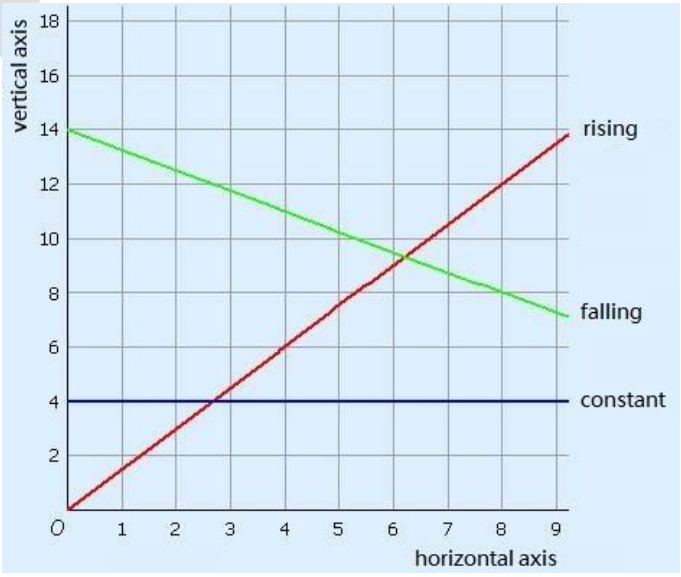
Edexcel OL Mathematics CODE: (4MA1)

Unit 1

Graphs



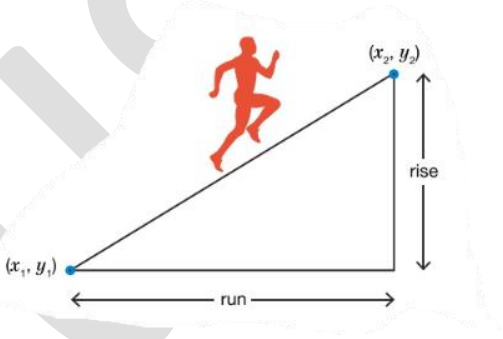
Chapter 05

BASIC PRINCIPLES

• Points on a graph are given by two numbers in brackets separated by a comma, for example (2, 3). All points are measured from the origin 0.
•The x-axis is horizontal; the y-axis is vertical.
• The first number gives the distance from 0 in the x direction.
• The second number gives the distance from O in the y direction.
• These numbers can be positive or negative.

The gradient of a straight line

The pictures show some steep slopes. The slope of a line is its gradient. The larger the **gradient**, the steeper the slope.
The letter *m* is usually used for the gradient.

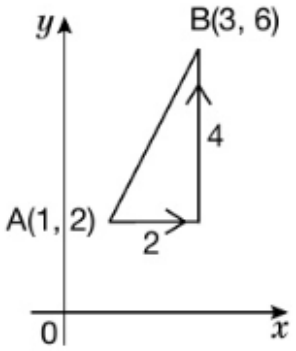


For a straight line $m = \frac{\text{change in the } y \text{ coordinates}}{\text{change in the } x \text{ coordinates}} = \frac{\text{'rise'}}{\text{'run'}}$

If the straight line joins the points (x_1, y_1) and (x_2, y_2) then 'rise' $= y_2 - y_1$ and 'run' $= x_2 - x_1$

The gradient is given by the formula $m = \frac{y_2 - y_1}{x_2 - x_1}$

EXAMPLE 1
SKILL: PROBLEM-SOLVING
Find the gradient of the straight-line joining A (1, 2) to B (3, 6). First, draw a diagram.

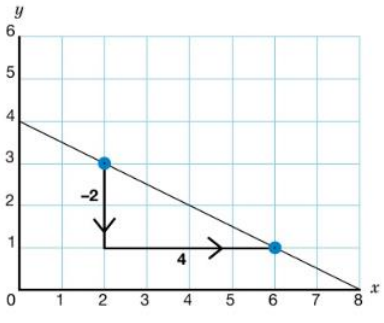


The gradient is $\frac{\text{rise}}{\text{run}} = \frac{4}{2} = 2$ (a positive gradient).

Or use the formula with $x_1 = 1$, $y_1 = 2$, $x_2 = 3$, $y_2 = 6$

$$m = \frac{6-2}{3-1} = \frac{4}{2} = 2$$

EXAMPLE 2
SKILL: PROBLEM-SOLVING
Find the gradient of the graph.
Choose two points on the graph and work out the rise and run.



The gradient is $\frac{\text{rise}}{\text{run}} = \frac{-2}{4} = -\frac{1}{2}$ (a negative gradient).

Or use the formula. The two points chosen are (2, 3) and (6, 1) so

$$m = \frac{1-3}{6-2} = \frac{-2}{4} = -\frac{1}{2}$$

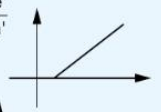
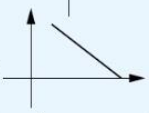
REAL-LIFE STRAIGHT-LINE GRAPHS

•These graphs simply replace x and y with variables which represent real-life values such as weight, length, time, speed etc.

•If a uniform rate is given, it is often necessary to produce the equation.

•When drawing a graph of two variables, p against q, it is normal practice to draw the first named variable (p) on the vertical axis.

KEY POINTS

- Gradient m = $\frac{\text{'rise'}}{\text{'run'}}$
- Lines like this  have a positive gradient.
- Lines like this  have a negative gradient.
- Parallel lines have the same gradient.
- Always draw a diagram.

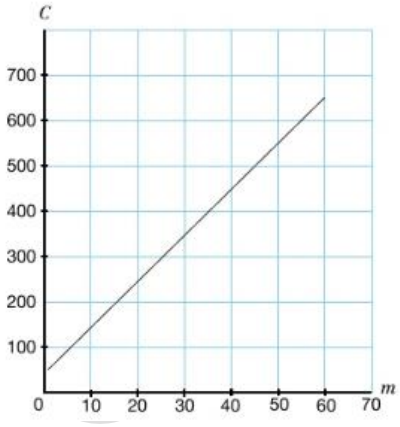
EXAMPLE 03

The cost of phoning is 10 cents per minute plus 50 cents. Write down an equation for the total cost, $C, for phoning form minutes if the minimum is 1 minute and the maximum is 60 minutes.

C = 10m + 50

1 ≤m ≤ 60

Usually, the graph would be drawn with C on the vertical axis and m on the horizontal axis.



KEY POINTS

- The graph of $y = mx + c$ is a straight line with gradient m and y-intercept c.
- If the points do not lie on a straight line, then there is a mistake in the table of values.
- It is usual to use only three or four widely spaced points in the table of values.

GRAPHS OF ax + by = c

The graph of 3x + 4y = 12 is a straight line. The equation can be rearranged as y = -3/4 *x*+3 showing it is a straight line with gradient -3/4 and y-intercept (0, 3). The easiest way to plot the graph is to find where the graph crosses the axes.

EXAMPLE 4

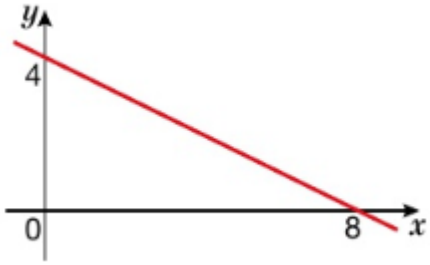
SKILL: INTERPRETATION

Draw the graph x + 2y = 8.

Find where the line crosses the axes.

Substituting y = 0 gives x = 8 (8, 0) lies on the line.

Substituting x = 0 gives y = 4 = (0, 4) lies on the line. Join the points with a straight line.



KEY POINTS

- $ax + by = c$ is a straight line.
- To draw the graph, find where it crosses the axes.

STRAIGHT-LINE CONVERSION GRAPHS

A graph gives an easy way of converting from one unit to another.

EXAMPLE 5

SKILL: MODELLING

a) In May, £1 was worth €1.38. Draw a conversion graph to convert £0 to £100 into euros.

b) Use your graph to convert (i) £60 to euros

and (ii) €120 to British pounds.
a) £100 is worth €138, £0 is worth €0. Plot both points on a graph and join with a straight line.

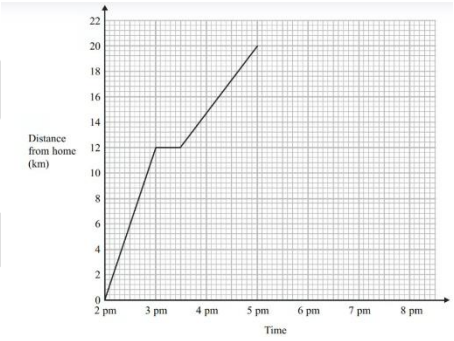
KEY POINTS

- A conversion graph is an easy way of converting from one unit to another.
- Because **readings** are taken from a graph, the answers are not exact.
- Not all conversion graphs pass through the origin.

b the arrows show how to use the conversion graph.
(i) £60 is approximately €83.
(ii) €120 is approximately £87.

Revision questions

1)Simon went for a cycle ride.
He left home at 2 pm.
The travel graph represents part of Simon's cycle ride.

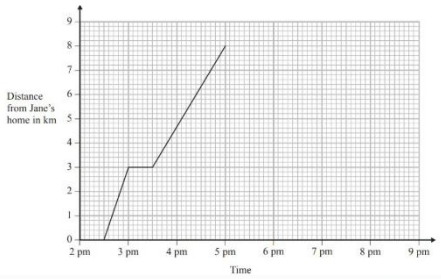


a) At 3 pm Simon stopped for a rest. How many minutes did he rest?

b) How far was Simon from home at 5 pm?

c) At 5 pm Simon stopped for 30 minutes. Then he cycled home at a steady speed. It took him 1 hour and 30 minutes to get home.
Complete the travel graph.

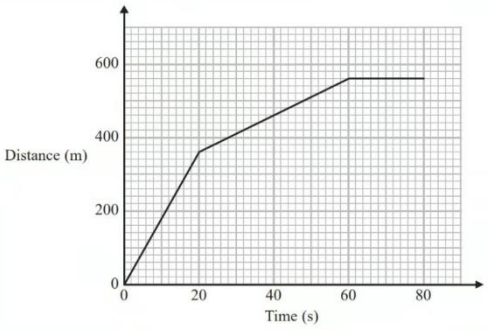
2)a) Jane walked from her home to the ice rink.
The travel graph for Jane's journey to the ice rink is shown below.



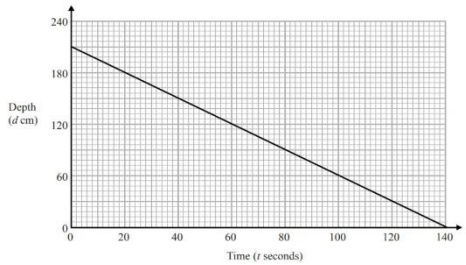
On the way to the ice rink, Jane stopped at her friend's house.
How far is it from her friend's house to the ice rink?

b) Jane was at the ice rink for 1 hour 30 minutes. She then walked home at a steady speed. Jane took 2 hours to walk home.
Complete the travel graph for this information.

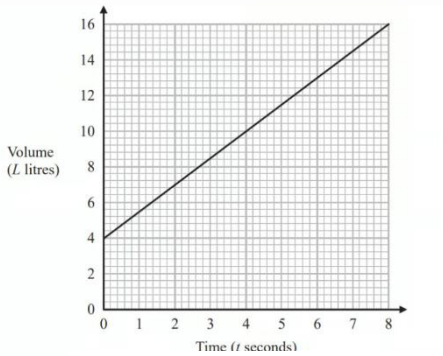
3)Here is part of a distance-time graph for a car's journey.
Between which two times does the car travel at its greatest speed?
a) Give a reason for your answer.
b) Work out this greatest speed.



4)The graph shows the depth, d cm, of water in a tank after t seconds.
a) Find the gradient of this graph.
b) Explain what this gradient represents.



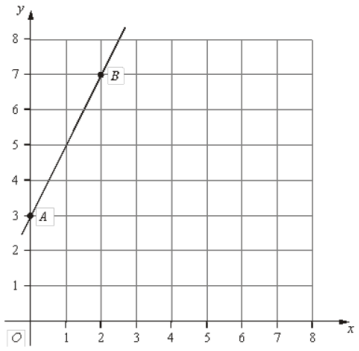
5)The graph shows the volume of liquid (L liters) in a container at time t seconds.



a) Find the gradient of the graph.
b) Explain what this gradient represents.
c)The graph intersects the volume axis at L = 4
Explain what this intercept represents.

6) a) A has coordinates (0, 3).
B has coordinates (2, 7).
Work out the gradient of the line that passes through A and B.

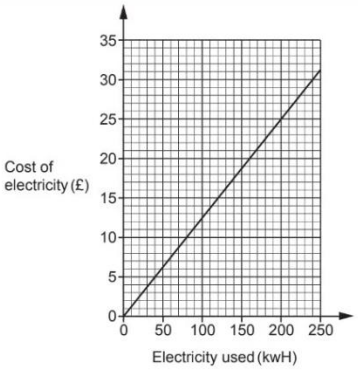
Q1.



7)The line y = 2x + 3 meets the line y = 4x + 2 at the point P.
Find an equation of the line which is perpendicular to the line y = 2x + 3 and which passes through the point P.

8)The line y = 2x + 3 meets the line y = 4x + 2 at the point P.
Find an equation of the line which is perpendicular to the line y = 2x + 3 and which passes through the point P.

9) The graph shows the cost of electricity with Company A.



a) Use the information in the graph to estimate the cost of electricity for a customer who uses 450kwH of electricity.
How did you do?
Company B charges 14.3 pence per kWh of electricity used.
b) If Company B's cost of electricity was plotted on the same axes as Company A's cost of electricity, which line would be steeper?
Explain how you know.

10)The graph shows the volume of liquid (L litres) in a container at time t seconds.

a) Find the gradient of the graph.
b) Explain what this gradient represents.