+7}{2}, \frac{2+10}{2} \right)$$

$$AB = 10, \quad (4, 6)$$

Your turn A3

$A(-1, 5)$ and $B(3, -3)$. Find the exact length of AB and the coordinates of its midpoint.



STRETCH

Worked example A4: perpendicular bisector

Find the perpendicular bisector of $A(-1, 3)$ and $B(5, -1)$, in the form $ax + by + c = 0$

Midpoint $(2, 1)$; $m_{AB} = -\frac{4}{6} = -\frac{2}{3}$, so the bisector has

gradient $\frac{3}{2}$

$$y - 1 = \frac{3}{2}(x - 2)$$

$$3x - 2y - 4 = 0$$

Your turn A4

Find the perpendicular bisector of $A(2, -4)$ and $B(-4, 6)$, in the form $ax + by + c = 0$

Worked example A5: intersection and area

Find the area of the triangle enclosed by $y = 2x - 1$, $x + 2y = 18$ and the y -axis.

Lines meet where $x + 2(2x - 1) = 18$: $P(4, 7)$

Base on the y -axis from $(0, -1)$ to $(0, 9)$; height 4

$$\frac{1}{2} \times 10 \times 4 = 20$$

Your turn A5

Find the area of the triangle enclosed by $y = 3x - 2$, $x + 3y = 24$ and the y -axis.

Worked example A6: proving a right angle

$A(1, 1)$, $B(4, 3)$, $C(2, 6)$. Show that angle ABC is a right angle, and find the area of triangle ABC .

$$m_{AB} = \frac{2}{3}, m_{BC} = \frac{3}{-2}, \text{ and } \frac{2}{3} \times \left(-\frac{3}{2}\right) = -1$$

So AB and BC are the base and height: $AB = BC = \sqrt{13}$

$$\text{area} = \frac{1}{2} \sqrt{13} \sqrt{13} = \frac{13}{2}$$

Your turn A6

$P(-2, 1)$, $Q(1, -1)$, $R(5, 5)$. Show that angle PQR is a right angle, and find the area of triangle PQR .

Worked example A7: a point at a given distance

C lies on the line $y = 3$, and $AC = 5$, where A is $(1, -1)$. Find the possible coordinates of C .

$C(c, 3)$: $(c - 1)^2 + 4^2 = 25$, so $(c - 1)^2 = 9$, $c = 4$ or $c = -2$

$$(4, 3) \text{ or } (-2, 3)$$

Your turn A7

C lies on the line $y = x$, and $AC = \sqrt{10}$, where A is $(3, 1)$. Find the possible coordinates of C .



B**Fluency**

Each question is a designed sequence. From one part to the next, ask yourself: what changed, and what did it do to the answer?

CORE*Secure the method*

B1 Write down the gradient and the y intercept of each line.

(a) $y = 3x - 5$

(b) $2y = 6x + 1$

(c) $4x + 2y - 3 = 0$

(d) $3x - 5y = 15$

[4 marks]

B2 Find an equation of each line in the form $ax + by + c = 0$, where a , b and c are integers.

(a) gradient 2, through (1, 4)

(b) gradient -2 , through (1, 4)

(c) gradient $\frac{1}{2}$, through (1, 4)

(d) gradient $-\frac{2}{3}$, through $(-3, 1)$

[4 marks]

B3 Find an equation of the line through each pair of points, in the form $ax + by + c = 0$, where a , b and c are integers.

(a) (1, 3) and (3, 7)

(b) $(-1, 3)$ and $(3, -5)$

(c) (2, 5) and (6, 7)

(d) (0, 4) and (6, 0)

[4 marks]

B4 State whether each pair of lines is parallel, perpendicular or neither.

(a) $y = 3x + 1$ and $6x - 2y = 5$

(b) $y = 3x + 1$ and $x + 3y = 4$

(c) $2x + 5y = 1$ and $5x - 2y = 3$

(d) $4x - 6y = 1$ and $3x - 2y = 5$

[4 marks]



CORE *continued: lengths and intersections*

B5 Find the exact length of the line segment joining each pair of points.

(a) (2, 1) and (5, 5)

(b) (−3, 4) and (1, −4)

(c) (−2, −7) and (4, 1)

[3 marks]

B6 Find the coordinates of the point where each pair of lines meet.

(a) $y = 2x - 3$ and $y = x + 1$

(b) $y = 2x - 3$ and $x + y = 6$

(c) $y = 2x$ and $2x + 3y = 12$

(d) $2x + 3y = 12$ and $3x - 4y = 1$

[4 marks]

STRETCH

B7 Find the perpendicular bisector of each pair of points, in the form $ax + by + c = 0$

(a) (0, 0) and (4, 2)

(b) (1, −3) and (5, 1)

(c) (−2, 5) and (4, 1)

(d) (3, 0) and (3, 8)

[4 marks]

B8 The line l has equation $(k - 1)x + 2y = 5$, where k is a constant. Find the value of k for which l

(a) is parallel to $y = 3x$

(b) is perpendicular to $y = 3x$

(c) passes through (3, 1)

(d) is parallel to the x -axis

[4 marks]

B9 Find the area of each triangle, with vertices

(a) (0, 0), (6, 0), (2, 5)

(b) (1, 1), (7, 1), (3, −4)

(c) (0, 0), (4, 2), (−1, 2)

(d) (1, 0), (5, 2), (3, 6)

[4 marks]

B10 Find the coordinates of every point P that satisfies each description.

(a) P lies on the line $y = x + 1$ and is $2\sqrt{2}$ from $A(2, 3)$

(b) P lies on the line $y = x + 1$ and is $\sqrt{2}$ from $A(2, 3)$

(c) P lies on the line $y = 1$ and is 5 from (3, 5)

(d) P lies on the x -axis and is 13 from (7, 12)

[4 marks]



C**Reasoning**

Show your working and explain your thinking. A correct answer without a reason does not score full marks.

CORE

Secure the method

- C1** Ana says the line perpendicular to $y = 4x - 1$ has gradient $\frac{1}{4}$
Explain Ana's mistake, and write down the correct gradient. [2 marks]
- C2** A question asks for an equation in the form $ax + by + c = 0$, where a , b and c are integers. Raj writes
 $y = -\frac{2}{3}x + \frac{11}{3}$
Explain why Raj would lose the final mark, and write his answer in the required form. [2 marks]
- C3** Prove that the points $A(-1, -2)$, $B(2, 4)$ and $C(4, 8)$ lie on one straight line, and find the equation of that line. [3 marks]
- C4** Joe says the midpoint of $(-3, 5)$ and $(7, -1)$ is $(5, -3)$
Explain Joe's mistake, find the correct midpoint, and find the exact length of the segment. [3 marks]



STRETCH

- C5** $A(0, 0)$, $B(4, 1)$, $C(6, 5)$ and $D(2, 4)$. Prove that $ABCD$ is a parallelogram, and show that it is not a rectangle. [3 marks]
- C6** $P(1, 2)$, $Q(5, 1)$, $R(6, 5)$ and $S(2, 6)$. Show that the diagonals PR and QS are perpendicular and bisect each other, and decide, with a reason, whether $PQRS$ is a square. [3 marks]
- C7** Kim finds the area of the triangle with vertices $A(0, 0)$, $B(6, 2)$ and $C(1, 4)$ as $\frac{1}{2} \times AB \times AC$. Explain why Kim's method is not valid here, and find the correct area. [3 marks]
- C8** The line l crosses the x -axis at $(a, 0)$ and the y -axis at $(0, b)$, where a and b are positive.
- (a) Show that l has equation $\frac{x}{a} + \frac{y}{b} = 1$, and that the triangle formed by l and the coordinate axes has area $\frac{1}{2}ab$. (2)
- Given that l passes through $(3, 4)$ and the area of the triangle is 24,
- (b) show that $a^2 - 12a + 36 = 0$, and hence find the equation of l in the form $px + qy + r = 0$. (3)
- [5 marks]



D**Problem solving**

You decide the method. Read the whole question first, and show every step.

CORE

Secure the method

D1 The line l passes through the points $A(-2, -1)$ and $B(6, 5)$

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

(2)

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

(b) Find the coordinates of C .

(1)

[3 marks]

D2 The points A and B have coordinates $(1, 7)$ and $(7, -1)$ respectively.

The line l is the perpendicular bisector of AB .

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

(3)

(b) Show that l passes through the origin O , and state what this tells you about the distances OA and OB .

(1)

[4 marks]

D3 *In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.*

The point A has coordinates $(\sqrt{3}, 2)$ and the point B has coordinates $(3\sqrt{3}, 8)$

(a) Show that the gradient of AB is $\sqrt{3}$

(1)

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

(b) Find an equation for l in the form $y = mx + c$, giving m and c in their simplest exact form.

(2)

[3 marks]



- D4** Figure 1 shows the line l_1 with equation $y = 2x + 2$ and the line l_2 with equation $x + 2y = 14$. The lines meet at the point P . The line l_1 crosses the x -axis at A and l_2 crosses the x -axis at B . Find the area of the shaded triangle APB .

(3)

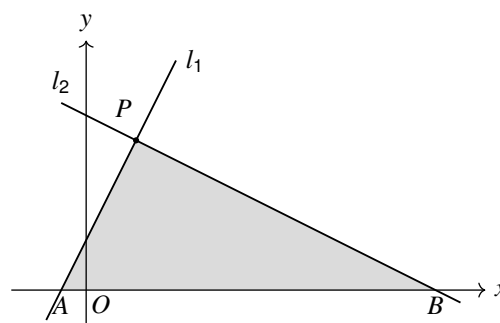


Diagram NOT accurately drawn

Figure 1

[3 marks]

STRETCH

- D5** In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.

The points A and B have coordinates $(-3, 1)$ and $(5, 7)$ respectively.

- (a) Show that the length of AB is 10

(1)

The point C lies on the line through A that is parallel to the x -axis, and the length of BC is also 10. The points A and C are different.

- (b) Find the coordinates of C .

(2)

- (c) Find the area of triangle ABC .

(1)

[4 marks]

- D6** In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.

The points $A(0, 4)$, $B(k, 0)$ and $C(2k, 3)$, where k is a positive constant, are such that angle ABC is a right angle.

- (a) Show that $k^2 = 12$

(2)

- (b) Find the exact area of triangle ABC , giving your answer in the form $p\sqrt{3}$

(2)

[4 marks]



- D7** Figure 2 shows the triangle with vertices $A(-2, 2)$, $B(6, 6)$ and $C(5, -1)$

The point D lies on AB and CD is perpendicular to AB .

- (a) Find an equation of the line AB .
(b) Find the coordinates of D .
(c) Hence find the area of triangle ABC .

(1)

(2)

(1)

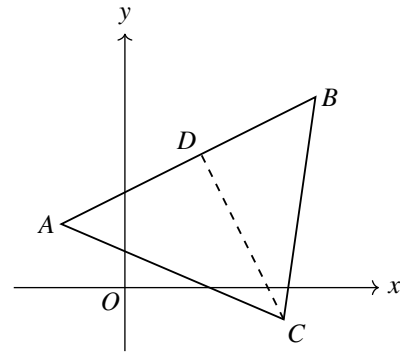


Diagram NOT accurately drawn

Figure 2

[4 marks]

- D8** In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.

The line l_1 has equation $2x - y + 4 = 0$ and the line l_2 has equation $x + 2y - 13 = 0$

The lines meet at the point P .

- (a) Find the coordinates of P , and show that l_1 and l_2 are perpendicular.

(2)

The point $Q(5, 4)$ lies on l_2 . The square $PQRS$ has S on l_1 .

- (b) Find the two possible positions of S , and the corresponding positions of R .

(3)

[5 marks]



E**Exam practice**

Exam-style questions in the style of WMA11. Write your answers in the spaces, and show every step.

CORE

Exam questions for everyone

- E1** *In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.*

The line l_1 passes through the point $A(-4, 3)$ and the point $B(2, 7)$

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

.....
(2)

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

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

.....
(3)

(Total for Question E1 is 5 marks)



E2 *In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.*

The line l_1 has equation $2x + y - 10 = 0$

The line l_1 crosses the x -axis at the point A and the y -axis at the point B .

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

(a) Find an equation for l_2 .

.....
(1)

The lines l_1 and l_2 meet at the point P .

(b) Use algebra to find the coordinates of P .

.....
(2)

(c) Find the exact length of OP , and the exact length of AB , giving each as a simplified surd.

.....
(2)

(d) Hence show that the area of triangle OAB is 25, using the lengths AB and OP

(1)

(Total for Question E2 is 6 marks)



STRETCH

E3 In this question you must show all stages of your working. Solutions relying on calculator technology are not acceptable.

The points A and B have coordinates $(-1, 2)$ and $(7, 6)$ respectively.

(a) Find an equation of the line AB in the form $y = mx + c$

.....
(2)

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

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

.....
(2)

The point C lies on l , and the area of triangle ABC is 30

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

.....
(4)

(Total for Question E3 is 8 marks)

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