

Unit 1 *Straight Lines*

Introduction

Learning objectives

This is the first unit in this strand on graphs, focusing on the straight line. After completing this unit you should

- be able to identify and use the gradient of a straight line
- be able to calculate and identify gradients of perpendicular lines
- be confident in applying the concept of straight line graphs in a variety of situations, including distance, time, velocity and acceleration
- be able to develop and use the general equation of a straight line.

Introduction

The inspiration behind the development of graphs to represent functions is commonly credited to *René Descartes* (1596-1650) but the much earlier work of the Frenchman, *Nicole d'Oresme* (c. 1323–1382) represented the real starting point. d'Oresme was essentially a clergyman, being appointed canon and later dean of Rouen, and in 1370, appointed chaplain to King Charles V. His contribution to this area of mathematics was to find the logical equivalence between tabulating and graphing values. He proposed the use of a graph for plotting a variable magnitude when one value depends on another.

It is possible that the work of *Descartes* was influenced by *d'Oresme's* work, which was reprinted several times during the century following its first publication; but, despite this possible influence, the concept of the use of coordinate axes for representing functions is clearly a mathematical landmark.

As the inventor of the Cartesian coordinate system, Descartes founded analytic geometry, the bridge between algebra and geometry, crucial to the discovery of infinitesimal calculus and analysis. He is best known for the philosophical statement

"Cogito ergo sum"

(French: "Je pense, donc je suis"; English: "I think, therefore I am"; or "I am thinking, therefore I exist".)

Nowadays, we take coordinate axes very much for granted and a function and the graph to represent it, are almost regarded as being totally equivalent. Indeed, for the functions dealt with in this unit, there is little difference, but it should be noted that not all functions can be adequately represented by a graph.



*Portrait of René Descartes
(after Frans Hals, 1648)*



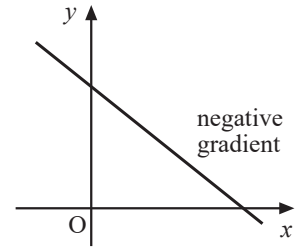
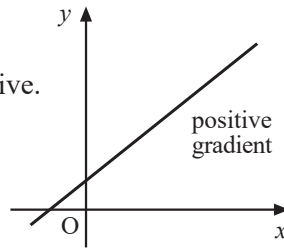
*Portrait of Nicole Oresme:
Miniature of Nicole Oresme's
Traité de l'espece,
Bibliothèque Nationale, Paris, France*

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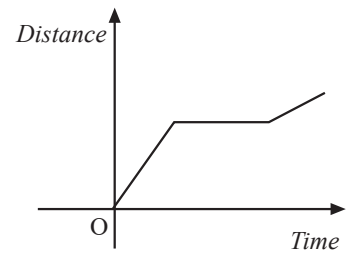
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Key points

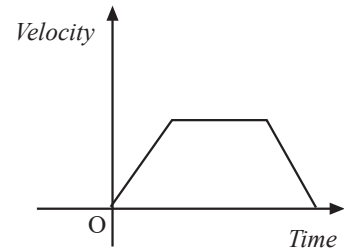
- The gradient of a line can be positive or negative.



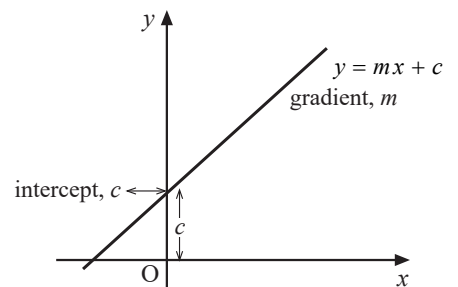
- Parallel lines have the same gradient.
- 'Perpendicular lines' means that the product of their gradients equals -1 (i.e. m and $-\frac{1}{m}$).
- The gradient in a distance-time graph is the *velocity*.
Note: if the gradient is zero, the object is not moving.



- The gradient in a velocity-time graph is the *acceleration*.
Note: if the gradient is zero, the object is moving with constant velocity; if the gradient is negative, it is decelerating.



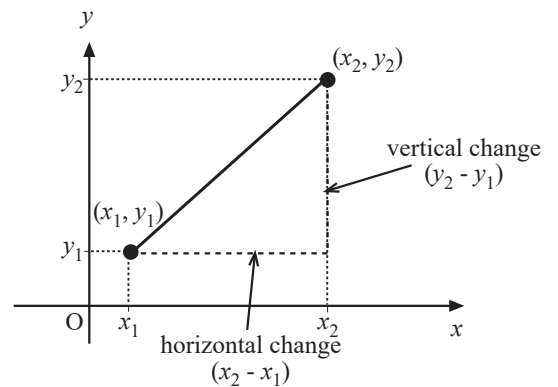
- The area under a velocity-time graph is the distance travelled.
- The general equation of a straight line is of the form
 $y = mx + c$
where m is its gradient and c the y -axis intercept.

**Facts to remember**

- The gradient of a straight line

$$= \frac{\text{vertical change}}{\text{horizontal change}}$$

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



- Parallel lines have equal gradients.

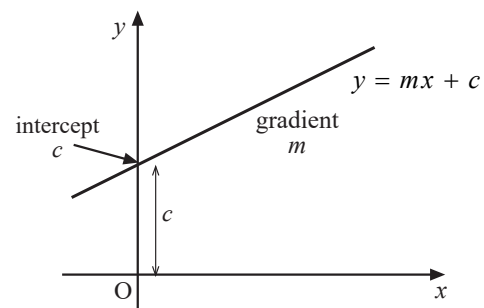
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- The product of the gradients of perpendicular lines is -1 ; if m is the gradient of one of the lines $\left(-\frac{1}{m}\right)$ is the gradient of the other line.
- The gradient of a distance-time graph is *velocity*.
- The gradient of a velocity-time graph is *acceleration*.
- The area under a velocity-time graph is the *distance covered*.
- The general equation of a straight line is

$$y = mx + c$$

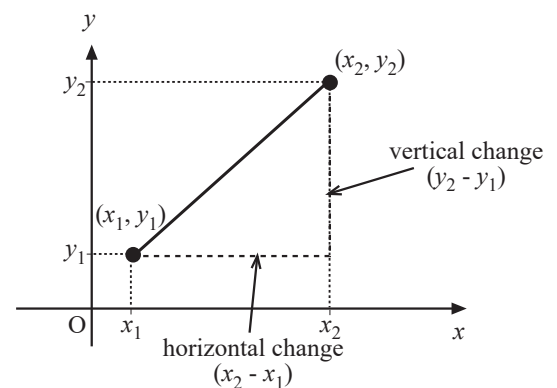
where m is the gradient and c is the y -axis intercept.

**Glossary of terms**

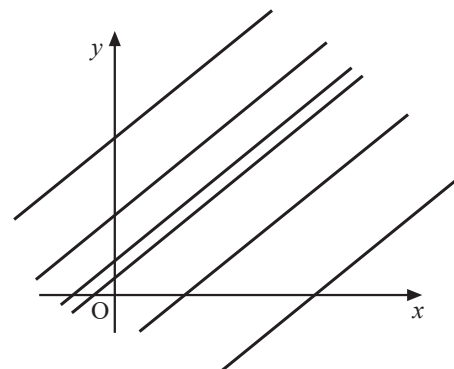
Gradient of a straight line describes how steep the line is and is defined as

$$m = \frac{\text{vertical change}}{\text{horizontal change}}$$

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



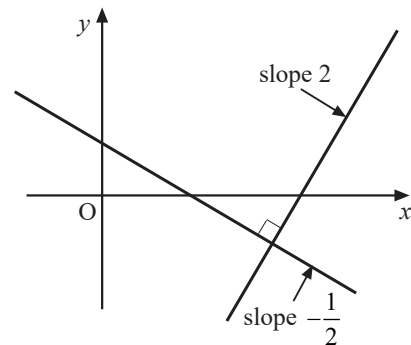
Parallel lines lines with the same gradient are parallel to one another.



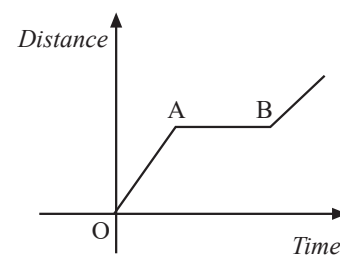
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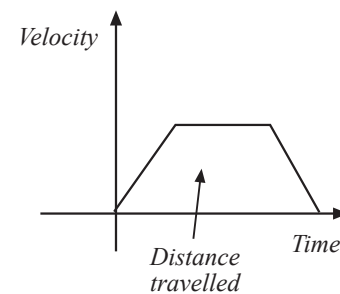
Perpendicular lines the product of their gradients is -1 ;
for example, see diagram.



Distance-time graph here the gradient represents the velocity;
the velocity is zero when the line has zero gradient (for example, A to B in
the diagram opposite).



Velocity-time graph here the gradient represents the acceleration;
the area under the graph is the distance travelled.



General equation of a straight line is

$$y = mx + c$$

when m is the gradient and c is
the y -axis intercept.

