**Chapter summary**

## Gradient of a line
Gradient measures the slope of a line

Gradient, $m = \dfrac{\text{rise}}{\text{run}}$    e.g.

$m = \dfrac{4}{2} = 2$

(2, 6)
rise = 4
run = 2

positive gradient
rise (positive)
run (positive)

run (positive)
rise (negative)
negative gradient

zero gradient

undefined gradient

A rate equals the gradient with units.

e.g. Speed $= \dfrac{40}{4} = 10$ km/h

Distance (km) vs Time (hours)

## Equation of a line

$$y = mx + c$$
gradient   $y$-intercept

• The rule is a linear equation.
• The graph is made up of points in a straight line.

### Special lines

Horizontal lines
e.g. $y = 3$

Vertical lines
e.g. $x = 2$

## Parallel and perpendicular lines
• Parallel-lines have the same gradient; e.g.
  $y = 3x - 4$ and $y = 3x + 1$
• For perpendicular lines, the product of their gradients is –1, so $m_1 \times m_2 = -1$ or $m_2 = -\dfrac{1}{m_1}$.

## For two variables that are directly proportional ⭐
• Both variables will increase or decrease together at the same rate.
• The rule is $y = kx$, where $k$ is the constant of proportionality.

Gradient = rate
= constant of proportionality

## For two variables that are inversely (or indirectly) proportional ⭐
• When one variable increases, then the other variable decreases.
• The graph is a curve.

**Straight-line graphs**

## Sketching a line
Plotting straight-line graphs:
• Complete a table of values.
• Plot points and join them to form a straight line.

Using the $y$-intercept and gradient:
• Plot the $y$-intercept ($c$).
• Use the gradient to plot the next point.
• Join points to form a straight line.

e.g. $y = 2x - 1$
$c = -1$    $m = \dfrac{2}{1}$
rise = 2
run = 1

## Using the axes intercepts
• Plot each axis intercept
  $x$-intercept (when $y = 0$)
  $y$-intercept (when $x = 0$)
• Join points to form a straight line.

e.g. $y = -2x + 4$
$y$-intercept = 4
$x$-intercept = 2

## Midpoint of a line segment
Find the average of the end point coordinates.

$M = \left( \dfrac{x_1 + x_2}{2}, \dfrac{y_1 + y_2}{2} \right)$

$x = \dfrac{-3 + 5}{2} = \dfrac{2}{2} = 1$

$y = \dfrac{-2 + 3}{2} = \dfrac{1}{2} = 0.5$

(5, 3)
M
(–3, –2)

$\therefore M = (1, 0.5)$

## Length of a line segment
Use Pythagoras' theorem.

$PQ^2 = 8^2 + 5^2$
$PQ^2 = 64 + 25$
$PQ^2 = 89$
$PQ = \sqrt{89}$

(5, 3) Q
5 units
P
(–3, –2)
8 units

$\sqrt{89}$ is an exact length.

## Distance–time graph

Distance vs Time

• Flat segment means the object is at rest.

Reading from a graph:
• Start on given distance; move across to line and then down to time scale (or in reverse).
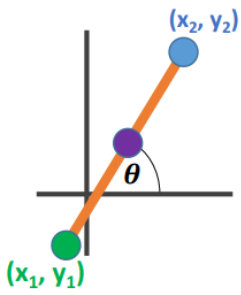
## Linear modelling ⭐
• Find a rule in the form $y = mx + c$, using the appropriate pronumerals.
• Sketch a graph.
• Apply the rule to solve problems.
• Answer the problem in words.

$(x_2, y_2)$

$(x_1, y_1)$

$\theta$

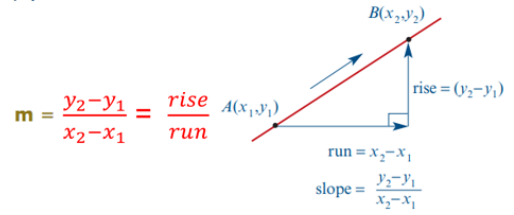**Length of line Segment** $= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

**Co-ordinate of Midpoint** $= \left( \frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$

$\theta = \tan^{-1}(\text{gradient})$

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

How do you find "m" and "c"?

- **C** is easy: just see where the line crosses the Y axis.
- **m** (the Slope) needs some calculation:

$B(x_2, y_2)$

$A(x_1, y_1)$

$\text{rise} = (y_2 - y_1)$

$\text{run} = x_2 - x_1$

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

$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1}$

## Types of Gradient Slope

There are four types of "Gradient" or "Slope"

⊕ Positive (Uphill)

⊖ Negative (Downhill)

Zero (Flat Horizontal)

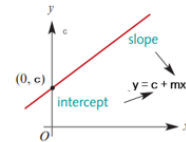Vertical (Infinite / Undefined)

Images Purchased from Photozone.com

**General Equation of a Straight Line...**

$y = c + mx$

$$y = c + mx$$

The 'c' represents the y-intercept of the line:
(where the line crosses the y-axis).

$y = c + mx$

$(0, c)$

intercept

slope
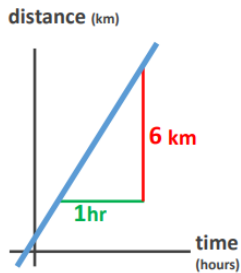
The 'm' represents the gradient/slope of the line:
$m = \frac{y_2 - y_1}{x_2 - x_1}$

Keywords: The intercept slope form Equation → y = c+mx

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**Rate of Change** is basically just gradient with units

units means km/h, m/s, L/s etc

Covered in detail in video tutorials, see RATES OF CHANGE

distance (km)

6 km

1hr

time (hours)

$\text{Rate of Change} = \frac{\text{rise}}{\text{run}} = \frac{6km}{1hr} = 6km/h$

MathsMethods.com

**Parallel** means the same **gradient**

y = 2x + 3    y = 2x - 2

**Perpendicular** means $m = \frac{-1}{m}$

y = 2x    y = -½x