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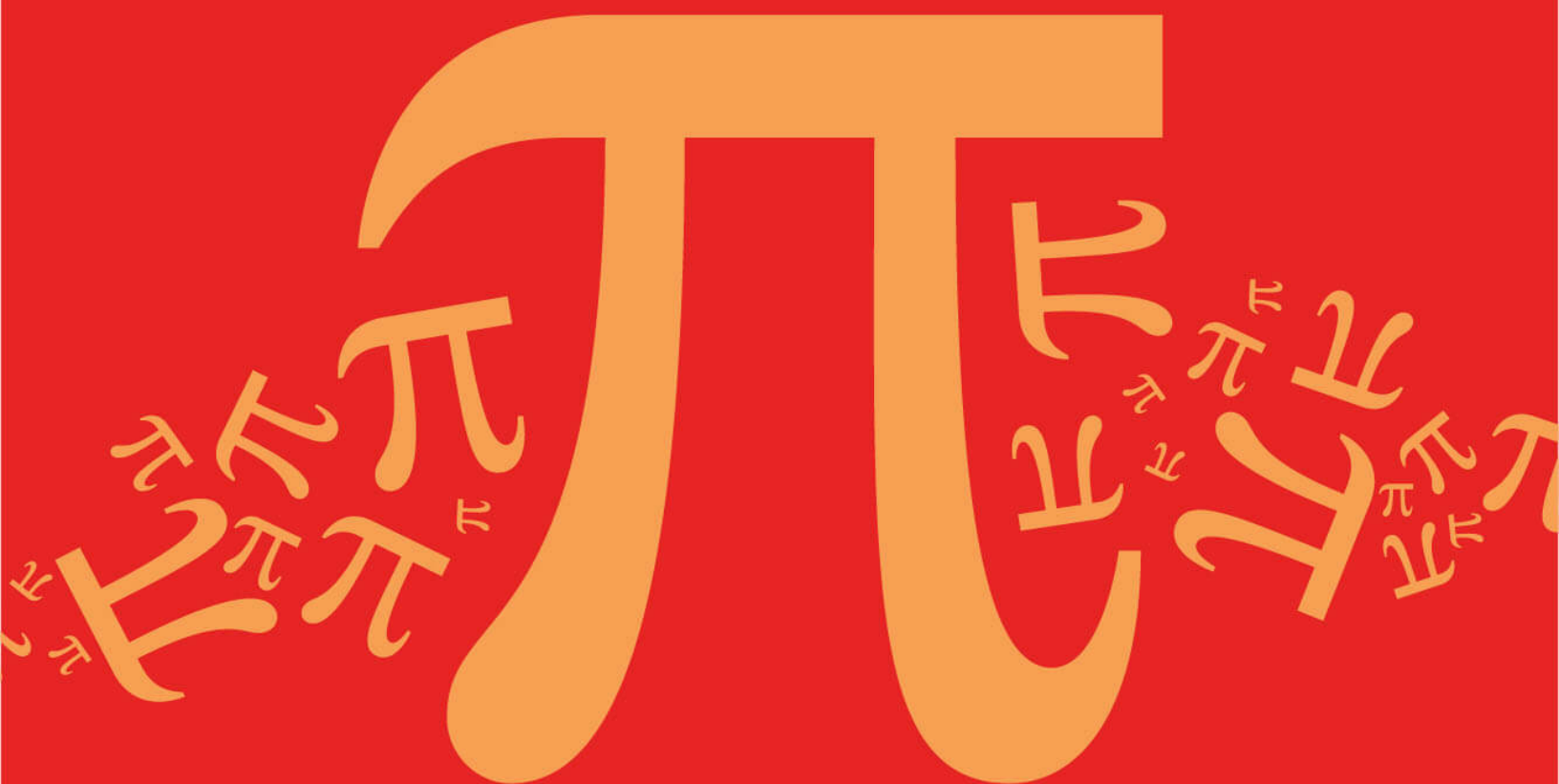
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## **2.1 Linear Functions & Graphs**



# **IB Maths - Revision Notes**

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## 2.1.1 Equations of a Straight Line

### Equations of a Straight Line

#### How do I find the gradient of a straight line?

- Find two points that the line passes through with coordinates  $(x_1, y_1)$  and  $(x_2, y_2)$
- The gradient between these two points is calculated by

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

- This is given in the **formula booklet**
- The gradient of a straight line measures its **slope**
  - A line with gradient 1 will go up 1 unit for every unit it goes to the right
  - A line with gradient -2 will go down two units for every unit it goes to the right

#### What are the equations of a straight line?

- $y = mx + c$ 
  - This is the **gradient-intercept form**
  - It clearly shows the gradient  $m$  and the  $y$ -intercept  $(0, c)$
- $y - y_1 = m(x - x_1)$ 
  - This is the **point-gradient form**
  - It clearly shows the gradient  $m$  and a point on the line  $(x_1, y_1)$
- $ax + by + d = 0$ 
  - This is the **general form**
  - You can quickly get the  $x$ -intercept  $\left(-\frac{d}{a}, 0\right)$  and  $y$ -intercept  $\left(0, -\frac{d}{b}\right)$

#### How do I find an equation of a straight line?

- You will need the gradient
  - If you are given two points then first find the gradient
- It is easiest to start with the **point-gradient form**
  - then rearrange into whatever form is required
    - multiplying both sides by any denominators will get rid of fractions
- You can check your answer by using your GDC
  - Graph your answer and check it goes through the point(s)
  - If you have two points then you can enter these in the **statistics mode** and find the regression line  $y = ax + b$

#### Exam Tip

- A sketch of the graph of the straight line(s) can be helpful, even if not demanded by the question
  - Use your GDC to plot them
- Ensure you state equations of straight lines in the format required
  - Usually  $y = mx + c$  or  $ax + by + d = 0$
  - Check whether coefficients need to be integers (they usually are for  $ax + by + d = 0$ )



**Worked example**

The line  $l$  passes through the points  $(-2, 5)$  and  $(6, -7)$ .

Find the equation of  $l$ , giving your answer in the form  $ax + by + d = 0$  where  $a$ ,  $b$  and  $c$  are integers to be found.

Find the gradient between  $(-2, 5)$  and  $(6, -7)$

Formula booklet

$$m = \frac{-7 - 5}{6 - -2} = -\frac{3}{2}$$

Gradient formula	$m = \frac{y_2 - y_1}{x_2 - x_1}$
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Use the point-gradient formula

Formula booklet

Equations of a straight line	$y - y_1 = m(x - x_1)$
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$$(x_1, y_1) = (-2, 5) \quad m = -\frac{3}{2}$$

$$y - 5 = -\frac{3}{2}(x - -2) \quad \text{Simplify}$$

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

$$2(y - 5) = -3(x + 2) \quad \text{Multiply by denominator}$$

$$2y - 10 = -3x - 6 \quad \text{Expand}$$

$$3x + 2y - 4 = 0 \quad \text{Rearrange}$$

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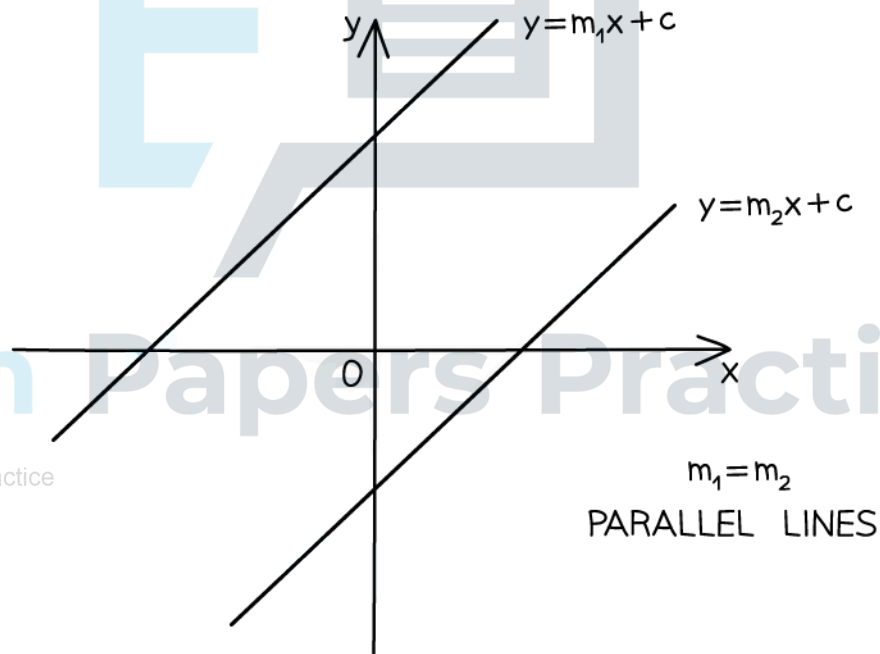
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## Parallel Lines

### How are the equations of parallel lines connected?

- **Parallel lines** are always equidistant meaning they never intersect
- Parallel lines have the same gradient
  - If the gradient of line  $l_1$  is  $m_1$  and gradient of line  $l_2$  is  $m_2$  then...
    - $m_1 = m_2 \Rightarrow l_1 \text{ \& } l_2$  are parallel
    - $l_1 \text{ \& } l_2$  are parallel  $\Rightarrow m_1 = m_2$
- To determine if two lines are parallel:
  - Rearrange into the gradient-intercept form  $y = mx + c$
  - Compare the coefficients of  $x$
  - If they are equal then the lines are parallel



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**Worked example**

The line  $l$  passes through the point  $(4, -1)$  and is parallel to the line with equation  $2x - 5y = 3$ .

Find the equation of  $l$ , giving your answer in the form  $y = mx + c$ .

Rearrange into  $y = mx + c$  to find the gradient

$$5y = 2x - 3 \Rightarrow y = \frac{2}{5}x - \frac{3}{5} \therefore \text{gradient} = \frac{2}{5}$$

Parallel lines  $\Rightarrow m_1 = m_2$

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

Use the point-gradient formula

Formula booklet

Equations of a straight line

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

$$(x_1, y_1) = (4, -1) \quad m = \frac{2}{5}$$

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

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

$$y = \frac{2}{5}x - \frac{13}{5}$$

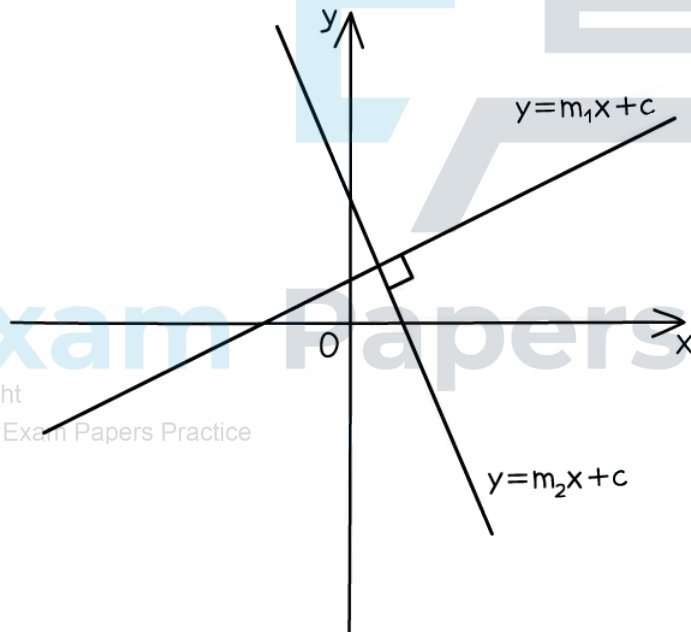
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## Perpendicular Lines

### How are the equations of perpendicular lines connected?

- **Perpendicular lines** intersect at right angles
- The gradients of two perpendicular lines are negative reciprocals
  - If the gradient of line  $l_1$  is  $m_1$  and gradient of line  $l_2$  is  $m_2$  then...
    - $m_1 \times m_2 = -1 \Rightarrow l_1 \text{ \& } l_2 \text{ are perpendicular}$
    - $l_1 \text{ \& } l_2 \text{ are perpendicular} \Rightarrow m_1 \times m_2 = -1$
- To determine if two lines are perpendicular:
  - Rearrange into the gradient-intercept form  $y = mx + c$
  - Compare the coefficients of  $X$
  - If their product is  $-1$  then they are perpendicular
- Be careful with horizontal and vertical lines
  - $x = p$  and  $y = q$  are perpendicular where  $p$  and  $q$  are constants



$$m_1 \times m_2 = -1$$

PERPENDICULAR LINES



**Worked example**

The line  $l_1$  is given by the equation  $3x - 5y = 7$ .

The line  $l_2$  is given by the equation  $y = \frac{1}{4} - \frac{5}{3}x$ .

Determine whether  $l_1$  and  $l_2$  are perpendicular. Give a reason for your answer.

Rearrange  $l_1$  into  $y = mx + c$  form

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

Identify gradients

$$m_1 = \frac{3}{5} \quad m_2 = -\frac{5}{3}$$

$m_1 \times m_2 = -1 \Rightarrow$  Perpendicular lines

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

$l_1$  and  $l_2$  are perpendicular as  $m_1 \times m_2 = -1$

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