Studying Mathematics: Applications and Interpretation at IB Diploma level

The IB Diploma programme Mathematics: Applications and Interpretation is a rigorous and challenging course of study which helps build your mathematical knowledge and understanding as well as your problem-solving skills. A key part of your studies will involve developing communication, interpretation, and reasoning skills through mathematical inquiry and argument and will require you to use appropriate mathematical terminology in precise statements.

How this resource can help you

Studying Mathematics: Applications and Interpretation as part of the IB Diploma programme involves a substantial amount of time for independent study and you may need additional support from your teacher, friends, or other resources. Of course, your teacher and friends may not always be available, particularly when it comes to acquiring, learning, and using the mathematical language and terminology from the course.

This book aims to help you in this process by unpacking the language of the IB Diploma with a focus on both course content and assessment.

- Each word or phrase included in this A-Z glossary has been carefully selected because we think it will be useful in your studies. This resource contains words and phrases from the IB Diploma Mathematics: Applications and Interpretation subject guide as well as subject-specific terms commonly found in most Maths textbooks.
- You will find key subject-specific vocabulary related to your study of Maths, such as mathematical terms, concepts, and techniques, as well as command terms and assessment terminology. Knowledge and appropriate use of these terms will have a significant impact on your overall achievement and final score.
- Terms related to the IB Learner Profile are also included and explained within the context of your Maths studies, so that you may understand how these learner attributes are applied within the Maths classroom.
- Support is offered on using your graphical display calculator with many of the abbreviations used on your calculator explained within this glossary, too.
- Your IB Diploma Maths course is divided up into five topics: Number and algebra, Functions, Geometry and trigonometry, Statistics and probability, and Calculus. To help your understanding of Maths, the relevant topic is given in brackets at the end of each definition. If no topic is provided, this is because you will find yourself using that term across a number of different topics in Maths.
- All of the terms in this resource will be appropriate for students studying at Higher Level. Words and phrases that are labelled (AHL) indicate content that is additional HL; this means that HL students will come across this language in their studies, but these terms do *not* form part of the SL course. Students studying at SL need only focus on those terms which are *not* highlighted (AHL).
- Where you see a word in the definition written in **green text**, this means that a glossed definition exists for it elsewhere in the book. This has been done where we thought it would be helpful for you.
- Do remember that this resource is *not* a dictionary, as it does not necessarily contain all possible definitions for each word or phrase. It is, however, a glossary of terms where the definitions are given in the context of the IB Diploma Mathematics: Applications and Interpretation course.
- Also note this is *not* a comprehensive list of mathematical terms. If your teacher gives you some additional words, you might choose to write them into the glossary yourself, so that the book is more like a living workbook for you.
- Your teacher might also encourage you to extend the current list with additional terms, enhance the definitions according to their own ideas and interpretations, or provide alternative examples.

We wish you the best on your learning journey and of course the greatest success in your exams!

Jane, Leisa, Spyridon, Margarita, and the team at Elemi

1D

One dimension (1D) is when we measure in one direction, usually length (a line). In calculus, used to describe an object that moves only in one direction.

2D

Two-dimensional. Shapes like squares, rectangles, etc are two dimensional as they are flat shapes. The shapes have two dimensions (eg height and width, but no depth). (Geometry and trigonometry)

3D

Three dimensional. Shapes like cubes, cuboids, spheres, etc are three dimensional as they have three dimensions (eg height, width and depth). (Geometry and trigonometry)

Absolute extremum (*plural* absolute extrema)

The largest or smallest **value** that a **function** may take. (Calculus)

Absolute value

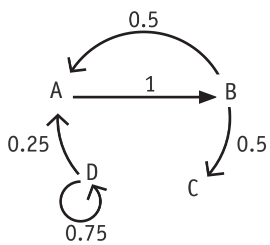
The size of a number regardless of whether it is positive or negative. The absolute value of a number will always be positive. For example, the absolute value of -30 is 30. (Also known as **modulus**.) (Number and algebra)

Absorbing Markov chain (AHL)

A **Markov chain** in which there is at least one **absorbing state** and it is possible from every state to reach an absorbing state. (Statistics and probability)

Absorbing state (AHL)

A state in a **Markov chain** that cannot be left once entered. For example, state C in the Markov chain shown below is an absorbing state because once you reach state C, you cannot get out of it. (see **periodic state**)



(Statistics and probability)

Abstract (abstraction)

To take away any element of real life to which a mathematical concept might be related and then generalize it so that it can be more broadly applied. (Number and algebra)

Acceleration (AHL)

The rate of change of the **velocity** of an object per unit of time. (Geometry and trigonometry, Calculus)

Acceleration function (AHL)

A function that describes the **acceleration** of an object at time t. The acceleration function is the **second derivative** with respect to time of the **displacement function**. If $s(t)$ is the displacement function, then $v(t) = \frac{ds}{dt}$ is the **velocity function** and the acceleration function is $a(t) = \frac{dv}{dt} = \frac{d^2s}{dt^2}$. (Calculus)

Acceptance region

The values which make the **null hypothesis** valid, and is expressed as an upper and lower limit. (Statistics and probability)

Accurate (accuracy)

How close a measured value is to the actual (true) value. An exam question will tell you how the answer should be given – this is the **degree of accuracy**. If a question asks for an exact answer, the answer should be given in full or as a **surd** if necessary. (Number and algebra)

Acute angle

An angle which measures between 0 and 90 degrees. (Geometry and trigonometry)

9781916413139 A-Z for Maths.indb 4 11/11/2019 12:03

Acyclic (AHL) — A graph that does not have a **cycle**, ie it does not have a **path** that begins and ends in the same place without revisiting any **vertices** (other than the start and end). (Geometry and trigonometry)

Addition (add) — Finding the sum of numbers. For example:

3 add 4 is $3 + 4 = 7$. (Number and algebra)

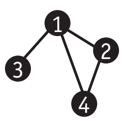
Additive identity (AHL) — The property stating that the **sum** of any real number and 0 is equal to the original number: $a + 0 = 0 + a = a$, for all real numbers. In this case, 0 is called the additive identity element. The additive identity property is extended to other sets as well, such as complex numbers, where the identity element is also 0, and matrices, where the identity element is the **zero matrix** O. (Number and algebra)

Additive inverse (AHL) — Every number has its **opposite** as an additive inverse. The sum of a number and its additive inverse is equal to the additive identity element, ie $a + (-a) = 0$. Similarly, every matrix A has matrix $-A$ as its additive inverse, and their sum is equal to the **zero matrix** O. (Number and algebra)

Address (AHL) — The **ordered pair** (i,j) stating the position of an **element** a_{ij} of a matrix. This lies in **row** i and **column** j. For example, the address of the element −6 in the matrix

$\begin{pmatrix} 3 & -4 \\ -6 & 5 \end{pmatrix}$ is $(2, 1)$. (Number and algebra)

Adjacency matrix (AHL) — A matrix used to represent a finite graph. It shows the connections between **vertices** and whether or not the vertices are **adjacent vertices**. For a graph with V vertices, the matrix is a $V \times V$ matrix. An entry of 1 in the (i, j) entry shows that the vertices i and j are connected by an edge and an entry of 0 shows they are not. For example:



	1	2	3	4
1	0	1	1	1
2	1	0	0	1
3	1	0	0	0
4	1	1	0	0

Powers of an adjacency matrix can be used to find the number of k-step walks between two vertices. For example, given A as the adjacency matrix, A^4 would give the number of 4-step walks. (Geometry and trigonometry)

Adjacent — This commonly means ‘next to’ but in trigonometry, this refers to the side of a right triangle which is neither the **hypotenuse** nor the side opposite the angle we are using in the sum. (Geometry and trigonometry)

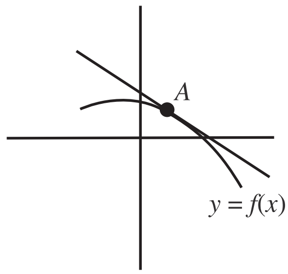
Adjacent edges (AHL) — In **graph theory**, adjacent edges are edges that share a common **vertex**. (Geometry and trigonometry)

Adjacent vertices (AHL) — **Vertices** that are connected to each other by an edge. (Geometry and trigonometry)

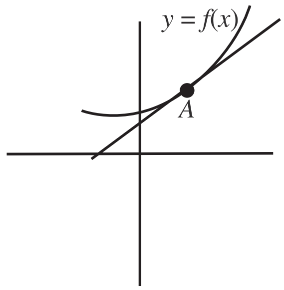
Algebra — The use of letters to replace numbers in order to work out a sum. For example, to work out how many sweets there are in a certain number of bags, we might say that if each bag contains c sweets, then a bags would contain $a \times c$ or ac sweets. (Number and algebra)

Algebraic expression — A mathematical expression consisting of numbers, letters and **operations**. For example: $5a + 2c$ (Number and algebra)

Compute (computation)	To work out – not necessarily with a computer.
Computer notation	A way of writing something that is used on a computer or calculator, but should not be used in written work. For example, **standard form** is written $5.6\text{E}7$ on a calculator or computer but should be written as 5.6×10^7 in your own work.
Concave down (AHL)	A curve that bends downward. A graph (or a function) is concave down at a point when the curve is below the **tangent** line at that point. The **second derivative** of the function is less than 0 at that point, $f''(x) < 0$. (Calculus)



Concave up (AHL)	A curve that bends upward. A graph (or a function) is concave up at a point when the curve is above the **tangent** line at that point. The **second derivative** of the function is greater than 0 at that point, $f''(x) > 0$. (Calculus)



Concept	An idea. Remember that if you understand a concept, you do not have to memorize formulae, etc. So if you understand the concept of **Pythagoras' theorem**, you can calculate any side in any right angled triangle.
Conclude (conclusion)	A comment on the result of an enquiry or question. In an **IA** it will be what the overall results show and whether a **hypothesis** is true or false.
Condition	A requirement that is needed in order for something to be true.
Conditional probability	The probability of one event happening given that another event has already occurred. (Statistics and probability)
Cone	A **three-dimensional** shape with a circle as a base and a point at the top. (Geometry and trigonometry)
Confidence interval (AHL)	The **range** of values between which the true value of a population statistic, eg **mean**, lies given a specified **probability**. For example, given a sample $1, 2, 3, 4, 5$ from a normally distributed population; the mean of the population has a 95% confidence interval of $[1.76, 4.24]$. For a ***t*-distribution**, a confidence interval is found using the formula $\bar{x} \pm t \times \frac{s_{n-1}}{\sqrt{n}}$ For a **normal distribution**, a confidence interval is found using the formula $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$ Both formulae are given in the formula book. (Statistics and probability)

C

9781916413139 A-Z for Maths.indb 17 11/11/2019 12:03

C

Confidence level (AHL)
The specified **probability** that the true value is contained within the **confidence interval**. (Statistics and probability)

Congruent
Exactly the same in every way (sides and angles) – often used for triangles. (Geometry and trigonometry)

Conic section
A conic section is where a surface of a **cone** meets with a **plane** and forms a curve. (Functions)

Conjugate (of complex number) (AHL)
The **complex number** $z^* = x - iy$ is the conjugate of complex number $z = x + iy$. It can be easily derived that $z \cdot z^* = |z|^2$, where $|z|$ is the **modulus** of both complex number z and its conjugate z^*. It is also true that $z + z^* = 2x = 2\text{Re}(z) = 2\text{Re}(z^*)$ and $z - z^* = 2iy = 2i\text{Im}(z) = -2i\text{Im}(z^*)$, where $\text{Re}(z)$ is the **real part** of z and $\text{Im}(z)$ denotes its **imaginary part**. (Number and algebra)

Conjugate pair (AHL)
A **complex number** z together with its **conjugate** z^*. When a **polynomial equation** with real-number coefficients accepts a complex number z as its solution, then the conjugate of z, denoted by z^*, is also a solution of the equation. Then the polynomial expression accepts $x - z$ and $x - z^*$ as linear factors, or $x^2 - 2\text{Re}(z) \cdot x + |z|^2$ as a quadratic factor. Note that the term conjugate pair is also used to describe pairs of real numbers of the form $2 + \sqrt{3}$ and $2 - \sqrt{3}$. (Number and algebra)

Connected graph (AHL)
A graph in which there is a **path** connecting any **vertex** to any other vertex. (Geometry and trigonometry)

Consecutive
One after the other. For example, consecutive even numbers would be $2, 4, 6, 8$. (Number and algebra)

Consequently
As a result of something happening, another event happens.

Constant
Something which does not change, usually just a number. For example, in $y = 5x + 3$, 3 is the constant. We also might refer to a 'constant speed' where the pace at which something travels remains the same. (Number and algebra, Functions)

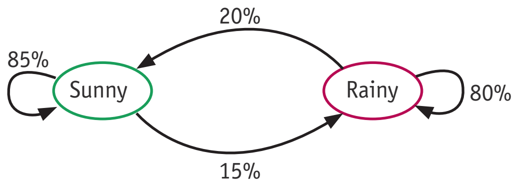
(see **variable**)

Constant difference
Another term for **common difference**. (Number and algebra)

9781916413139 A-Z for Maths.indb 18 11/11/2019 12:03

M

Magnitude (of a vector) (AHL)	The size of a vector. Given a vector $\boldsymbol{v}$, it is denoted $\lvert\boldsymbol{v}\rvert$. It is defined as the **square root** of the sum of the square of each **component of the vector**. For example, the magnitude of the vector $\boldsymbol{v} = -3\boldsymbol{i} + 4\boldsymbol{j} + \boldsymbol{k}$ is $\lvert\boldsymbol{v}\rvert = \sqrt{(-3)^2 + 4^2 + 1^2} = \sqrt{26}$. (Geometry and trigonometry).
Main diagonal (of a matrix) (AHL)	(see **diagonal (of a matrix)**) (Number and algebra)
Manipulate (manipulation)	A word which asks you to change an **expression** so that it becomes simpler. For example if $y = 2x - 5 + 7x + (7/2)$ it can be manipulated to $y = 9x - 1.5$
Mantissa	When a value is written in **standard form**, the mantissa is the number that appears before the multiplication sign. For example, in standard form $2563 = 2.563 \times 10^3$, and the mantissa is 2.563. (Number and algebra)
Many to one function	When more than one of the x (**domain**) values maps to the same y (**range**) value. (Functions)
Mapping	To change something by applying a rule, eg the set of whole numbers can be mapped to the set of square numbers by applying the rule that each number maps to its square. (Functions)
Mapping diagram	A visual way to show how x values map to the equivalent y values. (Functions)
Markov chain (AHL)	A sequence of states where the **probability** of the next state is only dependent on the current state. For example, if it is a sunny day today, there is an 85% chance it will be sunny tomorrow and a 15% chance it will be rainy. If it is a rainy day today, there is a 20% chance it will be sunny tomorrow and an 80% chance it will be rainy. It does not matter whether it was sunny or rainy yesterday or the day before. The states Sunny and Rainy form a Markov chain as displayed in the **transition diagram** below. (Statistics and probability)



Markov property (AHL)	The property in a **Markov chain** that the next state is dependent only on the current state and not any others that may have come before. (Statistics and probability) (see **memory-less**)
Matched pairs (AHL)	Putting experimental data together into groups of two where the two data points are as similar as possible. Using matched pairs can reduce the variability of the **sample**. For example, to evaluate the effect of a new revision guide for IB Diploma Mathematics, you could look at exam results of a group of students and pair up two students who had similar mock exam scores, one who used the new guide and one who did not. (Statistics and probability)
Mathematical exploration	Used in the **internal assessment** for IB Diploma Mathematics, this is a piece of written work which gives you an opportunity to investigate an aspect of Mathematics which interests you. It counts for 20% and is marked by your teacher but moderated by the IBO. In order to do well, you need to make sure that all your work is set out well and explained clearly using appropriate language.

9781916413139 A-Z for Maths.indb 52 11/11/2019 12:03

M

Mathematical model Something used to try and reproduce real-life situations using Mathematics. A model might help us understand or predict what happens when prices, **interest rates**, or temperatures change, for example. (Functions)

Matrix (*plural* matrices) (AHL) A collection of numbers, symbols, and/or expressions arranged in **rows** and **columns** in a rectangular block. For example:

$$\begin{pmatrix} 3 & 4 \\ 2 & 1 \end{pmatrix} \quad \begin{pmatrix} 6 & 4 & 9 \\ 5 & 7 & 2 \\ 1 & 3 & 8 \end{pmatrix} \quad \begin{pmatrix} a & b \\ c & 2x \\ 9 & 0 \end{pmatrix} \quad \begin{pmatrix} x+1 \\ y^2 \end{pmatrix}$$

In general, a matrix $\boldsymbol{A}$ with m rows and n columns is denoted by:

$$\boldsymbol{A} = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix}$$

Matrices are often used to store information, eg this table shows the choice of sport per gender for the members of a sports club.

	Tennis	Football	Swimming
Male	45	67	46
Female	56	34	38

This information may also be written in matrix form:

$$\begin{pmatrix} 45 & 67 & 46 \\ 56 & 34 & 38 \end{pmatrix}$$

where each row represents a gender and each column a different sport. (Number and algebra)

Matrix equation (AHL) An equation involving **matrices**, in which the unknown variable is a matrix. For example:

$$\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} + \begin{pmatrix} x & y \\ z & w \end{pmatrix} = \begin{pmatrix} -5 & 1 \\ 2 & -1 \end{pmatrix}$$

or

$$\boldsymbol{A} + \boldsymbol{X} = \boldsymbol{B}$$

where $\boldsymbol{X}$ is the variable matrix. Matrix equations are often used when solving **simultaneous equations**. For example, a system of linear equations with unknowns x and y, such as

$$\begin{cases} x + 2y = 5 \\ 3x - 8y = 12 \end{cases}$$

can be represented by the matrix equation:

$$\begin{pmatrix} 1 & 2 \\ 3 & -8 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 5 \\ 12 \end{pmatrix}$$

or

$$\boldsymbol{AX} = \boldsymbol{B}$$

where

$\boldsymbol{A} = \begin{pmatrix} 1 & 2 \\ 3 & -8 \end{pmatrix}$, $\boldsymbol{B} = \begin{pmatrix} 5 \\ 12 \end{pmatrix}$, and $\boldsymbol{X} = \begin{pmatrix} x \\ y \end{pmatrix}$

(Number and algebra)

(see **equal matrices**, **variable matrix**)

9781916413139 A-Z for Maths.indb 53 11/11/2019 12:03

Q

Quadrant

1 One of the four equal parts of a circle when it is divided into four by two perpendicular diameters. (Geometry and trigonometry)

2 One of the four regions defined on the Cartesian plane by the coordinate axes. Points in the first quadrant have both positive x and y coordinates. The remaining quadrants are numbered counter-clockwise starting from the first. So, for example, points in the second quadrant have negative x and positive y coordinates. (Geometry and trigonometry)

Quadratic equation (AHL) An equation of the form $ax^2 + bx + c = 0$, where a, b, c are real number constants ($a \neq 0$, otherwise it becomes a linear equation).

The equation has two **solutions** (or **roots**) of the form $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$. The nature of these solutions is determined by the sign of discriminant $\Delta = b^2 - 4ac$.

If $\Delta > 0$, there are two **distinct** real roots, representing the **x-intercepts** of the parabolic graph of the corresponding quadratic function $f(x) = ax^2 + bx + c$.

If $\Delta = 0$, the real root $x = \frac{-b}{2a}$ is a repeated (double root), representing the **vertex** of the parabolic graph that lies on the **x-axis**.

If $\Delta < 0$, the parabolic graph does not cross the x-axis. This means that the equation has no real roots. Instead, the roots of the equation are now two **conjugate complex numbers** of the form $x = \frac{-b \pm \mathrm{i}\sqrt{4ac-b^2}}{2a}$. These numbers represent points on the **Argand diagram** that lie on the axis of symmetry of the corresponding parabola $\left(x = \frac{-b}{2a}\right)$, being $\frac{\mathrm{i}\sqrt{4ac-b^2}}{2a}$ away and on either side of the x-axis. (Functions)

Quadratic expression (AHL) Any **algebraic expression** that has the form, or can be simplified to the form, $ax^2 + bx + c$, where a, b, c are real number constants ($a \neq 0$, otherwise it becomes a linear expression). Specifically, any expression that takes the form of a second-degree polynomial. For example, $-x^2 + 6x - 17$. (Functions)

Quadratic function A polynomial relationship where the largest term is a multiple of x^2, for example, $f(x) = 5x^2 + 7$. (Functions)

Quadratic inequality (AHL) An **inequality** involving a second order **polynomial**. Such an inequality is formed when the = sign is replaced by an inequality sign ≤, <, >, or ≥. For example:

$$ax^2 + bx + c \geq 0, a \neq 0$$

A quadratic inequality can be solved either algebraically or graphically. In general, one needs to identify the intervals at which the **quadratic expression** takes positive or negative values. (Number and algebra, Functions)

Quadratic model A way of representing a real-life problem mathematically, using quadratic (x^2) values. (Functions)

Quadratic regression (AHL) A **regression** curve (curve of best fit) that takes the form of a **quadratic function**. (Statistics and probability)

Quadrilateral A four-sided two-dimensional shape. (Geometry and trigonometry)

Qualitative (data) Information that describes something and which can be arranged in categories but that isn't associated with numbers, eg the colour of the sea. (Statistics and probability)

(see **quantitative (data)**)

Quantify (quantification) To measure how many there are of something.

9781916413139 A-Z for Maths.indb 70 11/11/2019 12:03

Quantitative (data)	Information which is numerical or about quantities and which can be measured, eg how many siblings people have. (Statistics and probability) (see **qualitative (data)**)
Quantity	An amount that can be measured, eg the quantity of flour needed is 400 grams.
Quarterly	Something that happens four times a year, or every quarter. For example, we might talk about **interest** being calculated quarterly. (Number and algebra)
Quartile	Dividing something into 4. You can have the lower quartile at 25% and the upper quartile at 75%. (Statistics and probability)
Questionnaire (AHL)	A list of questions used to collect data from respondents in a **survey**. Responses may be text, numerical, or multiple choice, and questions may be closed or open-ended. (Statistics and probability)
Quotient	The result when you divide a number by another number. (Number and algebra)
Quotient rule (AHL)	The method of finding the **derivative** of an expression that can be written as a **quotient** (division or fraction). For $y = \frac{f(x)}{g(x)}$, then $\frac{dy}{dx} = \frac{f'(x)\times g(x) - f(x)\times g'(x)}{(g(x))^2}$ The quotient rule is given in the formula booklet so you do not need to memorize it. (Calculus)

V

Valence	The number of edges at a vertex of a **Voronoi diagram**. (Geometry and trigonometry)
Valid (validity)	True and without **bias**. At AHL, you would be expected to know the difference between validity and **reliability**. (Number and algebra, Statistics and probability)
Validity test (AHL)	A measure of how well the data from a **sample** corresponds to data in a **population**. Validity can be tested for **content validity** and for **criterion-related validity**. (Statistics and probability)
Value	1 In Mathematics, an amount that has been worked out, expressed as a number. 2 In more general terms, the amount an item is worth; how much it costs or would sell for if sold.
Variable	An amount represented by a letter such as x or y, that can take several **values**. Even if it only has one value, it is still called a variable. (Number and algebra)
Variable matrix (AHL)	A matrix in which all **entries** are **variables**, often used when writing **systems of linear equations** in matrix form. In this case, the variable matrix is the matrix formed by the variables of the system of linear equations. A system of two linear equations with unknown variables x and y is written as: $\begin{cases} a_{11}x + a_{12}y = b_{11} \\ a_{21}x + a_{22}y = b_{21} \end{cases}$ where $a_{11}, a_{12}, a_{21}, a_{22}, b_{11}, b_{21}$ are real numbers. The system is written in matrix form as: $\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} b_{11} \\ b_{21} \end{pmatrix}$ or $\boldsymbol{AX} = \boldsymbol{B}$ where $\boldsymbol{X} = \begin{pmatrix} x \\ y \end{pmatrix}$ is the variable matrix. (Number and algebra) (see **answers matrix**, **coefficient matrix**, **constant matrix**)
Variance	A measure of how spread out numbers are in relation to the **mean**. It is the **square** of the **standard deviation**. (Statistics and probability)
Variation	A change in one **value**, related to a change in another. Variation can be described as **direct proportion** (or direction variation) or **inverse proportion** (or inverse variation). (Statistics and probability)
Vector	A way of showing both distance and direction of a line. It can be signified by two numbers in brackets on top of one another, where the top number represents a move to the right (or left, if negative) and the bottom number represents a move up (or down, if negative). (Geometry and trigonometry)
Vector algebra (AHL)	The operations of vector addition, **scalar multiplication**, **scalar product** and **vector product**. (Geometry and trigonometry)
Vector equation of a line (AHL)	Given a point travelling in a straight line, the vector equation of the line (also called the position vector) is $\boldsymbol{r} = \boldsymbol{a} + \lambda\boldsymbol{b}$, where $\boldsymbol{a}$ is the starting position, λ is a scalar, and $\boldsymbol{b}$ is the direction vector. (Geometry and trigonometry)
Vector field (AHL)	(see **slope field**) (Calculus)

9781916413139 A-Z for Maths.indb 92 11/11/2019 12:03

Vector product (AHL) | An operation on two **vectors** that gives a vector that is perpendicular to both vectors. It is denoted with the symbol × and is said as 'a cross b'. It is also called the cross product.

$\boldsymbol{a} \times \boldsymbol{b} = |\boldsymbol{a}||\boldsymbol{b}| \sin\theta\, \boldsymbol{n}$ where θ (is the angle between $\boldsymbol{a}$ and $\boldsymbol{b}$ and $\boldsymbol{n}$ is the **unit normal vector** for the plane containing $\boldsymbol{a}$ and $\boldsymbol{b}$. Use the **right-hand screw rule** to determine the direction of $\boldsymbol{n}$. The **magnitude** of the vector product is the area of a parallelogram bounded by the vectors $\boldsymbol{a}$ and $\boldsymbol{b}$. Note that $\boldsymbol{a} \times \boldsymbol{b}$ does not equal $\boldsymbol{b} \times \boldsymbol{a}$. (Geometry and trigonometry)

Vector theory (AHL) | Using **vectors** in **mathematical modelling**, for example, to model the movement of a **projectile**. (Geometry and trigonometry)

Velocity (AHL) | The rate of change of the position of an object per unit of time. Velocity is a vector quantity; it has magnitude (which we call speed) and direction. (Geometry and trigonometry, Calculus)

Velocity function (AHL) | A function that describes the **velocity** of an object x at time t. The velocity function is the **first derivative** with respect to time of the **displacement function**. If $x = x(t)$ is the displacement function, then $v(t) = \frac{dx}{dt}$ is the velocity function. (Calculus)

Venn diagram | A visual representation used in **sets** to show in which set elements belong and their relationship. A Venn diagram consists of a rectangle (see **universal set**) surrounding circles which represent the sets. (Statistics and probability)

Verify (verification) | To prove something is true through evidence. Often used as a **command term** where you need to provide evidence to prove that a result is correct.

Vertex (*plural* vertices) |

1. On a graph, the vertex is a maximum or minimum point. (Functions)
2. Where two lines or edges join in a **2D** or **3D** shape. (Geometry and trigonometry)
3. On a **Voronoi diagram**, where the boundaries of three or more Voronoi cells meet. (Geometry and trigonometry)
4. (AHL) In **graph theory**, a point in a graph. (Geometry and trigonometry)

Vertex disjoint (AHL) | Two **paths** in a graph that do not share a **vertex**. (Geometry and trigonometry)

Vertex set (AHL) | The set of **vertices** in a graph. (Geometry and trigonometry)

Vertical | Going from north to south or top to bottom. A vertical line is perpendicular to a **horizontal** line. (Functions, Geometry and trigonometry)

Vertical asymptote | A line (often drawn as dotted) which a graph approaches but never reaches. For example, the graph of $y = 1/(x-2)$ has a vertical asymptote of $x = 2$. (Functions)

Vertical line test | A test to prove that a graph is a **function**. If you draw a line through the graph from top to bottom and it cuts the graph more than once, then it is not a function. (Functions)

Vertical stretch | When a function $f(x)$ is transformed into $af(x)$ the graph undergoes a vertical stretch and all of its y coordinates are multiplied by a. For example, in the stretch $f(x)$ to $2f(x)$ the y coordinates are multiplied by 2. (Functions)

(see **horizontal stretch**)

Vertices | The plural form of **vertex**. (Functions, Geometry and trigonometry)

Visualize (visualization) | To make a problem more concrete in your mind by imagining or seeing how it looks in diagrammatical form.

9781916413139 A-Z for Maths.indb 93 11/11/2019 12:03