MathSphere Mathematical Dictionary

www.mathsphere.co.uk

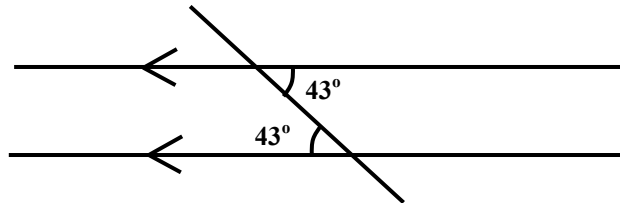**Abacus** A calculating device from the east constructed of beads sliding on rods.

Acute Angle An <u>angle</u> that is less than 90°.

Algorithm A sequence of steps that leads to the <u>solution</u> of a problem or tells you that the problem has no solutions.

Alternate Angles <u>Angles</u> on either side of a <u>transversal</u>.

e.g.

43°

43°

Alternate angles are equal in size.

A.M. *ante meridiem* (between midnight and noon).

Amicable Numbers Two numbers are called amicable (or an amicable pair) if all the <u>proper factors</u> of the first number add up to the second number and the proper factors of the second number add up to the first number.

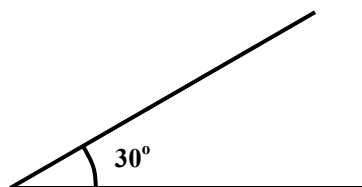e.g. **220** and **284** are amicable numbers

(Factors of **220** are **1, 2, 4, 5, 10, 11, 20, 22, 44, 55** and **110** which total **284**,

(Factors of **284** are **1, 2, 4, 71** and **142** which total **220**)

Other pairs are (**1184** and **1210**), (**2620** and **2924**) and (**5020** and **5564**).
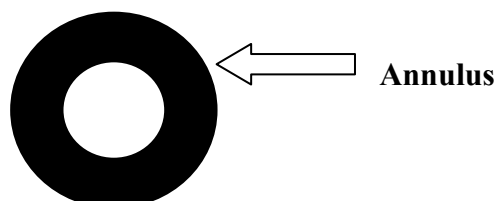
Angle An angle is a measure of <u>rotation</u>. The units of measurement of rotation are <u>degrees</u>.

e.g.

30°

Annulus If two circles are <u>concentric</u>, the space between them is called an annulus.
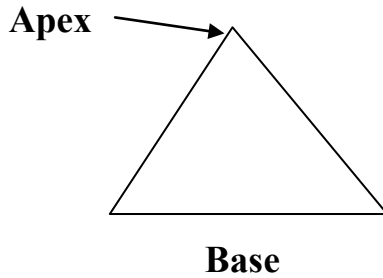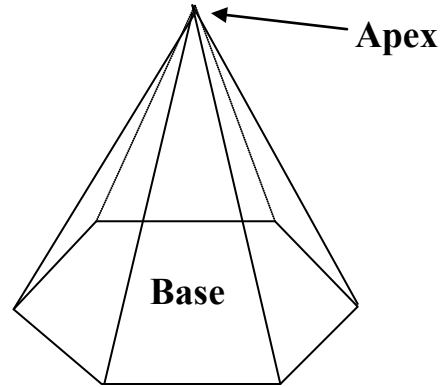
e.g.

Annulus

Anticlockwise The opposite way to the way the hands on a clock turn.

Apex The point directly opposite the base of a two dimensional or three dimensional shape.

Apex

Apex

Base

Base

Triangle

Hexagonal based pyramid

Approximation An answer that is not exact, but good enough for a particular situation.

e.g. If **23 936** people watched a football match, an approximation to the correct answer may be **24 000** people.

Arc **(i)** A part of the circumference of a circle or other curve.
(ii) A line joining two nodes in a network.

For diagram see network.

Archimedian Spiral A two dimensional spiral in which the spiral increases in size by the same amount for each revolution:

X cm

X cm
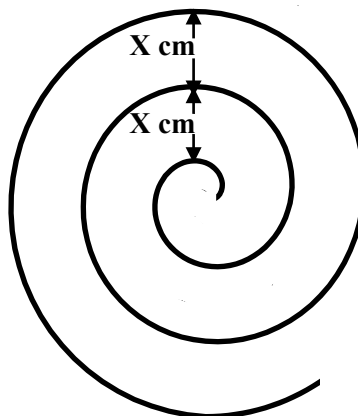
Area How much space there is inside a two dimensional shape. Area is measured in square units such as square centimetres (cm^2) or square metres (m^2).

**Arithmetic** The branch of mathematics concerned with numbers.

Average A term meaning one of Mean, Median or Mode. In everyday language, it normally means Mean, but in the mathematical world, it could be any of the three terms.

Average Speed Average speed is calculated by dividing the total distance covered by the total time taken.

e.g. A cyclist travels **55** Km in **5** hours. What was her average speed?

Average speed = $\dfrac{55}{5}$ = **11** Km/ hr.

Axis (Plural 'Axes') An axis is a line on a graph from which the measurements are taken. There is normally a horizontal and a vertical axis on graphs:

Vertical axis

Horizontal axis
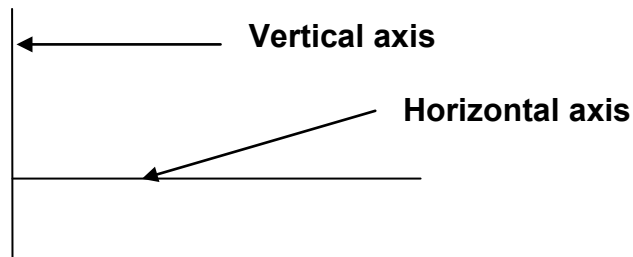
Axis of Symmetry A line through the middle of a shape so that one side of the line is a reflection of the other side:
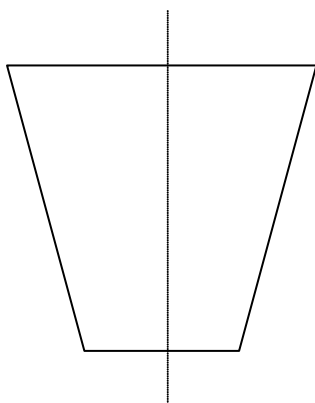
One axis of symmetry   **Four axes of symmetry**

<u>Bar Chart (Bar Graph)</u> A graph in which <u>frequency</u> is represented by the height of a bar (or length if drawn horizontally).

e.g.   **Pints of Milk used by small hotels during one week.**

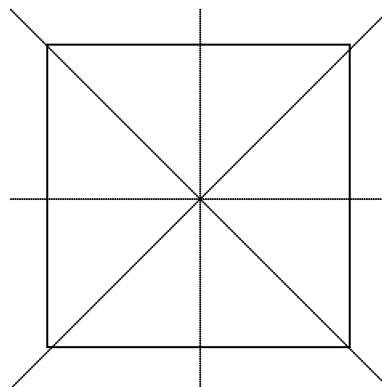|	0	100	200	300	400	500	600
Sand View	███	███	███				
Sea View	███	███	███	███			
Meadow View	███						
Beach View	███	███	███	███	███		
Down View	███	██					
Stone View	███	███	███				

<u>Base</u>   **(i)** The bottom of a <u>triangle</u>. The side opposite to the <u>apex</u>.

(ii) A counting system based on a particular number (or base) tells you how many <u>digits</u> there are in that system. Our normal numbering system is based on the number **10** (thought to be because we developed counting on our fingers) and we use the ten digits **0, 1, 2, 3, 4, 5, 6, 7, 8,** and **9**.

This system is called the denary system or decimal system.

Many other systems are possible. Some of the more popular are:

Binary. Here the digits 0 and 1 are used giving a counting system beginning: **0, 1, 10, 11, 100, 101, 110,   111, 1000 ...**

Octal. Here the digits are **0, 1, 2, 3, 4, 5, 6** and **7**, giving a counting system beginning: **0, 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13 ...**

**Hexadecimal.** In this system we need sixteen digits so we add another six by using the first six letters of the alphabet (normally capital letters):
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and **F**, giving a counting system beginning:

 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 1A, 1B, 1C, 1D, 1E, 1F, 20, 21 ...

Bearing A bearing is a direction given as an <u>angle</u> measured from <u>North</u>. Bearings are always measured <u>clockwise</u> from the Northerly direction and always have three <u>digits</u>. If the angle only has one or two digits, zeroes are placed in front of the figures to make it up to three figures.

e.g. **5°** becomes **005°**
    27° becomes **027°**

Bearings are normally used for the navigation of aeroplanes and ships, but may be used anywhere they would prove useful.

N

73°

This direction has a bearing of **073°**
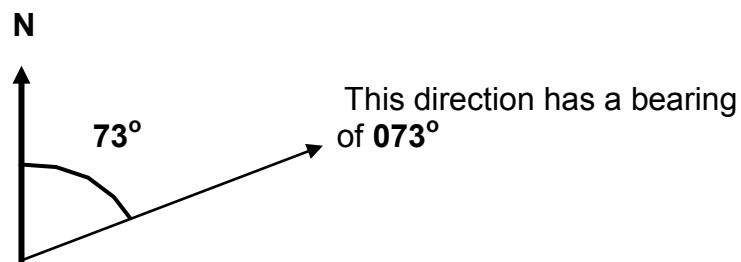
It is easy to see that **East**   has a bearing of **090°**
                    South has a bearing of **180°**
                     West has a bearing of **270°**
                    North has a bearing of **000°**

Billion **1 000 000 000**. This is the American billion. **(10⁹)**

    The British billion **(1 000 000 000 000)** is now rarely used. **(10¹²)**

Binary (See also <u>Base</u> (ii)) A number system based on two digits, **0** and **1**.
We normally count **1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, ...**

This is a number system based on **10**.

The electronic circuits of computers use a binary number system and all numbers (even decimals) may be written in this system.

Here are the first ten numbers in binary (sometimes called Base **2**).

1	2	3	4	5	6	7	8	9	10	Base 10
1	10	11	100	101	110	111	1000	1001	1010	Base 2

Bisect To cut something in half. In <u>geometry</u> this is normally a line or an <u>angle</u>.

<u>Bisector</u> A line that is normally drawn to cut a line or an <u>angle</u> in half.

Bisector

Line to be bisected.

Bisector

Angle to be bisected
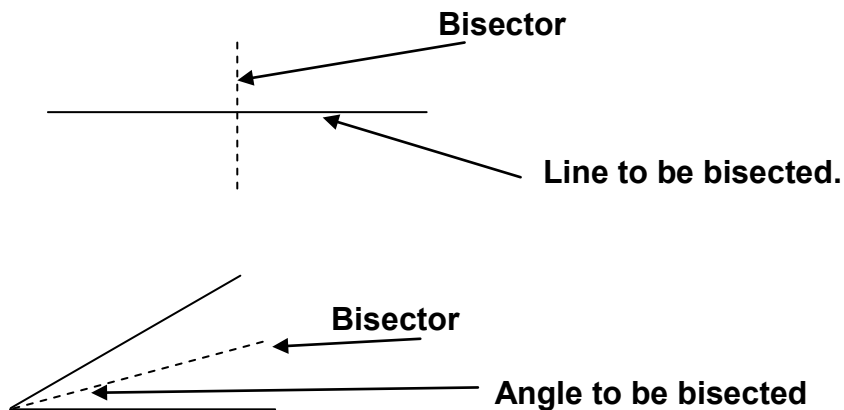
<u>Block Graph</u> Similar to a bar graph. A graph in which <u>frequency</u> is represented by the height of a column.

<u>BODMAS</u> stands for 'Brackets, Of, Division, Multiplication, Addition, Subtraction' and this indicates the order in which these operations should be performed with a complicated calculation. Anything in brackets should be calculated first, then anything involving the word 'of', then any multiplications and divisions and, finally, any multiplications and additions.

e.g. What is **$23 + \dfrac{3}{4}$ of 20** ? Using BODMAS, we see that $\dfrac{3}{4}$ **of 20**

should be calculated first and then this answer added to **23**, making **38** altogether.

e.g.   Calculate **5 + (2 × 7) – (16 ÷ 8) – 9**

Using BODMAS one step at a time gives:
> **5 + 14 – 2 – 9 = <u>8</u>**

<u>Branch of Mathematics</u> One of the sections into which mathematics may be divided. Some of them are: <u>Arithmetic</u>, <u>Geometry</u>, <u>Trigonometry</u>, Calculus, <u>Topology</u> and Algebra.

<u>Calculator</u> A device (previously mechanical, but now nearly always electronic), used for performing calculations. There are two types: simple and scientific and they give different answers to certain sums, so you need to be careful.

Simple calculators normally only carry out addition, subtraction, multiplication and division. They may have a square root button and a memory.

Scientific calculators have all the functions of the simple calculators, but also include an array of other functions such as <u>sines</u>, <u>cosines</u>, <u>tangents</u>, logarithms and antilogarithms.

The importance difference is that scientific calculators know the <u>BODMAS</u> rule and simple calculators do not.

Cancel Used to simplify fractions. Equivalent fractions may be obtained by cancelling or lecnacing. Cancelling means dividing both the numerator and denominator by the same number.

e.g.   Cancel $\frac{20}{24}$.   We notice that **4** divides exactly into **20** and **24**, so we divide these numbers by **4** to obtain $\frac{5}{6}$.   The fractions $\frac{20}{24}$ and $\frac{5}{6}$ are equivalent fractions.

Capacity The amount of liquid that a container will hold when it is full. Capacity is a measure of volume, so its units are litres, millilitres or cubic metres in the metric system and pints or gallons in the imperial system.

**Cardinal Number** The whole numbers when used to indicate quantities.

e.g.   Mrs Jones bought **12** Kilos of potatoes today.

Centre Another word for 'middle'. The centre of a circle is the point which is the same distance from all points on the circumference.

Centre of Rotation A point about which a shape is rotated. The centre of rotation may be on the shape being rotated (perhaps even the centre of the shape) or it may be off the shape altogether.
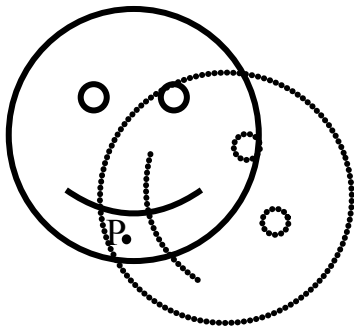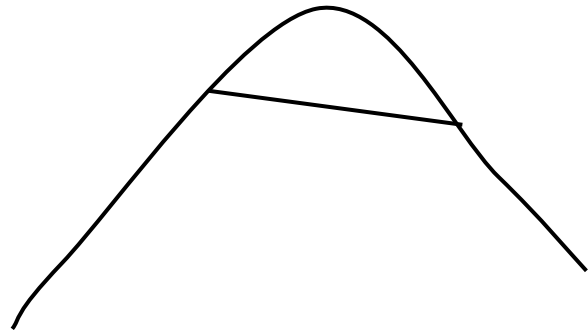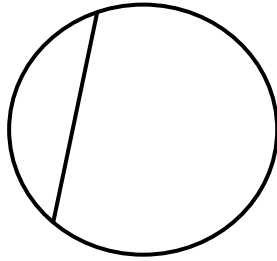

A simple face rotated about the point P, which is on the face. (The rotated face is shown dotted).
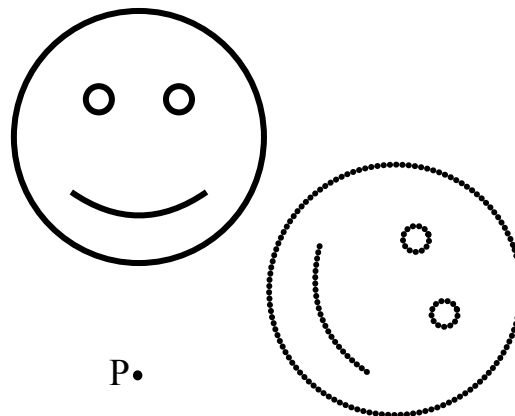
A simple face rotated about the point P, which is not on the face.

Chord A straight line joining two points on a curve (often a <u>circle</u>). The straight lines below are chords.

In a circle, the longest chord of all, the one that passes through the <u>centre</u>, is called the <u>diameter</u>.

Cipher A cipher is a way of encoding messages so that every time a letter or symbol appears, it is coded with a different cipher letter. There are many ways of doing this.

e.g. Message: MEET AT THE OLD OAK TREE.
    Cipher text: FYHD KY EXL OGE NOD WIIM

You can see here, for example, that the letter E has several corresponding cipher letters: Y, H, L, I and M. This makes ciphers much more difficult to break than <u>codes</u>.

Circle A <u>two-dimensional</u> shape, every point of which is the same distance from a fixed point (the centre).

Circumcentre The point at which you could place the point of a compass to draw a circle around a given shape. In a triangle this point is obtained by <u>bisecting</u> the three sides at <u>right angles</u>. The place where the three lines meet is the circumcentre.

e.g. Find the circumcentre of this triangle:
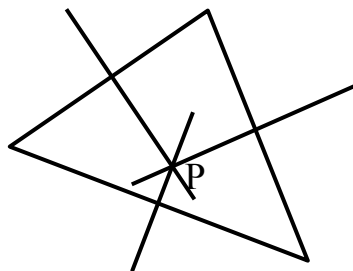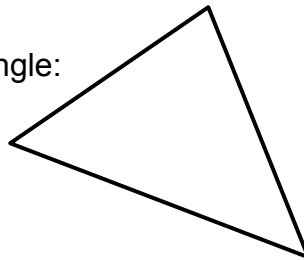
Bisect each side at right angles: P is the circumcentre. Test this by drawing a circle around the triangle with P as the centre of the circle.
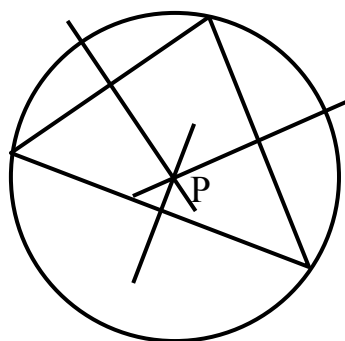
<u>Circumference</u> The circumference of a circle is the distance around the circle.

Circumference

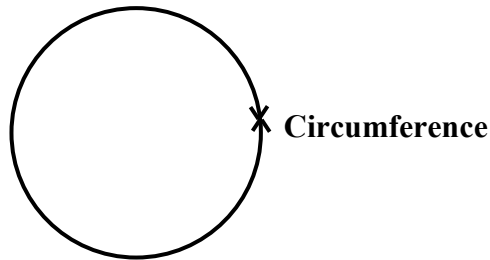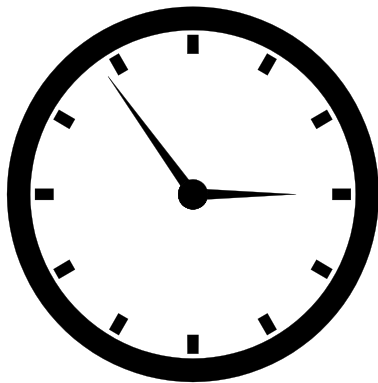## <u>Clock</u> A device for telling the time. There are two types: analogue clocks and digital clocks. Analogue clocks are the older type with a circular dial. Digital clocks are the modern type with a panel showing numbers.

Analogue Clock
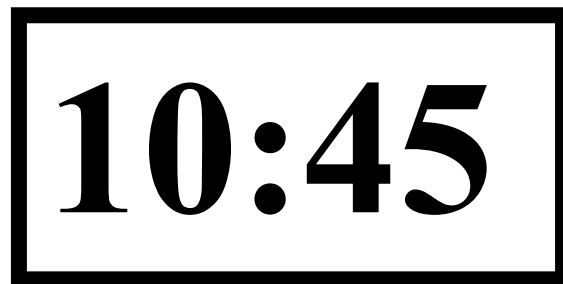
Digital Clock

Digital Clocks can show 12 hour or <u>24 hour</u> time.

<u>Clockwise</u> The way the hands on a clock turn.

<u>Code</u> A code is a way of sending secret messages in which each letter or symbol is replaced by another. In a message a letter is always replaced by the same symbol.

e**.**g**.** Letter: A B C D E F G H ....
Code symbol: x h d f u p j m ....

(A method of writing secret messages so that each time a letter occurs it is replaced by a different symbol is called a <u>cipher</u>.)

<u>Coefficient</u> The number before a letter in a function or equation.

e.g. In the equation   **y = 3x^2 + 4x**,   **3** and **4** are coefficients.

Column Matrix A column matrix is a matrix with just one column, such as:

$$\begin{pmatrix} 4 \\ 5 \\ 2 \end{pmatrix}$$

Compass (i) Drawing Compass. A device for drawing circles or arcs of circles, normally used with a pencil.
(ii) Magnetic Compass. A device for showing the north direction. It normally has a magnetic needle which swings on top of a pointer.

Complementary Angles Two angles that add up to **90°**.

e.g. The two angles in a right angled triangle that are not the right angle are complementary.

Concave Used to describe a shape that curves inwards, like the inside surface of a mug. Some mirrors are concave shaped. In this sense it is the opposite of convex.

Concentric Circles Circles, one within another, so that their centres are in the same place.

e.g.
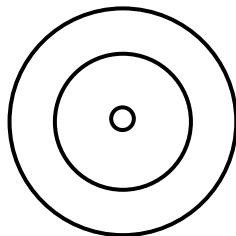
Cone A three dimensional shape with circular base and an apex. The most familiar in everyday life is the ice-cream cone.

Congruent Two shapes that are exactly the same are said to be congruent. These may be two dimensional shapes, such as triangles or pentagons, or three dimensional shapes such as cuboids or pyramids.

Consecutive Numbers Numbers next to each other in a sequence.

e.g. In the sequence **1, 2, 3, 4, 5, 6, 7, 8, 9, ...**
the numbers **4, 5** and **6** are consecutive.

e.g. **5, 7, 9** and **11** are consecutive odd numbers.

Conversion Graph A graph for converting one set of units to another.

e.g. The graph below converts pounds to dollars (assuming **£1 = $1.60**).

Dollars

Pounds
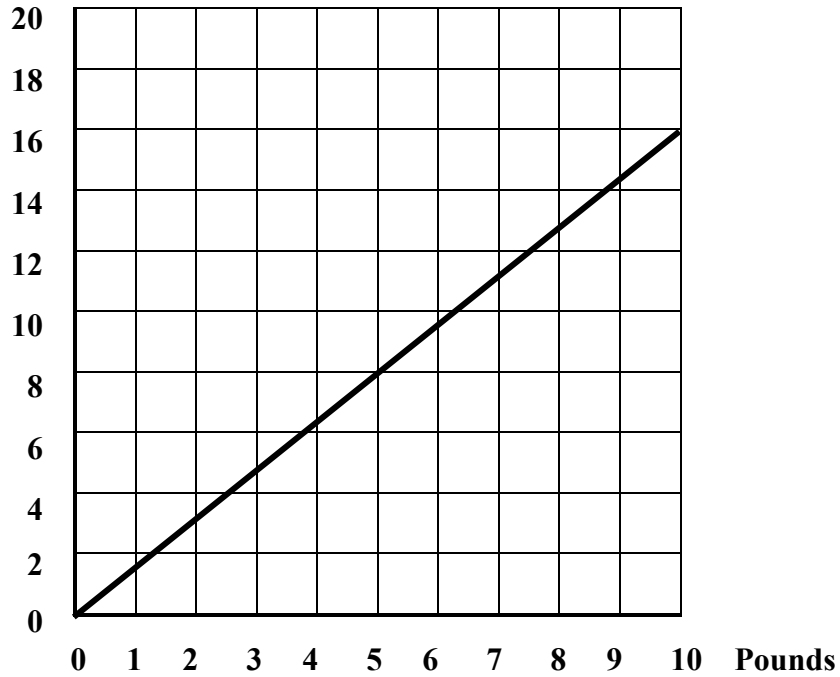
Convex Used to describe a shape that curves outwards, like the surface of a mug or ball. Some mirrors are convex shaped. In this sense it is the opposite of <u>concave</u>.

Convex Polygon A **polygon** in which all **interior angles** are less than 180^0. Polygons which have at least one **angle** greater than 180^0 are called **non-convex**.
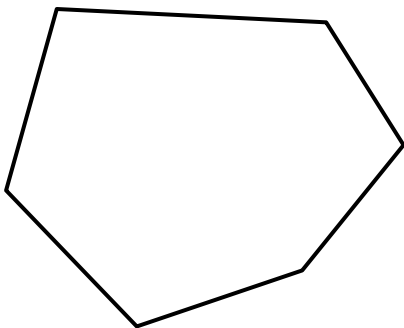
A convex polygon

A non-convex polygon

Co-ordinates A system used to specify a point on a grid. Each point is given two numbers (which may be fractions or decimals). These are distances from a set of axes and are written in round brackets with the horizontal distance first and the vertical distance second. The numbers are separated by a comma.

Each quarter of the grid is called a quadrant and these are numbered starting with the top right quadrant and moving in an anti-clockwise direction.

y

	2nd Quadrant				**6**		1st Quadrant			

2nd Quadrant   **1st Quadrant**

•A at (4.5, 3)

•B at (-3, 2)

−6 −5 −4 −3 −2 −1 **0** 1 2 3 4 5 6 **X**

•C at (-5, -3)

•D at (3.5, -3.5)

3rd Quadrant   **4th Quadrant**

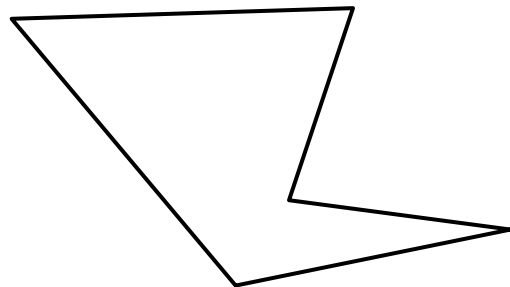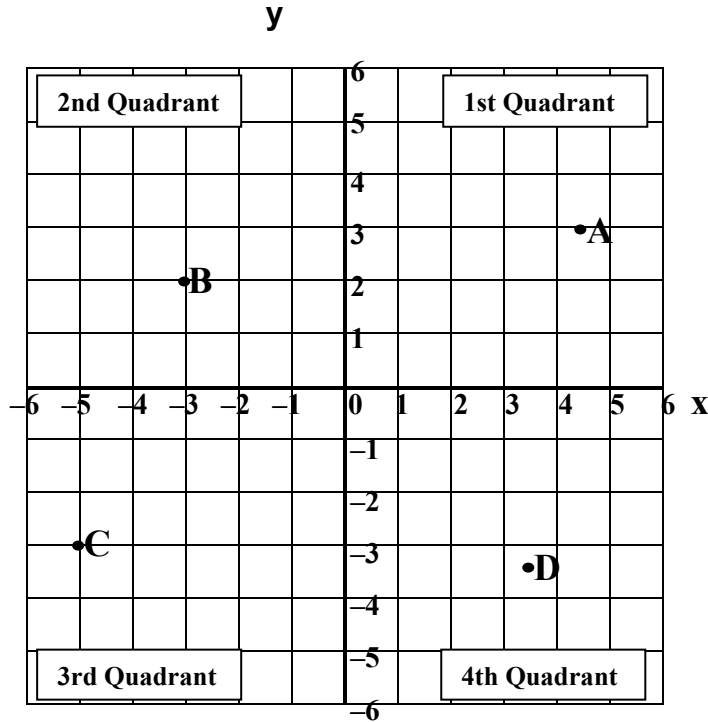Point **A** has co-ordinates **(4.5, 3).**   Point B has co-ordinates **(−3, 2).**
Point **C** has co-ordinates **(−5, −3)**.   Point D has co-ordinates **(3.5, −3.5)**.

These axes have been labelled **x** and **y**, but any suitable letters may be used.

In simpler applications, only the 1st quadrant is used.

Coprime Two numbers are said to be coprime (or relatively prime) if their largest common factor is **1**.   EG.   **15** and **49** are coprime.

Corresponding Angles Angles on the same side of a transversal.

e.g.

43°

43°

Corresponding angles are equal in size.

Cosine (Abbreviation **'cos'**) In a right angled triangle, the cosine of an angle is the length of the adjacent side to the angle divided by the hypotenuse.
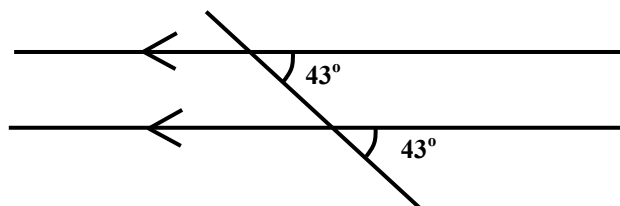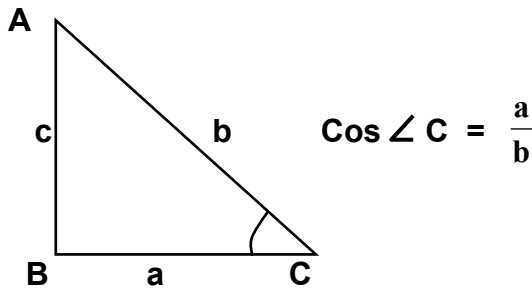

$$\text{Cos} \angle C = \frac{a}{b}$$

Counting Numbers The whole numbers beginning at **1**, in other words, the simple numbers we use to count objects.

Cryptography The science of designing ciphers.

Cube **(i)** A three dimensional shape having six faces, each of which is a square. It also has twelve edges and eight vertices.
 (ii) To cube a number, multiply it by itself and by itself again. Notice that this is **not** the same as multiplying by three.

e.g. **6** cubed is **6 × 6 × 6 = 216.**

6 cubed is often written as **6^3.**

Cube Root The cube root of a number is the number which when multiplied by itself and by itself again, gives the number you started with.

e.g. The cube root of **64** is **4** because **4 × 4 × 4 = 64.**

Most numbers do not have an exact cube root.

e.g. The cube root of **9** is approximately **2.08**.

Cuboid A three dimensional shape having six faces, each of which is a rectangle. It also has twelve edges and eight vertices.

Cyclic Quadrilateral A quadrilateral whose four vertices (vertex) lie on a circle (the circle does not have to be drawn). It has some interesting properties, one of which is that opposite angles add up to **180^0.**
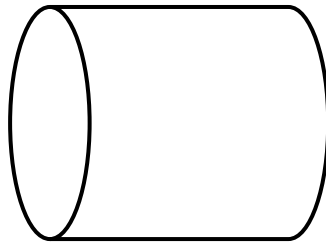
ABCD is a cyclic quadrilateral.

$\angle\,B + \angle\,D = 180^o$
$\angle\,A + \angle\,C = 180^o$
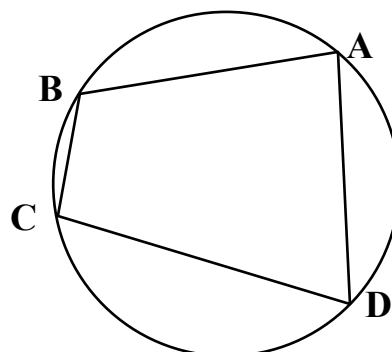
Cylinder A <u>three dimensional</u> shape which has two circular ends of equal size.

Cylinders are very common in everyday life. For example, most cans and tins are almost perfect cylinders. Cylinders are <u>prisms</u>.

Data The individual items collected during a survey or experiment. When you carry out a survey, the numbers or words you write down are called data.

When this data has been processed to make sense (perhaps by calculating <u>averages</u> or drawing graphs, it becomes 'information').

Decagon A <u>polygon</u> with ten <u>sides</u>.

Decahedron A <u>polyhedron</u> with ten <u>faces</u>.

Decimal Places The figures after the decimal point in a number.

e.g. **27.549** has three decimal places.

Decrease Reduce in size. This could refer to a drawing or volume or an amount of money; anything, in fact, that can be made smaller.

Degree A unit used to measure angles. One degree is one three hundred and sixtieth of a complete turn. So one right angle is 90^0 and so on.

Denary Another word for <u>Base</u> **10**.

Denominator The lower number in a fraction.

Determinant The answer calculated by multiplying the numbers in the leading diagonal and the numbers in the trailing diagonal of a **2 x 2** matrix and subtracting the second answer from the first.

The determinant of the matrix $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is **ad – bc**.

Diagonal A straight line going across a polygon from one vertex to another.

Diagonal →
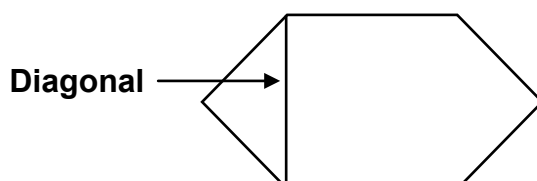
Diameter The distance straight across a circle, passing through the centre.
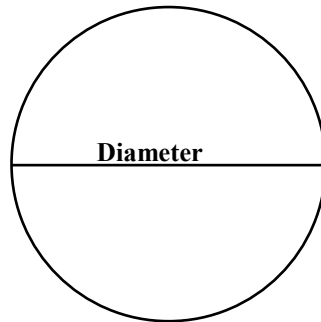
Difference The answer when the smaller of two numbers is subtracted from the larger.

e.g. The difference between **15.5** and **10** is **5.5**.

Digit A single figure, normally from **0** to **9**, but may be different in other bases.

Digital Root The answer when the digits of a number are added together. If the answer has more than one digit when this is done, the digits of the answer are added. This is repeated until only one digit remains.

e.g. The digital root of **27** is **2 + 7 = 9**

e.g. Find the digital root of **5836**.

> **5 + 8 + 3 + 6 = 22**
> **2 + 2 = 4**

Dimension **(i)** The length of a side of a shape.

e.g. 'A cuboid has dimensions **23cm** x **15cm** x **17cm'**.

(ii) The surface of a piece of paper has only length and width, which means that any object drawn on it can only be two dimensional (even it is a drawing of a three dimensional object). Real objects such as cubes or elephants normally have length, width and height and are therefore three dimensional.

Disjoint Sets Sets that have no common members.

e.g. **{cat, dog, hamster, guinea pig}** and **{lion, tiger, monkey, seal, giraffe}**

Distance Chart A table that shows the distances from one town to another.

e.g.

Aberdeen				
750	Aberystwyth			
744	**370**	Cambridge		
978	**464**	**194**	Brighton	
875	**381**	**96**	**95**	London

The distances between towns in kilometres.

The distance from Brighton to Aberystwyth is **464** kilometres.
The distance from Brighton to London is **95** kilometres.

Distance - Time Graph A graph showing how far an object (cyclist, car etc) is away from a particular place at certain times.

e.g..
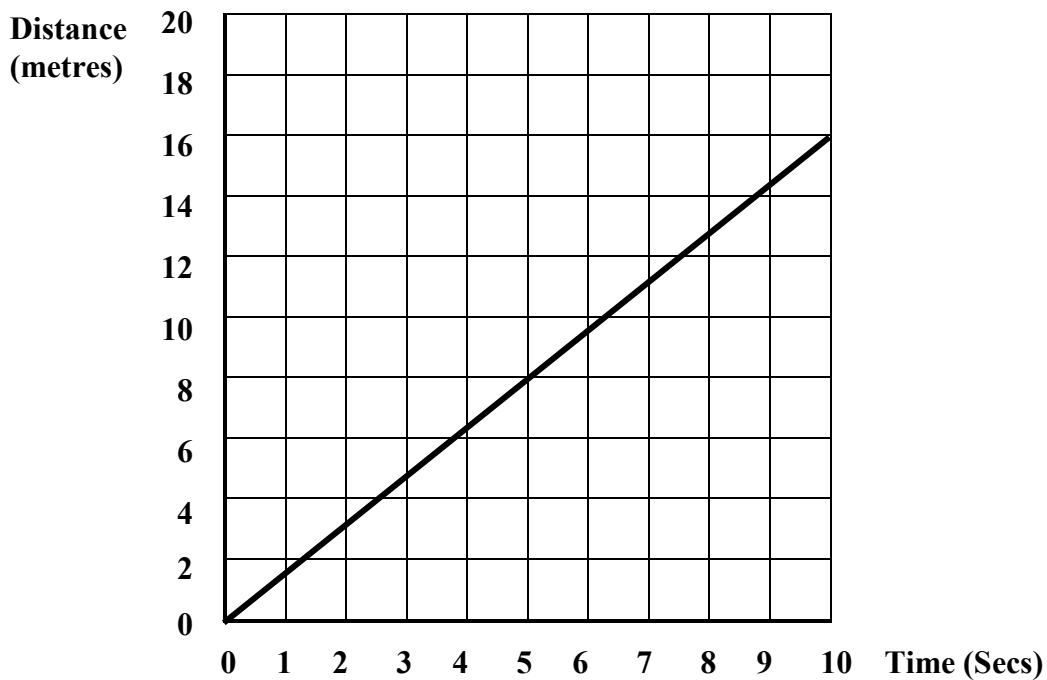
This particular distance-time graph shows an object moving at a steady <u>speed</u>. On other graphs, the line may be curved showing faster and slower movement.

Dividend A number that is going to be divided **by** another number.

e.g. In the sum: **24 ÷ 4 = 6,   24** is the dividend.

Division A type of sum in which we calculate the number of times that one number may be repeatedly subtracted from another until nothing remains.

e.g. **30 ÷ 5 = 6**

Divisor A number that we are going to divide **into** another number.

EG. In the sum: **24 ÷ 4 = 6,   4** is the divisor.

Dodecagon A polygon with twelve sides.

Dodecahedron A three dimensional shape having twelve faces. In a regular dodecahedron each face is a regular pentagon. The regular dodecahedron also has thirty edges and twenty vertices (vertex).

East To face east, begin by facing north and make a 90° turn clockwise.

Edge On a three dimensional shape, the line between two faces. Edges should not be called sides.

Element One member of a set.

e.g. The set **{television, cooker, toaster, video recorder}** has four elements.

Ellipse A two dimensional shape looking rather like an elongated (stretched out) circle. It has a centre, but it also has two foci (singular 'focus'). Planets orbit the Sun in an elliptical path.

Focus

Ellipse
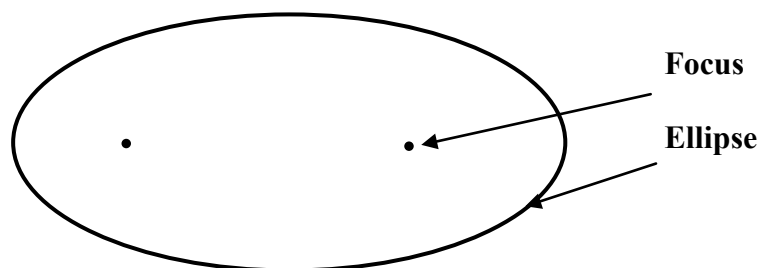
Enlarge To make bigger (see Enlargement).

Enlargement If we draw a shape and then make it bigger, the new shape is an **enlargement** of the old. The number of times a shape is made larger is called the Scale Factor. A scale factor of three means that the new shape is three times larger than the old.

If the scale factor is between **0** and **1**, the new shape is smaller than the old.

e.g. If the scale factor is **0.5**, the new shape is only a half the size of the old.
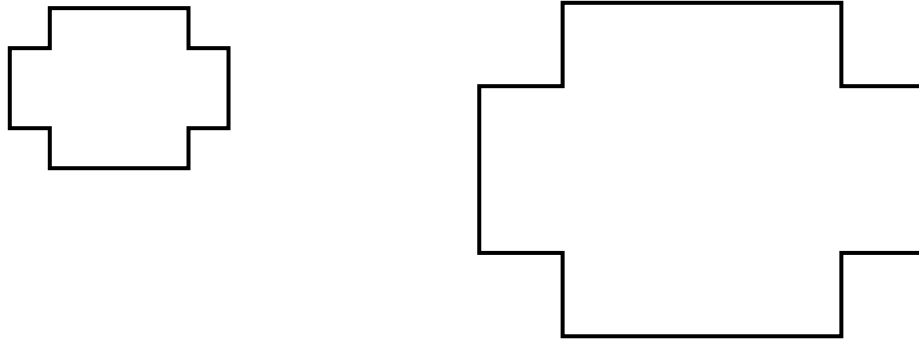
The shape on the left has been enlarged with a scale factor of **2** to obtain the shape on the right.

Equal When two things have the same value, they are said to be equal. They may not always look equal when you first see them, as in this equality:
$$3^2 \div 4 = 0.125 \times 18$$

Equality A statement with an equals sign, telling you that two things have the same value.

e.g. The equality **5(x + 4) = 5x + 20** is true for all values of **x**

Equation A statement, normally written in algebra, which is true only for certain values of the variables involved.

e.g.   **7x − 3 = 32** is true only when **x = 5**.
(In this equation, **x** is the variable.)

Equidistant The same distance from a line or point.

e.g. 'The points on the circumference of a circle are equidistant from the centre'.

 e.g. The points **A** and **B** are equidistant from the point **P**.

●**P**

A ●

●**B**

Equilateral triangle A triangle with all three sides the same length. This means that all three angles will also be the same value (**60⁰**).

Equivalent Fractions Two or more fractions that look different, but have the same value.

e.g. $\dfrac{20}{24}$, $\dfrac{10}{12}$ and $\dfrac{5}{6}$ are all equivalent fractions.

Fractions may be changed into other, equivalent, fractions by the processes of cancelling and lecnacing.

Eratosthenes - Sieve of. A device for generating prime numbers. Begin by writing the natural numbers as far as you wish to go, say **1** to **100**. This may be easier in a square or rectangle pattern, but this is not necessary.

Cross out every second number except **2**. Cross out every third number except **3**. Cross out every fourth number except **4**. Keep doing this until you can do it no more. The numbers remaining are the prime numbers.

You will soon find that there are two main shortcuts you can take to speed up the process:

a) If you have crossed out every second number, you have crossed out all the even numbers (except **2**), so you do not need to cross out multiples of **4, 6, 8** etc. Similarly, if you have crossed out every third number (except **3**), you have crossed out all the multiples of three, so there is no need to cross out multiples of **6, 9, 12** etc.

b) Once you have reached the square root of the largest number you have written down, you have finished. For example, if you were finding all the prime numbers up to **121**, you will have finished when you have crossed out all the multiples of **11**.

Estimate **(i)** A good guess at a measurement.

e.g. You might guess the length of your classroom is about nine metres.

   (ii) the process of having a good guess.

Euler's Theorem This applies to both two-dimensional shapes and three-dimensional shapes.

(i) In three dimensional shapes, we can count up the number of edges (**E**), faces (**F**) and vertices (**V**). Euler's Theorem tells us that:

$$E + 2 = F + V$$

e.g. A cube has **12** edges, **6** faces and **8** vertices.   **12 + 2 = 6 + 8**

Contd...

(ii) In <u>two dimensional</u> networks, we can count up the number of arcs (**A**), regions (**R**) and nodes (**N**). Euler's Theorem tells us that:

$$A + 2 = R + N$$

e.g. In this <u>network</u>, we have **20** arcs, **10** regions (the outside is counted as a region) and **12** nodes.
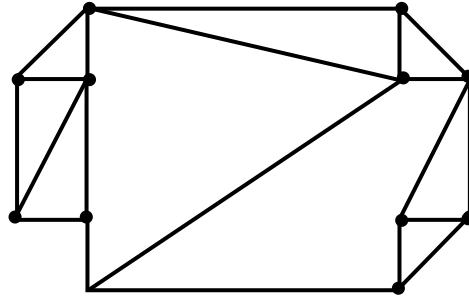
$$20 + 2 = 10 + 12$$

<u>Evaluate</u> Calculate the value of an expression.

e.g. Evaluate **$3 + 4^2$**

e.g. Evaluate **$x^2 + 5y - 3$**, when **x = 4** and **y = 7.**

<u>Even</u> Even numbers are numbers that are divisible by two with no remainder.

2, 4, 6, 8, 10, 12, 14, ...

<u>Exact</u> Absolutely accurate, spot on.
Many sums have exact answers such as **5.3 × 4.7 = 24.91.**
In many cases we do not need to calculate answers exactly.

When measuring, it is impossible to obtain a measurement absolutely accurately, although we often pretend that we have done.

e.g. A piece of **A4** paper should be **297** mm long, but it will never be exactly that measurement.

<u>Expression</u> A combination of numbers and letters (variables) for which a value may be calculated.
e.g. **$y^3 + 6tx$**. Each part of the expression is called a <u>term</u>.

Exterior Angles The <u>angle</u> outside a <u>polygon</u> between one <u>side</u> and the adjacent side <u>produced</u>.

The total of all the exterior angles of any polygon is always **360⁰**

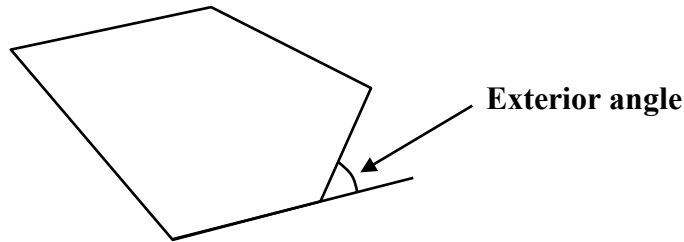**Face** **(i)** The front of an analogue <u>clock</u>, normally marked with the hours.
  (ii) One of the surfaces of a <u>polyhedron</u> such as a <u>cuboid</u>, which has six faces.

Factor A number that divides exactly into another number.

e.g.   The factors of **32** are **1, 2, 4, 8, 16** and **32**.

Note that the number itself (**32**) is a factor.

Factorise To find the factors of a number. This can be a very difficult job if the number is large and can take many hours (or even years) using the fastest computers in the world. For example, how long would it take you to find the factors of **192 343 993 140 277 293 096 491 917** ? Good luck!

Answer: This number only has two factors (except **1** and itself, of course).
They are **8 174 912 477 117** and **23 528 569 104 401**.

Fibonacci Numbers or Sequence Numbers in the sequence**:**
1, 1, 2, 3, 5, 8, 13, 21, 34, 55 ... This sequence is obtained by writing down two **1**'s and then obtaining the next numbers by adding together the two numbers before it.

e.g.   **1 + 1 = 2,   1 + 2 = 3,   2 + 3 = 5,   3 + 5 = 8** etc.

Fibonacci first came across this sequence by investigating the number of rabbits in a colony which bred according to certain rules and never died.

Finite A quantity that does not go on for ever. This term is often used to refer to sequences that do not go on for ever, such as:

1, 3, 5, ... 17 the sequence of odd number up to **17**.

Sequences that do go on forever **(infinite)** are shown with three dots at the end of the terms shown, like this:

1, 3, 5, 7, 9, ...   the sequence of all <u>odd</u> numbers.

The term is also used to express the idea that the universe does not go on forever, i.e. the universe is finite.

Formula (UK plural 'Formulae', U.S.A. plural 'Formulas')

A formula is an expression, normally involving quantities expressed by letters of the alphabet, that shows how to calculate one quantity in terms of another.

e.g. The formula for the area of a rectangle is **A = L x W**, where **A** is the area, **L** is the length and **W** is the width of the rectangle.

e.g. the **n**th triangle number is $$\frac{n(n+1)}{2}$$

Four Colour Problem
The four colour problem is about colouring maps: If you sat in a room and people gave you many maps, some simple and some very complicated, which had 'countries' or regions to be shaded, what is the smallest number of colours you would need to be able to colour **all** the maps, if no two countries with a common border are coloured with the same colour.

It was long thought that the number of colours needed was four, but this has only recently been proved beyond doubt. It is possible to draw maps that need only two or three colours, but there will always be some maps that need four colours. No map drawn on a piece of paper **needs** five colours.

Fractal
A fractal is an irregular shape produced by repeating the same geometrical process over and over again. The main characteristic of a fractal is that it has the same amount of detail no matter how closely you look at it (in other words, no matter how big your magnifying glass is). This is not true of non-fractal shapes such as circles, which seem to become straighter and straighter as you look at them with greater magnification.

Fraction
A way of writing a number with one numeral above another. The upper is called the numerator and the lower is called the denominator.

The denominator tells you how many pieces a whole one is divided into and the numerator tells you how many of those pieces you have.

e.g. $\frac{3}{5}$ tells you that a whole has been cut into five equal pieces and you have

three of them.

A fraction can also be thought of as a division sum (more important in higher levels of mathematics),

so $\frac{3}{5}$ is the same as **3 ÷ 5.**

Frequency
The number of times something occurs.

e.g. The frequency with which my work telephone rings is greater than the frequency with which my home telephone rings.

<u>Frequency Chart (Table)</u> A table showing how often something happens.

e.g. Here is a frequency chart showing how many people came to school by different means of transport.

Bicycle	24
Car	16
Train	10
Bus	3

<u>Fundamental Theorem of Arithmetic</u> When you find all **the prime factors** of a number, you always obtain the same answer, no matter how you set about finding them.

e.g. The prime factors of **60** are **2**, **3** and **5**. No matter how you work this out, you will always end up with these three numbers.

<u>Geometry</u> A <u>branch</u> of mathematics related to shapes. In geometry, the sizes of <u>angles</u> and the lengths of the <u>sides</u> of shapes are very important.

<u>Girth</u> The distance around objects that are normally approximately circular such as trees.

<u>Goldbach's Conjecture</u> Every <u>even number</u> can be made up from the <u>sum</u> of two <u>prime numbers</u>. (In this conjecture **1** is counted as a prime number, although this is not normally the case.) This idea was first put forward by Christian Goldbach in a letter to Euler in 1742. Although computers have shown this to be true for many, many numbers, no-one has yet proved it true for **all** even numbers.

e.g. **4 = 2 + 2,   10 = 7 + 3,   76 = 17 + 59**

<u>Gradient</u> The slope of a line (normally a graph). It is found by drawing a <u>right angled</u> <u>triangle</u> under the line and dividing the length of the <u>vertical</u> <u>side</u> by the length of the <u>horizontal</u> side.
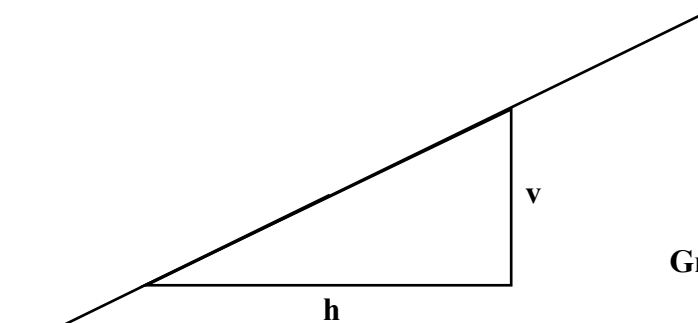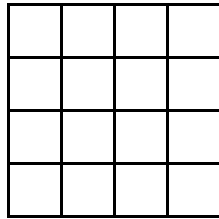
$$\text{Gradient} = \frac{v}{h}$$

<u>Graph</u> A way of showing a relationship on a diagram. The most common types of graph are <u>block graphs</u>, <u>line graphs</u> and <u>pie charts</u>.

Grid A sequence of (normally) horizontal and vertical intersecting lines used to draw patterns or graphs.

Heptagon A polygon with seven sides.

Hexagon A polygon with six sides.

Highest Common Factor (H.C.F.) The highest number that will divide exactly into two or more larger numbers.

e.g. **6** is the highest common factor of **42, 54** and **66**.

Horizontal Parallel to the horizon. Going from left to right.

Hundred Square A square divided into a hundred smaller squares (**10 x 10**). The numbers **1** to **100** are written in the squares.

Hundredth One whole divided into a hundred parts. Written $\dfrac{1}{100}$ as

a fraction or **0.01** as a decimal.

A hundredth is the same as **1%.**

Hypotenuse The longest side in a right angled triangle.
The side opposite to the right angle.

Icosahedron A three dimensional shape having twenty faces. In a regular icosahedron each face is an equilateral triangle.

Image The shape that is the result when a shape is transformed. For example, if a shape is reflected in a mirror line, the reflection is the image.

Improper Fraction A fraction whose numerator is greater than its denominator.

e.g. $\dfrac{8}{5}$

Inscribed circle A circle drawn inside a <u>polygon</u> (normally a triangle) so that it just touches each of the sides of the polygon. In a triangle the centre of this circle is obtained by <u>bisecting</u> each angle and putting the compass point at the place where the three bisectors meet.

Each angle is bisected
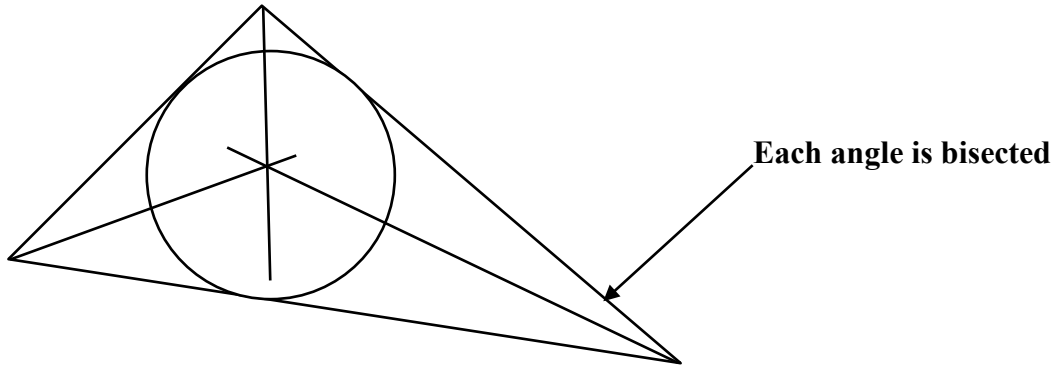
Increase To make something bigger. Sometimes increases are written as percentages.

e.g. Increase **£40** by **20%**.

Identity Matrix There are two identity matrices that are two rows by two columns in size.

The identity matrix for addition is $\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$.

The identity matrix for multiplication is $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$.

Index (Plural 'indices') Another word for 'power', the number of times a quantity is multiplied by itself.

e.g. 4^5 is read as 'four to the power of five' and means **4 × 4 × 4 × 4 × 4 = 1024**. In this case **5** is the index.

If we have the same number raised to several different powers (or indices) the indices may be added when the quantities are multiplied.

e.g. $4^5 \times 4^3 \times 4^6 = 4^{14}$

Inequality A statement showing that one quantity is greater than or less than another. The symbols **<** (less than) and **>** (greater than) are used.

e.g. **7 > 3 × 2,   y > 4x + 8,   7x – 9 < 4y + 3**

Infinite Going on forever, without end. There is no such number as infinity - the word infinity expresses the idea of going on for ever. For example, to say that there are infinite number of points on a straight line means that however close two points are on the line, it is always possible to find another between them.

An infinite sequence is a <u>sequence</u> that has an infinite number of terms.
If we wish to show this, we usually put three dots at the end of the written part of the sequence:

2, 4, 6, 8, 10, 12, ...

Integer A whole number. Integers may be <u>positive</u>, <u>negative</u> or zero.
These are all integers: **–5, 0, 3,   62 435**

Interest When money is put into a bank account or building society account, the bank or building society add a certain amount to your money each year. This extra is called 'interest'.

Similarly, if you borrow money, the bank or building society (the lender) that lent you the money will expect you to pay back more than you borrowed. This extra is also called 'interest'.

There are two types of interest: simple and compound.
Simple interest is when the same amount is added on each year, making no allowance for the interest that was added on in the previous year.

Compound interest is when the amount added on each year increases to allow for the fact that you have more in your account each year because of the interest added on in the previous years.

The formula for **simple** interest is **I =** $\dfrac{PRT}{100}$

The formula for **compound** interest is **I = P(1 +** $\dfrac{R}{100}$ **)ᵀ**

Where **I** is the amount of the interest.
      P is the principal (the amount invested)
      R is the rate of interest
      T is the time in years.

e.g. What would the simple interest be if **£3 000** were invested at **6%** for **4** years?

I = $\dfrac{PRT}{100}$ **=** $\dfrac{3000 \times 6 \times 4}{100}$ **=** <u>**£720**</u>

Interior Angles The inside <u>angle</u> between two sides of a <u>polygon</u>. The size of an interior angle in a <u>regular polygon</u> may be calculated from the formula

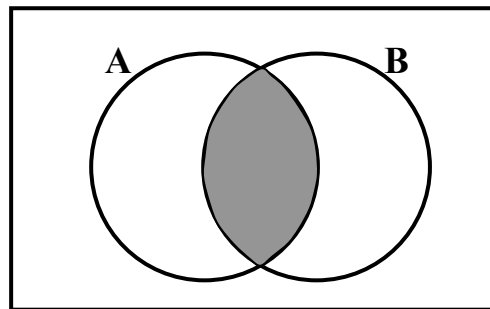   Angle = $180 - \dfrac{360}{n}$ where **n** is the number of sides.

Intersection (∩) The intersection of two <u>sets</u> gives you the <u>elements</u> that are in the fist set and **also** in the second set.

e.g. **A = {3, 6, 9, 12, 15, 18, 21) B= {2, 4, 6, 8, 10, 12, 14}**

The intersection of sets **A** and **B** is written as **A** ∩ **B**

  A ∩ **B = {6, 12}**

See also <u>union.</u>

The shaded area represents **A** ∩ **B**

Inverse Matrix The inverse of a matrix is the <u>matrix</u> which, when multiplied by the original matrix, gives the <u>identity matrix.</u>

e.g. With **2 x 2** matrices:

Original matrix is $\begin{pmatrix} 5 & 6 \\ 3 & 4 \end{pmatrix}$. The inverse of this matrix is $\dfrac{1}{5 \times 4 - 6 \times 3} \begin{pmatrix} 4 & -6 \\ -3 & 5 \end{pmatrix}$

$= \dfrac{1}{2} \begin{pmatrix} 4 & -6 \\ -3 & 5 \end{pmatrix}$ because $\dfrac{1}{2} \begin{pmatrix} 4 & -6 \\ -3 & 5 \end{pmatrix} \begin{pmatrix} 5 & 6 \\ 3 & 4 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

Irrational Number A number that cannot be written as a fraction (see also <u>rational numbers</u>).

e.g. $\sqrt{2}$ = **1.41421356237309504880168872420969807 8...**

This is an <u>infinite</u> decimal that does not <u>recur</u>. Therefore it cannot be written as a <u>fraction</u> and is irrational.

Irregular Shape **(i)** A <u>polygon</u> in which not all the <u>sides</u> are the same length and the <u>angles</u> the same value.

(ii) A <u>polyhedron</u> in which not all the <u>faces</u> are <u>regular polygons</u>.

Isosceles Trapezium A <u>trapezium</u> in which the two non-<u>parallel</u> sides are the same length. It therefore has two pairs of equal angles.

Isosceles Triangle A <u>triangle</u> in which two sides are the same length. It also has the two <u>base</u> angles the same value.

Kilogram One thousand <u>grams</u>. The <u>mass</u> of a <u>litre</u> of pure water at **4⁰C**. This temperature is chosen because it is the temperature at which a certain mass of water has the <u>minimum</u> <u>volume</u>.

Volume

4⁰C   **Temperature**
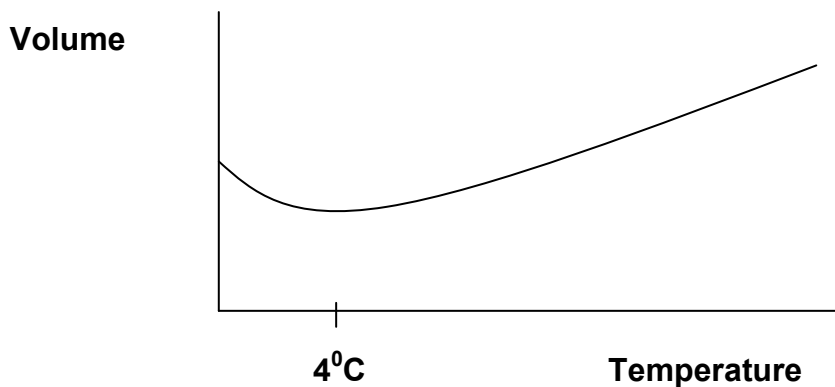
Kilometre **1 000** metres.   This is about $\dfrac{5}{8}$ of a mile.

Kite A <u>quadrilateral</u> which has two pairs of sides with equal length. The sides in each pair are adjacent.
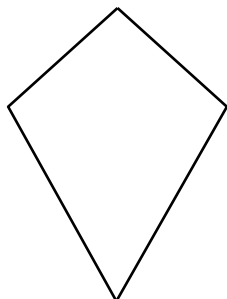
Leap Year A year having **366** days, instead of the normal **365**.

A year is a leap year if it is divisible by **4**, except if it is divisible by **100**.
A year that is divisible by **100** is only a leap year if it is divisible by **400**.

So these years **are** leap years: **1200, 1600, 2000, 2400** etc
These years are **not** leap years: **1300, 1400, 1500, 1700, 1800, 1900, 2100**, etc.

Lecnac Used to increase the numerator and denominator in a fraction. <u>Equivalent fractions</u> may be obtained by <u>cancelling</u> or lecnacing. Lecnacing means multiplying both the <u>numerator</u> and <u>denominator</u> by the same number.

e.g. Lecnac $\dfrac{3}{4}$ by **6** .

Multiply the numerator and denominator by **6** to obtain $\dfrac{18}{24}$.

The fractions $\dfrac{3}{4}$ and $\dfrac{18}{24}$ are equivalent.

Level Flat and <u>horizontal</u>. A ball would not be able to run downhill on a perfectly level surface.

Line Graph A <u>graph</u> in which the plotted points are joined with a continuous line which may be straight or curved. The spaces between the plotted points should normally have a meaning.

Graphs of how quantities such as temperature change over time and graphs drawn from <u>equations</u> such as y = 3x + 5 are normally drawn as line graphs.
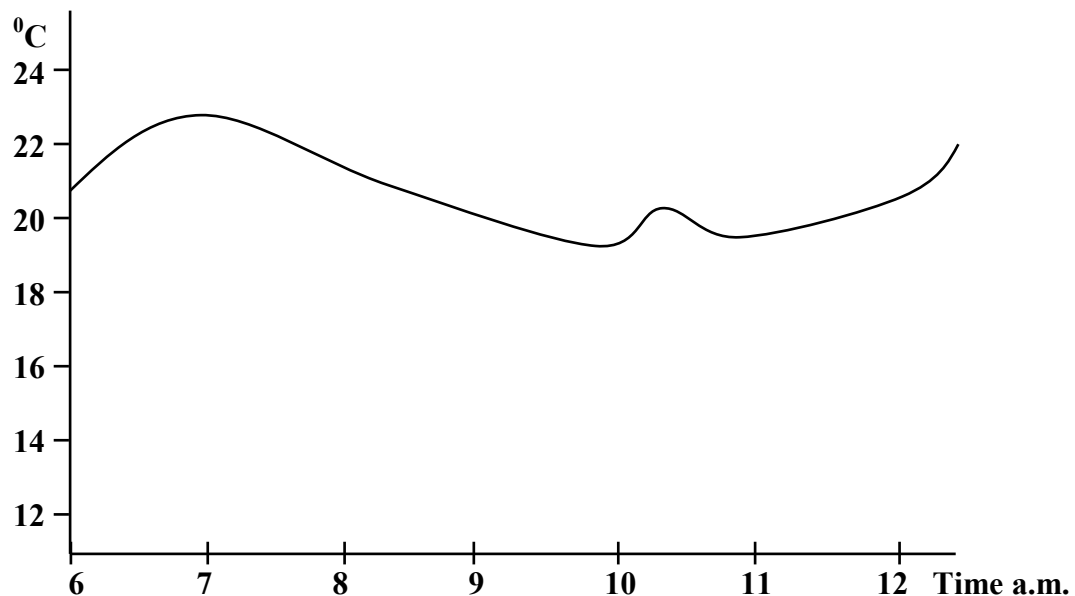
e.g. Graph of how the temperature varied in a room between **6.00** a.m. and **12.00** a.m.


Line of Symmetry Another name for <u>Axis of Symmetry.</u>

Litre **1 000** cm^3. See also <u>volume</u>.

Locus The path of a point that moves according to certain rules.

e.g. The locus of a point that is always **3**cm from a fixed point is a circle of radius **3**cm.

e.g. The locus of a point that moves so that it is inside a rectangle **10cm x 8cm** and is never closer to the sides than **2**cm is the shaded area in the diagram.

←—— **10cm** ——→

8cm
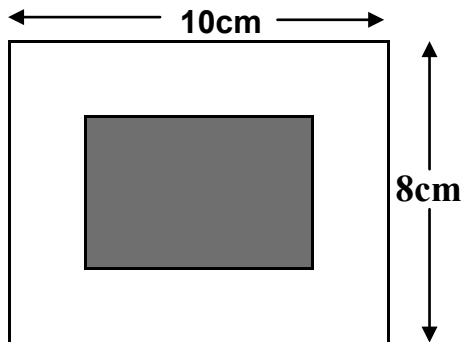
Logo A computer programming language that allows you to move a turtle according to certain rules. It is possible to begin gently with simple commands such as FORWARD 20 and progress to much more complicated structures involving subroutines and variables.

Lowest Common Multiple The lowest common multiple of two or more numbers is the lowest multiple that is the same for both (or all) of the numbers.

e.g. Find the lowest common multiple of **5, 6** and **15**.

The multiples of **5** are: **5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65...**
The **multiples** of **6** are: **6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72** ...
The **multiples** of **15** are: **15, 30, 45, 60, 75, 90, 105, 120 ...**

The **common multiples** of **5, 6** and **15** are therefore: **30, 60, 90 ...**

The **lowest** common multiple of **5, 6** and **15** is therefore 30.

Lowest terms A fraction is in its lowest terms if it cannot be cancelled any more.

e.g. $\dfrac{1}{3}$ $\dfrac{2}{5}$ $\dfrac{17}{33}$

Mandelbrot Set A set of points in a given area on an Argand Diagram that are coloured according to a fixed rule. The mathematics behind the Mandelbrot is quite complicated, but the results of the calculations produce very beautiful fractals. Follow the link from the MathSphere Home Page (under 'Other Related Internet Sites') to the Mandelbrot Internet site to see some of these images.

Mass The amount of matter in an object. In the metric system this is measured in grams, kilograms or tonnes.

1 000 grams   = **1** kilogram
1 000 kilograms = **1** tonne

(See also <u>weight</u>.)

Matrix A group of numbers written between round brackets. The size of a matrix is indicated by the number of rows and columns.

e.g. the matrix $\begin{pmatrix} 4 & 8 & -6 \\ 7 & -1 & 9 \end{pmatrix}$ is a **2 x 3** matrix.

Matrices are used for many problems including the solving of equations and the transformations of shapes.

Maximum The largest value of a quantity.

e.g. 'The maximum temperature today will be about **24⁰C**.'

e.g. 'The maximum height reached by the climbers was **6 700** metes.'

Mean One of the three <u>averages</u> Mean, <u>Median</u> and <u>Mode</u>. To find the mean, add up the numbers and divide by how many there are.

e.g. What is the mean of **6, 8** and **10** ?

Mean $= \dfrac{6 + 8 + 10}{3} = \dfrac{24}{3} = \underline{8}$

Median One of the three types of average: <u>Mean</u>, Median and <u>Mode</u>.
Put the numbers you have in numerical order. The median is the one in the middle if there is an <u>odd</u> number of items or the <u>mean</u> of the two in the middle if there is an <u>even</u> number.

e.g. Find the median of **5, 7, 2, 4, 2, 10, 3**
Put them in order: **2, 2, 3, 4, 5, 7, 10**
The median is therefore **<u>4.</u>**

e.g. Find the median of **4, 2, 6, 3, 8, 5, 3, 7, 6, 9, 12, 3**
Put them in order: **2, 3, 3, 3, 4, 5, 6, 6, 7, 8, 9, 12**
The median is therefore the mean of **5** and **6**, which is **<u>5.5</u>**.

Mersenne Prime Number Some numbers of the form $2^n - 1$ are prime numbers. **n** can be any whole number.

e.g. Is $2^n - 1$ a prime number when **n** is **8**? $2^8 - 1 = 255$. This is obviously not a prime number since it has a factor of **5**.

If you try a few of these, you will see that $2^n - 1$ is a prime number only if n itself is a prime number. This does not mean, however, that if n is a prime number, $2^n - 1$ will always be prime.

e.g. $2^{13} - 1 = 8\ 191$ is a prime number, but $2^{11} - 1\ =\ 2047$ is not a prime number as it has factors **89** and **23**.

Numbers of the form $2^n - 1$ that are prime numbers are called Mersenne Prime Numbers or just Mersenne Primes after the 17th French monk, Father Marin Mersenne.

The largest Mersenne Prime known before computers began to work on the problem was $2^{127} - 1$. This is the number:

170 141 183 460 469 231 731 687 303 715 884 105 727

Modern known Mersenne primes are huge. If you want to know more about these and other large prime numbers please go to our section 'Other Related Internet Sites' from the Home Page and choose the Prime Number internet site.

Million **1 000 000**. A thousand thousands.

Numbers involving millions should be read as in the following example:

23 628 775 is twenty three million, six hundred and twenty eight thousand, seven hundred and seventy five.

Minimum The smallest value of a quantity.

Mirror Line Another name for Axis of Symmetry.

Mixed Number A number consisting of a whole number and a fraction such as $7\frac{3}{4}$.

Möbius Strip To produce a Möbius Strip, take a long piece of paper about **30**cm by **2**cm and join the ends to make a loop. Just before you stick them together give one of the ends a half turn. You now have a Möbius Strip. Other versions may be produced by giving a full turn or one and a half turns and so on just before you stick it. When you have produced one, try cutting it down the middle, being careful not to cut across the edge.

Mode One of the three types of average: Mean, Median and Mode.
The mode is the one that occurs most often. Sometimes, there are two or more modes if different quantities occur the same number of times. This type of average is mainly used for items such as clothes sizes.

e.g. Find the mode of **5, 7, 2, 4, 2, 10, 3**
The mode is therefore **2** , since it is the only one that occurs more than once.

e.g. Find the mode of **4, 6, 7, 4, 8, 3, 7, 9, 4, 9, 2, 7**

4 and **7** are the modes since they occur three times each and none of the other numbers occur as often.

Model (i) A construction made from materials such as straws or card to show the make up of two- or three dimensional shapes such as cubes, tetrahedra and dodecagons.

(ii) A set of equations that describe a physical system such as the way a bridge bends when traffic passes over it or how the weather behaves. It is called a model because no set of equations, no matter how complicated, can fully describe a real system. The mathematicians task is to refine the set of equations until the results they predict matches the real results to an acceptable degree of accuracy.

Modular (Modulo) Arithmetic A system of arithmetic based on a clock face with zero normally at the top. The clock face can have any number of figures you like, but zero is always the first.

e.g.. Modulo **6:**
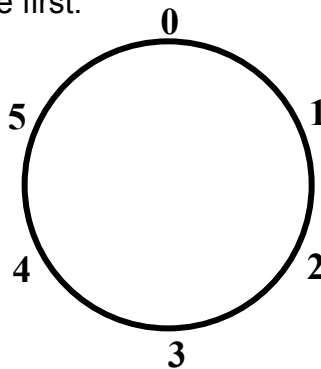
This gives a rather strange arithmetic in which **2 + 3 = 5,** but **4 + 3 = 1**

Months The twelve subdivisions of the year. Some are named after Roman Gods, such as January - named after Juno.

Months have the following numbers of days.

January	**31**	July	**31**
February	**28 ****	August	**31**
March	**31**	September	**30**
April	**30**	October	**31**
May	**31**	November	**30**
June	**30**	December	**31**

** 29 in a leap year.

Multiple A number produced by multiplying a starting number by another whole number. Think of it as the numbers in the multiplication table.

e.g. The multiples of **7** are **7**, **14**, **21**, **28**, **35** etc.

Multiplication An operation equivalent to repeated addition.

EG. Multiplying **7** by **5** is the same as adding five sevens together.

Natural Number Natural numbers are the counting numbers starting at **1** (i.e. As they occur naturally).

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, ...

Negative Below zero. Negative numbers are normally written with a small subtraction sign.

e.g. ⁻**4,** ⁻**196,** ⁻**4.7,** ⁻**0.2** are all negative numbers.

Negative Rotation A rotation in a clockwise direction.

Net A shape that, when drawn on paper and cut out and folded, makes a three dimensional shape such as a cube.
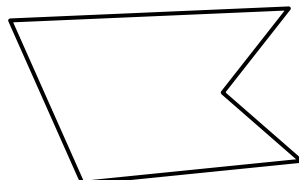
Network A system of arcs meeting at nodes and enclosing regions. They may represent real routes such as roads or railways.
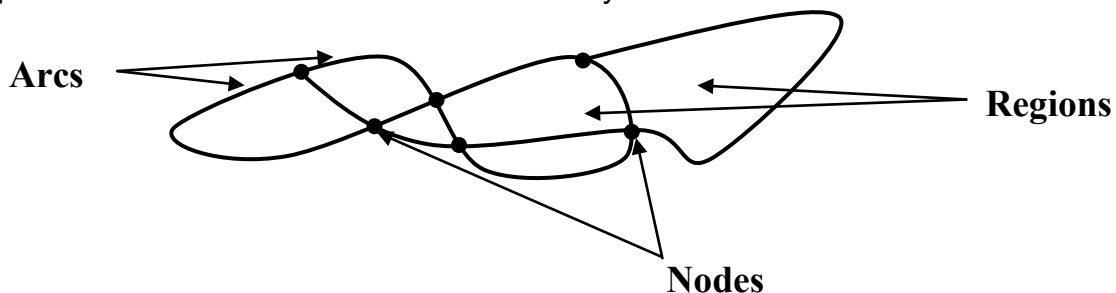
Node A point on a network where arcs meet. For diagram see Network.

Nonagon A polygon with nine sides.

Non-Convex Polygon A polygon having at least one interior angle greater than **180⁰**.

North The direction on a compass pointing towards the North Pole.
A north wind, on the other hand, comes **from** the direction of the North Pole.

Numeral Another word for number.

Numerator The upper number in a fraction.

Obtuse Angle An <u>angle</u> greater than **90^0** and smaller than **180**^{0}.

Octagon A <u>polygon</u> with eight <u>sides</u>.

Octahedron A <u>polyhedron</u> with eight <u>faces</u>.

Octal A number system based on eight instead of ten as in our normal number system. See also <u>binary</u>.

Odd Number A number that has a remainder of **1** when divided by **2**.

The odd numbers are: **1,   3,   5, 7, 9,   11,   13,   15,   17,   19, ...**

Order of Rotational Symmetry Imagine rotating a shape about its centre point. The number of positions (including the starting position) in which the shape looks as though it has not been moved is called the order of rotational symmetry.

e.g.   A square has order of rotational symmetry **4**, because when rotated it looks the same in four different positions.

Similarly, a regular pentagon has order of rotational symmetry **5**, a regular hexagon **6** and a parallelogram **2** (not **4** as you might expect initially).

A shape that looks the same in only one position such as an elephant or most irregular shapes have order of rotational symmetry **1**. We normally say that such shapes have **no** rotational symmetry.

Ordered Set A <u>set</u> of items in which the order of writing them down is important. Mostly this is not the case with sets.

Ordinal Number A whole number used to show the order of items.

e.g. House numbers are ordinal numbers.

Numbers are being used in an ordinal sense when we say 'first, second, third etc'.

Origin The point where the zero on one axis of a graph meets the zero of the other axis. The point with co-ordinates **(0,0).**

Orthocentre The point where the three perpendicular bisectors of the sides of a triangle meet.

Orthogonal At right angles. This word is normally used for two or more lines which are drawn at **90°** to each other.

Palindromic Number A number that reads the same backwards as it does forwards, such as:

22,   165561,   72927

You can try to produce palindromic numbers by writing down any number and underneath writing down the number reversed. Add the two numbers together.

Sometimes this will produce a palindromic number:

> **35**
> **53**
> **88**

If this does not produce a palindromic number do the same with the answer.
Keep going until you obtain a palindromic number.

Parallel Two or more straight lines are parallel if they go in the same direction. In mathematical diagrams, we often put small arrows on them to show they are parallel.
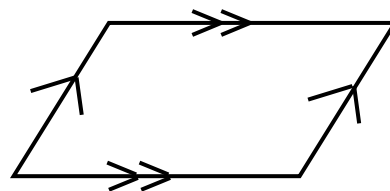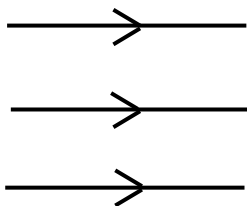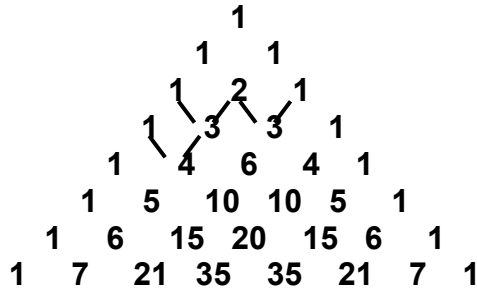
Parallelogram A quadrilateral with two pairs of parallel sides.
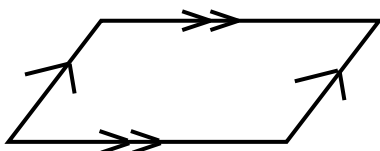
Pascal's Triangle
A triangle of numbers investigated by the mathematician Pascal which begins

```
        1
      1   1
```

The numbers in each following row are obtained by adding the two numbers immediately above.

```
            1
          1   1
        1   2   1
      1   3   3   1
    1   4   6   4   1
  1   5   10  10  5   1
1   6   15  20  15  6   1
1  7  21  35  35  21  7  1
```

This pattern goes on for ever and is very useful in more advanced mathematics.

It has some very interesting properties, one of which is that if the number immediately after the **1** is a prime number, it divides exactly into every other number in the line (except **1**, of course).

In the above portion of the triangle, **7** is a prime number and **7** divides exactly into **21** and **35**. Try this yourself for longer rows.

Pentagon
A <u>polygon</u> with five sides.

Pentagonal Prism
A <u>prism</u> whose end face is a <u>pentagon</u>.

Pentagonal Pyramid
A <u>pyramid</u> whose <u>base</u> is a <u>pentagon</u>.

Per Cent
Out of **100**. Percentages were invented in order to compare different fractional amounts.

e.g. A pupil obtains **25/50** in an English test, **12/20** in a science test and **15/25** in a mathematics test. By writing these as percentages, we can more easily compare her results:

English   **25/50 = 50%**
Science   **12/20 = 60%**
Mathematics **15/25 = 60%**

We can see now that, although she obtained more **marks** in the English test, she actually did better in the other two tests.

<u>Perfect Number</u> A number in which the <u>factors</u> add up to the number itself. (Obviously in this calculation, the number itself is not added in, although it is in fact a factor).

e.g. The first two perfect numbers are **6** and **28**.

The factors of **6** are **1, 2** and **3** and **1 + 2 + 3 = 6**
The factors of **28** are **1, 2, 4, 7,** and **14** and **1 + 2 + 4 + 7 + 14 = 28**

The next perfect number is **496**. After that they become pretty big!

<u>Perimeter</u> The path around the outside of a shape. Often used to mean the **distance** around the shape.

e.g. The perimeter of a rectangle **12**cm long and **8**cm wide is **40**cm.

<u>Perpendicular</u> At <u>right angles</u>. Two lines drawn at right angles to each other are said to be perpendicular.

e.g. The adjacent sides of a <u>rectangle</u> are perpendicular.

<u>Perpendicular Bisector</u> A line which <u>bisects</u> another line at <u>right angles</u>.

<u>Pi</u> π The number of times that the <u>diameter</u> of a <u>circle</u> divides into the <u>circumference</u> of the circle. Every circle produces the same answer. Unfortunately, the answer is not a whole number, nor even a number that may be written as a simple fraction. The number has an infinite number of decimal places and does not recur.

It begins **3.1415926535897932384626...**

<u>Pictogram</u> A type of graph in which quantities are used to represent numbers.

e.g. In this pictogram showing the number of people travelling to work by bus, by car and on foot, each stick figure represents **100** people.
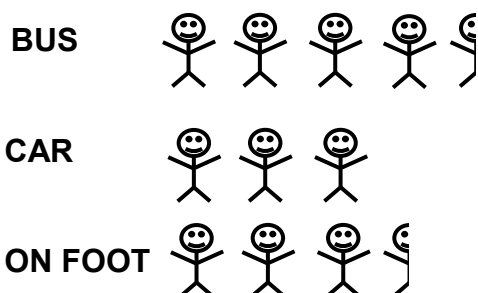
Pie Chart A type of graph in which everything being discussed in a problem is represented by a circle. Each group is then shown by a sector of the circle, its size being related to the size of the group.

e.g. **180** people were asked about their favourite chocolate bars.

60 liked SMAR BAR
20 liked RATTY BARS
100 liked PIGGY BARS

SMAR BARS

PIGGY BARS

RATTY BARS
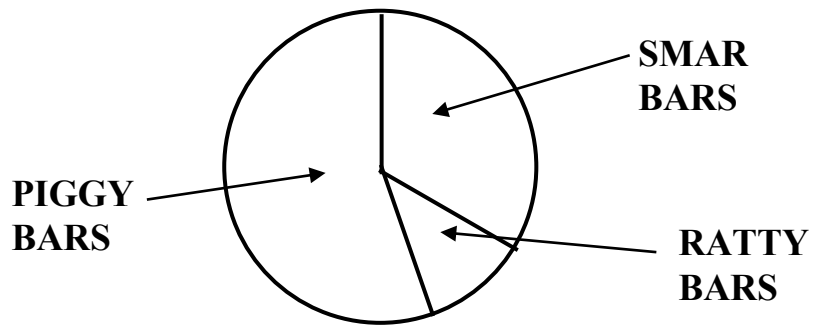
Place Value Probably the most important thing about our number system. The value of a digit depends on where it is placed.

e.g. A figure **5** placed in the units column has a value of **5**, but when placed in the hundreds column it would have a value of **500**.

Plane A flat area such as a desk top. It does not have to be horizontal.

Plane Figure A shape drawn on a plane, such as a square or an octagon.

P.M. *post meridiem* (between noon and midnight).

Polygon A two dimensional shape made up of straight sides only.

e.g. Square, rectangle, hexagon, octagon etc are all polygons.
A semicircle is not a polygon because it includes a curved part.

Polyhedron (Plural **Polyhedra**) A three dimensional shape made up of flat faces only.

e.g. Cube, cuboid, tetrahedron, dodecahedron etc are all polyhedra.
A sphere is not a polyhedron because its surface is curved.

Positive Greater than zero.

Positive Rotation An anti-clockwise rotation.

Power The number of times a quantity is multiplied by itself.

e.g. 4^5 is **4** to the power of **5**, which is **4 × 4 × 4 × 4 × 4 = 1024**

Precise Exact. Normally used to refer to a measurement which is so accurate any error can be ignored.

Prime Factor A prime factor of a number is a <u>factor</u> of a number that is also a <u>prime number</u>.

e.g. The factors of **12** are **1, 2, 3, 4, 6** and **12**

The prime factors of **12** are therefore **2** and **3**.

All other factors can be made by multiplying some or all of the prime factors together.

e.g. **4 = 2 x 2**   **6 = 2 x 3**   **12 = 2 x 2 x 3**

Prime Number A whole number which has only two <u>factors</u>. These are **1** and the number itself. No other numbers will divide exactly into a prime number.

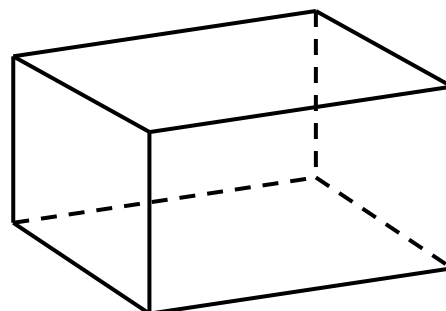The first few prime numbers are: **2, 3, 5, 7, 11, 13, 17, 19, 23, 29 ....**

Note that **1** is not a prime number and that **2** is the only **even** prime number.

Prism A prism is a three dimensional shape that has the same cross sectional shape throughout its length. To put it another way, if you were to saw across a prism anywhere along its length, you would always obtain the same shape.
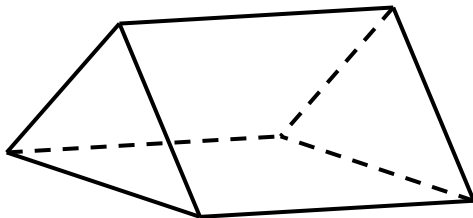
e.g.

Triangular prism   **Cuboid**

Calculating the <u>volume</u> of a prism is simple. Find the <u>area</u> of the end and multiply by the length.

<u>Probability</u> The chances of something happening. Normally written as a number between **0** and **1**, either as a decimal, percentage or as a fraction.

A probability of **0** means something is impossible (not just high unlikely).
A probability of **1** means something is certain to happen (not just highly likely).
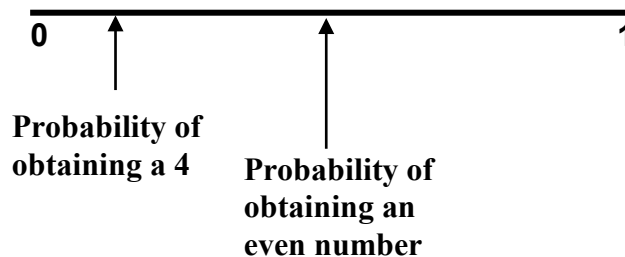
e.g. There is a probability of **0.5** that it will rain tomorrow.
This means that weather forecasters believe there is an equal chance that it will or will not rain tomorrow.

e.g. There is a probability of **1/6** that if I throw a normal dice once, I will obtain a number **4**.
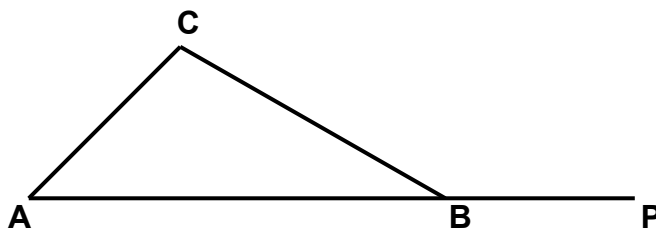
<u>Probability Scale</u> A line going from **0** to **1**, showing the probabilities of events.

e.g. Throwing a normal dice:

```
0                                                    1
     ↑              ↑

  Probability of
  obtaining a 4    Probability of
                   obtaining an
                   even number
```

<u>Produce</u> Producing a line means extending it at one end.

e.g. In the triangle, **P** is a point on the line **AB** produced.

```
        C



 A                    B        P
```

<u>Product</u> The answer when two or more numbers are multiplied together.
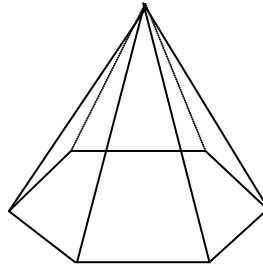
e.g. The product of **3**, **5** and **6** is **90**.

<u>Proper Factor</u> The <u>factors</u> of a number not including the number itself.
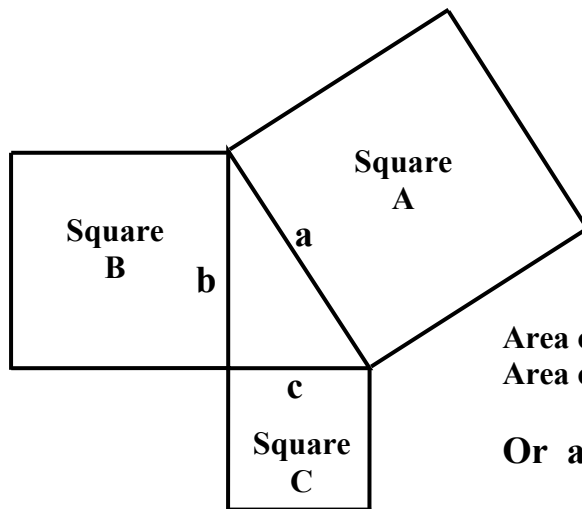
e.g. The factors of **20** are **1**, **2**, **4**, **5**, **10** and **20**.

The proper factors of **20** are **1**, **2**, **4**, **5** and **10**.

<u>Pyramid</u> A <u>three dimensional shape</u> whose <u>base</u> is a <u>polygon</u> and whose other <u>edges</u> meet at a point (<u>apex</u>).

<u>Pythagoras' Theorem</u> A theorem that states: In a <u>right angled triangle</u>, the <u>square</u> on the <u>hypotenuse</u> is equal to the <u>sum</u> of the squares on the other two sides.
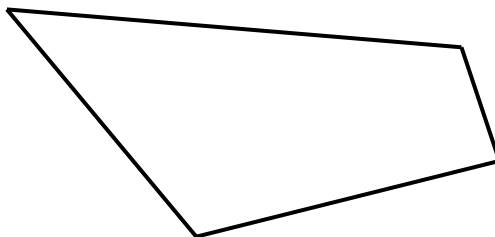
Square A

Square B

a

b

c

Square C

**Area of Square A =
Area of Square B + Area of Square C.**

Or $a^2 = b^2 + c^2$

<u>Quadratic Equation</u> An <u>equation</u> whose highest <u>power</u> is **2.**

e.g.   **$3x^2 + 4x - 5 = 15$**

<u>Quadrilateral</u> A <u>polygon</u> with four <u>sides</u>. This includes such shapes as <u>squares</u>, <u>rectangles</u>, <u>parallelograms</u> and <u>rhombuses</u>, but also includes many shapes with no special properties such as:

<u>Quotient</u> The answer when the larger of two numbers is divided by the smaller.

e.g. The quotient of **20** and **5** is **4**.

Radius The distance from the centre of a circle to its circumference.

Radius
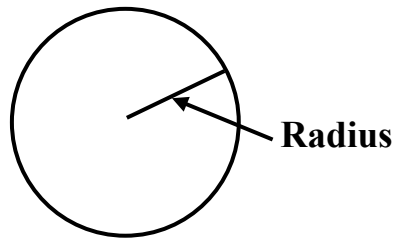
Random Number A number chosen at random. This may be done with a small device such as a dice or a spinner, or on a computer.

Range The difference between the smallest and the largest of a group of numbers.

e.g. The range of   **6, 8, 19, 4, 12, 4, 7**   is **15**   **(i.e. 19 - 4)**

It is **incorrect** to say that the range is 'from **4** to **19'**.

Rate of Interest The percentage amount that is added to a loan or investment each year.

Rational Number A number that may be written as a fraction.

The following types of numbers may be written as fractions and are therefore rational:

Fractions with a numerator and denominator such as $\frac{6}{7}$.

Whole numbers such as **8**, which may be written as $\frac{8}{1}$ or $\frac{16}{2}$.

Simple decimals such as **0.45** which may be written as $\frac{45}{100}$.

Decimals with whole numbers such as **5.9** which may be written as $\frac{59}{10}$.

Recurring decimals such as **0.5656565656...** which may be written as $\frac{56}{99}$.

Numbers that are not rational are called irrational.

<u>Reciprocal</u> The reciprocal of a number is the answer when **1** is divided by that number.

e.g. the reciprocal of **4** is $\dfrac{1}{4}$ or **0.25**.

e.g. The reciprocal of **0.2** is $\dfrac{1}{0.2}$ or **5**.

If you multiply a number by its reciprocal, the answer is always **1**.

<u>Rectangle</u> A <u>quadrilateral</u> with four <u>right angles</u>.

Note that this **includes** <u>squares</u>.

<u>Recurring Decimal</u> A decimal with a sequence of digits that repeat for ever.

e.g.   **23.678678678678678678678......**
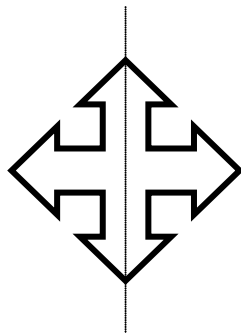
    0.33333333333333333333333333......

    6.375898989898989898989......

Recurring decimals are normally written with a dot over the first and last digits that recur:

      .   **.**   **.**   **.** **.**
    23.678   **0.3**   **6.37589**

<u>Reflection</u> The process of mirroring a shape in a line of symmetry. The shape is the original shape as seen in a mirror. The <u>line of symmetry</u> may overlap the shapes or may be between them.

Here the line of symmetry overlaps the two halves of the reflection.
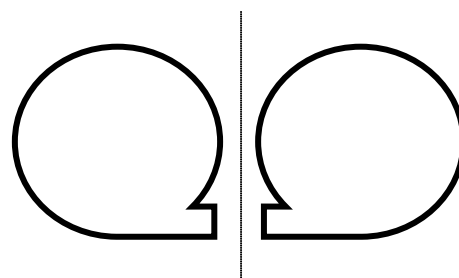
Here the line of symmetry is between the two shapes.

<u>Reflex Angle</u> An <u>angle</u> that is greater than **180°** and less than **360°**.

<u>Region</u> An area enclosed by <u>arcs</u> on a <u>network</u>.. (For diagram see <u>Network</u>.)

<u>Regular</u> Normally used to describe a <u>two-dimensional</u> shape that has all its <u>sides</u> the same length and all its <u>angles</u> the same value or a <u>three- dimensional</u> shape whose <u>faces</u> are made from regular <u>polygons</u>.

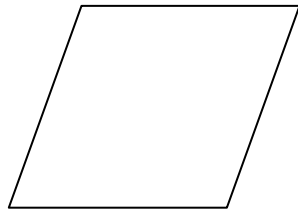**<u>Remainder</u>** The number left over when a division sum is performed.

e.g. **22** divided by **6** is **3** with remainder **4**.

<u>Revolution</u> One complete turn. (A turn of four right angles or **360°**.)
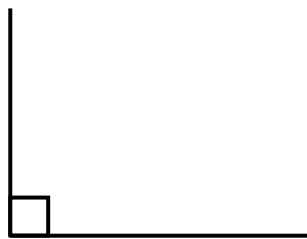
The speed of things that rotate is often measured in rpm (revolutions per minute).

<u>Revolve</u> Another word for 'turn'.
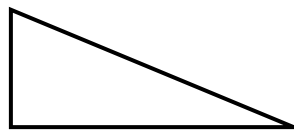
<u>Rhombus</u> A <u>quadrilateral</u> with all four sides equal in length.

<u>Right Angle</u> An <u>angle</u> of 90°. The angle at the corner of a piece of paper.

<u>Right Angled Triangle</u> A triangle with one right angle.

<u>Right Cone or Pyramid</u> A <u>cone</u> or <u>pyramid</u> whose <u>apex</u> is directly above the centre of the <u>base</u>.

Roman Numerals Capital letters of the alphabet used by the Romans to represent numbers.
I = 1,   V = 5, X = 10, L = 50, C = 100, D = 500, M = 1 000.

If a smaller symbol is placed in front of a larger symbol, its value is subtracted from the larger one.

e.g. **IX = 9, XL = 40.**

If a smaller symbol is placed after a larger symbol, its value is added to the larger one. Eg. **XII = 12, LX = 60**

Here are some numbers expressed in Roman Numerals:

   CCCXL = 340,   MM = 2 000,   MDCDLXIX = 1969.

Root The opposite of a <u>power</u>. The square root is the number which when multiplied by itself, gives the number you started with.

e.g. The square root of **9** is **3**,   or $\sqrt{9}$ **= 3,** because **3 × 3 = 9**

Other roots are written: $\sqrt[3]{64}$ **= 4**   (Cube root of **64 = 4**)

$\sqrt[4]{96}$ **= 3.1301...** (Fourth root of **96 = 3.1301**)

Rotation The turning of a shape. When you rotate a shape you need to say where the centre of rotation is, how many degrees the shape is rotated and whether the rotation is <u>clockwise</u> or <u>anti-clockwise</u> (except for **180^0**, which is the same clockwise or anti-clockwise).

e.g.

Shape **A** has been rotated **90^0** clockwise about point **P**.
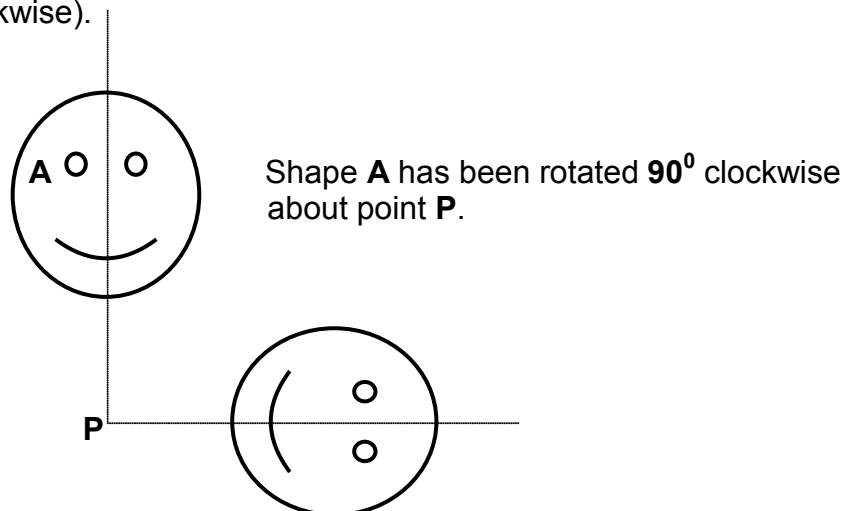
Rotational Symmetry A shape has rotational symmetry if it may be rotated by an angle less than **360^0** about its centre and still look the same. See also <u>Order of Rotational Symmetry.</u>

e.g. A regular hexagon may be rotated into six different positions and still look the same.

Round Circular in shape. Spheres, cylinders and circles are all round.

Rounding Often a number is too accurate for our purposes so we round it to the nearest **10, 100, 1 000** etc.

e.g.   The number of people attending a football match is **23 482**. We can round this to the nearest **1 000.   23 482** becomes **23 000**.

e.g. The number **4.783** rounded to one decimal place is **4.8**.

Row Matrix A matrix consisting just of one row of numbers, such as

{3 5 2 −5}

Scalar A value that has quantity only. No direction is implied.
Scalars are normally simple numbers which may represent measurements.

e.g.   **6** houses, **98** kilograms, 'Today I walked **12** kilometres'.

Quantities that have a direction such as force are called vectors.

**Scale** The amount by which items on a map or scale drawing are reduced from their real size.

e.g. **2**cm represents **1** metre.

e.g.   **1: 50 000**   means **1** cm on the map represents **50 000** cm on the ground.

Scale factor The number of times that a shape has been enlarged. A number greater than **1** means that the new shape (image) is larger than the original. A number between **0** and **1** means that the new shape is smaller that the original.
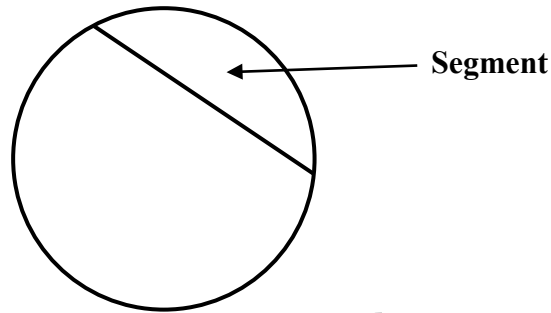
Scalene Triangle A triangle with sides of different lengths.
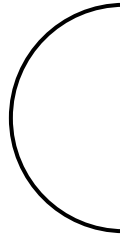

Sector A part of a circle between two radii.

Sector
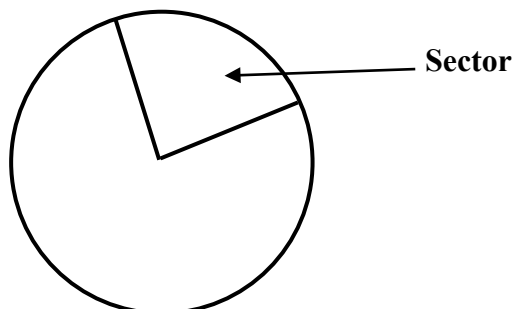
Segment A part of a circle cut off by a <u>chord.</u>

Segment

Semicircle Half a circle.

Sequence A set or group of numbers, put into order according to some rule.

e.g. **1, 2, 3, 4, 5, 6, ...**

e.g. **1, 1, 2, 3, 5, 8, 13, ...** (Fibonacci Sequence).

Series The total or sum of a sequence of numbers.

e.g. **1 + 2 + 3 + 4 + 5 + 6**

e.g. $1 + \dfrac{1}{2} + \dfrac{1}{4} + \dfrac{1}{8} + \dfrac{1}{16} + \dfrac{1}{32} + \dfrac{1}{64} \ ...$

Set A group of items such as objects, colours or numbers. Sets are normally written in curly brackets: **{red, green, yellow}.**

Set Theory The branch of mathematics dealing with sets. Sets may be combined using the operations of <u>intersection</u> and <u>union</u>.

Side One of the straight lines joining two corners of a <u>polygon</u>.

Sieve Of Eratosthenes See <u>Eratosthenes - Sieve of.</u>

Sign of a Number Whether a number is <u>positive</u> or <u>negative</u>.

Significant Figures The most important figures in a number. The first non-zero figure is the most significant figure, the one immediately following that is the second most significant figure and so on.

<u>Similar Shapes</u> Shapes are said to be similar if they have the same number of sides and the same angles. In other words, one is an <u>enlargement</u> of the other.

<u>Sine</u> (Abbreviation **'sin'**) In a right angled triangle, the sine of an angle is the length of the opposite side to the angle divided by the <u>hypotenuse</u>.

A

c   b $\text{Sin} \angle \text{C} = \dfrac{c}{b}$

B   **a**   **C**
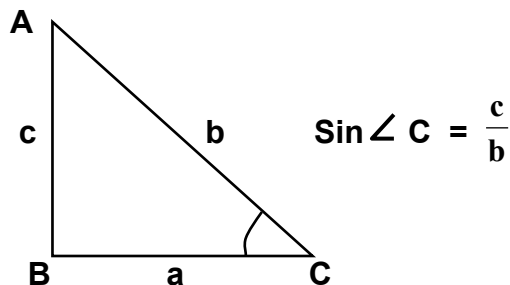
<u>Smallest Common Multiple</u> The smallest number that is a <u>multiple</u> of several smaller numbers.

e.g. The smallest common multiple of **15** and **20** is **60**.

e.g. The smallest common multiple of **4**, **5** and **9** is **180**.

<u>Solution</u> **(i)** The answer to a problem.
(ii) A number (or set of numbers) that make an <u>equation</u> true.

e.g. The solution to the equation **3x + 5 = 26** is **x = 7.**

<u>Solving an equation</u> The process of finding numbers that make an equation true. See also <u>solution</u>.

<u>South</u> To face south, begin by facing <u>north</u> and make a 180° turn.

<u>Speed</u> The rate at which distance is covered. Measured in metres per second, kilometres per hour, miles per hour, or similar units.

<u>Speed - Time Graph</u> A <u>line graph</u> showing how fast an object moves over a period of time. Time is always placed on the <u>horizontal</u> <u>axis</u> and speed on the <u>vertical</u> <u>axis</u>. The area under a Speed - Time graph gives the distance travelled in that time.

<u>Sphere</u> A perfectly round <u>three dimensional</u> shape like a ball.

<u>Spherical</u> Shaped like a sphere.

e.g. The Earth is almost perfectly spherical.

<u>Spiral</u> A line that starts at a single point and moves outwards from that point whilst moving around it.
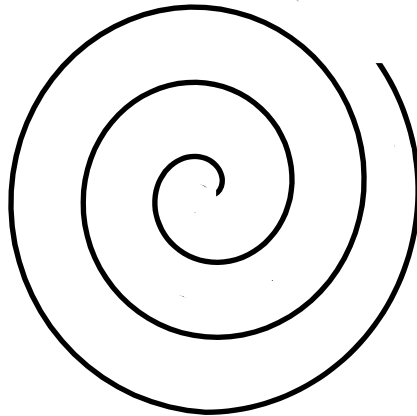
<u>Square</u> A <u>quadrilateral</u> with equal sides and **90⁰** <u>angles</u>.

<u>Square Root</u> The square root of a number is the number, which when multiplied by itself, gives the original number.

    e.g. The **square root of 16** is **4**, because **4 × 4 = 16.**

    e.g.   The **square root of 1.21** is **1.1** because **1.1 × 1.1 = 1.21**

The square root of **16** is normally written as $\sqrt{16}$.

<u>Standard Form</u> A way of writing numbers so that the decimal point is after the first non-zero digit and this is multiplied by a power of ten.

    e.g.   **310** written in standard form is $\mathbf{3.1 \times 10^2}$

    e.g. **2382.65** written in standard form is $\mathbf{2.38265 \times 10^3}$

If the number is smaller than one, the power of ten is negative.

    e.g. **0.003708** written in standard form is $\mathbf{3.708 \times 10^{-3}}$

<u>Statistics</u> The branch of mathematics concerned with collecting and analysing data. Some of the tasks carried out in statistics are finding <u>averages</u> and <u>ranges</u>, drawing graphs and working out <u>probabilities</u>.

<u>Stellated Polyhedron</u> A <u>polyhedron</u> with a <u>pyramid</u> placed on every <u>face</u> of the polyhedron. The pyramids are constructed so that their bases exactly match the shape of the face to which they are attached.

Subset A small subset taken from a larger set.

e.g. **A = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}   B = {3, 5, 7}**

    B is a subset of **A**   or   **B ⊂ A**

Straight line The path between two points giving the shortest distance.

Subtraction The operation of reducing a number by another number. The opposite of addition.

Sum   **(i)** Any of the operations addition, subtraction, multiplication or division applied to two or more numbers.
   **(ii)** Another word for total.

e.g. The sum of **6, 4** and **9** is **19**.

Supplementary Angles Angles which add up to **180^0**. Opposite angles in a cyclic quadrilateral are supplementary.

Surface Area The total area of all the faces (flat or curved) of a three-dimensional shape such as a cuboid or a cylinder.

Symmetry (i) Reflective symmetry. The idea that some shapes, when divided down the middle, give two halves, one of which is a reflection of the other. The line through the middle is called the axis of symmetry and some shapes have more than one axis of symmetry.

This shape has two axes of symmetry.
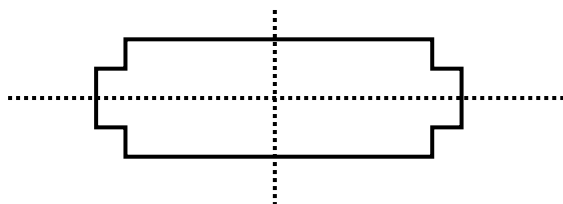
Tally A method or recording counting in which a line is drawn for each number counted. These are drawn in groups of five with the first four vertical and the fifth horizontal.

e.g.   This tally represents **23**:   ⊬⊬ ⊬⊬⊬⊬ ⊬⊬ |||

Tangent **(i)** A straight line outside a circle that just touches the circle at one point on its circumference. The angle between the tangent and the <u>radius</u> at that point is **90⁰**.
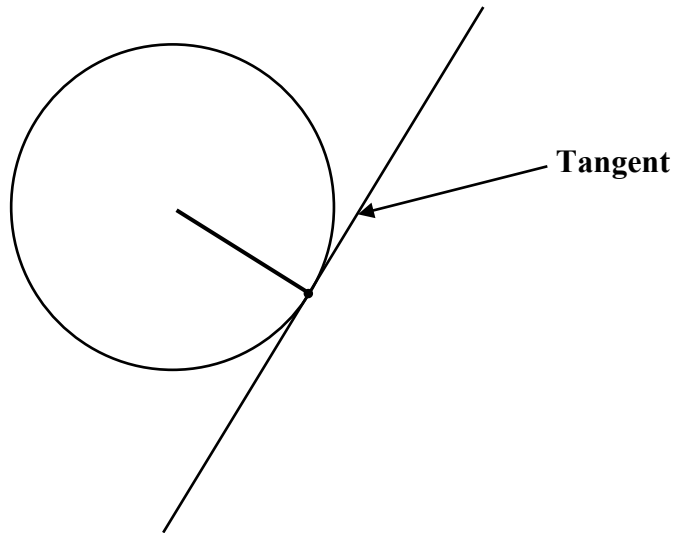
Tangent

(ii) (Abbreviation **'tan'**) In a right angled triangle, the tangent of an angle is the length of the opposite side to the angle divided by the length of the adjacent side.

$$\text{Tan} \angle\, C = \frac{c}{a}$$
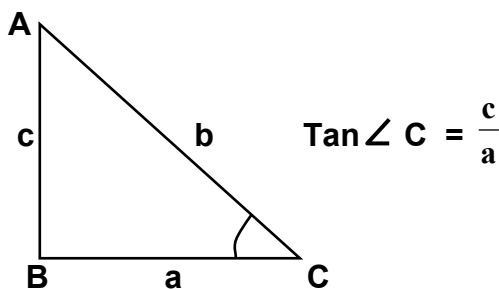
Term A term is part of a <u>function</u> or <u>equation</u>. Terms are separated from each other by addition or subtraction signs.

e.g.   The function   **4x² + 3x – 7**   has three terms.

Tessellation An arrangement of the same shape repeatedly in the same way as tiling, so that there are no gaps between the shapes. There should be a repeated pattern so that the process may be carried on to cover an infinitely large surface.

Some shapes obviously tessellate such as <u>squares</u> or <u>rectangles</u> which may be seen as tiles in kitchens or bathrooms. Some shapes tessellate, but this may not be obvious (for example, all <u>quadrilaterals</u> will tessellate - even non-<u>convex</u> ones!). Some shapes such as regular <u>octagons</u> may look as though they should tessellate, but do not.
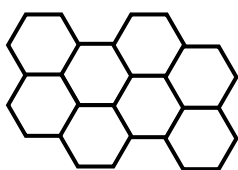
**Regular Hexagons
will tessellate**
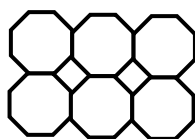
**Regular Octagons
leave small squares between**

Tetrahedron A polyhedron with four faces, each being a triangle.
A regular tetrahedron has equilateral triangles for all its faces.

Therefore Shown by the sign $\therefore$, therefore indicates the next logical step in a proof or explanation.

 e.g. **6p = 18** $\therefore$ **p = 3**

Three Dimensional A three dimensional shape is a shape that has length, width and height. You can think of it as a shape that you can hold in your hand such as a cube, a cone or a model elephant.

Topology A branch of mathematics concerned with shape. In topology, the sizes of angles and the lengths of lines are not important. What is studied is the ways in which lines (arcs) connect and the relationships between areas (regions). Typical problems in topology concern whether shapes may be drawn without taking the pencil off the paper or if maps can be coloured with a certain number of colours (see four colour problem). One practical use, for example, is in the designing of underground railway maps.

Total (Also called 'sum'). The answer when you add some numbers together.

e.g. The total of **4, 7** and **3** is **14**.

Transformation The process of changing a figure's position or shape. The most common transformations are reflection, rotation, translation and enlargement.

Transcendental Number A number that cannot be obtained by solving an equation.

e.g. π (Pi)

Translation The movement of a shape in a straight line. This can be in any direction and any distance.

Transversal A line crossing two (normally parallel) lines.

Trapezium A quadrilateral with two parallel sides.

Travel Graph A graph with time on the <u>horizontal</u> <u>axis</u> and distance travelled on the <u>vertical</u> axis.

Trial and Improvement Method A method used for solving problems where the exact answer is not easy to find straight away.

First make an intelligent guess as the answer. Then improve this 'guess' until your answer is accurate enough.

     e.g. Find the **square root of 12.**
    Guess   **3.5**

          3.5^2 = 12. 25   **Too large, so guess 3.4**
          3.4^2 = 11.56   **Too small, so guess 3.43**
          3.43^2 = 11.7649 Too small, so guess 3.44
          3.44^2 = 11.8336 Too small, so guess 3.46
          3.46^2 = 11.9716 Too small, so guess 3.47
          3.47^2 = 12.0409 Too large, so guess 3.465

    Keep going until your answer is accurate enough.

Triangle A <u>polygon</u> with three <u>sides</u>.

Triangle Numbers The following sequence of numbers:

    1, 3, 6, 10, 15, 21, 28, 36, 45, 55, ...

These are the numbers that may be arranged as triangles using suitable objects.

```
  X       X        X            X            X
 X X     X X      X X          X X          X X
        X X X    X X X        X X X        X X X      etc.
                X X X X      X X X X      X X X X
                           X X X X X    X X X X X
                                       X X X X X X
```


Trigonometry The branch of mathematics concerned with finding the values of <u>angles</u> and lengths in diagrams. Trigonometry uses <u>sines</u>, <u>cosines</u> and <u>tangents</u>.

Turtle Turtles come in two forms. The first is a model containing motors connected to wheels, which in turn is connected to a computer. The second is a symbol (normally an arrow) drawn on a computer screen.

Both types move, following instructions from the computer operator, often using a language called <u>LOGO</u>.

Twenty Four Hour Clock The twenty four clock does not divide the day into two periods of twelve hours each. Midnight is 0000, noon is 1200 and six o'clock in the afternoon is 1800, for example.

Minutes are included as normal. 2124 means 24 minutes past 9 o'clock in the evening.

The twenty four hour time is always written as four figures. This system is mainly used to avoid confusion about whether a time is in the morning or afternoon, for example in the army or on bus and train timetables.

Twin Primes A pair of prime numbers that are only two apart, such as **29** and **31**. Many thousands of pairs of twin primes are known, but it is not known if there is an infinite number of them!

Two Dimensional A two dimensional shape is a shape that has length and width **or** length and height only (it has no thickness). Two dimensional shapes are often drawn on paper and include triangles, squares and pictures of elephants.

Union The process of joining together two or more sets.

e.g. **A = {red, green, blue, orange, pink}** and **B = {yellow, pink, black}**

A∪ B = {red, green, blue, orange, pink, yellow, black}

On a Venn Diagram:
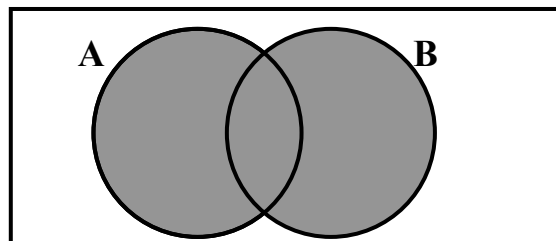
The shaded area represents **A∪ B**

Unit **(i)** The last digit in a whole number. The figure before the decimal point. We talk about the 'units column'.

(ii) A standard quantity used for measurement.

EG. metre, newton, gram, second.

(iii) The number of items that are sold together or packaged together.

e.g. 'These light bulbs are sold in units of ten.'

(iv) A kilowatt hour - used for the sale of electricity.

<u>Universal Set</u> The set of everything you are going to think about in a particular situation. For example, the Universal Set in a problem may be all the people in one class in a school. In another problem it may be the plants sold by a particular garden centre.

The important idea about a Universal Set is that once you have said what it is in a particular situation, you should not be tempted to talk about anything outside it, when drawing a <u>Venn Diagram</u>, for instance.


<u>Value</u> The amount of a quantity or the answer when numbers are put into a formula.

> e.g. 'The value on the time axis on the graph is 13 seconds.'
>
> e.g. 'The value of **3x + 5** when **x = 7** is **26**.'

<u>Vector</u> A value that has quantity and direction. Force is vector because not only is it measured in newtons, but a force is in a particular direction. See also <u>scalar</u>.


<u>Venn Diagram</u> A diagram used in set theory to show how sets intersect (overlap). The large rectangle represents the Universal Set (everything you are going to think about in a particular problem). The circles represent individual sets.
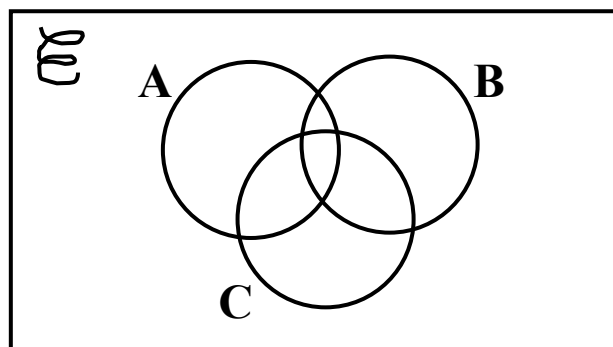

<u>Vertex (plural 'vertices')</u> One of the 'corners' on a <u>polyhedron</u>. A cube, for example, has eight vertices.

<u>Vertical</u> **(i)** A line or object standing straight up, at right angles to the Earth's surface or horizon.

(ii) A line at right angles to the base of a shape such as a <u>triangle</u> or <u>pyramid</u>.

Vertical line

Base
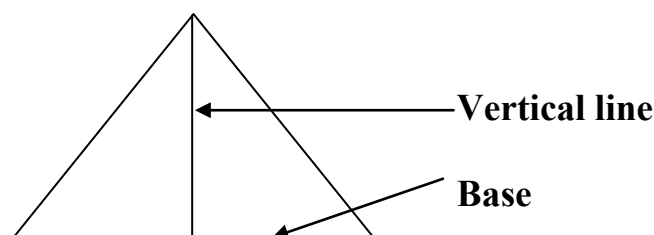
Vertically Opposite Angles Angles opposite to each other across a pair of intersecting lines.
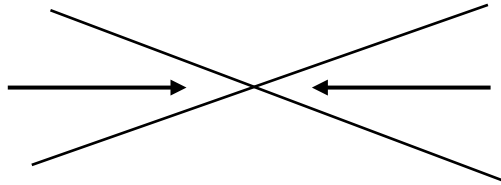
The two arrowed angles in this diagram are vertically opposite. Vertically opposite angles are equal in value.

Volume The amount of space taken up by an object or the amount of space inside an empty object. Because space is three dimensional (it has length, width and height) it has cubic units. In the metric system the units of volume are mm^3, cm^3, and m^3. The litre is also a metric measurement of volume and is the same as **1000** cm^3.

Vulgar Fraction A fraction written as one whole number over another, rather than as a decimal.

Weight Weight is the force by which gravity pulls an object downwards. It is measured in newtons. A one kilogram <u>mass</u> is pulled down by the Earth with a force of approximately ten Newtons. A child having a mass of **36** Kg would therefore have a weight on the Earth of about **360** Newtons. On the Moon, where the force of gravity is about one sixth that of the Earth's, the same child would weigh about **60** Newtons, although his mass would still be **36**Kg.

West To face west, begin by facing <u>north</u> and make a 90° turn <u>anti-clockwise</u>.

Whole Number A number with no fractional or decimal part. Whole numbers may be positive, negative or zero. Technically they are referred to as <u>integers</u>.

x-axis and y-axis When drawing a <u>line graph</u>, the <u>axes</u> are normally given single letters as names. There are no rules about what names to give them and the names chosen should reflect the measurement on the axis. For example, **t** is nearly always used for time, **d** may be used for distance and **f** for force.

However, when the axes do not refer to any particular measurements, we often call them the x-axis and the y-axis and the x-axis is nearly always the <u>horizontal</u> one.