Solutionbank C1
Edexcel Modular Mathematics for AS and A-Level

Coordinate geometry in the (x, y) plane
Exercise A, Question 1

Question:

Work out the gradients of these lines:

(a) $y = -2x + 5$

(b) $y = -x + 7$

(c) $y = 4 + 3x$

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

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

(f) $y = \frac{5}{4}x + \frac{2}{3}$

(g) $2x - 4y + 5 = 0$

(h) $10x - 5y + 1 = 0$

(i) $-x + 2y - 4 = 0$

(j) $-3x + 6y + 7 = 0$

(k) $4x + 2y - 9 = 0$

(l) $9x + 6y + 2 = 0$

Solution:

(a) Gradient $= -2$

(b) Gradient $= -1$

(c) Gradient $= 3$

(d) Gradient $= \frac{1}{3}$

(e) Gradient $= -\frac{2}{3}$

(f) Gradient $= \frac{5}{4}$

(g) $2x - 4y + 5 = 0$
$2x + 5 = 4y$

$4y = 2x + 5$

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

$y = \frac{1}{2}x + \frac{5}{4}$

Gradient $= \frac{1}{2}$

(h) $10x - 5y + 1 = 0$
$10x + 1 = 5y$
$5y = 10x + 1$

$y = \frac{10}{5}x + \frac{1}{5}$

$y = 2x + \frac{1}{5}$

Gradient $= 2$

(i) $-x + 2y - 4 = 0$
$2y - 4 = x$
$2y = x + 4$

$y = \frac{1}{2}x + 2$

Gradient $= \frac{1}{2}$

(j) $-3x + 6y + 7 = 0$
$6y + 7 = 3x$
$6y = 3x - 7$

$y = \frac{3}{6}x - \frac{7}{6}$

$y = \frac{1}{2}x - \frac{7}{6}$

Gradient $= \frac{1}{2}$

(k) $4x + 2y - 9 = 0$
$2y - 9 = -4x$
$2y = -4x + 9$

$y = -\frac{4}{2}x + \frac{9}{2}$

$y = -2x + \frac{9}{2}$

Gradient $= -2$

(l) $9x + 6y + 2 = 0$
$6y + 2 = -9x$
$6y = -9x - 2$

$y = -\frac{9}{6}x - \frac{2}{6}$

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

Gradient $= -\frac{3}{2}$

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Coordinate geometry in the (x, y) plane
Exercise A, Question 2

Question:

These lines intercept the y-axis at $(0, c)$. Work out the value of c in each case.

(a) $y = -x + 4$

(b) $y = 2x - 5$

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

(d) $y = -3x$

(e) $y = \frac{6}{7}x + \frac{7}{5}$

(f) $y = 2 - 7x$

(g) $3x - 4y + 8 = 0$

(h) $4x - 5y - 10 = 0$

(i) $-2x + y - 9 = 0$

(j) $7x + 4y + 12 = 0$

(k) $7x - 2y + 3 = 0$

(l) $-5x + 4y + 2 = 0$

Solution:

(a) $c = 4$

(b) $c = -5$

(c) $c = -\frac{2}{3}$

(d) $y = -3x$
$y = -3x + 0$
$c = 0$

(e) $c = \frac{7}{5}$

(f) $y = 2 - 7x$
$y = -7x + 2$
$c = 2$

(g) $3x - 4y + 8 = 0$

$3x + 8 = 4y$
$4y = 3x + 8$

$y = \frac{3}{4}x + \frac{8}{4}$

$y = \frac{3}{4}x + 2$

$c = 2$

(h) $4x - 5y - 10 = 0$
$4x - 10 = 5y$
$5y = 4x - 10$

$y = \frac{4}{5}x - \frac{10}{5}$

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

$c = -2$

(i) $-2x + y - 9 = 0$
$y - 9 = 2x$
$y = 2x + 9$
$c = 9$

(j) $7x + 4y + 12 = 0$
$4y + 12 = -7x$
$4y = -7x - 12$

$y = -\frac{7}{4}x - \frac{12}{4}$

$y = -\frac{7}{4}x - 3$

$c = -3$

(k) $7x - 2y + 3 = 0$
$7x + 3 = 2y$
$2y = 7x + 3$

$y = \frac{7}{2}x + \frac{3}{2}$

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

(l) $-5x + 4y + 2 = 0$
$4y + 2 = 5x$
$4y = 5x - 2$

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

$y = \frac{5}{4}x - \frac{1}{2}$

$c = -\frac{1}{2}$

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Coordinate geometry in the (x, y) plane
Exercise A, Question 3

Question:

Write these lines in the form $ax + by + c = 0$.

(a) $y = 4x + 3$

(b) $y = 3x - 2$

(c) $y = -6x + 7$

(d) $y = \frac{4}{5}x - 6$

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

(f) $y = \frac{7}{3}x$

(g) $y = 2x - \frac{4}{7}$

(h) $y = -3x + \frac{2}{9}$

(i) $y = -6x - \frac{2}{3}$

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

(k) $y = \frac{2}{3}x + \frac{5}{6}$

(l) $y = \frac{3}{5}x + \frac{1}{2}$

Solution:

(a) $y = 4x + 3$
$0 = 4x + 3 - y$
$4x + 3 - y = 0$
$4x - y + 3 = 0$

(b) $y = 3x - 2$
$0 = 3x - 2 - y$
$3x - 2 - y = 0$
$3x - y - 2 = 0$

(c) $y = -6x + 7$
$6x + y = 7$
$6x + y - 7 = 0$

(d) $y = \frac{4}{5}x - 6$

Multiply each term by 5:
$5y = 4x - 30$
$0 = 4x - 30 - 5y$
$4x - 30 - 5y = 0$
$4x - 5y - 30 = 0$

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

Multiply each term by 3:
$3y = 5x + 6$
$0 = 5x + 6 - 3y$
$5x + 6 - 3y = 0$
$5x - 3y + 6 = 0$

(f) $y = \frac{7}{3}x$

Multiply each term by 3:
$3y = 7x$
$0 = 7x - 3y$
$7x - 3y = 0$

(g) $y = 2x - \frac{4}{7}$

Multiply each term by 7:
$7y = 14x - 4$
$0 = 14x - 4 - 7y$
$14x - 4 - 7y = 0$
$14x - 7y - 4 = 0$

(h) $y = -3x + \frac{2}{9}$

Multiply each term by 9:
$9y = -27x + 2$
$27x + 9y = 2$
$27x + 9y - 2 = 0$

(i) $y = -6x - \frac{2}{3}$

Multiply each term by 3:
$3y = -18x - 2$
$18x + 3y = -2$
$18x + 3y + 2 = 0$

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

Multiply each term by 6 (6 is divisible by both 3 and 2):
$6y = -2x + 3$
$2x + 6y = 3$
$2x + 6y - 3 = 0$

(k) $y = \frac{2}{3}x + \frac{5}{6}$

Multiply each term by 6 (6 is divisible by both 3 and 6):
$6y = 4x + 5$

$0 = 4x + 5 - 6y$
$4x + 5 - 6y = 0$
$4x - 6y + 5 = 0$

(l) $y = \frac{3}{5}x + \frac{1}{2}$

Multiply each term by 10 (10 is divisible by both 5 and 2):
$10y = 6x + 5$
$0 = 6x + 5 - 10y$
$6x + 5 - 10y = 0$
$6x - 10y + 5 = 0$

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Coordinate geometry in the (x, y) plane
Exercise A, Question 4

Question:

A line is parallel to the line $y = 5x + 8$ and its intercept on the y-axis is $(0 , 3)$. Write down the equation of the line.

Solution:

The line is parallel to $y = 5x + 8$, so $m = 5$.
The line intercepts the y-axis at $(0 , 3)$, so $c = 3$.
Using $y = mx + c$, the equation of the line is $y = 5x + 3$.

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Coordinate geometry in the (x, y) plane
Exercise A, Question 5

Question:

A line is parallel to the line $y = -\frac{2}{5}x + 1$ and its intercept on the y-axis is $(0, -4)$. Work out the equation of the line. Write your answer in the form $ax + by + c = 0$, where a, b and c are integers.

Solution:

The line is parallel to $y = -\frac{2}{5}x + 1$, so $m = -\frac{2}{5}$.

The line intercepts the y-axis at $(0, -4)$, so $c = -4$.
Using $y = mx + c$, the equation of the line is

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

Multiply each term by 5:
$5y = -2x - 20$
$2x + 5y = -20$
$2x + 5y + 20 = 0$

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Coordinate geometry in the (x, y) plane
Exercise A, Question 6

Question:

A line is parallel to the line $3x + 6y + 11 = 0$ and its intercept on the y-axis is $(0, 7)$. Write down the equation of the line.

Solution:

$3x + 6y + 11 = 0$
$6y + 11 = -3x$
$6y = -3x - 11$
$y = -\frac{3}{6}x - \frac{11}{6}$

$y = -\frac{1}{2}x - \frac{11}{6}$

The line is parallel to $y = -\frac{1}{2}x - \frac{11}{6}$, so $m = -\frac{1}{2}$.

The line intercepts the y-axis at $(0, 7)$, so $c = 7$.

Using $y = mx + c$, the equation of the line is $y = -\frac{1}{2}x + 7$

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Coordinate geometry in the (x, y) plane

Exercise A, Question 7

Question:

A line is parallel to the line $2x - 3y - 1 = 0$ and it passes through the point $(0 , 0)$. Write down the equation of the line.

Solution:

$2x - 3y - 1 = 0$
$2x - 1 = 3y$
$3y = 2x - 1$
$y = \frac{2}{3}x - \frac{1}{3}$

The line is parallel to $y = \frac{2}{3}x - \frac{1}{3}$, so $m = \frac{2}{3}$.

The intercept on the y-axis is $(0 , 0)$, so $c = 0$.
Using $y = mx + c$:

$y = \frac{2}{3}x + 0$

$y = \frac{2}{3}x$

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Coordinate geometry in the (x, y) plane
Exercise A, Question 8

Question:

The line $y = 6x - 18$ meets the x-axis at the point P. Work out the coordinates of P.

Solution:

$y = 6x - 18$
Substitute $y = 0$:
$6x - 18 = 0$
$6x = 18$
$x = 3$
The line meets the x-axis at $P(3, 0)$.

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Coordinate geometry in the (x, y) plane
Exercise A, Question 9

Question:

The line $3x + 2y - 5 = 0$ meets the x-axis at the point R. Work out the coordinates of R.

Solution:

$3x + 2y - 5 = 0$
Substitute $y = 0$:
$3x + 2 (0) - 5 = 0$
$3x - 5 = 0$
$3x = 5$
$x = \frac{5}{3}$

The line meets the x-axis at $R \left(\frac{5}{3} , 0 \right)$.

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Coordinate geometry in the (x, y) plane
Exercise A, Question 10

Question:

The line $5x - 4y + 20 = 0$ meets the y-axis at the point A and the x-axis at the point B. Work out the coordinates of the points A and B.

Solution:

$5x - 4y + 20 = 0$
Substitute $x = 0$:
$5 (0) - 4y + 20 = 0$
$- 4y + 20 = 0$
$20 = 4y$
$4y = 20$
$y = 5$
The line meets the y-axis at $A (0 , 5)$.
Substitute $y = 0$:
$5x - 4 (0) + 20 = 0$
$5x + 20 = 0$
$5x = - 20$
$x = - 4$
The line meets the x-axis at $B (- 4 , 0)$.

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Coordinate geometry in the (x, y) plane
Exercise B, Question 1

Question:

Work out the gradient of the line joining these pairs of points:

(a) $(4, 2), (6, 3)$

(b) $(-1, 3), (5, 4)$

(c) $(-4, 5), (1, 2)$

(d) $(2, -3), (6, 5)$

(e) $(-3, 4), (7, -6)$

(f) $(-12, 3), (-2, 8)$

(g) $(-2, -4), (10, 2)$

(h) $\left(\frac{1}{2}, 2\right), \left(\frac{3}{4}, 4\right)$

(i) $\left(\frac{1}{4}, \frac{1}{2}\right), \left(\frac{1}{2}, \frac{2}{3}\right)$

(j) $(-2.4, 9.6), (0, 0)$

(k) $(1.3, -2.2), (8.8, -4.7)$

(l) $(0, 5a), (10a, 0)$

(m) $(3b, -2b), (7b, 2b)$

(n) $(p, p^2), (q, q^2)$

Solution:

(a) $(x_1, y_1) = (4, 2), (x_2, y_2) = (6, 3)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{3-2}{6-4} = \frac{1}{2}$$

(b) $(x_1, y_1) = (-1, 3), (x_2, y_2) = (5, 4)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{4-3}{5-(-1)} = \frac{1}{6}$$

(c) $(x_1, y_1) = (-4, 5), (x_2, y_2) = (1, 2)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{2 - 5}{1 - (-4)} = -\frac{3}{5}$$

(d) $(x_1, y_1) = (2, -3), (x_2, y_2) = (6, 5)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{5 - (-3)}{6 - 2} = \frac{8}{4} = 2$$

(e) $(x_1, y_1) = (-3, 4), (x_2, y_2) = (7, -6)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{-6 - 4}{7 - (-3)} = -\frac{10}{10} = -1$$

(f) $(x_1, y_1) = (-12, 3), (x_2, y_2) = (-2, 8)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{8 - 3}{-2 - (-12)} = \frac{5}{-2 + 12} = \frac{5}{10} = \frac{1}{2}$$

(g) $(x_1, y_1) = (-2, -4), (x_2, y_2) = (10, 2)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{2 - (-4)}{10 - (-2)} = \frac{6}{12} = \frac{1}{2}$$

(h) $\left(x_1, y_1\right) = \left(\frac{1}{2}, 2\right), \left(x_2, y_2\right) = \left(\frac{3}{4}, 4\right)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{4 - 2}{\frac{3}{4} - \frac{1}{2}} = \frac{2}{\frac{1}{4}} = 8$$

(i) $\left(x_1, y_1\right) = \left(\frac{1}{4}, \frac{1}{2}\right), \left(x_2, y_2\right) = \left(\frac{1}{2}, \frac{2}{3}\right)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{\frac{2}{3} - \frac{1}{2}}{\frac{1}{2} - \frac{1}{4}} = \frac{\frac{1}{6}}{\frac{1}{4}} = \frac{2}{3}$$

(j) $(x_1, y_1) = (-2.4, 9.6), (x_2, y_2) = (0, 0)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{0 - 9.6}{0 - (-2.4)} = \frac{-9.6}{2.4} = -4$$

(k) $(x_1, y_1) = (1.3, -2.2), (x_2, y_2) = (8.8, -4.7)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{-4.7 - (-2.2)}{8.8 - 1.3} = \frac{-2.5}{7.5} = -\frac{1}{3}$$

(l) $(x_1, y_1) = (0, 5a), (x_2, y_2) = (10a, 0)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{0 - 5a}{10a - 0} = \frac{-5a}{10a} = \frac{-5}{10} = -\frac{1}{2}$$

(m) $(x_1, y_1) = (3b, -2b), (x_2, y_2) = (7b, 2b)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{2b - (-2b)}{7b - 3b} = \frac{4b}{4b} = 1$$

(n) $(x_1, y_1) = (p, p^2)$, $(x_2, y_2) = (q, q^2)$

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{q^2 - p^2}{q - p} = \frac{(q - p)(q + p)}{q - p} = q + p$$

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Coordinate geometry in the (x, y) plane

Exercise B, Question 2

Question:

The line joining $(3, -5)$ to $(6, a)$ has gradient 4. Work out the value of a.

Solution:

$(x_1, y_1) = (3, -5)$, $(x_2, y_2) = (6, a)$

$\frac{y_2 - y_1}{x_2 - x_1} = 4$

so $\frac{a - (-5)}{6 - 3} = 4$

$\Rightarrow \quad \frac{a + 5}{3} = 4$

$\Rightarrow \quad a + 5 = 12$

$\Rightarrow \quad a = 7$

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Coordinate geometry in the (x, y) plane
Exercise B, Question 3

Question:

The line joining $(5, b)$ to $(8, 3)$ has gradient -3. Work out the value of b.

Solution:

$(x_1, y_1) = (5, b)$, $(x_2, y_2) = (8, 3)$

$\frac{3-b}{8-5} = -3$

$\frac{3-b}{3} = -3$

$3 - b = -9$

$b = 12$

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Coordinate geometry in the (x, y) plane
Exercise B, Question 4

Question:

The line joining $(c , 4)$ to $(7 , 6)$ has gradient $\frac{3}{4}$. Work out the value of c.

Solution:

$(x_1 , y_1) = (c , 4) , (x_2 , y_2) = (7 , 6)$

$\frac{6 - 4}{7 - c} = \frac{3}{4}$

$\frac{2}{7 - c} = \frac{3}{4}$

$2 = \frac{3}{4} \left(7 - c \right)$

$8 = 3 (7 - c)$

$8 = 21 - 3c$

$- 13 = - 3c$

$c = \frac{- 13}{- 3} = \frac{13}{3} = 4 \frac{1}{3}$

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Coordinate geometry in the (x, y) plane
Exercise B, Question 5

Question:

The line joining $(-1, 2b)$ to $(1, 4)$ has gradient $-\frac{1}{4}$. Work out the value of d.

Solution:

$(x_1, y_1) = (-1, 2b)$, $(x_2, y_2) = (1, 4)$

$\frac{4-2b}{1-(-1)} = -\frac{1}{4}$

$\frac{4-2b}{2} = -\frac{1}{4}$

$2 - b = -\frac{1}{4}$

$2\frac{1}{4} - b = 0$

$b = 2\frac{1}{4}$

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Coordinate geometry in the (x, y) plane
Exercise B, Question 6

Question:

The line joining $(-3, -2)$ to $(2e, 5)$ has gradient 2. Work out the value of e.

Solution:

$(x_1, y_1) = (-3, -2), (x_2, y_2) = (2e, 5)$

$\frac{5-(-2)}{2e-(-3)} = 2$

$\frac{7}{2e+3} = 2$

$7 = 2(2e+3)$
$7 = 4e + 6$
$4e = 1$
$e = \frac{1}{4}$

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Coordinate geometry in the (x, y) plane
Exercise B, Question 7

Question:

The line joining $(7 , 2)$ to $(f , 3f)$ has gradient 4. Work out the value of *f*.

Solution:

$(x_1 , y_1) = (7 , 2) , (x_2 , y_2) = (f , 3f)$

$\frac{3f - 2}{f - 7} = 4$

$3f - 2 = 4 (f - 7)$
$3f - 2 = 4f - 28$
$- 2 = f - 28$
$28 - 2 = f$
$f = 26$

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Coordinate geometry in the (x, y) plane
Exercise B, Question 8

Question:

The line joining $(3, -4)$ to $(-g, 2g)$ has gradient -3. Work out the value of g.

Solution:

$(x_1, y_1) = (3, -4), (x_2, y_2) = (-g, 2g)$

$\frac{2g - (-4)}{-g - 3} = -3$

$\frac{2g + 4}{-g - 3} = -3$

$2g + 4 = -3(-g - 3)$
$2g + 4 = 3g + 9$
$4 = g + 9$
$g = -5$

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Coordinate geometry in the (x, y) plane
Exercise B, Question 9

Question:

Show that the points $A(2, 3)$, $B(4, 4)$, $C(10, 7)$ can be joined by a straight line. (Hint: Find the gradient of the lines joining the points: **i** *A* and *B* and **ii** *A* and *C*.)

Solution:

The gradient of AB is $\frac{4-3}{4-2} = \frac{1}{2}$

The gradient of AC is $\frac{7-3}{10-2} = \frac{4}{8} = \frac{1}{2}$

The gradients are equal so the points can be joined by a straight line.

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Coordinate geometry in the (x, y) plane
Exercise B, Question 10

Question:

Show that the points $(-2a , 5a)$, $(0 , 4a)$, $(6a , a)$ are collinear (i.e. on the same straight line).

Solution:

The gradient of the line joining $(-2a , 5a)$ and $(0 , 4a)$ is

$$\frac{4a - 5a}{0 - (-2a)} = \frac{-a}{2a} = \frac{-1}{2}$$

The gradient of the line joining $(-2a , 5a)$ and $(6a , a)$ is

$$\frac{a - 5a}{6a - (-2a)} = \frac{-4a}{8a} = \frac{-4}{8} = \frac{-1}{2}$$

The gradients are equal so the points can be joined by a straight line (i.e. they are collinear).

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Coordinate geometry in the (x, y) plane
Exercise C, Question 1

Question:

Find the equation of the line with gradient m that passes through the point (x_1 , y_1) when:

(a) $m = 2$ and $(x_1 , y_1) = (2 , 5)$

(b) $m = 3$ and $(x_1 , y_1) = (-2 , 1)$

(c) $m = -1$ and $(x_1 , y_1) = (3 , -6)$

(d) $m = -4$ and $(x_1 , y_1) = (-2 , -3)$

(e) $m = \frac{1}{2}$ and $(x_1 , y_1) = (-4 , 10)$

(f) $m = -\frac{2}{3}$ and $(x_1 , y_1) = (-6 , -1)$

(g) $m = 2$ and $(x_1 , y_1) = (a , 2a)$

(h) $m = -\frac{1}{2}$ and $(x_1 , y_1) = (-2b , 3b)$

Solution:

(a) $y - y_1 = m (x - x_1)$
$y - 5 = 2 (x - 2)$
$y - 5 = 2x - 4$
$y = 2x + 1$

(b) $y - y_1 = m (x - x_1)$
$y - 1 = 3 [x - (-2)]$
$y - 1 = 3 (x + 2)$
$y - 1 = 3x + 6$
$y = 3x + 7$

(c) $y - y_1 = m (x - x_1)$
$y - (-6) = -1 (x - 3)$
$y + 6 = -x + 3$
$y = -x - 3$

(d) $y - y_1 = m (x - x_1)$
$y - (-3) = -4 [x - (-2)]$
$y + 3 = -4 (x + 2)$
$y + 3 = -4x - 8$
$y = -4x - 11$

(e) $y - y_1 = m (x - x_1)$

$y - 10 = \frac{1}{2}\left[x - \left(-4\right)\right]$

$y - 10 = \frac{1}{2}\left(x + 4\right)$

$y - 10 = \frac{1}{2}x + 2$

$y = \frac{1}{2}x + 12$

(f) $y - y_1 = m(x - x_1)$

$y - \left(-1\right) = -\frac{2}{3}\left[x - \left(-6\right)\right]$

$y + 1 = -\frac{2}{3}\left(x + 6\right)$

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

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

(g) $y - y_1 = m(x - x_1)$
$y - 2a = 2(x - a)$
$y - 2a = 2x - 2a$
$y = 2x$

(h) $y - y_1 = m(x - x_1)$

$y - 3b = -\frac{1}{2}\left[x - \left(-2b\right)\right]$

$y - 3b = -\frac{1}{2}\left(x + 2b\right)$

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

$y = -\frac{1}{2}x - b + 3b$

$y = -\frac{1}{2}x + 2b$

Solutionbank C1
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Coordinate geometry in the (x, y) plane
Exercise C, Question 2

Question:

The line $y = 4x - 8$ meets the x-axis at the point A. Find the equation of the line with gradient 3 that passes through the point A.

Solution:

$y = 4x - 8$
Substitute $y = 0$:
$4x - 8 = 0$
$4x = 8$
$x = 2$
So A has coordinates $(2 , 0)$.

$y - y_1 = m (x - x_1)$
$y - 0 = 3 (x - 2)$
$y = 3x - 6$
The equation of the line is $y = 3x - 6$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 3

Question:

The line $y = -2x + 8$ meets the y-axis at the point B. Find the equation of the line with gradient 2 that passes through the point B.

Solution:

$y = -2x + 8$
Substitute $x = 0$:
$y = -2(0) + 8$
$y = 8$
So B has coordinates $(0, 8)$.

$y - y_1 = m(x - x_1)$
$y - 8 = 2(x - 0)$
$y - 8 = 2x$
$y = 2x + 8$
The equation of the line is $y = 2x + 8$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 4

Question:

The line $y = \frac{1}{2}x + 6$ meets the x-axis at the point C. Find the equation of the line with gradient $\frac{2}{3}$ that passes through the point C. Write your answer in the form $ax + by + c = 0$, where a, b and c are integers.

Solution:

$y = \frac{1}{2}x + 6$

Substitute $y = 0$:

$\frac{1}{2}x + 6 = 0$

$\frac{1}{2}x = -6$

$x = -12$

So C has coordinates $(-12 , 0)$.

$y - y_1 = m (x - x_1)$

$y - 0 = \frac{2}{3}\left[x - \left(-12 \right) \right]$

$y = \frac{2}{3}\left(x + 12 \right)$

$y = \frac{2}{3}x + 8$

Multiply each term by 3:

$3y = 2x + 24$

$0 = 2x + 24 - 3y$

$2x - 3y + 24 = 0$

The equation of the line is $2x - 3y + 24 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 5

Question:

The line $y = \frac{1}{4}x + 2$ meets the y-axis at the point B. The point C has coordinates $(- 5 , 3)$. Find the gradient of the line joining the points B and C.

Solution:

$y = \frac{1}{4}x + 2$

Substitute $x = 0$:

$y = \frac{1}{4}\left(0 \right) + 2$

$y = 2$

So B has coordinates $(0 , 2)$.

$\frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 2}{- 5 - 0} = \frac{1}{- 5} = - \frac{1}{5}$

The gradient of the line joining B and C is $- \frac{1}{5}$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 6

Question:

The lines $y = x$ and $y = 2x - 5$ intersect at the point A. Find the equation of the line with gradient $\frac{2}{5}$ that passes through the point A. (Hint: Solve $y = x$ and $y = 2x - 5$ simultaneously.)

Solution:

Substitute $y = x$:
$x = 2x - 5$
$0 = x - 5$
$x = 5$

$y = x$
Substitute $x = 5$:
$y = 5$
The coordinates of A are $(5 , 5)$.

$y - y_1 = m (x - x_1)$

$y - 5 = \frac{2}{5} \left(x - 5 \right)$

$y - 5 = \frac{2}{5}x - 2$

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

The equation of the line is $y = \frac{2}{5}x + 3$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 7

Question:

The lines $y = 4x - 10$ and $y = x - 1$ intersect at the point T. Find the equation of the line with gradient $-\frac{2}{3}$ that passes through the point T. Write your answer in the form $ax + by + c = 0$, where a, b and c are integers.

Solution:

Substitute $y = x - 1$:
$x - 1 = 4x - 10$
$-1 = 3x - 10$
$9 = 3x$
$x = 3$

$y = x - 1$
Substitute $x = 3$:
$y = 3 - 1 = 2$
The coordinates of T are $(3 , 2)$.

$y - y_1 = m (x - x_1)$

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

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

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

$\frac{2}{3}x + y - 4 = 0$

$2x + 3y - 12 = 0$
The equation of the line is $2x + 3y - 12 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 8

Question:

The line p has gradient $\frac{2}{3}$ and passes through the point $(6 , - 12)$. The line q has gradient -1 and passes through the point $(5 , 5)$. The line p meets the y-axis at A and the line q meets the x-axis at B. Work out the gradient of the line joining the points A and B.

Solution:

The equation of p is

$y - \left(- 12 \right) = \frac{2}{3} \left(x - 6 \right)$

$y + 12 = \frac{2}{3}x - 4$

$y = \frac{2}{3}x - 16$

The equation of q is
$y - 5 = - 1 (x - 5)$
$y - 5 = - x + 5$
$y = - x + 10$

For the coordinates of A substitute $x = 0$ into

$y = \frac{2}{3}x - 16$

$y = \frac{2}{3} \left(0 \right) - 16$

$y = - 16$
Coordinates are $A (0 , - 16)$

For the coordinates of B substitute $y = 0$ into
$y = - x + 10$
$0 = - x + 10$
$x = 10$
Coordinates are $B (10 , 0)$

Gradient of AB is

$\frac{y_2 - y_1}{x_2 - x_1} = \frac{- 16 - 0}{0 - 10} = \frac{- 16}{- 10} = \frac{8}{5}$

The gradient of the line joining A and B is $\frac{8}{5}$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 9

Question:

The line $y = -2x + 6$ meets the x-axis at the point P. The line $y = \frac{3}{2}x - 4$ meets the y-axis at the point Q. Find the equation of the line joining the points P and Q. (Hint: First work out the gradient of the line joining the points P and Q.)

Solution:

$y = -2x + 6$
Substitute $y = 0$:
$0 = -2x + 6$
$2x = 6$
$x = 3$
P has coordinates $(3, 0)$.

$y = \frac{3}{2}x - 4$

Substitute $x = 0$:

$y = \frac{3}{2}\left(0\right) - 4$

$y = -4$
Q has coordinates $(0, -4)$

Gradient of PQ is

$\frac{y_2 - y_1}{x_2 - x_1} = \frac{0 - (-4)}{3 - 0} = \frac{4}{3}$

Equation of PQ is
$y - y_1 = m(x - x_1)$
Substitute $(3, 0)$:

$y - 0 = \frac{4}{3}\left(x - 3\right)$

$y = \frac{4}{3}x - 4$

The equation of the line through P and Q is $y = \frac{4}{3}x - 4$.

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Coordinate geometry in the (x, y) plane
Exercise C, Question 10

Question:

The line $y = 3x - 5$ meets the x-axis at the point M. The line $y = -\frac{2}{3}x + \frac{2}{3}$ meets the y-axis at the point N. Find the equation of the line joining the points M and N. Write your answer in the form $ax + by + c = 0$, where a, b and c are integers.

Solution:

$y = 3x - 5$
Substitute $y = 0$:
$3x - 5 = 0$
$3x = 5$
$x = \frac{5}{3}$

M has coordinates $\left(\frac{5}{3}, 0 \right)$.

$y = -\frac{2}{3}x + \frac{2}{3}$
Substitute $x = 0$:
$y = -\frac{2}{3}\left(0 \right) + \frac{2}{3} = \frac{2}{3}$

N has coordinates $\left(0, \frac{2}{3} \right)$.

Gradient of MN is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{0 - \frac{2}{3}}{\frac{5}{3} - 0} = \frac{-\frac{2}{3}}{\frac{5}{3}} = -\frac{2}{5}$$

Equation of MN is
$y - y_1 = m \left(x - x_1 \right)$
Substitute $\left(\frac{5}{3}, 0 \right)$:

$y - 0 = -\frac{2}{5}\left(x - \frac{5}{3} \right)$

$y = -\frac{2}{5}x + \frac{2}{3}$
Multiply each term by 15:
$15y = -6x + 10$
$6x + 15y = 10$
$6x + 15y - 10 = 0$

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Coordinate geometry in the (x, y) plane
Exercise D, Question 1

Question:

Find the equation of the line that passes through these pairs of points:

(a) $(2, 4)$ and $(3, 8)$

(b) $(0, 2)$ and $(3, 5)$

(c) $(-2, 0)$ and $(2, 8)$

(d) $(5, -3)$ and $(7, 5)$

(e) $(3, -1)$ and $(7, 3)$

(f) $(-4, -1)$ and $(6, 4)$

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

(h) $(-4, -1)$ and $(-3, -9)$

(i) $\left(\frac{1}{3}, \frac{2}{5}\right)$ and $\left(\frac{2}{3}, \frac{4}{5}\right)$

(j) $\left(-\frac{3}{4}, \frac{1}{7}\right)$ and $\left(\frac{1}{4}, \frac{3}{7}\right)$

Solution:

(a) $(x_1, y_1) = (2, 4)$, $(x_2, y_2) = (3, 8)$

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 4}{8 - 4} = \frac{x - 2}{3 - 2}$$

$$\frac{y - 4}{4} = \frac{x - 2}{1}$$

$$\frac{y - 4}{4} = x - 2$$

Multiply each side by 4:

$$4 \times \frac{y - 4}{4} = 4\left(x - 2\right)$$

$y - 4 = 4(x - 2)$
$y - 4 = 4x - 8$
$y = 4x - 4$

(b) $(x_1, y_1) = (0, 2)$, $(x_2, y_2) = (3, 5)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-2}{5-2}=\frac{x-0}{3-0}$$

$$\frac{y-2}{3}=\frac{x}{3}$$

Multiply each side by 3:

$$3\times\frac{y-2}{3}=3\times\frac{x}{3}$$

$y-2=x$
$y=x+2$

(c) $(x_1, y_1) = (-2, 0)$, $(x_2, y_2) = (2, 8)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-0}{8-0}=\frac{x-(-2)}{2-(-2)}$$

$$\frac{y}{8}=\frac{x+2}{4}$$

Multiply each side by 8:

$$8\times\frac{y}{8}=8\times\frac{x+2}{4}$$

$y=2(x+2)$
$y=2x+4$

(d) $(x_1, y_1) = (5, -3)$, $(x_2, y_2) = (7, 5)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-(-3)}{5-(-3)}=\frac{x-5}{7-5}$$

$$\frac{y+3}{8}=\frac{x-5}{2}$$

Multiply each side by 8:

$$8\times\frac{y+3}{8}=8\times\frac{x-5}{2}$$

$y+3=4(x-5)$
$y+3=4x-20$
$y=4x-23$

(e) $(x_1, y_1) = (3, -1)$, $(x_2, y_2) = (7, 3)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-(-1)}{3-(-1)}=\frac{x-3}{7-3}$$

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

Multiply each side by 4:
$y+1=x-3$
$y=x-4$

(f) $(x_1, y_1) = (-4, -1)$, $(x_2, y_2) = (6, 4)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-(-1)}{4-(-1)}=\frac{x-(-4)}{6-(-4)}$$

$$\frac{y+1}{5}=\frac{x+4}{10}$$

Multiply each side by 10:
$2(y+1)=x+4$
$2y+2=x+4$
$2y=x+2$
Divide each term by 2:

$y=\frac{1}{2}x+1$

(g) $(x_1, y_1)=(-1,-5)$, $(x_2, y_2)=(-3,3)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-(-5)}{3-(-5)}=\frac{x-(-1)}{-3-(-1)}$$

$$\frac{y+5}{8}=\frac{x+1}{-2}$$

Multiply each side by 8:

$y+5=-4(x+1)$ (**Note:** $\frac{8}{-2}=-4$)

$y+5=-4x-4$
$y=-4x-9$

(h) $(x_1, y_1)=(-4,-1)$, $(x_2, y_2)=(-3,-9)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-(-1)}{-9-(-1)}=\frac{x-(-4)}{-3-(-4)}$$

$$\frac{y+1}{-8}=\frac{x+4}{1}$$

Multiply each side by -8:
$y+1=-8(x+4)$
$y+1=-8x-32$
$y=-8x-33$

(i) $\left(x_1, y_1\right)=\left(\frac{1}{3},\frac{2}{5}\right)$, $\left(x_2, y_2\right)=\left(\frac{2}{3},\frac{4}{5}\right)$

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1}$$

$$\frac{y-\frac{2}{5}}{\frac{4}{5}-\frac{2}{5}}=\frac{x-\frac{1}{3}}{\frac{2}{3}-\frac{1}{3}}$$

$$\frac{y-\frac{2}{5}}{\frac{2}{5}}=\frac{x-\frac{1}{3}}{\frac{1}{3}}$$

$\frac{5}{2}\left(y - \frac{2}{5}\right) = 3\left(x - \frac{1}{3}\right)$ (**Note:** $\frac{1}{\frac{2}{5}} = \frac{5}{2}$ and $\frac{1}{\frac{1}{3}} = 3$)

$\frac{5}{2}y - 1 = 3x - 1$

$\frac{5}{2}y = 3x$

$5y = 6x$

$y = \frac{6}{5}x$

(j) $\left(x_1, y_1\right) = \left(\frac{-3}{4}, \frac{1}{7}\right), \left(x_2, y_2\right) = \left(\frac{1}{4}, \frac{3}{7}\right)$

$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$

$\frac{y - \frac{1}{7}}{\frac{3}{7} - \frac{1}{7}} = \frac{x - \left(-\frac{3}{4}\right)}{\frac{1}{4} - \left(-\frac{3}{4}\right)}$

$\frac{y - \frac{1}{7}}{\frac{2}{7}} = \frac{x + \frac{3}{4}}{1}$

Multiply each side by $\frac{2}{7}$:

$y - \frac{1}{7} = \frac{2}{7}\left(x + \frac{3}{4}\right)$

$y - \frac{1}{7} = \frac{2}{7}x + \frac{3}{14}$

$y = \frac{2}{7}x + \frac{3}{14} + \frac{1}{7}$

$y = \frac{2}{7}x + \frac{5}{14}$

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Edexcel Modular Mathematics for AS and A-Level

Coordinate geometry in the (x, y) plane
Exercise D, Question 2

Question:

The line that passes through the points $(2 , - 5)$ and $(- 7 , 4)$ meets the *x*-axis at the point *P*. Work out the coordinates of the point *P*.

Solution:

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - (- 5)}{4 - (- 5)} = \frac{x - 2}{- 7 - 2}$$

$$\frac{y + 5}{9} = \frac{x - 2}{- 9}$$

Multiply each side by 9:

$y + 5 = - 1 (x - 2)$ (**Note:** $\frac{9}{- 9} = - 1$)

$y + 5 = - x + 2$
$y = - x - 3$
Substitute $y = 0$:
$0 = - x - 3$
$x = - 3$
So the line meets the *x*-axis at $P (- 3 , 0)$.

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Coordinate geometry in the (x, y) plane
Exercise D, Question 3

Question:

The line that passes through the points $(- 3 , - 5)$ and $(4 , 9)$ meets the y-axis at the point G. Work out the coordinates of the point G.

Solution:

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - (- 5)}{9 - (- 5)} = \frac{x - (- 3)}{4 - (- 3)}$$

$$\frac{y + 5}{14} = \frac{x + 3}{7}$$

Multiply each side by 14:
$y + 5 = 2 (x + 3)$
$y + 5 = 2x + 6$
$y = 2x + 1$
Substitute $x = 0$:
$y = 2 (0) + 1 = 1$
The coordinates of G are $(0 , 1)$.

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Coordinate geometry in the (x, y) plane
Exercise D, Question 4

Question:

The line that passes through the points $\left(3 , 2 \frac{1}{2} \right)$ and $\left(-1 \frac{1}{2} , 4 \right)$ meets the y-axis at the point J. Work out the coordinates of the point J.

Solution:

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

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

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

Multiply top and bottom of each fraction by 2:

$$\frac{2y - 5}{3} = \frac{2x - 6}{-9}$$

Multiply each side by 9:

$3 (2y - 5) = -1 (2x - 6)$ (**Note:** $\frac{9}{-9} = -1$)

$6y - 15 = -2x + 6$

$6y = -2x + 21$

$y = - \frac{2}{6} x + \frac{21}{6}$

$y = - \frac{1}{3} x + \frac{7}{2}$

Substitute $x = 0$:

$y = - \frac{1}{3} \left(0 \right) + \frac{7}{2} = \frac{7}{2}$

The coordinates of J are $\left(0 , \frac{7}{2} \right)$ or $\left(0 , 3 \frac{1}{2} \right)$.

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Coordinate geometry in the (x, y) plane
Exercise D, Question 5

Question:

The line $y = 2x - 10$ meets the x-axis at the point A. The line $y = -2x + 4$ meets the y-axis at the point B. Find the equation of the line joining the points A and B. (Hint: First work out the coordinates of the points A and B.)

Solution:

$y = 2x - 10$
Substitute $y = 0$:
$2x - 10 = 0$
$2x = 10$
$x = 5$
The coordinates of A are $(5, 0)$.

$y = -2x + 4$
Substitute $x = 0$:
$y = -2(0) + 4 = 4$
The coordinates of B are $(0, 4)$.

Equation of AB:

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 0}{4 - 0} = \frac{x - 5}{0 - 5}$$

$$\frac{y}{4} = \frac{x - 5}{-5}$$

Multiply each side by 4:

$$y = 4\frac{(x - 5)}{-5} = \frac{4}{-5}\left(x - 5\right) = -\frac{4}{5}\left(x - 5\right) = -\frac{4}{5}x + 4$$

The equation of the line is $y = -\frac{4}{5}x + 4$.

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Coordinate geometry in the (x, y) plane
Exercise D, Question 6

Question:

The line $y = 4x + 5$ meets the y-axis at the point C. The line $y = -3x - 15$ meets the x-axis at the point D. Find the equation of the line joining the points C and D. Write your answer in the form $ax + by + c = 0$, where a, b and c are integers.

Solution:

$y = 4x + 5$
Substitute $x = 0$:
$y = 4(0) + 5 = 5$
The coordinates of C are $(0, 5)$.

$y = -3x - 15$
Substitute $y = 0$:
$0 = -3x - 15$
$3x = -15$
$x = -5$
The coordinates of D are $(-5, 0)$.

Equation of CD:

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 5}{0 - 5} = \frac{x - 0}{-5 - 0}$$

$$\frac{y - 5}{-5} = \frac{x}{-5}$$

Multiply each side by -5:
$y - 5 = x$
$-5 = x - y$
$0 = x - y + 5$
The equation of the line is $x - y + 5 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise D, Question 7

Question:

The lines $y = x - 5$ and $y = 3x - 13$ intersect at the point S. The point T has coordinates $(- 4 , 2)$. Find the equation of the line that passes through the points S and T.

Solution:

$y = 3x - 13$
$y = x - 5$
So $3x - 13 = x - 5$

$\Rightarrow \quad 3x = x + 8$

$\Rightarrow \quad 2x = 8$

$\Rightarrow \quad x = 4$

when $x = 4$, $y = 4 - 5 = - 1$
The coordinates of S are $(4 , - 1)$.
Equation of ST:

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

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

$$\frac{y + 1}{3} = \frac{x - 4}{- 8}$$

Multiply each side by 3:

$$y + 1 = 3 \times \frac{(x - 4)}{- 8}$$

$$y + 1 = \frac{3}{- 8} \times \left(x - 4 \right)$$

$$y + 1 = - \frac{3}{8} \left(x - 4 \right)$$

$$y + 1 = - \frac{3}{8} x + \frac{3}{2}$$

$$y = - \frac{3}{8} x + \frac{1}{2}$$

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Coordinate geometry in the (x, y) plane
Exercise D, Question 8

Question:

The lines $y = -2x + 1$ and $y = x + 7$ intersect at the point L. The point M has coordinates $(-3, 1)$. Find the equation of the line that passes through the points L and M.

Solution:

$y = x + 7$
$y = -2x + 1$
So $x + 7 = -2x + 1$

$\Rightarrow \quad 3x + 7 = 1$

$\Rightarrow \quad 3x = -6$

$\Rightarrow \quad x = -2$

when $x = -2$, $y = (-2) + 7 = 5$
The coordinates of L are $(-2, 5)$.
Equation of LM:

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 5}{1 - 5} = \frac{x - (-2)}{-3 - (-2)}$$

$$\frac{y - 5}{-4} = \frac{x + 2}{-1}$$

Multiply each side by -4:

$y - 5 = 4(x + 2)$ (**Note:** $\frac{-4}{-1} = 4$)

$y - 5 = 4x + 8$
$y = 4x + 13$

Solutionbank C1
Edexcel Modular Mathematics for AS and A-Level

Coordinate geometry in the (x, y) plane
Exercise D, Question 9

Question:

The vertices of the triangle ABC have coordinates $A(3,5)$, $B(-2,0)$ and $C(4,-1)$. Find the equations of the sides of the triangle.

Solution:

(1) Equation of AB:
$(x_1, y_1) = (3, 5)$, $(x_2, y_2) = (-2, 0)$

$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$

$\frac{y - 5}{0 - 5} = \frac{x - 3}{-2 - 3}$

$\frac{y - 5}{-5} = \frac{x - 3}{-5}$

Multiply each side by -5:
$y - 5 = x - 3$
$y = x + 2$

(2) Equation of AC:
$(x_1, y_1) = (3, 5)$, $(x_2, y_2) = (4, -1)$

$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$

$\frac{y - 5}{-1 - 5} = \frac{x - 3}{4 - 3}$

$\frac{y - 5}{-6} = \frac{x - 3}{1}$

Multiply each side by -6:
$y - 5 = -6(x - 3)$
$y - 5 = -6x + 18$
$y = -6x + 23$

(3) Equation of BC:
$(x_1, y_1) = (-2, 0)$, $(x_2, y_2) = (4, -1)$

$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$

$\frac{y - 0}{-1 - 0} = \frac{x - (-2)}{4 - (-2)}$

$\frac{y}{-1} = \frac{x + 2}{6}$

Multiply each side by -1:

$y = -1\frac{(x + 2)}{6}$

$y = -\frac{1}{6}\left(x + 2\right)$

$y = -\frac{1}{6}x - \frac{1}{3}$

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Coordinate geometry in the (x, y) plane
Exercise D, Question 10

Question:

The line V passes through the points $(-5 , 3)$ and $(7 , -3)$ and the line W passes through the points $(2 , -4)$ and $(4 , 2)$. The lines V and W intersect at the point A. Work out the coordinates of the point A.

Solution:

(1) The equation of V:
$(x_1 , y_1) = (-5 , 3) , (x_2 , y_2) = (7 , -3)$

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 3}{-3 - 3} = \frac{x - (-5)}{7 - (-5)}$$

$$\frac{y - 3}{-6} = \frac{x + 5}{12}$$

Multiply each side by -6:

$y - 3 = -\frac{1}{2}\left(x + 5 \right)$ (**Note:** $\frac{-6}{12} = -\frac{1}{2}$)

$$y - 3 = -\frac{1}{2}x - \frac{5}{2}$$

$$y = -\frac{1}{2}x + \frac{1}{2}$$

(2) The equation of W:
$(x_1 , y_1) = (2 , -4) , (x_2 , y_2) = (4 , 2)$

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

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

$$\frac{y + 4}{6} = \frac{x - 2}{2}$$

Multiply each side by 6:

$y + 4 = 3 (x - 2)$ (**Note:** $\frac{6}{2} = 3$)

$y + 4 = 3x - 6$
$y = 3x - 10$

Solving simultaneously:

$$y = -\frac{1}{2}x + \frac{1}{2}$$

$$y = 3x - 10$$

So $3x - 10 = -\frac{1}{2}x + \frac{1}{2}$

$$\Rightarrow \quad \frac{7}{2}x - 10 = \frac{1}{2}$$

$$\Rightarrow \quad \frac{7}{2}x = \frac{21}{2}$$

$\Rightarrow \quad 7x = 21$

$\Rightarrow \quad x = 3$

When $x = 3$, $y = 3 (3) - 10 = 9 - 10 = - 1$
The lines intersect at $A (3 , - 1)$.

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Coordinate geometry in the (x, y) plane
Exercise E, Question 1

Question:

Work out if these pairs of lines are parallel, perpendicular or neither:

(a) $y = 4x + 2$

$y = -\frac{1}{4}x - 7$

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

$y = \frac{2}{3}x - 11$

(c) $y = \frac{1}{5}x + 9$

$y = 5x + 9$

(d) $y = -3x + 2$

$y = \frac{1}{3}x - 7$

(e) $y = \frac{3}{5}x + 4$

$y = -\frac{5}{3}x - 1$

(f) $y = \frac{5}{7}x$

$y = \frac{5}{7}x - 3$

(g) $y = 5x - 3$
$5x - y + 4 = 0$

(h) $5x - y - 1 = 0$

$y = -\frac{1}{5}x$

(i) $y = -\frac{3}{2}x + 8$

$2x - 3y - 9 = 0$

(j) $4x - 5y + 1 = 0$
$8x - 10y - 2 = 0$

(k) $3x + 2y - 12 = 0$
$2x + 3y - 6 = 0$

(l) $5x - y + 2 = 0$

$2x + 10y - 4 = 0$

Solution:

(a) The gradients of the lines are 4 and $-\frac{1}{4}$.

$4 \times -\frac{1}{4} = -1$

The lines are **perpendicular**.

(b) The gradients of the lines are $\frac{2}{3}$ and $\frac{2}{3}$, i.e. they have the same gradient.

The lines are **parallel**.

(c) The gradients of the lines are $\frac{1}{5}$ and 5.

$\frac{1}{5} \times 5 = 1$

The lines are **neither** perpendicular nor parallel.

(d) The gradients of the lines are -3 and $\frac{1}{3}$.

$-3 \times \frac{1}{3} = -1$

The lines are **perpendicular**.

(e) The gradients of the lines are $\frac{3}{5}$ and $-\frac{5}{3}$.

$\frac{3}{5} \times -\frac{5}{3} = -1$

The lines are **perpendicular**.

(f) The gradients of the lines are $\frac{5}{7}$ and $\frac{5}{7}$, i.e. they have the same gradient.

The lines are **parallel**.

(g) The gradient of $y = 5x - 3$ is 5.
$5x - y + 4 = 0$
$5x + 4 = y$
$y = 5x + 4$
The gradient of $5x - y + 4 = 0$ is 5.
The lines have the same gradient.
The lines are **parallel**.

(h) $5x - y - 1 = 0$
$5x - 1 = y$
$y = 5x - 1$
The gradient of $5x - y - 1 = 0$ is 5.

The gradient of $y = -\frac{1}{5}x$ is $-\frac{1}{5}$.

The product of the gradients is $5 \times -\frac{1}{5} = -1$

So the lines are **perpendicular**.

(i) The gradient of $y = -\frac{3}{2}x + 8$ is $-\frac{3}{2}$.

$2x - 3y - 9 = 0$

$2x - 9 = 3y$
$3y = 2x - 9$
$y = \frac{2}{3}x - 3$

The gradient of $2x - 3y - 9 = 0$ is $\frac{2}{3}$.

The product of the gradients is $\frac{2}{3} \times - \frac{3}{2} = -1$

So the lines are **perpendicular**.

(j) $4x - 5y + 1 = 0$
$4x + 1 = 5y$
$5y = 4x + 1$
$y = \frac{4}{5}x + \frac{1}{5}$

The gradient of $4x - 5y + 1 = 0$ is $\frac{4}{5}$.

$8x - 10y - 2 = 0$
$8x - 2 = 10y$
$10y = 8x - 2$
$y = \frac{8}{10}x - \frac{2}{10}$

$y = \frac{4}{5}x - \frac{1}{5}$

The gradient of $8x - 10y - 2 = 0$ is $\frac{4}{5}$.

The lines have the same gradient, they are **parallel**.

(k) $3x + 2y - 12 = 0$
$3x + 2y = 12$
$2y = -3x + 12$
$y = -\frac{3}{2}x + 6$

The gradient of $3x + 2y - 12 = 0$ is $-\frac{3}{2}$.

$2x + 3y - 6 = 0$
$2x + 3y = 6$
$3y = -2x + 6$
$y = -\frac{2}{3}x + 2$

The gradient of $2x + 3y - 6 = 0$ is $-\frac{2}{3}$.

The product of the gradient is
$-\frac{3}{2} \times -\frac{2}{3} = 1$

So the lines are **neither** parallel nor perpendicular.

(l) $5x - y + 2 = 0$
$5x + 2 = y$
$y = 5x + 2$
The gradient of $5x - y + 2 = 0$ is 5.
$2x + 10y - 4 = 0$
$2x + 10y = 4$
$10y = -2x + 4$
$y = -\frac{2}{10}x + \frac{4}{10}$

$y = -\frac{1}{5}x + \frac{2}{5}$

The gradient of $2x + 10y - 4 = 0$ is $-\frac{1}{5}$.

The product of the gradients is

$5 \times -\frac{1}{5} = -1$

So the lines are **perpendicular**.

Solutionbank C1
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Coordinate geometry in the (x, y) plane
Exercise E, Question 2

Question:

Find an equation of the line that passes through the point $(6 , - 2)$ and is perpendicular to the line $y = 3x + 5$.

Solution:

The gradient of $y = 3x + 5$ is 3.

The gradient of a line perpendicular to $y = 3x + 5$ is $-\frac{1}{3}$.

$y - y_1 = m (x - x_1)$

$y - \left(- 2 \right) = - \frac{1}{3} \left(x - 6 \right)$

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

$y = - \frac{1}{3}x$

The equation of the line is $y = - \frac{1}{3}x$.

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Coordinate geometry in the (x, y) plane
Exercise E, Question 3

Question:

Find an equation of the line that passes through the point $(-2 , 7)$ and is parallel to the line $y = 4x + 1$. Write your answer in the form $ax + by + c = 0$.

Solution:

The gradient of a line parallel to $y = 4x + 1$ is 4.
$y - y_1 = m (x - x_1)$
$y - 7 = 4 [x - (-2)]$
$y - 7 = 4 (x + 2)$
$y - 7 = 4x + 8$
$y = 4x + 15$
$0 = 4x + 15 - y$
$4x - y + 15 = 0$
The equation of the line is $4x - y + 15 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise E, Question 4

Question:

Find an equation of the line:

(a) parallel to the line $y = -2x - 5$, passing through $\left(-\frac{1}{2}, \frac{3}{2}\right)$.

(b) parallel to the line $x - 2y - 1 = 0$, passing through $(0, 0)$.

(c) perpendicular to the line $y = x - 4$, passing through $(-1, -2)$.

(d) perpendicular to the line $2x + y - 9 = 0$, passing through $(4, -6)$.

Solution:

(a) The gradient of a line parallel to $y = -2x - 5$ is -2.

$y - y_1 = m(x - x_1)$

$y - \frac{3}{2} = -2\left[x - \left(-\frac{1}{2}\right)\right]$

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

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

$y = -2x + \frac{1}{2}$

(b) $x - 2y - 1 = 0$

$x - 1 = 2y$

$2y = x - 1$

$y = \frac{1}{2}x - \frac{1}{2}$

The gradient of $x - 2y - 1 = 0$ is $\frac{1}{2}$.

$y - y_1 = m(x - x_1)$

$y - 0 = \frac{1}{2}(x - 0)$

$y = \frac{1}{2}x$

(c) The gradient of $y = x - 4$ is 1.

The gradient of a line perpendicular to $y = x - 4$ is $-\frac{1}{1} = -1$.

$y - y_1 = m(x - x_1)$

$y - (-2) = -1[x - (-1)]$

$y + 2 = -1(x + 1)$

$y + 2 = -x - 1$

$y = -x - 3$

(d) $2x + y - 9 = 0$
$2x + y = 9$
$y = -2x + 9$
The gradient of $2x + y - 9 = 0$ is -2.

The gradient of a line perpendicular to $2x + y - 9 = 0$ is $-\frac{1}{-2} = \frac{1}{2}$.

$y - y_1 = m\left(x - x_1\right)$

$y - \left(-6\right) = \frac{1}{2}\left(x - 4\right)$

$y + 6 = \frac{1}{2}\left(x - 4\right)$

$y + 6 = \frac{1}{2}x - 2$

$y = \frac{1}{2}x - 8$

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Coordinate geometry in the (x, y) plane
Exercise E, Question 5

Question:

Find an equation of the line:

(a) parallel to the line $y = 3x + 6$, passing through $(-2, 5)$.

(b) perpendicular to the line $y = 3x + 6$, passing through $(-2, 5)$.

(c) parallel to the line $4x - 6y + 7 = 0$, passing through $(3, 4)$.

(d) perpendicular to the line $4x - 6y + 7 = 0$, passing through $(3, 4)$.

Solution:

(a) The gradient of a line parallel to $y = 3x + 6$ is 3.
$y - y_1 = m(x - x_1)$
$y - 5 = 3[x - (-2)]$
$y - 5 = 3(x + 2)$
$y - 5 = 3x + 6$
$y = 3x + 11$

(b) The gradient of a line perpendicular to $y = 3x + 6$ is $-\frac{1}{3}$.

$y - y_1 = m(x - x_1)$

$y - 5 = -\frac{1}{3}\left[x - \left(-2\right)\right]$

$y - 5 = -\frac{1}{3}\left(x + 2\right)$

$y - 5 = -\frac{1}{3}x - \frac{2}{3}$

$y = -\frac{1}{3}x + \frac{13}{3}$

(c) $4x - 6y + 7 = 0$
$4x + 7 = 6y$
$6y = 4x + 7$

$y = \frac{4}{6}x + \frac{7}{6}$

$y = \frac{2}{3}x + \frac{7}{6}$

The gradient of a line parallel to $4x - 6y + 7 = 0$ is $\frac{2}{3}$.

$y - y_1 = m(x - x_1)$

$y - 4 = \frac{2}{3}\left(x - 3\right)$

$y - 4 = \frac{2}{3}x - 2$

$y = \frac{2}{3}x + 2$

(d) The gradient of the line $4x - 6y + 7 = 0$ is $\frac{2}{3}$ [see part (c)].

The gradient of a line perpendicular to $4x - 6y + 7 = 0$ is $-\frac{1}{\frac{2}{3}} = -\frac{3}{2}$.

$y - y_1 = m (x - x_1)$

$y - 4 = -\frac{3}{2}\left(x - 3 \right)$

$y - 4 = -\frac{3}{2}x + \frac{9}{2}$

$y = -\frac{3}{2}x + \frac{17}{2}$

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Coordinate geometry in the (x, y) plane
Exercise E, Question 6

Question:

Find an equation of the line that passes through the point $(5, -5)$ and is perpendicular to the line $y = \frac{2}{3}x + 5$. Write your answer in the form $ax + by + c = 0$, where a, b and c are integers.

Solution:

The gradient of a line perpendicular to $y = \frac{2}{3}x + 5$ is $-\frac{1}{\frac{2}{3}} = -\frac{3}{2}$.

$y - y_1 = m(x - x_1)$

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

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

Multiply each term by 2:

$2y + 10 = -3(x - 5)$

$2y + 10 = -3x + 15$

$3x + 2y + 10 = 15$

$3x + 2y - 5 = 0$

The equation of the line is $3x + 2y - 5 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise E, Question 7

Question:

Find an equation of the line that passes through the point $\left(-2 , -3 \right)$ and is perpendicular to the line $y = -\frac{4}{7}x + 5$.

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

Solution:

The gradient of a line perpendicular to $y = -\frac{4}{7}x + 5$ is $-\frac{1}{-\frac{4}{7}} = \frac{7}{4}$.

$y - y_1 = m \left(x - x_1 \right)$

$y - \left(-3 \right) = \frac{7}{4}\left[x - \left(-2 \right) \right]$

$y + 3 = \frac{7}{4}\left(x + 2 \right)$

Multiply each term by 4:

$4y + 12 = 7\left(x + 2 \right)$

$4y + 12 = 7x + 14$

$4y = 7x + 2$

$0 = 7x + 2 - 4y$

$7x - 4y + 2 = 0$

The equation of the line is $7x - 4y + 2 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise E, Question 8

Question:

The line *r* passes through the points $(1, 4)$ and $(6, 8)$ and the line *s* passes through the points $(5, -3)$ and $(20, 9)$. Show that the lines *r* and *s* are parallel.

Solution:

The gradient of *r* is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{8 - 4}{6 - 1} = \frac{4}{5}$$

The gradient of *s* is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{9 - (-3)}{20 - 5} = \frac{12}{15} = \frac{4}{5}$$

The gradients are equal, so the lines are **parallel**.

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Coordinate geometry in the (x, y) plane
Exercise E, Question 9

Question:

The line l passes through the points $(-3 , 0)$ and $(3 , -2)$ and the line n passes through the points $(1 , 8)$ and $(-1 , 2)$. Show that the lines l and n are perpendicular.

Solution:

The gradient of l is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 0}{3 - (-3)} = -\frac{2}{6} = -\frac{1}{3}$$

The gradient of n is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{2 - 8}{-1 - 1} = \frac{-6}{-2} = 3$$

The product of the gradients is

$$-\frac{1}{3} \times 3 = -1$$

So the lines are **perpendicular**.

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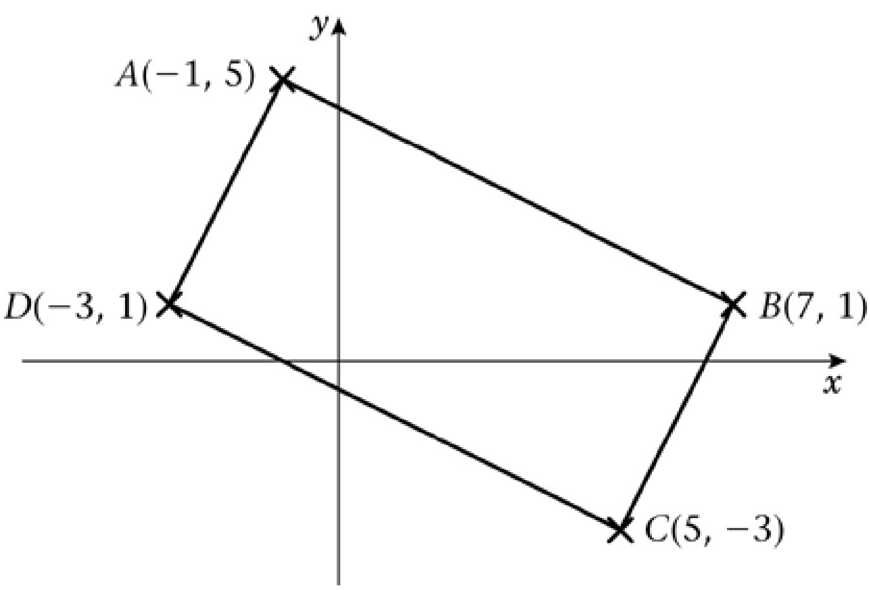
Coordinate geometry in the (x, y) plane
Exercise E, Question 10

Question:

The vertices of a quadrilateral *ABCD* has coordinates $A(-1,5)$, $B(7,1)$, $C(5,-3)$, $D(-3,1)$. Show that the quadrilateral is a rectangle.

Solution:



(1) The gradient of *AB* is

$$\frac{y_2-y_1}{x_2-x_1}=\frac{5-1}{-1-7}=\frac{4}{-8}=-\frac{1}{2}$$

(2) The gradient of *DC* is

$$\frac{y_2-y_1}{x_2-x_1}=\frac{-3-1}{5-(-3)}=-\frac{4}{8}=-\frac{1}{2}$$

The gradient of *AB* is the same as the gradient of *DC*, so the lines are parallel.

(3) The gradient of *AD* is

$$\frac{y_2-y_1}{x_2-x_1}=\frac{5-1}{-1-(-3)}=\frac{4}{-1+3}=\frac{4}{2}=2$$

(4) The gradient of *BC* is

$$\frac{y_2-y_1}{x_2-x_1}=\frac{-3-1}{5-7}=\frac{-4}{-2}=2$$

The gradient of *AD* is the same as the gradient of *BC*, so the lines are parallel.

The line *AD* is perpendicular to the line *AB* as

$$2\times-\frac{1}{2}=-1$$

So *ABCD* is a rectangle.

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Coordinate geometry in the (x, y) plane
Exercise F, Question 1

Question:

The points *A* and *B* have coordinates $(-4, 6)$ and $(2, 8)$ respectively. A line *p* is drawn through *B* perpendicular to *AB* to meet the *y*-axis at the point *C*.

(a) Find an equation of the line *p*.

(b) Determine the coordinates of *C*. **[E]**

Solution:

(a) The gradient of *AB* is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{8-6}{2-(-4)} = \frac{2}{6} = \frac{1}{3}$$

The gradient of a line perpendicular to *AB* is

$$-\frac{1}{\frac{1}{3}} = -3$$

The equation of *p* is
$y - y_1 = m(x - x_1)$
$y - 8 = -3(x - 2)$
$y - 8 = -3x + 6$
$y = -3x + 14$

(b) Substitute $x = 0$:
$y = -3(0) + 14 = 14$
The coordinates of *C* are $(0, 14)$.

Solutionbank C1

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Coordinate geometry in the (x, y) plane

Exercise F, Question 2

Question:

The line l has equation $2x - y - 1 = 0$.
The line m passes through the point $A(0, 4)$ and is perpendicular to the line l.

(a) Find an equation of m and show that the lines l and m intersect at the point $P(2, 3)$.
The line n passes through the point $B(3, 0)$ and is parallel to the line m.

(b) Find an equation of n and hence find the coordinates of the point Q where the lines l and n intersect. **[E]**

Solution:

(a) $2x - y - 1 = 0$
$2x - 1 = y$
$y = 2x - 1$
The gradient of $2x - y - 1 = 0$ is 2.

The gradient of a line perpendicular to $2x - y - 1 = 0$ is $-\frac{1}{2}$.

The equation of the line m is
$y - y_1 = m(x - x_1)$

$y - 4 = -\frac{1}{2}\left(x - 0\right)$

$y - 4 = -\frac{1}{2}x$

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

To find P solve $y = -\frac{1}{2}x + 4$ and $2x - y - 1 = 0$ simultaneously.

Substitute:

$2x - \left(-\frac{1}{2}x + 4\right) - 1 = 0$

$2x + \frac{1}{2}x - 4 - 1 = 0$

$\frac{5}{2}x - 5 = 0$

$\frac{5}{2}x = 5$

$5x = 10$
$x = 2$

Substitute $x = 2$ into $y = -\frac{1}{2}x + 4$:

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

The lines intersect at $P(2, 3)$, as required.

(b) A line parallel to the line m has gradient $-\frac{1}{2}$.

The equation of the line n is

$y - y_1 = m (x - x_1)$

$y - 0 = -\frac{1}{2}\left(x - 3 \right)$

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

To find Q solve $2x - y - 1 = 0$ and $y = -\frac{1}{2}x + \frac{3}{2}$ simultaneously.

Substitute:

$2x - \left(-\frac{1}{2}x + \frac{3}{2} \right) - 1 = 0$

$2x + \frac{1}{2}x - \frac{3}{2} - 1 = 0$

$\frac{5}{2}x - \frac{5}{2} = 0$

$\frac{5}{2}x = \frac{5}{2}$

$x = 1$

Substitute $x = 1$ into $y = -\frac{1}{2}x + \frac{3}{2}$:

$y = -\frac{1}{2}\left(1 \right) + \frac{3}{2} = -\frac{1}{2} + \frac{3}{2} = 1$

The lines intersect at $Q (1 , 1)$.

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Coordinate geometry in the (x, y) plane
Exercise F, Question 3

Question:

The line L_1 has gradient $\frac{1}{7}$ and passes through the point $A(2, 2)$. The line L_2 has gradient -1 and passes through the point $B(4, 8)$. The lines L_1 and L_2 intersect at the point C.

(a) Find an equation for L_1 and an equation for L_2.

(b) Determine the coordinates of C. **[E]**

Solution:

(a) The equation of L_1 is

$y - y_1 = m(x - x_1)$

$y - 2 = \frac{1}{7}\left(x - 2\right)$

$y - 2 = \frac{1}{7}x - \frac{2}{7}$

$y = \frac{1}{7}x + \frac{12}{7}$

The equation of L_2 is

$y - y_1 = m(x - x_1)$

$y - 8 = -1(x - 4)$

$y - 8 = -x + 4$

$y = -x + 12$

(b) Solve $y = \frac{1}{7}x + \frac{12}{7}$ and $y = -x + 12$ simultaneously.

Substitute:

$-x + 12 = \frac{1}{7}x + \frac{12}{7}$

$12 = \frac{8}{7}x + \frac{12}{7}$

$10\frac{2}{7} = \frac{8}{7}x$

$x = \dfrac{10\frac{2}{7}}{\frac{8}{7}} = 9$

Substitute $x = 9$ into $y = -x + 12$:

$y = -9 + 12 = 3$

The lines intersect at $C(9, 3)$.

Solutionbank C1
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Coordinate geometry in the (x, y) plane
Exercise F, Question 4

Question:

The straight line passing through the point $P(2, 1)$ and the point $Q(k, 11)$ has gradient $-\frac{5}{12}$.

(a) Find the equation of the line in terms of x and y only.

(b) Determine the value of k. **[E]**

Solution:

(a) $m = -\frac{5}{12}$, $(x_1, y_1) = (2, 1)$

The equation of the line is

$y - y_1 = m(x - x_1)$

$y - 1 = -\frac{5}{12}\left(x - 2\right)$

$y - 1 = -\frac{5}{12}x + \frac{5}{6}$

$y = -\frac{5}{12}x + \frac{11}{6}$

(b) Substitute $(k, 11)$ into $y = -\frac{5}{12}x + \frac{11}{6}$:

$11 = -\frac{5}{12}k + \frac{11}{6}$

$11 - \frac{11}{6} = -\frac{5}{12}k$

$\frac{55}{6} = -\frac{5}{12}k$

Multiply each side by 12:

$110 = -5k$

$k = -22$

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Coordinate geometry in the (x, y) plane

Exercise F, Question 5

Question:

(a) Find an equation of the line l which passes through the points $A(1, 0)$ and $B(5, 6)$.
The line m with equation $2x + 3y = 15$ meets l at the point C.

(b) Determine the coordinates of the point C. **[E]**

Solution:

(a) The equation of l is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 0}{6 - 0} = \frac{x - 1}{5 - 1}$$

$$\frac{y}{6} = \frac{x - 1}{4}$$

Multiply each side by 6:

$$y = 6\frac{(x - 1)}{4}$$

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

$$y = \frac{3}{2}x - \frac{3}{2}$$

(b) Solve $2x + 3y = 15$ and $y = \frac{3}{2}x - \frac{3}{2}$ simultaneously.

Substitute:

$$2x + 3\left(\frac{3}{2}x - \frac{3}{2}\right) = 15$$

$$2x + \frac{9}{2}x - \frac{9}{2} = 15$$

$$\frac{13}{2}x - \frac{9}{2} = 15$$

$$\frac{13}{2}x = \frac{39}{2}$$

$13x = 39$
$x = 3$

Substitute $x = 3$ into $y = \frac{3}{2}x - \frac{3}{2}$:

$$y = \frac{3}{2}\left(3\right) - \frac{3}{2} = \frac{9}{2} - \frac{3}{2} = \frac{6}{2} = 3$$

The coordinates of C are $(3, 3)$.

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Coordinate geometry in the (x, y) plane
Exercise F, Question 6

Question:

The line L passes through the points $A(1,3)$ and $B(-19,-19)$.

Find an equation of L in the form $ax + by + c = 0$, where a, b and c are integers. **[E]**

Solution:

$(x_1, y_1) = (1, 3)$, $(x_2, y_2) = (-19, -19)$

The equation of L is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 3}{-19 - 3} = \frac{x - 1}{-19 - 1}$$

$$\frac{y - 3}{-22} = \frac{x - 1}{-20}$$

Multiply each side by -22:

$$y - 3 = \frac{-22}{-20}\left(x - 1\right)$$

$$y - 3 = \frac{11}{10}\left(x - 1\right)$$

Multiply each term by 10:

$10y - 30 = 11(x - 1)$

$10y - 30 = 11x - 11$

$10y = 11x + 19$

$0 = 11x - 10y + 19$

The equation of L is $11x - 10y + 19 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise F, Question 7

Question:

The straight line l_1 passes through the points A and B with coordinates $(2, 2)$ and $(6, 0)$ respectively.

(a) Find an equation of l_1.

The straight line l_2 passes through the point C with coordinates $(-9, 0)$ and has gradient $\frac{1}{4}$.

(b) Find an equation of l_2. **[E]**

Solution:

(a) The equation of l_1 is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 2}{0 - 2} = \frac{x - 2}{6 - 2}$$

$$\frac{y - 2}{-2} = \frac{x - 2}{4}$$

Multiply each side by -2:

$y - 2 = -\frac{1}{2}\left(x - 2\right)$ (**Note:** $-\frac{2}{4} = -\frac{1}{2}$)

$$y - 2 = -\frac{1}{2}x + 1$$

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

(b) The equation of l_2 is

$$y - y_1 = m(x - x_1)$$

$$y - 0 = \frac{1}{4}\left[x - \left(-9\right)\right]$$

$$y = \frac{1}{4}\left(x + 9\right)$$

$$y = \frac{1}{4}x + \frac{9}{4}$$

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Coordinate geometry in the (x, y) plane
Exercise F, Question 8

Question:

The straight line l_1 passes through the points A and B with coordinates $(0, -2)$ and $(6, 7)$ respectively.

(a) Find the equation of l_1 in the form $y = mx + c$.
The straight line l_2 with equation $x + y = 8$ cuts the y-axis at the point C. The lines l_1 and l_2 intersect at the point D.

(b) Calculate the coordinates of the point D.

(c) Calculate the area of $\triangle ACD$. **[E]**

Solution:

(a) The equation of l_1 is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - (-2)}{7 - (-2)} = \frac{x - 0}{6 - 0}$$

$$\frac{y + 2}{9} = \frac{x}{6}$$

Multiply each term by 9:

$$y + 2 = \frac{9}{6}x$$

$$y + 2 = \frac{3}{2}x$$

$$y = \frac{3}{2}x - 2$$

(b) Solve $x + y = 8$ and $y = \frac{3}{2}x - 2$ simultaneously.

Substitute:

$$x + \left(\frac{3}{2}x - 2\right) = 8$$

$$x + \frac{3}{2}x - 2 = 8$$

$$\frac{5}{2}x - 2 = 8$$

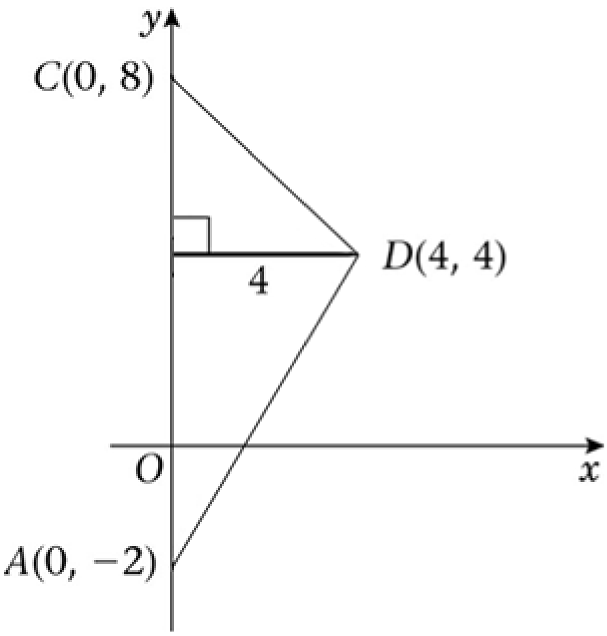
$$\frac{5}{2}x = 10$$

$5x = 20$
$x = 4$
Substitute $x = 4$ into $x + y = 8$:
$(4) + y = 8$
$y = 4$
The coordinates of D are $(4, 4)$.

(c) $x + y = 8$ cuts the y-axis when $x = 0$.
Substitute $x = 0$:

$0 + y = 8$
$y = 8$
The coordinates of C are $(0, 8)$
$AC = 10$
$h = 4$

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



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Coordinate geometry in the (x, y) plane

Exercise F, Question 9

Question:

The points *A* and *B* have coordinates $(2, 16)$ and $(12, -4)$ respectively. A straight line l_1 passes through *A* and *B*.

(a) Find an equation for l_1 in the form $ax + by = c$.

The line l_2 passes through the point *C* with coordinates $(-1, 1)$ and has gradient $\frac{1}{3}$.

(b) Find an equation for l_2. **[E]**

Solution:

(a) The equation of l_1 is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 16}{-4 - 16} = \frac{x - 2}{12 - 2}$$

$$\frac{y - 16}{-20} = \frac{x - 2}{10}$$

Multiply each side by -20:

$y - 16 = -2(x - 2)$ (**Note:** $-\frac{20}{10} = -2$)

$y - 16 = -2x + 4$
$y = -2x + 20$
$2x + y = 20$

(b) The equation of l_2 is
$y - y_1 = m(x - x_1)$

$$y - 1 = \frac{1}{3}\left[x - \left(-1\right)\right]$$

$$y - 1 = \frac{1}{3}\left(x + 1\right)$$

$$y - 1 = \frac{1}{3}x + \frac{1}{3}$$

$$y = \frac{1}{3}x + \frac{4}{3}$$

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Coordinate geometry in the (x, y) plane
Exercise F, Question 10

Question:

The points $A(-1, -2)$, $B(7, 2)$ and $C(k, 4)$, where k is a constant, are the vertices of $\triangle ABC$. Angle ABC is a right angle.

(a) Find the gradient of AB.

(b) Calculate the value of k.

(c) Find an equation of the straight line passing through B and C. Give your answer in the form $ax + by + c = 0$, where a, b and c are integers. **[E]**

Solution:

(a) The gradient of AB is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{2 - (-2)}{7 - (-1)} = \frac{4}{8} = \frac{1}{2}$$

(b) The gradient of BC is

$$\frac{-1}{\frac{1}{2}} = -2$$

So $\frac{y_2 - y_1}{x_2 - x_1} = -2$

$$\Rightarrow \quad \frac{4 - 2}{k - 7} = -2$$

$$\Rightarrow \quad \frac{2}{k - 7} = -2$$

Multiply each side by $(k - 7)$:
$2 = -2(k - 7)$
$2 = -2k + 14$
$-12 = -2k$
$k = 6$

(c) The equation of the line passing through B and C is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 2}{4 - 2} = \frac{x - 7}{6 - 7}$$

$$\frac{y - 2}{2} = \frac{x - 7}{-1}$$

Multiply each side by 2:

$y - 2 = -2(x - 7)$ (**Note:** $\frac{2}{-1} = -2$)

$y - 2 = -2x + 14$
$y = -2x + 16$
$2x + y = 16$
$2x + y - 16 = 0$

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Coordinate geometry in the (x, y) plane
Exercise F, Question 11

Question:

The straight line l passes through $A\left(1, 3\sqrt{3}\right)$ and $B\left(2+\sqrt{3}, 3+4\sqrt{3}\right)$.

(a) Calculate the gradient of l giving your answer as a surd in its simplest form.

(b) Give the equation of l in the form $y = mx + c$, where constants m and c are surds given in their simplest form.

(c) Show that l meets the x-axis at the point $C\left(-2, 0\right)$. **[E]**

Solution:

(a) The gradient of l is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{\left(3+4\sqrt{3}\right)-3\sqrt{3}}{\left(2+\sqrt{3}\right)-1} = \frac{3+\sqrt{3}}{1+\sqrt{3}}$$

Rationalise the denominator:

$$\frac{3+\sqrt{3}}{1+\sqrt{3}} \times \frac{1-\sqrt{3}}{1-\sqrt{3}} = \frac{3-3\sqrt{3}+\sqrt{3}-3}{1-3} = \frac{-2\sqrt{3}}{-2} = \sqrt{3}$$

(b) The equation of l is

$y - y_1 = m\left(x - x_1\right)$

$y - 3\sqrt{3} = \sqrt{3}\left(x - 1\right)$

$y - 3\sqrt{3} = \sqrt{3}x - \sqrt{3}$

$y = \sqrt{3}x + 2\sqrt{3}$

(c) Substitute $y = 0$:

$0 = \sqrt{3}x + 2\sqrt{3}$

$\sqrt{3}x = -2\sqrt{3}$

$$x = \frac{-2\sqrt{3}}{\sqrt{3}} = -2$$

The coordinates of C are $\left(-2, 0\right)$.

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Coordinate geometry in the (x, y) plane
Exercise F, Question 12

Question:

(a) Find an equation of the straight line passing through the points with coordinates $(-1, 5)$ and $(4, -2)$, giving your answer in the form $ax + by + c = 0$, where a, b and c are integers.
The line crosses the x-axis at the point A and the y-axis at the point B, and O is the origin.

(b) Find the area of $\triangle OAB$. **[E]**

Solution:

(a) The equation of the line is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 5}{-2 - 5} = \frac{x - (-1)}{4 - (-1)}$$

$$\frac{y - 5}{-7} = \frac{x + 1}{5}$$

Multiply each side by -35:

$5(y - 5) = -7(x + 1)$ (**Note:** $\frac{-35}{-7} = 5$ and $\frac{-35}{5} = -7$)

$5y - 25 = -7x - 7$
$7x + 5y - 25 = -7$
$7x + 5y - 18 = 0$

(b) For the coordinates of A substitute $y = 0$:
$7x + 5(0) - 18 = 0$
$7x - 18 = 0$
$7x = 18$
$x = \frac{18}{7}$

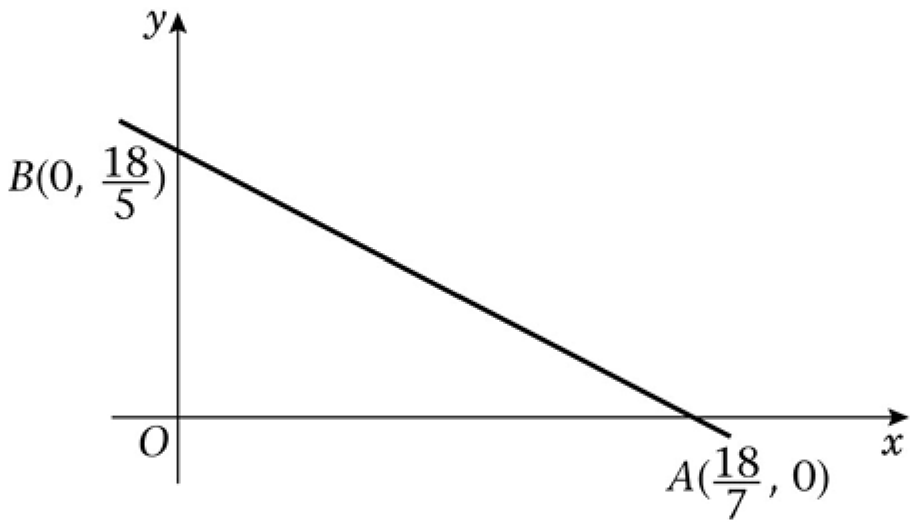
The coordinates of A are $\left(\frac{18}{7}, 0\right)$.

For the coordinates of B substitute $x = 0$:
$7(0) + 5y - 18 = 0$
$5y - 18 = 0$
$5y = 18$
$y = \frac{18}{5}$

The coordinates of B are $\left(0, \frac{18}{5}\right)$.

The area of $\triangle OAB$ is

$$\frac{1}{2} \times \frac{18}{7} \times \frac{18}{5} = \frac{162}{35}$$



y
$B(0, \frac{18}{5})$
O
x
$A(\frac{18}{7}, 0)$

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Coordinate geometry in the (x, y) plane
Exercise F, Question 13

Question:

The points A and B have coordinates $(k, 1)$ and $(8, 2k - 1)$ respectively, where k is a constant. Given that the gradient of AB is $\frac{1}{3}$,

(a) Show that $k = 2$.

(b) Find an equation for the line through A and B. **[E]**

Solution:

(a) The gradient of AB is

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{1}{3}$$

$$\frac{(2k - 1) - 1}{8 - k} = \frac{1}{3}$$

$$\frac{2k - 1 - 1}{8 - k} = \frac{1}{3}$$

$$\frac{2k - 2}{8 - k} = \frac{1}{3}$$

Multiply each side by $(8 - k)$:

$$2k - 2 = \frac{1}{3}\left(8 - k\right)$$

Multiply each term by 3:
$6k - 6 = 8 - k$
$7k - 6 = 8$
$7k = 14$
$k = 2$

(b) $k = 2$
So A and B have coordinates $(2, 1)$ and $(8, 3)$.
The equation of the line is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 1}{3 - 1} = \frac{x - 2}{8 - 2}$$

$$\frac{y - 1}{2} = \frac{x - 2}{6}$$

Multiply each side by 2:

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

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

$$y = \frac{1}{3}x + \frac{1}{3}$$

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Coordinate geometry in the (x, y) plane
Exercise F, Question 14

Question:

The straight line l_1 has equation $4y + x = 0$.
The straight line l_2 has equation $y = 2x - 3$.

(a) On the same axes, sketch the graphs of l_1 and l_2. Show clearly the coordinates of all points at which the graphs meet the coordinate axes.
The lines l_1 and l_2 intersect at the point A.

(b) Calculate, as exact fractions, the coordinates of A.

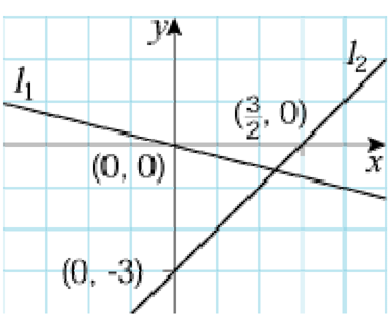
(c) Find an equation of the line through A which is perpendicular to l_1. Give your answer in the form $ax + by + c = 0$, where a, b and c are integers. **[E]**

Solution:

(a) (1) Rearrange $4y + x = 0$ into the form $y = mx + c$:
$4y = -x$
$y = -\frac{1}{4}x$

l_1 has gradient $-\frac{1}{4}$ and it meets the coordinate axes at $(0, 0)$.
(2) l_2 has gradient 2 and it meets the y-axis at $(0, -3)$.
l_2 meets the x-axis when $y = 0$.
Substitute $y = 0$:
$0 = 2x - 3$
$2x = 3$
$x = \frac{3}{2}$

l_2 meets the x-axis at $\left(\frac{3}{2}, 0\right)$.



(b) Solve $4y + x = 0$ and $y = 2x - 3$ simultaneously.
Substitute:
$4(2x - 3) + x = 0$
$8x - 12 + x = 0$
$9x - 12 = 0$
$9x = 12$

$x = \frac{12}{9}$

$x = \frac{4}{3}$

Substitute $x = \frac{4}{3}$ into $y = 2x - 3$:

$y = 2\left(\frac{4}{3}\right) - 3 = \frac{8}{3} - 3 = -\frac{1}{3}$

The coordinates of A are $\left(\frac{4}{3}, -\frac{1}{3}\right)$.

(c) The gradient of l_1 is $-\frac{1}{4}$.

The gradient of a line perpendicular to l_1 is $-\frac{1}{-\frac{1}{4}} = 4$.

The equation of the line is
$y - y_1 = m(x - x_1)$

$y - \left(-\frac{1}{3}\right) = 4\left(x - \frac{4}{3}\right)$

$y + \frac{1}{3} = 4x - \frac{16}{3}$

$y = 4x - \frac{17}{3}$

Multiply each term by 3:
$3y = 12x - 17$
$0 = 12x - 3y - 17$
The equation of the line is $12x - 3y - 17 = 0$.

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Coordinate geometry in the (x, y) plane
Exercise F, Question 15

Question:

The points A and B have coordinates $(4, 6)$ and $(12, 2)$ respectively.

The straight line l_1 passes through A and B.

(a) Find an equation for l_1 in the form $ax + by + c = 0$, where a, b and c are integers.
The straight line l_2 passes through the origin and has gradient -4.

(b) Write down an equation for l_2.
The lines l_1 and l_2 intersect at the point C.

(c) Find the coordinates of C. **[E]**

Solution:

(a) The equation of l_1 is

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

$$\frac{y - 6}{2 - 6} = \frac{x - 4}{12 - 4}$$

$$\frac{y - 6}{-4} = \frac{x - 4}{8}$$

Multiply each side by 8:

$-2(y - 6) = x - 4$ (**Note:** $\frac{8}{-4} = -2$)

$-2y + 12 = x - 4$
$-2y + 16 = x$
$16 = x + 2y$
$0 = x + 2y - 16$
The equation of the line is $x + 2y - 16 = 0$

(b) The equation of l_2 is
$y - y_1 = m(x - x_1)$
$y - 0 = -4(x - 0)$
$y = -4x$

(c) Solve $y = -4x$ and $x + 2y = 16$ simultaneously.
Substitute:
$x + 2(-4x) = 16$
$x - 8x = 16$
$-7x = 16$

$$x = \frac{16}{-7}$$

$$x = -\frac{16}{7}$$

Substitute $x = -\frac{16}{7}$ in $y = -4x$:

$$y = -4\left(-\frac{16}{7}\right) = \frac{64}{7}$$

The coordinates of C are $\left(-\frac{16}{7}, \frac{64}{7}\right)$.