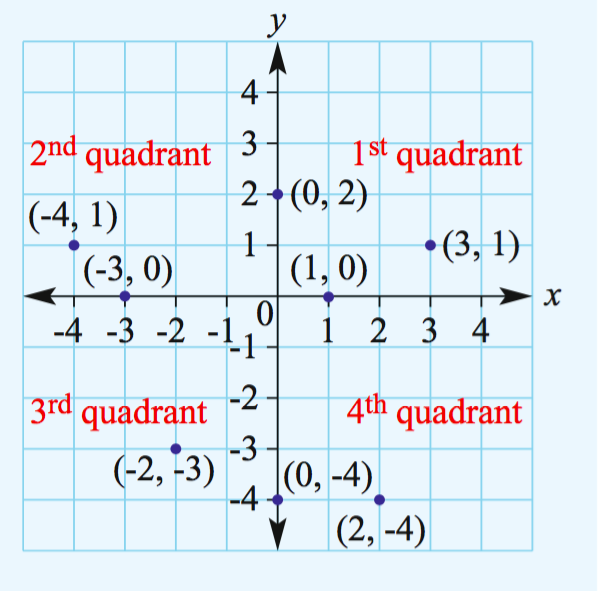
**Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Year 9 2020**

Linear Relations

# 4A Introduction to Linear Relations

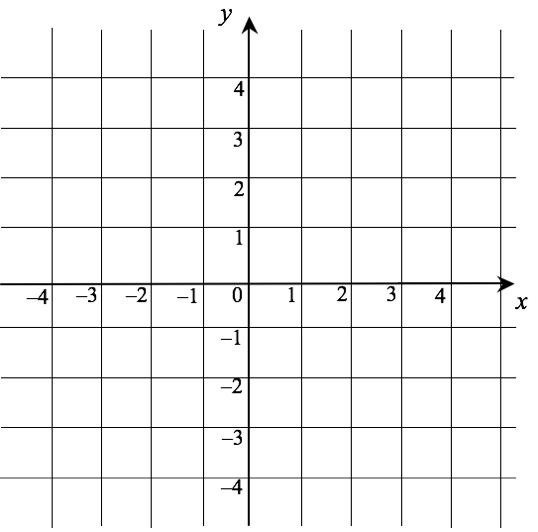
**The Cartesian Plane:**

* A **Cartesian plane** consists of two axes.
  + The horizontal axis is called the *x*-axis
  + The vertical axis is called the *y*-axis.
* The centre of a Cartesian plane is called the **origin**.
* A Cartesian **coordinate** is written as (x, y),

Eg. (-4, 1) means the coordinate is positioned at x=-4 and y=1

**Hint:** To locate a point on the Cartesian plane, move along the x-axis to the number indicated by the x-coordinate and then along the y-axis to the number indicated by the y-coordinate.

For example, to locate the point with coordinates (1, 2), move 1 unit to the right of the origin and then 2 units up.

Example 1:

Plot the following points onto the Cartesian Plane

1. Plot: (3,4), (-2, 4), (-2, -3), (3, -3), (3,4)
2. Using a ruler, join the points in order.
3. What shape has been formed?

**Linear Relations:**

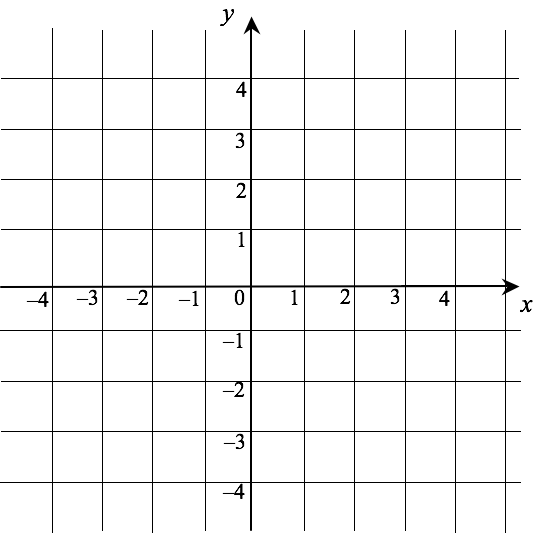
* A **Linear Relation** is a set of ordered pairs (x,y) that when graphed give a straight line.

**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/f1bf9ee429b4e4f5756bac90c9be50a4>

Example 2:

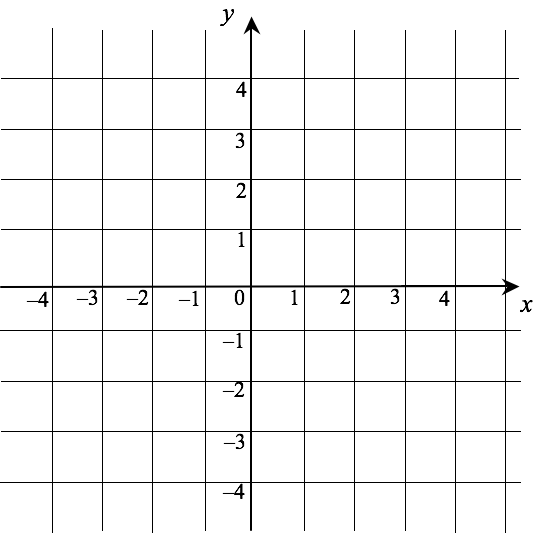
Using construct a table of values and plot a graph for



|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *x* | -3 | -2 | -1 | 0 | 1 | 2 | 3 |
| *y* |  |  |  |  |  |  |  |

Example 3:

Using construct a table of values and plot a graph for

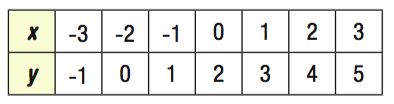


|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *x* | -3 | -2 | -1 | 0 | 1 | 2 | 3 |
| *y* |  |  |  |  |  |  |  |

**X and y intercept:**

* The **x intercept** is where the graph cuts the x axis
* The **y intercept** is where the graph cuts the y axis

These intercepts can be found from a graph or from a table of values.

Table of values:

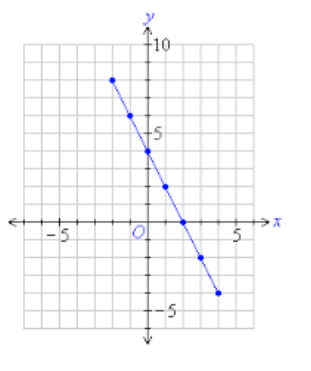
x intercept is located where y=0

x intercept = (-2, 0)

y intercept is located where x=0

y intercept = (0, 2)

Graph:



y intercept is located where x=0

y intercept = (4, 0)

x intercept is located where y=0

x intercept = (2, 0)

**Screencast.**

[**https://cambridgemaths.cambridge.edu.au/link/4e39b930823ce39e1384991d70da28b7**](https://cambridgemaths.cambridge.edu.au/link/4e39b930823ce39e1384991d70da28b7)

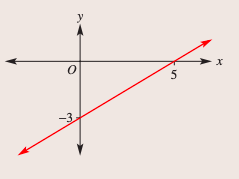
Example 4:

Write down the x and y intercept from this table



Example 5:

Write down the x and y intercept from this graph



**Decide if a point is on a line:**

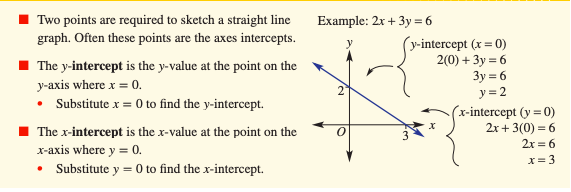
* Sometimes we want to see whether a particular coordinate is on the line that a linear relation forms.

**Screencast.** <https://cambridgemaths.cambridge.edu.au/link/94c5316f3f5f6b24d68a08d057dbcbd7>

Example 6:

Decide if the point (-2,4) is on the line with the given rules:

4B Graphing straight lines using intercepts



**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/baeb4aa07049d820252a87d4ee203855>

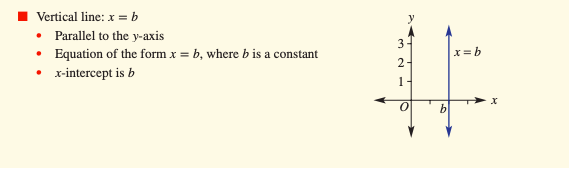
Example 1:

Sketch the graph of the following, showing the x and y intercepts.

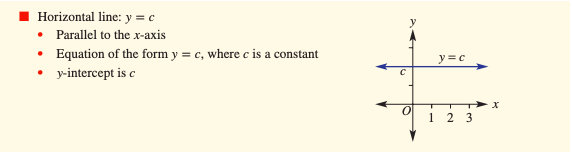


4C Graphing straight lines using intercepts

**Vertical Lines:**



**Horizontal Lines:**



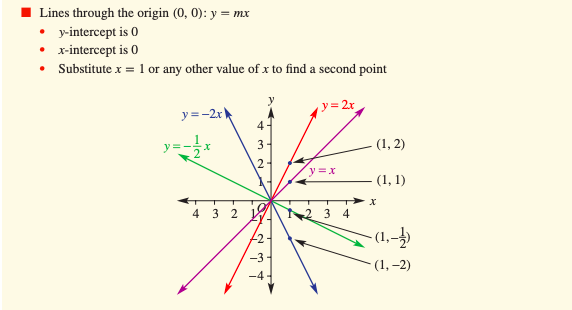
**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/af8c76e370440a0098a67b1f210afc88>

Example 1:

Sketch the graph of the following horizontal and vertical lines

**Lines through the Origin:**



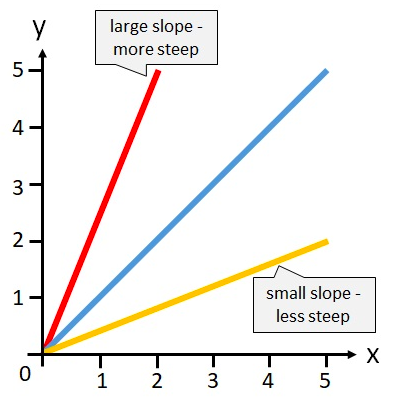
**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/7229b6272164ccbc7cb0139057db0d7c>

Example 2:

Sketch the graph of

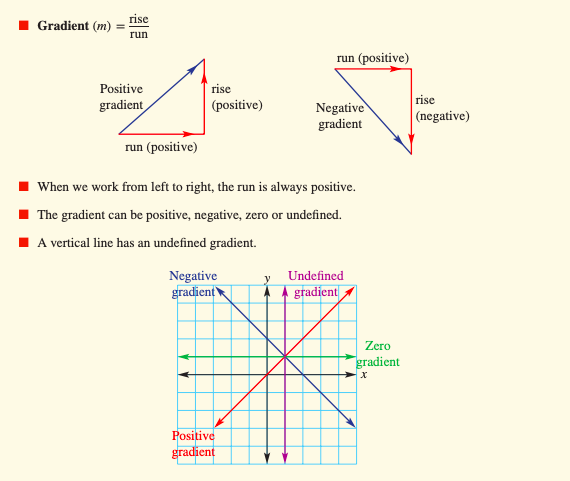
4D Gradient

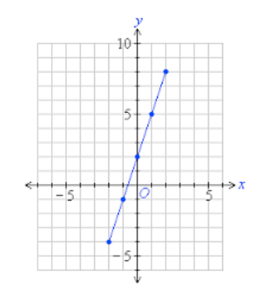


* The gradient/slope of a line

is a number that describes the **steepness** of the line.

* The **larger** the gradient, the **steeper** the line.
* Specifically, gradient measures the vertical increase/decrease for every unit moved right.



**How to find the gradient from a graph:**

1. Choose two points on the line

(1,5)

(-1,-1)

1. Calculate the vertical distance between the two points (rise).

Rise from -1 to 5

Rise = 6

1. Calculate the horizontal distance between the two points (run).

Run from -1 to 1

Rise = 2

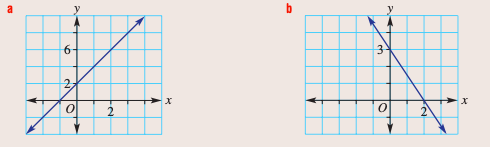
1. Gradient (m) = m = m = 3

**Screencast.**

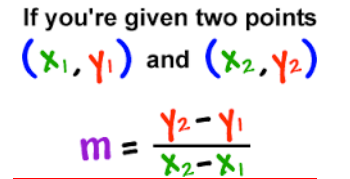
<https://cambridgemaths.cambridge.edu.au/link/ef33469c7aa3c7758bd61423b19a7c20>

Example 1:

For each graph, state whether the gradient is positive or negative, and find the gradient if possible.



**How to find the gradient from two coordinates:**



**Screencast.**

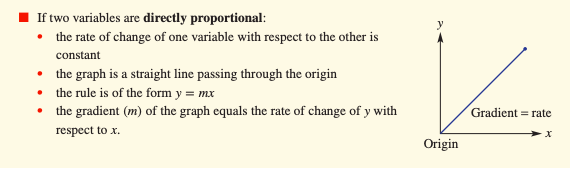
<https://cambridgemaths.cambridge.edu.au/link/e6de2542a78a0fe1bc4a6e00889fa2de>

Example 2:

Find the gradient (*m*) of the line joining the given points.

1. A(3,4) and B(5,6)
2. A(-3,6) and B(1,-3)

4E Gradient and direct proportion



**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/2a7b4f5b86c4b735137bf5acc5e68189>

Example 1:

Water is poured into an empty tank at a constant rate. It takes 3 hours to fill the tank with 6000 litres.

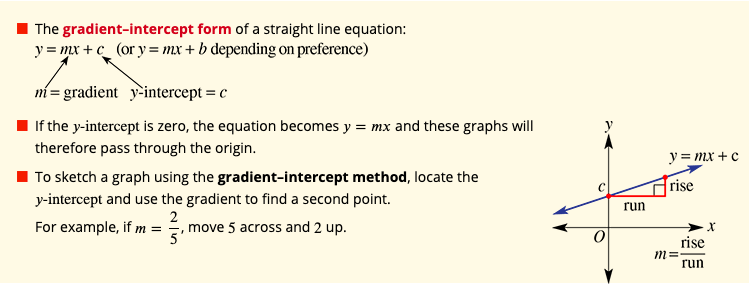
1. What is the rate at which water is poured into the tank?
2. Draw a graph of Volume (*V* litres) vs Time (*t* hours) using
3. Find:
4. The gradient of your graph
5. The rule for *V.*
6. Use your rule to find:
7. The volume after 1.5 hours
8. The time to fill 5000 litres

4F The ‘gradient-intercept’ form

* An equation is usually written in what’s known as ‘gradient-intercept’ form.
* This is a form of the equation where both the gradient and the y intercept can be found via inspection.

y intercept = 2

gradient = 5



**Finding the gradient and y intercept from inspection:**

**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/a3dcc1094f89c9604c3a66c418b0c23d>

Example 1:

State the **gradient** and the **y intercept** for the graphs of the following relations:

**Rearranging equations**

**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/4d12ee3c7e4ab601596c76900b6f8bdb>

Example 2:

Rearrange these linear equations into the form shown in brackets.

1. ()
2. ()

**Sketching graphs using the y intercept and gradient**

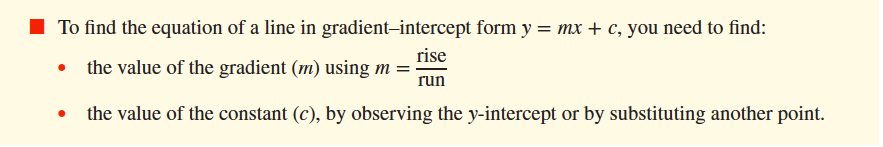
**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/4d12ee3c7e4ab601596c76900b6f8bdb>

Example 3:

Find the **gradient** and the **y intercept** for these relations, and **sketch** their graphs.

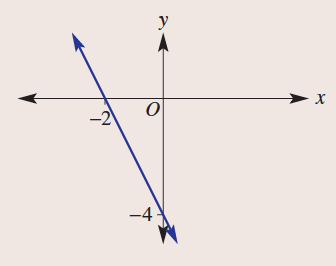
4G Finding the Equation of a line

****

**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/a7409316ad5592f8ca4447bc81d9a1c3>

Example 1:

Determine the equation of the linear relation shown here:

**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/5f9ab228322afbccd42fd6b95bc01fe6>

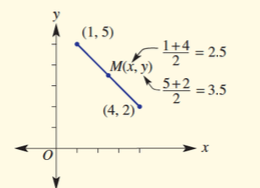
Example 2:

Find the equation of a line that has a gradient of and passes through the point (-3,4).

4H Midpoint and length of a line segment

**Midpoint**

* The midpoint between any two coordinates (is given by:





**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/7366711a2a8fa163b1b894acdd19332c>

Example 1:

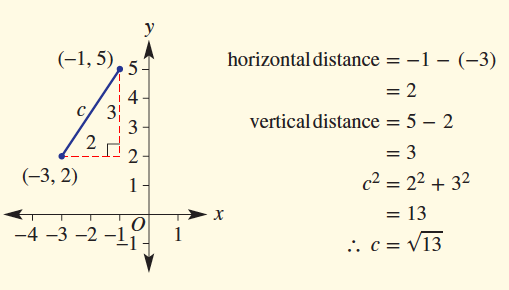
Find the midpoint of the line segment joining the following set of coordinates:

1. (1,0) and (4,4)
2. (-3,-2) and (5,3)

**Length of a Line Segment**

* The distance between any two coordinates (x1, y1) and (x2, y2) is given by:





This formula is an application of Pythagoras’ theorem which we investigated earlier in the year.

Effectively, we are making a right-angle triangle with the distance between the two points representing the hypotenuse.

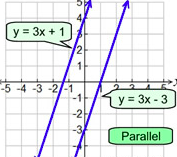
**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/f0ad1520b133ef82f870c982793ef352>

Example 2:

Find the length of the line segment joining (-2,2) and (4,-1), correct to two decimal places.

4I Perpendicular and Parallel Lines



**Parallel Lines**

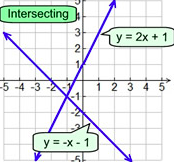
* If any two lines are parallel, then they will have the same gradient.

**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/ed40f6c14eebd0da2d890c6a639be475>

Example 1:

Find equation of a line that is parallel to and passes through the point (0,4)



**Perpendicular Lines**

* If two perpendicular lines (lines that intersect) have gradients gradients of then:



**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/924bede9979cb2595c3f703da4584aec>

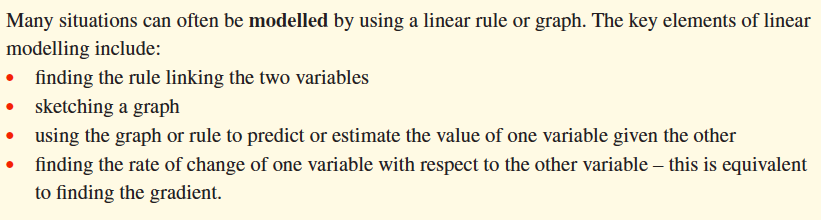
Example 2:

Find the equation of a line that is perpendicular to

and passes through (0,-1)

4J Linear Modelling

* In this section, we will look at some practical situations using linear graphs and their equations.
* This will involve interpretation of worded problems and the application of skills used in the previous exercises.
* Please make sure that you use your highlighter when tackling these questions.



**Screencast.**

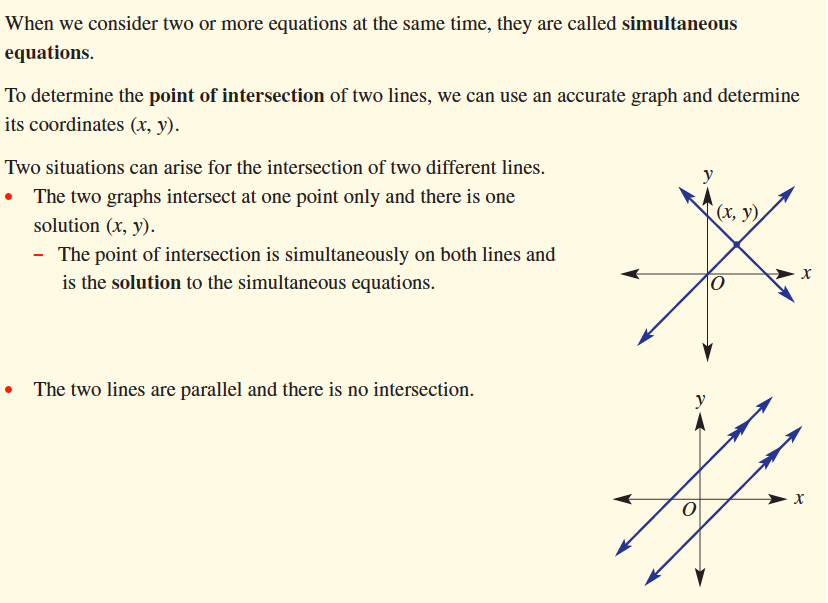
<https://cambridgemaths.cambridge.edu.au/link/a07080f1fbf8da21859a41d5a7fed451>

Example 1:

The deal offered by Netshare, an internet provider, to its new customers is a fixed charge of $20 per month plus $5 per hour of use.

1. Write a rule for the total monthly cost, $*C*, of using Netshare for *t* hours per month
2. Sketch the graph of $*C* versus *t* using .
3. What is the total cost in a month when Netshare is used for 4 hours?
4. If the monthly cost was $50, for how many hours was Netshare used for the month?

4k Graphical solutions to simultaneous equations



**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/cb9198549f09a763be46ed29d74b6b09>

Example 1:

Decide if the given point is at the intersection of the two lines with the given equations.

1. with the point (-1,1)
2. with the point (2,-4)

**Screencast.**

<https://cambridgemaths.cambridge.edu.au/link/b0800ac00dd066be2ebb337d5b5f77d7>

Example 2:

Solve the simultaneous equations graphically.

Summary Sheet

* Put your own hints and tips into the table below.

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

