DELTA
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Primary Maths Calculation Strategy

Introduced trust-wide - January 2019
Version 2 – January 2019

	Expectation by the end of Year 1	Expectation by the end of Year 2	Expectation by the end of Year 3	Expectation by the end of Year 4	Expectation by the end of Year 5	Expectation by the end of Year 6
Place Value	Count to and across 100, forwards and backwards, beginning with 0 or 1, or from any given number. Count, read and write numbers to 100 in numerals. Given a number, identify one more and one less. Identify and represent numbers using objects and pictorial representations including the number line, and use the language of: equal to, more than, less than, most, least.	Read and write numbers to at least 100 in numerals and in words. Recognise the place value of each digit in a two digit number (tens, ones) Identify, represent and estimate numbers using different representations including the number line. Compare and order numbers from 0 up to 100; use <, > and = signs. Use place value and number facts to solve problems. Count in steps of 2, 3 and 5 from 0, and in tens from any number, forward and backward.	Identify, represent and estimate numbers using different representations. Find 10 or 100 more or less than a given number Recognise the place value of each digit in a three-digit number (hundreds, tens, ones). Compare and order numbers up to 1000 Read and write numbers up to 1000 in numerals and in words. Solve number problems and practical problems involving these ideas. Count from 0 in multiples of 4, 8, 50 and 100	Count in multiples of 6, 7, 9. 25 and 1000. Find 1000 more or less than a given number. Recognise the place value of each digit in a four digit number (ths, hs, ts and ones) Order and compare numbers beyond 1000 Identify, represent and estimate numbers using different representations. Round any number to the nearest 10, 100 or 1000 Solve number and practical problems involving all of the above and with increasingly large positive numbers. Count backwards through zero to include negative numbers. Read Roman numerals to 100 and know that over time, the numeral system changed to include the concept of zero and place value.	Read, write, order and compare numbers to at least 1000000 and determine the value of each digit. Count forwards or backwards in steps of powers of 10 for any given number up to 1000000. Interpret negative numbers in context, count forwards and backwards with positive and negative whole numbers including through zero. Round any number up to 1000000 to the nearest 10, 100, 1000, 10000 and 100000 Solve number problems and practical problems that involve all of the above. Read Roman numerals to 1000 (M) and recognise years written in Roman numerals.	Read, write, order and compare numbers up to 10,000,000 and determine the value of each digit. Round any whole number to a required degree of accuracy. Use negative numbers in context, and calculate intervals across zero. Solve number and practical problems that involve all of the above.

	Expectation by the end of Year 1	Expectation by the end of Year 2	Expectation by the end of Year 3	Expectation by the end of Year 4	Expectation by the end of Year 5	Expectation by the end of Year 6
Addition, subtraction, multiplication and division	Read, write and interpret mathematical statements involving addition (+), subtraction (-) and equals (=) signs. Represent and use number bonds and related subtraction facts within 20. Add and subtract one-digit and two-digit numbers to 20, including zero.	Add and subtract numbers using concrete objects, pictorial representations, and mentally, including: -a two-digit number and ones -a two-digit number and tens -two two-digit numbers -adding three one-digit numbers Show that addition of two numbers can be done in any order (commutative) and subtraction of one number from another cannot. Calculate mathematical statements for multiplication and division within the multiplication tables and write them using the multiplication (×), division (÷) and equals (=) signs. Show that multiplication of two numbers can be done in any order (commutative) and division of one number by another cannot.	Add and subtract numbers with up to three digits, using formal written methods of columnar addition and subtraction Add and subtract numbers mentally, including: - a three-digit number and ones; a three-digit number and tens ; - a three-digit number and hundreds Write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods.	Add and subtract numbers with up to four digits using the formal written methods of columnar addition and subtraction Use place value, known and derived facts to multiply and divide mentally, including: - multiplying by 0 and 1 - dividing by 1 - multiplying together three numbers Multiply two-digit and three-digit numbers by a one-digit number using formal written layout	Add and subtract whole numbers with more than 4 digits, including using formal written methods (columnar addition and subtraction). Add and subtract numbers mentally with increasingly large numbers. Multiply and divide numbers mentally drawing upon known facts Multiply and divide whole numbers and those involving decimals by 10, 100 and 1000 Multiply numbers up to 4 digits by a one or two digit number using a formal written method, including long multiplication for 2-digit numbers Divide numbers up to 4 digits by a one-digit number using the formal written method of short division and interpret remainders appropriately for the context.	Perform mental calculations, including with mixed operations and large numbers Multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication Divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division, and interpret remainders as whole number remainders, fractions, or by rounding, as appropriate for the context Use their knowledge of the order of operations to carry out calculations involving the four operations
Derive and recall +-x÷		Recall and use multiplication and division facts for the 2, 5 and 10 multiplication tables, including recognising odd and even numbers. Recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100	Recall and use multiplication and division facts for the 3, 4 and 8 multiplication tables.	Recall multiplication and division facts for multiplication tables up to 12 × 12		

	Expectation by the end of Year 1	Expectation by the end of Year 2	Expectation by the end of Year 3	Expectation by the end of Year 4	Expectation by the end of Year 5	Expectation by the end of Year 6
Prime numbers and factors				Recognise and use factor pairs and commutativity in mental calculations	Identify multiples and factors, including finding all factor pairs of a number, and common factors of two numbers. Know and use the vocabulary of prime numbers, prime factors and composite (non-prime) numbers. Establish whether a number up to 100 is prime and recall prime numbers up to 19. Recognise and use square numbers and cube numbers, and the notation for squared (^{2}) and cubed (^{3}).	Identify common factors, common multiples and prime numbers
Solving problems	Solve one-step problems that involve addition and subtraction, using concrete objects and pictorial representations, and missing number problems such as 7 = ? - 9. Solve one-step problems involving multiplication and division, by calculating the answer using concrete objects, pictorial representations and arrays with the support of the teacher.	Solve problems with addition and subtraction using concrete objects and pictorial representations, including those involving numbers, quantities and measures. Solve problems with addition and subtraction applying their increasing knowledge of mental and written methods. Solve problems with addition and subtraction recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100. Solve problems involving multiplication and division, using materials, arrays, repeated addition, mental methods, and multiplication and division facts, including problems in contexts. calculate mathematical statements for multiplication and division within the multiplication tables and write them using the multiplication (×), division (÷) and equals (=) signs	Solve problems, including missing number problems, using number facts, place value, and more complex addition and subtraction. Solve problems, including missing number problems, involving multiplication and division, including positive integer scaling problems and correspondence problems in which n objects are connected to m objects	Solve addition and subtraction two-step problems in contexts, deciding which operations and methods to use and why Solve problems involving multiplying and adding, including using the distributive law to multiply two digit numbers by one digit, integer scaling problems and harder correspondence problems such as n objects are connected to m objects	Solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why. Solve problems involving multiplication and division including using their knowledge of factors and multiples, squares and cubes. Solve problems involving addition, subtraction, multiplication and division and a combination of these, including understanding the meaning of the equals sign. Solve problems involving multiplication and division, including scaling by simple fractions and problems involving simple rates.	Solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why Solve problems involving addition, subtraction, multiplication and division

	Expectation by the end of Year 1	Expectation by the end of Year 2	Expectation by the end of Year 3	Expectation by the end of Year 4	Expectation by the end of Year 5	Expectation by the end of Year 6
Checking		Recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems.	Estimate the answer to a calculation and use inverse operations to check answers.	Estimate and use inverse operations to check answers to a calculation	Use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy	Use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy
Fractions	Recognise, find and name a half as one of two equal parts of an object, shape or quantity. Recognise, find and name a quarter as one of four equal parts of an object, shape or quantity. Compare, describe and solve practical problems for: lengths and heights (for example, long/short, longer/shorter, tall/short, double/half) Compare, describe and solve practical problems for: mass/weight [for example, heavy/light, heavier than, lighter than]; capacity and volume [for example, full/empty, more than, less than, half, half full, quarter]	Recognise, find, name and write fractions 1/3, 1/4, 2/4 and 3/4 of a length, shape, set of objects or quantity. Write simple fractions for example, 1/2 of 6 = 3 and recognise the equivalence of 2/4 and 1/2.	Count up and down in tenths; recognise that tenths arise from dividing an object into 10 equal parts and in dividing one-digit numbers or quantities by 10 Recognise and use fractions as numbers: unit fractions and non-unit fractions with small denominators. Recognise, find and write fractions of a discrete set of objects: unit fractions and non-unit fractions with small denominators. Recognise and show, using diagrams, equivalent fractions with small denominators. Compare and order unit fractions, and fractions with the same denominators. Add and subtract fractions with the same denominator within one whole [for example, 5/7 + 1/7 = 6/7] Solve problems that involve all of the above.	Recognise and show, using diagrams, families of common equivalent fractions. Count up and down in hundredths; recognise that hundredths arise when dividing an object by one hundred and dividing tenths by ten. Solve problems involving increasingly harder fractions to calculate quantities, and fractions to divide quantities, including non-unit fractions where the answer is a whole number. Add and subtract fractions with the same denominator.	Compare and order fractions whose denominators are multiples of the same number. Identify, name and write equivalent fractions of a given fraction, represented visually including tenths and hundredths. Recognise mixed numbers and improper fractions and convert from one form to the other and write mathematical statements >1 as a mixed number [for example 2/5 + 4/5 = 6/5 = 1 1/5] Add and subtract fractions with the same denominator and denominators that are multiples of the same number. Multiply proper fractions and mixed numbers by whole numbers, supported by materials and diagrams. Read and write decimal numbers as fractions [for example 0.71 = 71/100] Solve problems involving multiplication and division, including scaling by simple fractions and problems involving simple rates.	Use common factors to simplify fractions; use common multiples to express fractions in the same denomination. Compare and order fractions, including fractions > 1 Generate and describe linear number sequences (with fractions) Add and subtract fractions with different denominations and mixed numbers, using the concept of equivalent fractions. Multiply simple pairs of proper fractions, writing the answer in its simplest form [for example 1/4 x 1/2 = 1/8] Divide proper fractions by whole numbers [for example 1/3 ÷ 2 = 1/6] Associate a fraction with division and calculate decimal fraction equivalents [for example, 0.375] for a simple fraction [for example 3/8] Recall and use equivalences between simple fractions, decimals and percentages, including in different contexts.

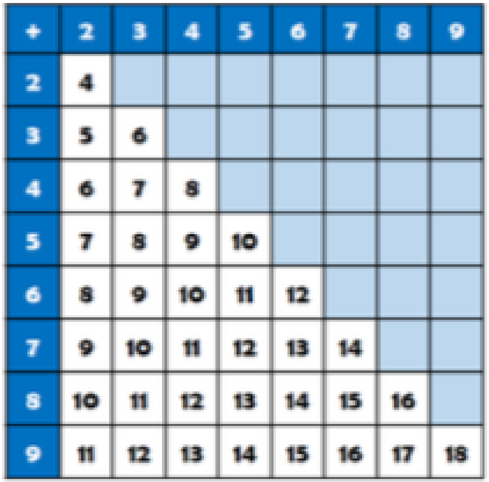
	Expectation by the end of Year 1	Expectation by the end of Year 2	Expectation by the end of Year 3	Expectation by the end of Year 4	Expectation by the end of Year 5	Expectation by the end of Year 6
Decimals				Recognise and write decimal equivalents of any number of tenths or hundredths. Find the effect of dividing a one or two digit number by 10 or 100, identifying the value of the digits in the answer as ones, tenths and hundredths Solve simple measure and money problems involving fractions and decimals to two decimal places. Convert between different units of measure Compare numbers with the same number of decimal places up to two decimal places. Round decimals with one decimal place to the nearest whole number. Recognise and write decimal equivalents to 1/4, 1/2 and ¾. Find the effect of dividing a one or two digit number by 10 or 100, identifying the value of the digits in the answer as ones, tenths and hundredths	Read, write, order and compare numbers with up to three decimal places. Recognise and use thousandths and relate them to tenths, hundredths and decimal equivalents. Round decimals with two decimal places to the nearest whole number and to one decimal place. Solve problems involving number up to three decimal places. Multiply and divide whole numbers and those involving decimals by 10, 100 and 1000. Use all four operations to solve problems involving measure [for example, length, mass, volume, money] using decimal notation, including scaling.	Identify the value of each digit in numbers given to 3 decimal places and multiply numbers by 10, 100 and 1,000 giving answers up to 3 decimal places. Multiply one-digit numbers with up to 2 decimal places by whole numbers. Use written division methods in cases where the answer has up to 2 decimal places. Solve problems which require answers to be rounded to specified degrees of accuracy.
Percentages					Recognise the per cent symbol (%) and understand that per cent relates to 'number of parts per hundred', and write percentages as a fraction with denominator 100, and as a decimal. Solve problems which require knowing percentage and decimal equivalents of 1/2, 1/4, 1/5, 2/5, 4/5 and those fractions with a denominator of a multiple of 10 or 25.	Solve problems involving the calculation of percentages [for example, of measures and such as 15% of 360] and the use of percentages for comparison. Recall and use equivalences between simple fractions, decimals and percentages including in different contexts.

	Expectation by the end of Year 1	Expectation by the end of Year 2	Expectation by the end of Year 3	Expectation by the end of Year 4	Expectation by the end of Year 5	Expectation by the end of Year 6
Algebra						Use simple formulae Generate and describe linear number sequences. Express missing number problems algebraically. Find pairs of numbers that satisfy an equation with two unknowns. Enumerate possibilities of combinations of two variables.
Ratio						Solve problems involving the relative sizes of two quantities where missing values can be found by using integer multiplication and division facts. Solve problems involving similar shapes where the scale factor is known or can be found. Solve problems involving unequal sharing and grouping using knowledge of fractions and multiples.

Calculation policy: Guidance

	EYFS/Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Addition	Combining two parts to make a whole: part whole model. Starting at the bigger number and counting on- using cubes. Regrouping to make 10 using ten frame.	Adding three single digits. Use of base 10 to combine two numbers.	Column method- regrouping. Using place value counters (up to 3 digits).	Column method- regrouping. (up to 4 digits)	Column method- regrouping. Use of place value counters for adding decimals.	Column method- regrouping. Abstract methods. Place value counters to be used for adding decimal numbers.
Subtraction	Taking away ones Counting back Find the difference Part whole model Make 10 using the ten frame	Counting back Find the difference Part whole model Make 10 Use of base 10	Column method with regrouping. (up to 3 digits using place value counters)	Column method with regrouping. (up to 4 digits)	Column method with regrouping. Abstract for whole numbers. Start with place value counters for decimals- with the same amount of decimal places.	Column method with regrouping. Abstract methods. Place value counters for decimals- with different amounts of decimal places.

Multiplication	Recognising and making equal groups. Doubling Counting in multiples Use cubes, Numicon and other objects in the classroom	Arrays- showing commutative multiplication	Arrays 2d × 1d using base 10	Column multiplication- introduced with place value counters. (2 and 3 digit multiplied by 1 digit)	Column multiplication Abstract only but might need a repeat of year 4 first(up to 4 digit numbers multiplied by 1 or 2 digits)	Column multiplication Abstract methods (multi-digit up to 4 digits by a 2 digit number)
Division	Sharing objects into groups Division as grouping e.g. I have 12 sweets and put them in groups of 3, how many groups? Use cubes and draw round 3 cubes at a time.	Division as grouping Division within arrays- linking to multiplication Repeated subtraction	Division with a remainder-using lollipop sticks, times tables facts and repeated subtraction. 2d divided by 1d using base 10 or place value counters	Division with a remainder Short division (up to 3 digits by 1 digit- concrete and pictorial)	Short division (up to 4 digits by a 1 digit number including remainders)	Short division Long division with place value counters (up to 4 digits by a 2 digit number) Children should exchange into the tenths and hundredths column too



+	2	3	4	5	6	7	8	9
2	4							
3	5	6						
4	6	7	8					
5	7	8	9	10				
6	8	9	10	11	12			
7	9	10	11	12	13	14		
8	10	11	12	13	14	15	16	
9	11	12	13	14	15	16	17	18

36 addition number facts

x	2	3	4	5	6	7	8	9
2	4							
3	6	9						
4	8	12	16					
5	10	15	20	25				
6	12	18	24	30	36			
7	14	21	28	35	42	49		
8	16	24	32	40	48	56	64	
9	18	27	36	45	54	63	72	81

36 multiplication number facts

Addition Number Facts	Table Facts	Term
	Times Table Screening	Y4 T3
	Revise ALL facts	Y4 T2
	Only TEN facts left!	Y4 T1
	x9 Table	Y3 T3
	x8 Table	Y3 T2
	x4 Table	Y3 T1
5+9, 6+9, 7+9, 5+7, 5+8, 6+8	x3 Table	Y2 T3
4+5, 5+6, 6+7, 7+8, 8+9	x2 Table	Y2 T2
3+8, 3+9, 4+7, 4+8, 4+9	x5 Table	Y2 T1
6+6, 7+7, 8+8, 9+9	x10 Table	Y1 T3
4+2, 5+2, 6+2, 7+2, 9+2, 4+3, 5+3, 6+3	Multiples of 2	Y1 T2
2+8, 3+7, 4+6	Multiples of 5	Y1 T1
1+2, 2+3	Multiples of 10	R T3
3+3, 4+4, 5+5		R T2
1+1, 2+2		R T1

x	1	2	3	4	5	6	7	8	9	10	11	12
1	1	2	3	4	5	6	7	8	9	10	11	12
2		4	6	8	10	12	14	16	18	20	22	24
3			9	12	15	18	21	24	27	30	33	36
4				16	20	24	28	32	36	40	44	48
5					25	30	35	40	45	50	55	60
6						36	42	48	54	60	66	72
7		Year 1					49	56	63	70	77	84
8		Year 2						64	72	80	88	96
9		Year 3							81	90	99	108
10		Year 4								100	110	120
11											121	132
12												144

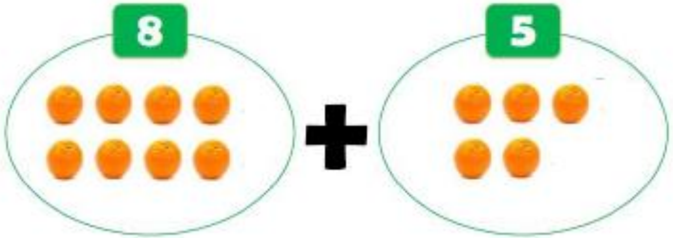
This table indicates the expectation of Times Table learning for each year group. All the Tables and their related division facts should be secure before leaving the corresponding year group. However, every year group should also give time to revising and consolidating those that have come before. Children who master the Times Tables for their year group should then explore them in greater depth (see Real Life Maths example on page 38) and not move on to other year groups.

Models and images to support understanding

8 + 5 = 13

8 things and 5 things is 13 things.

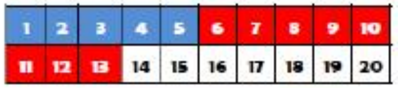
8 + 5 = 13



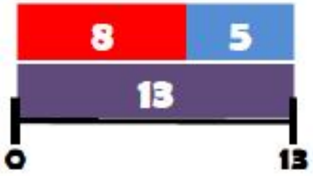
8 + 5 = 13

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20

5 + 8 = 13



1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20

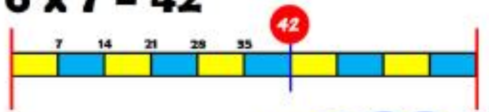


6 x 7 = 42

6 lots of 7 things is 42 things.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

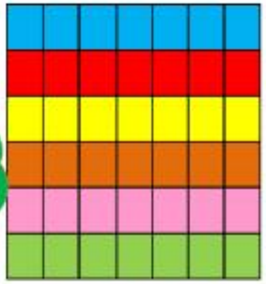
6 x 7 = 42



42 is the 6th multiple of 7

6 x 7 = 42

6 lots of 7 things is 42 things.



Key (Milestone) Mental Calculations for Addition, Subtraction, Multiplication and Division

2d + 1d	16 + 3	Y1
2d + 2d	38 + 26	Y2
3d + 2d	118 + 26	Y3
3d + 3d	118 + 326	Y4
1dp + 1dp	4.8 + 3.6	Y5
2dp + 2dp	2.38 + 4.26	Y6

2d - 1d	17 - 3	Y1
2d - 2d	62 - 28	Y2
100 - 2d	100 - 34	Y3
3d - 2d	125 - 34	Y4
1dp - 1dp	5.4 - 3.6	Y5

2d x 1d	27 x 3	Y3
2d x 1d	47 x 8	Y4
x multiples of 10	70 x 80	Y4
2d x multiple of 10	47 x 30	Y5
3d x 1d	243 x 6	Y5
1dp x 1d	4.6 x 7	Y6

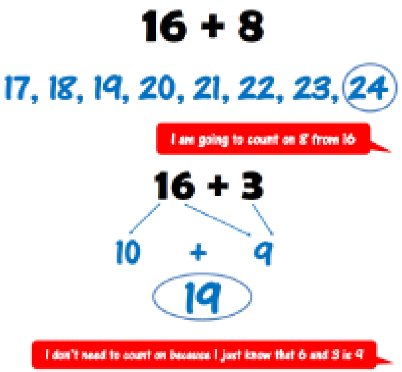
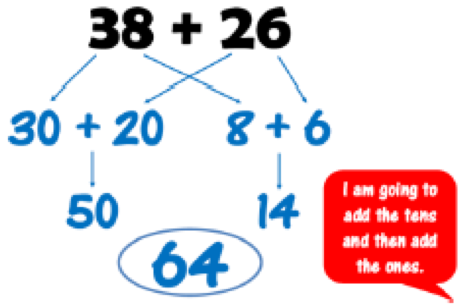
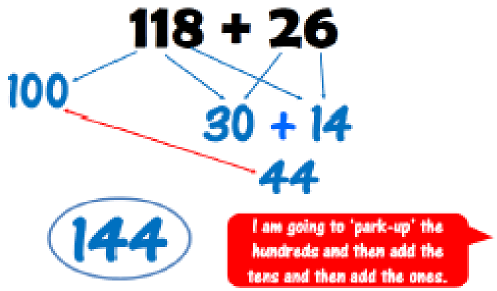
2d ÷ 1d	42 ÷ 3	Y3
2d ÷ 1d	44 ÷ 3	Y3
2d/3d ÷ 1d	91 ÷ 7	Y4
2d/3d ÷ 3d	100 ÷ 7	Y4
3d ÷ 1d	420 ÷ 6	Y5
3d ÷ 1d	423 ÷ 6	Y5

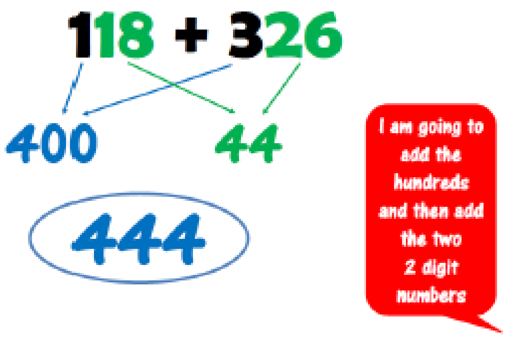
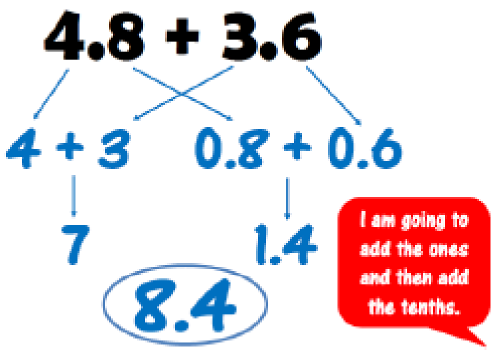
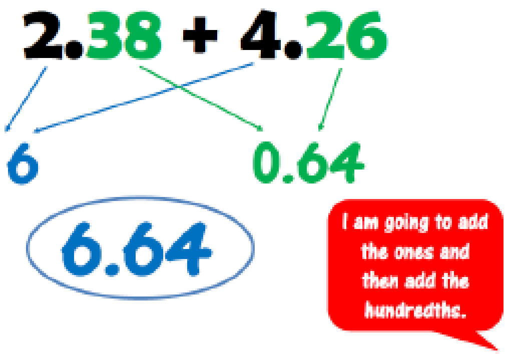
Addition

NB: The positioning of exchanged figures (carried digits) is up to the individual academy to employ a consistent approach.

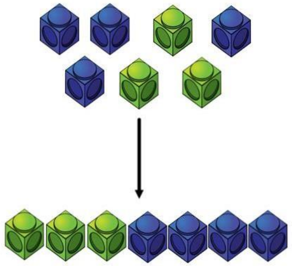
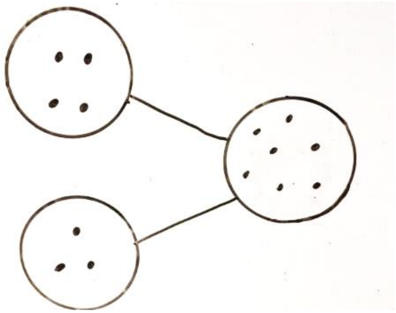
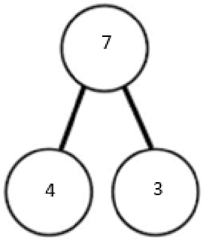
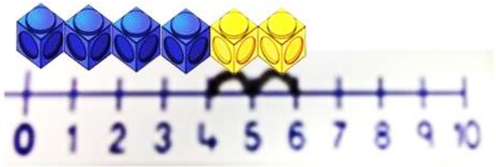
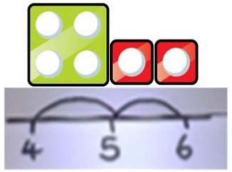
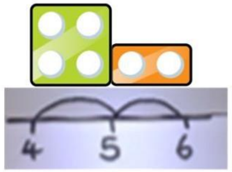
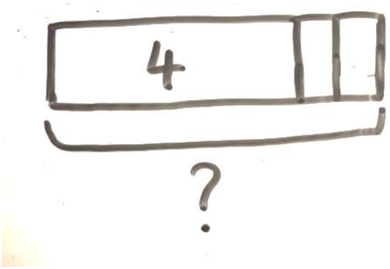
Key language: sum, total, parts and wholes, plus, add, altogether, more, 'is equal to' 'is the same as'.

Guidance for mental strategies

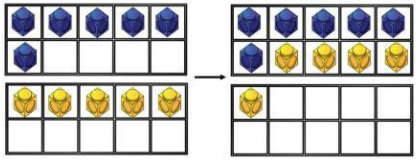
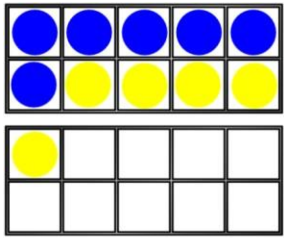
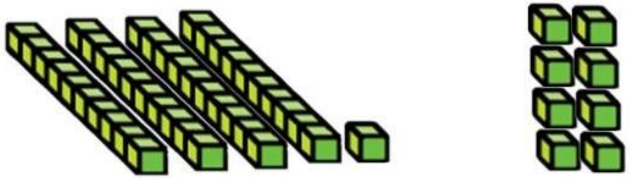
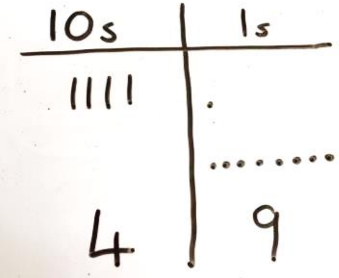
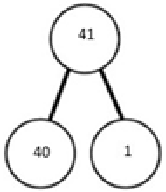
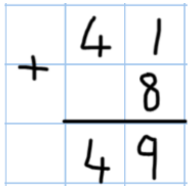
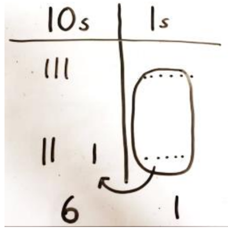
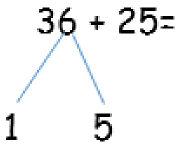
<table>
<tr><th>EYFS</th><th>Year 1</th><th>Year 2</th><th colspan="2">Year 3</th></tr>
<tr><td rowspan="4">Pupils will continue to develop their actual counting skills. They engage in a range of practical activities using different apparatus to support both 'doing' and 'understanding'.
They respond to the question, 'How many altogether?' by counting and knowing that the final number in the count is the total.
Given two groups, they learn to count on the larger group, understanding why this is more efficient.
There are six number facts, i.e. counting shortcuts to be achieved by the end of Reception. These include knowing the doubles of any number to five.</td><td colspan="4">Mental Calculation (Agreed Core Method)</td></tr>
<tr><td> </td><td> </td><td colspan="2"> </td></tr>
<tr><td colspan="4">(Formal) Written Method</td></tr>
<tr><td></td><td>$\begin{array}{r} 4\ 3 \\ +\ 3\ 2 \\ \hline 5 \\ 7\ 0 \\ \hline 7\ 5 \\ \hline \end{array}$
2d + 2d (not crossing 10)</td><td>$\begin{array}{r} 5\ 7 \\ +\ 8\ 6 \\ \hline 1\ 3 \\ 1\ 3\ 0 \\ 1\ 4\ 3 \end{array}$
2d + 2d (crossing 10)</td><td>$\begin{array}{r} 7\ 8\ 5 \\ +\ 4\ 2\ 9 \\ \hline 1\ 4 \\ 1\ 0\ 0 \\ 1\ 1\ 0\ 0 \\ 1\ 2\ 1\ 4 \end{array}$
3d + 3d (crossing 10)</td></tr>
</table>

Year 4	Year 5		Year 6	
Mental Calculation (Agreed Core Method)				
				
(Formal) Written Method				
$\begin{array}{r} 7\ 8\ 5\ 6 \\ +\ 4_{1}\ 2_{1}\ 9_{1}\ 7 \\ \hline 1\ 2,\ 1\ 5\ 3 \end{array}$ Up to 4d + 4d (crossing 10)	$\begin{array}{r} 4\ 2\ 5 \\ 6\ 5\ 2 \\ +\ 3_{1}\ 4_{1}\ 9 \\ \hline 1\ 4\ 2\ 5 \end{array}$ Several numbers (crossing 10)	$\begin{array}{r} 6\ 8,\ 9\ 6\ 2 \\ +\ 1_{1}\ 4,_{1}\ 8_{1}\ 7\ 5 \\ \hline 8\ 3,\ 8\ 3\ 7 \end{array}$ 5d + 5d (crossing 10)	$\begin{array}{r} 6\ 8\ .\ 9 \\ +\ _{1}\ 4_{1}\ .\ 8 \\ \hline 7\ 3\ .\ 7 \end{array}$ Add decimals with 1 or more dp (crossing 10)	$\begin{array}{r} 6\ .\ 8\ 2 \\ +\ 3_{1}\ .\ 5_{1}\ 7 \\ \hline 1\ 0\ .\ 3\ 9 \end{array}$ Add decimals with 1 or more dp (crossing 10)

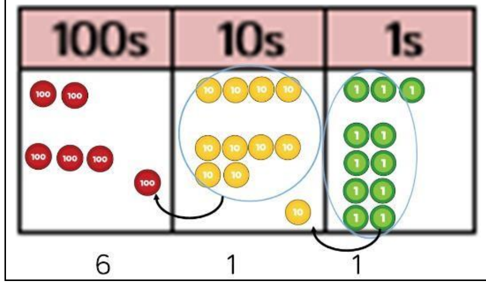
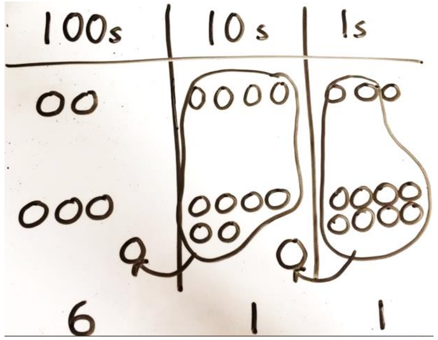
EYFS/Year 1

Concrete	Pictorial	Abstract
Combining two parts to make a whole (use other resources too e.g. eggs, shells, teddy bears, cars). 	Children to represent the cubes using dots or crosses. They could put each part on a part whole model too.  4 + 7	4 + 3 = 7 Four is a part, 3 is a part and the whole is seven. 
Counting on using number lines using cubes or Numicon.    	A bar model which encourages the children to count on, rather than count all.  4 + 2	The abstract number line: What is 2 more than 4? What is the sum of 2 and 4? What is the total of 4 and 2? 4 + 2 

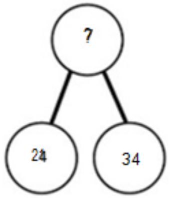
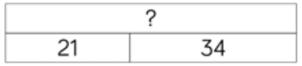
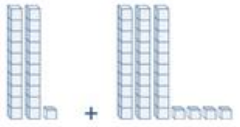
Year 2 upwards

Concrete	Pictorial	Abstract
Regrouping to make 10; using ten frames and counters/cubes or using Numicon. 6 + 5 	Children to draw the ten frame and counters/cubes. 6 + 5 	Children to develop an understanding of equality e.g. 6 + □ = 11 6 + 5 = 5 + □ 6 + 5 = □ + 4
TO + O using base 10. Continue to develop understanding of partitioning and place value. 41 + 8 	Children to represent the base 10 e.g. lines for tens and dot/crosses for ones. 41 + 8 	41 + 8 1 + 8 = 9 40 + 9 = 49  
TO + TO using base 10. Continue to develop understanding of partitioning and place value. 36 + 25	Children to represent the base 10 in a place value chart. 36 + 25 	Looking for ways to make 10.  30 + 20 = 50 5 + 5 = 10 50 + 10 + 1 = 61 Formal method: $\begin{array}{r}36\\+25\\\hline 61\\\hline {}_{1}\end{array}$

Year 3 upwards

Concrete	Pictorial	Abstract
Use of place value counters to add HTO + TO, HTO + HTO etc. When there are 10 ones in the 1s column - we exchange/regroup for 1 ten. When there are 10 tens in the 10s column - we Exchange/regroup for 1 hundred. 243 + 368 	Children to represent the counters in a place value chart, circling when they make an exchange. 243 + 368 	243 +368 611 1 1

Conceptual variation; different ways to ask children to solve 21 + 34

 	Word problems: In year 3, there are 21 children and in year 4, there are 34 children. How many children in total? 21 + 34 = 55. Prove it	21 +34 **21 + 34 =** ☐ = 21 + 34 Calculate the sum of twenty-one and thirty-four.	 Missing digit problems: 

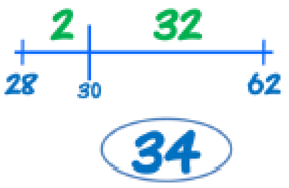
Subtraction

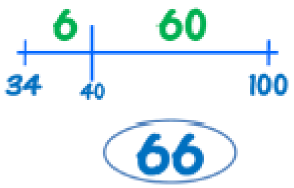
NB: The positioning of exchanged figures (carried digits) is up to the individual academy to employ a consistent approach.

Key language: sum, total, parts and wholes, plus, add, altogether, more, 'is equal to' 'is the same as'.

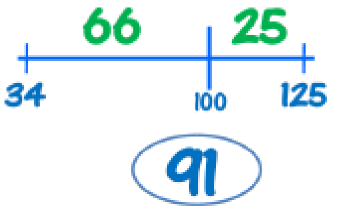
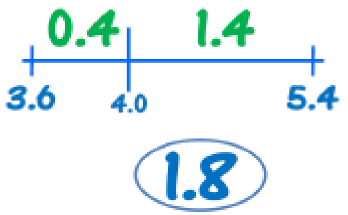
Guidance for mental strategies

<table>
<tr><th>EYFS</th><th>Year 1</th><th>Year 2</th><th colspan="2">Year 3</th></tr>
<tr><td rowspan="4">Pupils engage in a range of practical activities starting with different amounts and know that the process of 'taking away' will result in fewer items being left.
Once again keep pushing both 'doing' and 'understanding'. "How do you know?"
Pupils can take away the right amount and count how many are left.
Pupils learn about subtraction by knowing how to count back in ones to find the answer. They learn the skill of taking away one.
When an addition number fact becomes secure, show the resulting inverse (subtraction) relationship.
Encourage children to 'just know it' without counting!</td><td colspan="4">Mental Calculation (Agreed Core Method)</td></tr>
<tr><td>19 - 4
18, 17, 16, 15
I am going to count back 4 from 19
17 - 3

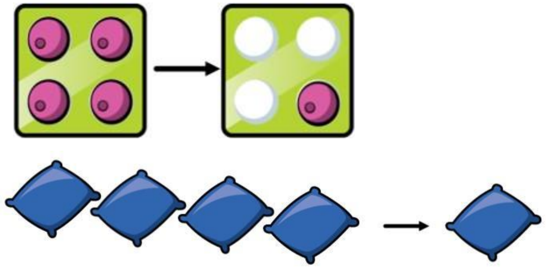
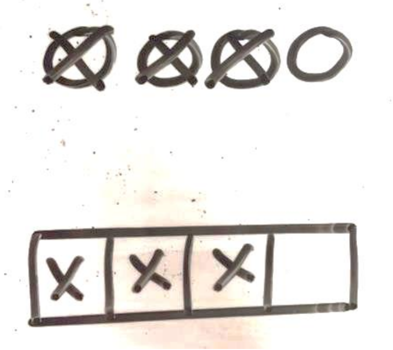
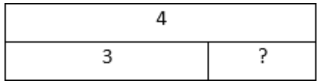
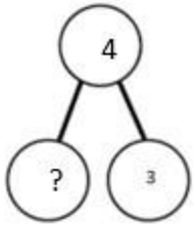
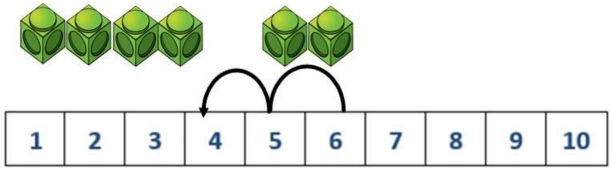
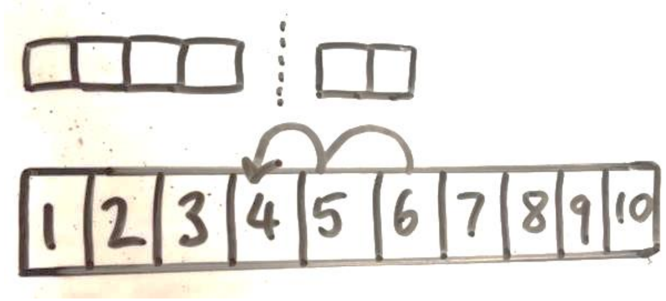
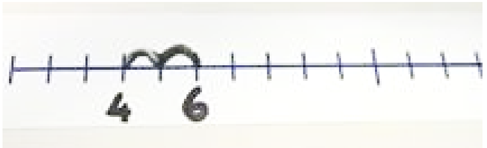

I don't need to count back because I just know that 4 and 3 is 7 so 7 take away 3 must be 4!</td><td>62 - 28


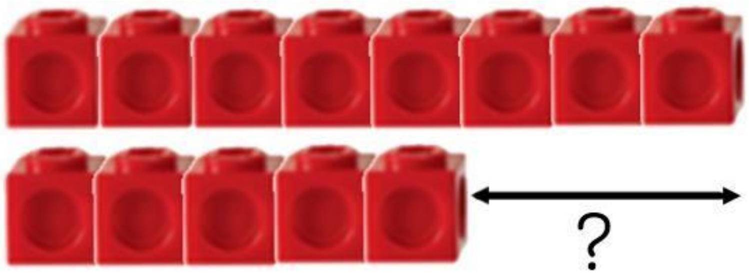
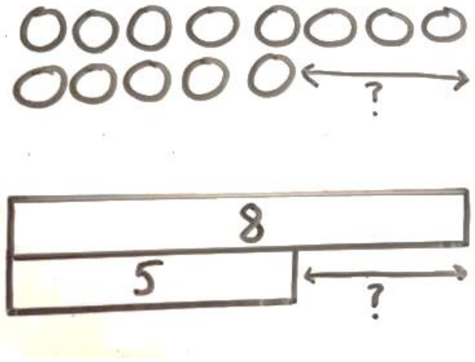
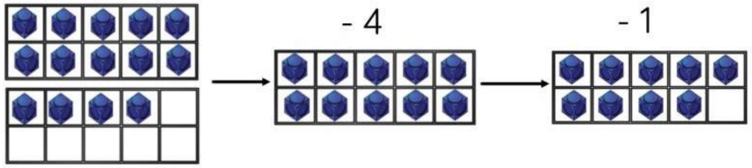
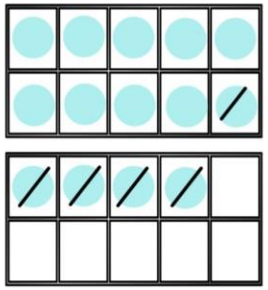
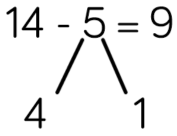
I am going to use a number line because I know that the answer is just the size of the 'gap' between the two numbers!</td><td colspan="2">100 - 34


I am going to use a number line because I know that the answer is just the size of the 'gap' between the two numbers!</td></tr>
<tr><td colspan="4">(Formal) Written Method</td></tr>
<tr><td></td><td>6 8
- 1 4
4
5 0
5 4
2d - 2d (not exchanging)</td><td>$^{3}\cancel{4}\;^{1}3$
- 2 8
5
1 0
1 5
2d - 2d (exchanging)</td><td>$^{4}\cancel{5}\;^{10}\cancel{1}\;^{1}2$
- 2 6 7
5
4 0
2 0 0
2 4 5
3d - 3d (exchanging)</td></tr>
</table>

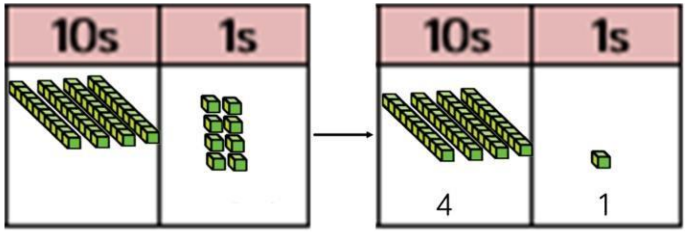
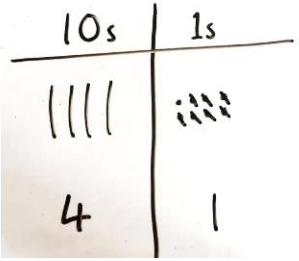
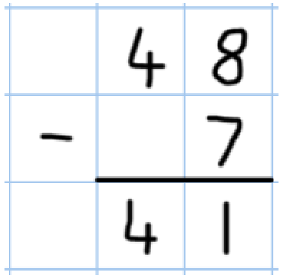
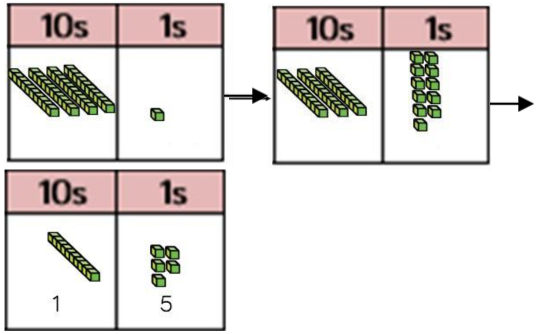
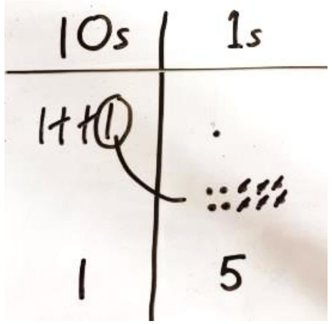
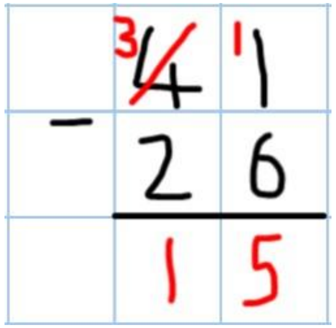
Year 4	Year 5	Year 6
Mental Calculation (Agreed Core Method)		
125 - 34  I am going to use a number line because I know that the answer is just the size of the 'gap' between the two numbers!	**5.4 – 3.6**  I am going to use a number line because I know that the answer is just the size of the 'gap' between the two numbers!	
(Formal) Written Method		
$\begin{array}{rrrr} ^{0}\cancel{1} & ^{1}2 & ^{3}\cancel{4} & ^{1}3 \\ - & 7 & 0 & 5 \\ \hline & 5 & 3 & 8 \end{array}$ 4d – 2/3d (exchanging) $\begin{array}{rrrr} 6 & ^{3}\cancel{4} & ^{10}\cancel{1} & ^{1}2 \\ -2 & 2 & 8 & 7 \\ \hline 4 & 1 & 2 & 5 \end{array}$ 4d – 4d (exchanging)	$\begin{array}{rrrrr} 8 & ^{8}\cancel{9}, & ^{11}\cancel{2} & ^{10}1 & ^{1}\cancel{4} \\ -1 & 6, & 7 & 3 & 5 \\ \hline 7 & 2, & 4 & 7 & 9 \end{array}$ 5d – 5d (exchanging)	$\begin{array}{rrrrr} ^{5}\cancel{6} & . & ^{10}\cancel{1} & ^{1}\cancel{2} & ^{1}5 \\ -\ 3 & . & 4 & 7 & 8 \\ \hline 2 & . & 6 & 4 & 7 \end{array}$ Subtract decimals with 1 or more dp

EYFS/Year 1

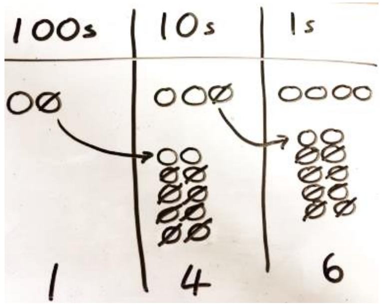
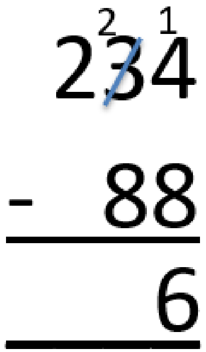
Concrete	Pictorial	Abstract
Physically taking away and removing objects from a whole (ten frames, Numicon, cubes and other items such as beanbags could be used). 4 – 3 = 1 	Children to draw the concrete resources they are using and cross out the correct amount. The bar model can also be used. 4 – 3 = 1 	**4 - 3 =**  **= 4 – 3** 
Counting back (using number lines or number tracks) children start with 6 and count back 2. 6 – 2 = 4 	Children to represent what they see pictorially e.g. 6 – 2 = 4 	Children to represent the calculation on a number line or number track and show their jumps. Encourage children to use an empty number line. 6 – 2 = 4  

Finding the difference (using cubes, Numicon or Cuisenaire rods, other objects can also be used). Calculate the difference between 8 and 5. 	Children to draw the cubes/other concrete objects which they have used or use the bar model to illustrate what they need to calculate. 8 -5, the difference is ? 	Find the difference between 8 and 5. 8 – 5, the difference is Children to explore why 9 - 6 = 8 – 5 = 7 – 4 have the same difference.
Making 10 using ten frames. 14 – 5 	Children to present the ten frame pictorially and discuss what they did to make 10. 14 – 5 	Children to show how they can make 10 by partitioning the subtrahend.  14 – 4 =10 10 – 1 = 9

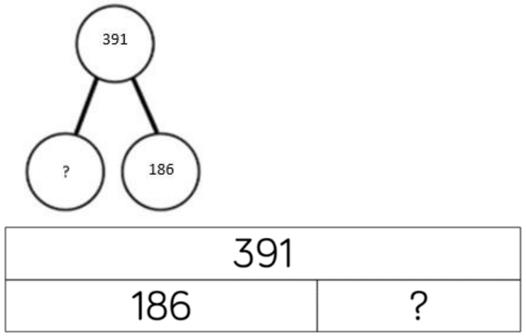
Year 2 upwards

Column method using base 10. 48-7  	Children to represent the base 10 pictorially. 48 - 7  	Column method or children could count back 7. 
Column method using base 10 and having to exchange. 41 – 26  	Represent the base 10 pictorially, remembering to show the exchange. 41 – 26  	Formal column method. Children must understand that when they have exchanged the 10 they still have 41 because 41 = 30 + 11. 

Year 3 upwards

Column method using place value counters. 234 – 88 (see right)	Represent the place value counters pictorially; remembering to show what has been exchanged. 234 – 88 	Formal column method. Children must understand what has happened when they have crossed out digits. 

Conceptual variation; different ways to ask children to solve 391 – 186

	Raj spent £391, Timmy spent £186. How much more did Raj spend? Calculate the difference between 391 and 186.	☐ = 391 – 186 391 -186 ____ What is 186 less than 391?	Missing digit calculations 3 9 ☐ - ☐ ☐ 6 ☐ 0 5

Multiplication

NB: The positioning of exchanged figures (carried digits) is up to the individual academy to employ a consistent approach.

Key language: double, times, multiplied by, the product of, groups of, lots of, equal groups.

Guidance for mental strategies

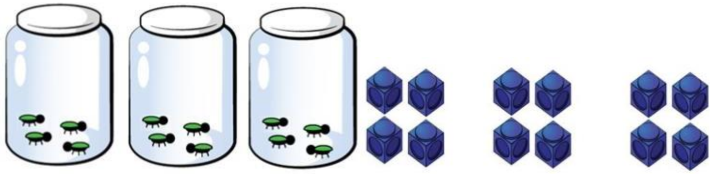
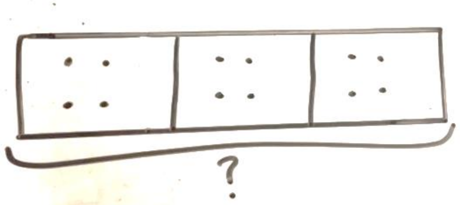
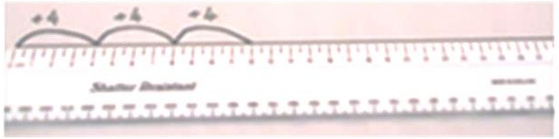
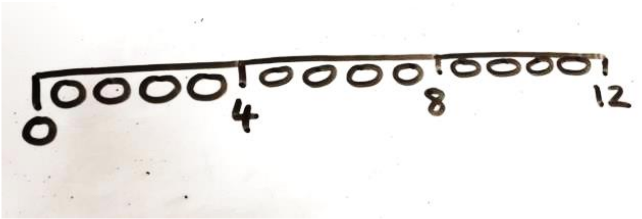
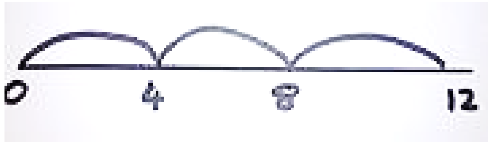
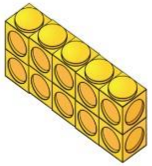
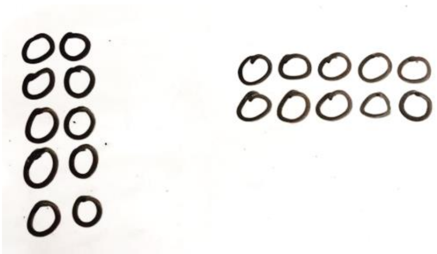
<table>
<tr><th>EYFS</th><th>Year 1</th><th>Year 2</th><th>Year 3</th></tr>
<tr><td rowspan="4">Pupils learn extend their counting skills by setting out groups of objects with the same number in each group.
They understand instructions such as:
Set out 1 group of 3 toy cars, set out 2 groups, 3 groups, etc.
They are able to check that there is the same number in each group and that they have the correct number of groups.
They can find out 'how many altogether' by counting all the items.
They understand the concept of 'doubling', i.e. two groups with the same amount in each group.
They 'just know' the doubles of 1, 2, 3, 4 and 5.</td><td colspan="3">Mental Calculation (Agreed Core Method)</td></tr>
<tr><td></td><td></td><td>27 x 3
20 x 3 = 60
7 x 3 = 21
$\boxed{81}$
3 lots of 2 'tens' is 6 'tens'.
I am going to multiply the tens and then multiply the ones.</td></tr>
<tr><td colspan="3">(Formal) Written Method</td></tr>
<tr><td></td><td></td><td>$\begin{array}{rl} 35 & \\ \underline{\times\ \ 4} & \\ 20 & (4x5) \\ \underline{120} & (4x30) \\ \underline{140} & \end{array}$
(x2, 3, 4, 5 and 8)</td></tr>
</table>

<table>
<tr><th>Year 4</th><th colspan="3">Year 5</th><th>Year 6</th></tr>
<tr><td colspan="5">Mental Calculation (Agreed Core Method)</td></tr>
<tr>
<td>47 x 8
40 x 8 = 320
8 x 7 = 56
376
8 lots of 4 'tens' is 32 'tens'.
I am going to multiply the tens and then multiply the ones.

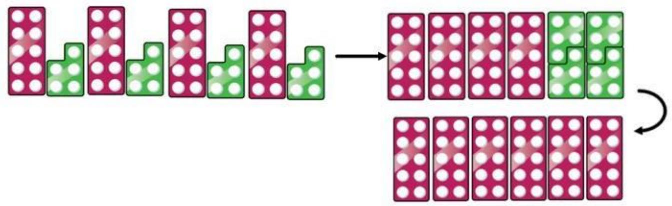
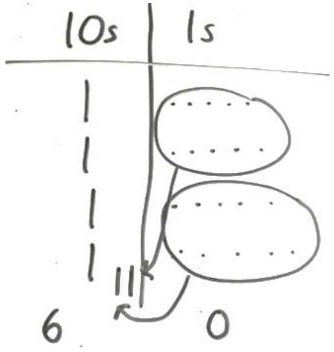
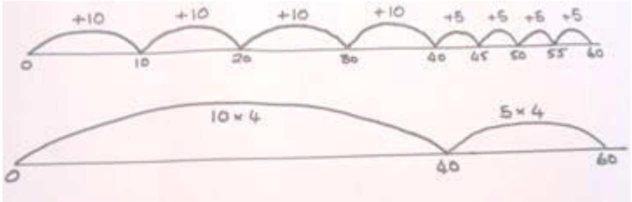
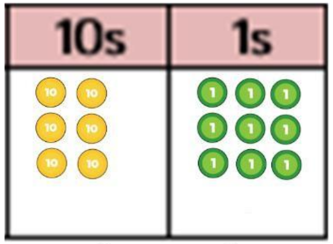
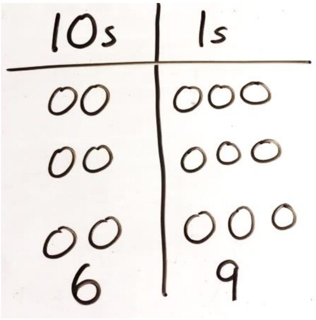
70 x 80
7 x 80 = 560
70 x 80 = 5600
5600
7 lots of 8 'tens' is 56 'tens'.
I am going to use the fact that I just know the answer to 7 lots of 8 'tens'.</td>
<td colspan="3">47 x 30
47 x 3 = 141
47 x 30 = 1410
1410
I am going to multiply 47 by 3 first (easy!) and then make my answer ten times bigger!

243 x 6
200 x 6 = 1200
43 x 6 = 258
1458
6 lots of 2 'hundreds' is 12 'hundreds'.
I am going to multiply 43 by 6 (easy!) and multiply 200 by 6 (easy!)</td>
<td>4.6 x 7
7 x 4 = 28
7 x 0.6 = 4.2
32.2
7 lots of 6 'tenths' is 42 'tenths'.
I am going to multiply the ones and then multiply the tenths.</td>
</tr>
<tr><td colspan="5">(Formal) Written Method</td></tr>
<tr>
<td>2 5 6
x 7
4 2 (7x6)
3 5 0 (7x50)
1 4 0 0 (7x200)
1 7 9 2
2/3d x 1d</td>
<td>2 7 4 1
x 6
4 2
1 6,4 4 6
4d x 1d</td>
<td>3 2 1
x 2 7
1
2 2 4 7
6 4 2 0
8 6 6 7
3/4d x 2d</td>
<td>^{2}2 4
x 1 6
2 4 0 (10x24)
1 4 4 (6x24)
3 8 4
2d x 2d (long)</td>
<td>^{1}2 ^{1}5 7 3
x 3 2
7 7,1 9 0
5 1 4 6
8 2,3 3 6
Up to 4d x 2d (long)</td>
</tr>
</table>

EYFS/Year 1/Year 2

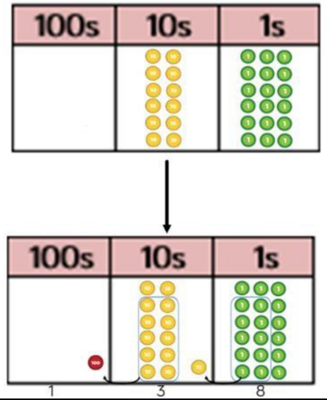
Concrete	Pictorial	Abstract
Repeated grouping/repeated addition 3 × 4 4 + 4 + 4 There are 3 equal groups, with 4 in each group. 	Children to represent the practical resources in a picture and use a bar model. 3 × 4 4 + 4 + 4   	3 × 4 = 12 4 + 4 + 4 = 12
Number lines to show repeated groups. 3 × 4 4 + 4 + 4  Cuisenaire rods can be used too.  	Represent this pictorially alongside a number line e.g. 3 × 4 4 + 4 + 4  	Abstract number line showing three jumps of four. 3 × 4 = 12 4 + 4 + 4 = 12 
Use arrays to illustrate commutativity counters and other objects can also be used. 2 × 5 = 5 × 2  2 lots of 5  5 lots of 2	Children to represent the arrays pictorially. 2 × 5 = 5 × 2 	Children to be able to use an array to write a range of calculations e.g. 10 = 2 × 5 5 × 2 = 10 2 + 2 + 2 + 2 + 2 = 10 10 = 5 + 5

Year 3 onwards

Partition to multiply using Numicon, base 10 or Cuisenaire rods. 4 × 15 	Children to represent the concrete manipulatives pictorially. 4 × 15 	Children to be encouraged to show the steps they have taken. 4 x 15 10 5 10 x 4 = 40 5 x 4 = 20 40 + 20 = 60 A number line can also be used. 
Formal column method with place value counters (base 10 can also be used.) 3 × 23  6 9	Children to represent the counters pictorially. 3 × 23 	Children to record what it is they are doing to show understanding. 3 × 23 = 3 × 3 = 9 3 × 20 = 60 60 + 9 = 69 $\begin{array}{r} 23 \\ \times\ \ 3 \\ \hline 69 \\ \hline \end{array}$

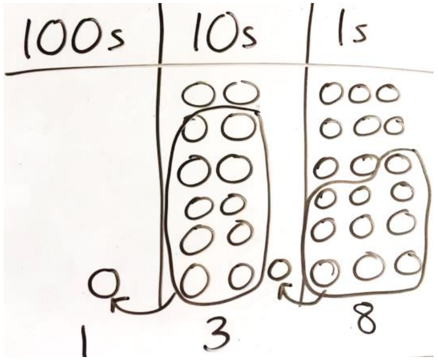
Formal column method with place value counters.

6 x 23

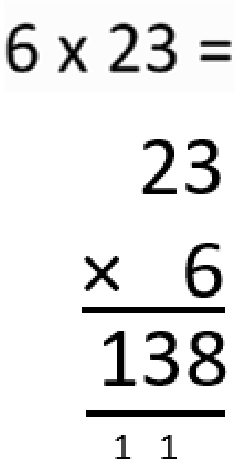


Children to represent the counters/base 10, pictorially. E.g. the image below.

6 x 23



Formal written method



6 x 23 =

```
  23
×  6
 138
 1 1
```

Steps:

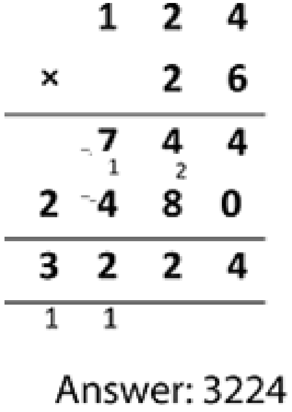
124 x 26 = 6 x 124 + 20 x 124

20 x 124 = 6 x 4(ones) = 24
6 x 2(tens) = 120 + 2 tens = 140
6 x 1(hundred) = 600 +1hundred = 700
Total = 744

20 x 124 = 20 x 4 = 80
20 x 2(tens) = 400
20 x 1(hundred) = 2000
Total = 2480

744 + 2480 = 3224

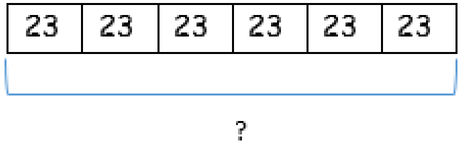
When children start to multiply 3d × 3d and 4d × 2d etc., they should be confident with the abstract:
To get 744 children have solved 6 × 124. To get 2480 they have solved 20 × 124.



```
    1  2  4
×      2  6
    7  4  4
    1  2
 2  4  8  0
 3  2  2  4
 1  1
```

Answer: 3224

Conceptual variation; different ways to ask children to solve 6 × 23

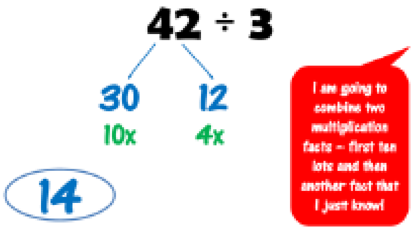
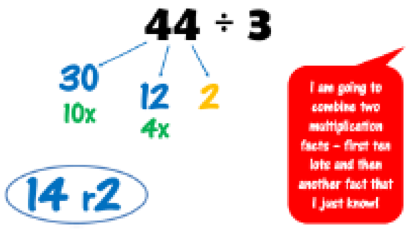
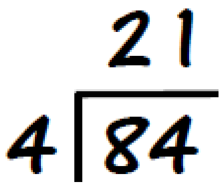
	Mai had to swim 23 lengths, 6 times a week. How many lengths did she swim in one week? With the counters, prove that 6 x 23 = 138	Find the product of 6 and 23 6 × 23 = = 6 × 23 $\begin{array}{r} 6 \\ \times\ \underline{23} \\ \hline \end{array}$ $\begin{array}{r} 23 \\ \times\ \underline{\ 6} \\ \hline \end{array}$	What is the calculation? What is the product? 

Division

NB: The positioning of exchanged figures (carried digits) is up to the individual academy to employ a consistent approach.

Key language: share, group, divide, divided by, half.

Guidance for mental strategies

EYFS	Year 1	Year 2	Year 3
Pupils understand the process of 'sharing' by giving out objects fairly! Pupils can share an even number of objects between two people and understand that they are finding 'one half'. Example: Pupils understand that one half of six must be three because they just know that double three is six. Pupils are able to share an amount into three equal size groups. They can check that each group has the same amount and they can count how many in each group.	**Mental Calculation (Agreed Core Method)**		
			 I am going to combine two multiplication facts – first ten lots and then another fact that I just know!  I am going to combine two multiplication facts – first ten lots and then another fact that I just know!
	(Formal) Written Method		
			 x2, 3, 4, 5 and 8

<table>
<tr><th colspan="2">Year 4</th><th colspan="2">Year 5</th><th>Year 6</th></tr>
<tr><th colspan="5">Mental Calculation (Agreed Core Method)</th></tr>
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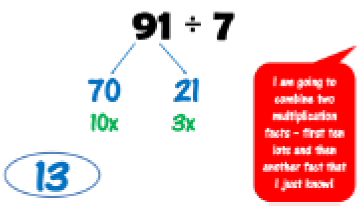
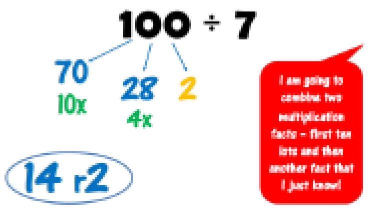
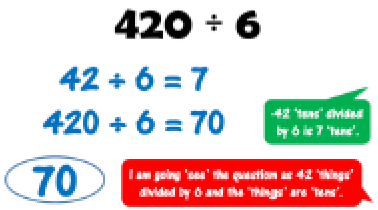
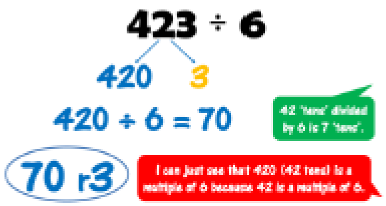
<td colspan="2">
 </td>
<td colspan="2">
 </td>
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<tr><th colspan="5">(Formal) Written Method</th></tr>
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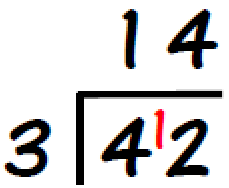
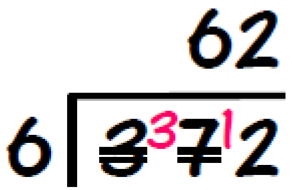
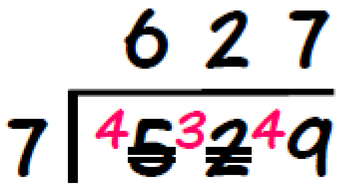
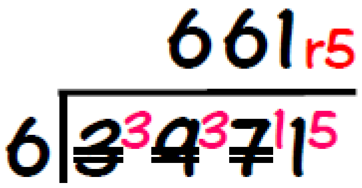
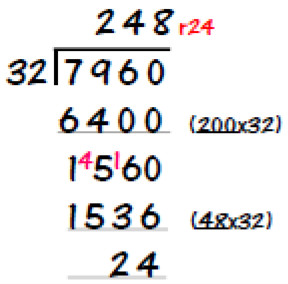
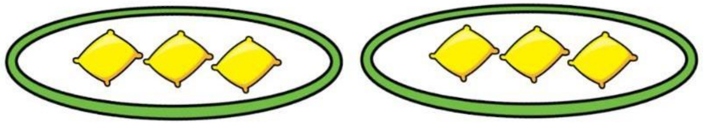
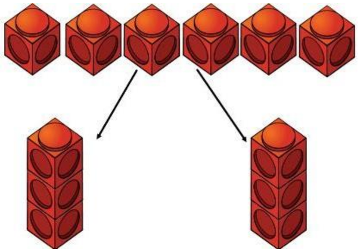
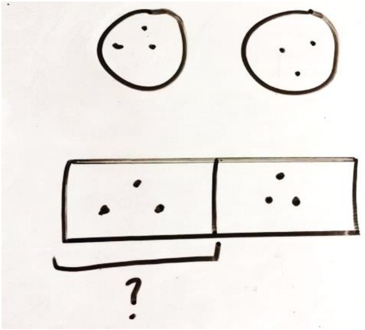
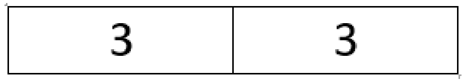
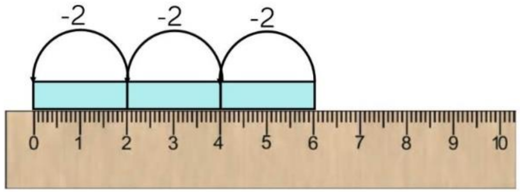
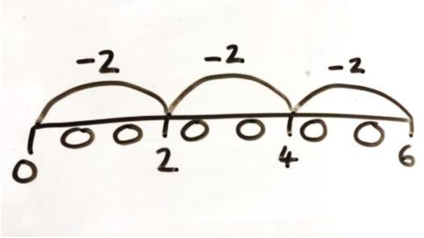
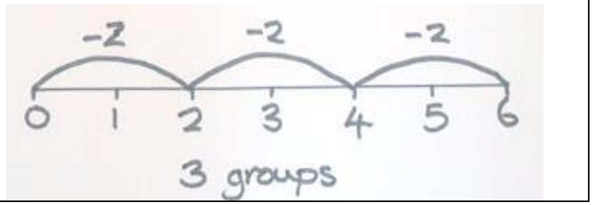
<td>
2d ÷ 1d (no remainders)</td>
<td>
3d ÷ 1d (no remainders)</td>
<td>
Up to 4d ÷ 1d (no remainders)</td>
<td>
Up to 4d ÷ 1d (interpret remainders)</td>
<td>
Up to 4d ÷ 2d long/short (remainders as 'r', decimals and fractions) - including using 'coin facts'</td>
</tr>
</table>

EYFS/Year 1/Year 2

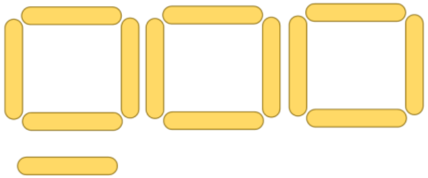
Concrete	Pictorial	Abstract
Sharing using a range of objects. 6 ÷ 2  	Represent the sharing pictorially.  	6 ÷ 2 = 3  Children should also be encouraged to use their 2 times tables facts.

Year 2

Repeated subtraction using Cuisenaire rods above a ruler. 6 ÷ 2 6 – 2 – 2 – 2  3 groups of 2	Children to represent repeated subtraction pictorially. 6 ÷ 2 6 – 2 – 2 – 2  	Abstract number line to represent the equal groups that have been subtracted. 6 ÷ 2 6 – 2 – 2 – 2 

Year 3

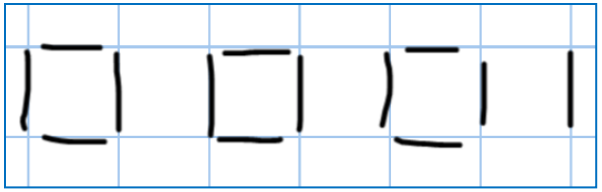
2d ÷ 1d with remainders using lollipop sticks. Cuisenaire rods, above a ruler can also be used.
13 ÷ 4
Use of lollipop sticks to form wholes- squares are made because we are dividing by 4.



There are 3 whole squares, with 1 left over.

Children to represent the lollipop sticks pictorially.

13 ÷ 4

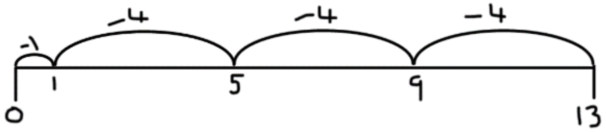


There are 3 whole squares, with 1 left over.

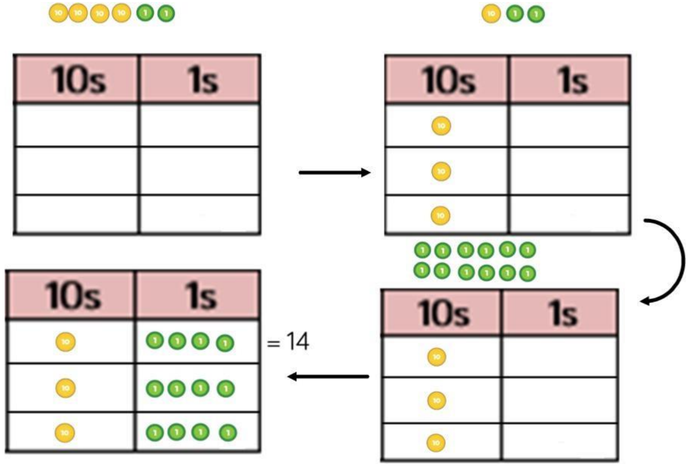
13 ÷ 4 – 3 remainder 1

Children should be encouraged to use their times table facts; they could also represent repeated addition on a number line.

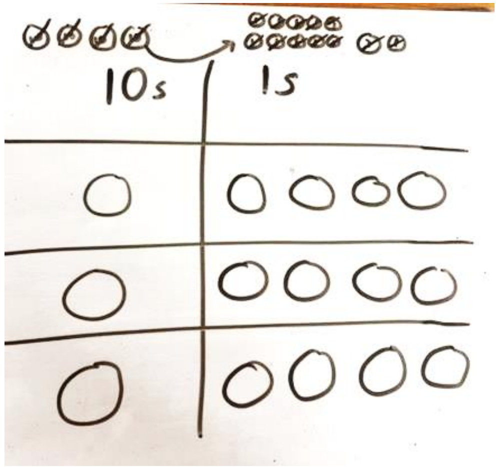
‘3 groups of 4, with 1 left over’



Sharing using place value counters. 42 ÷ 3 = 14



Children to represent the place value counters pictorially.
42 ÷ 3 = 14

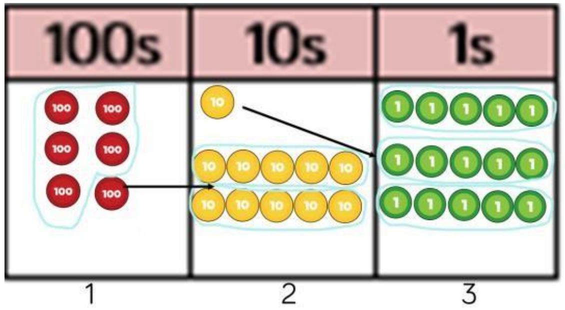


Children to be able to make sense of the place value counters and write calculations to show the process.

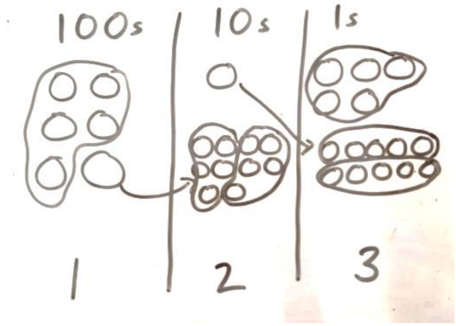
42 ÷ 3
42 = 30 + 12
30 ÷ 3 = 10
12 ÷ 3 = 4
10 + 4 = 14

Year 4 – Year 5

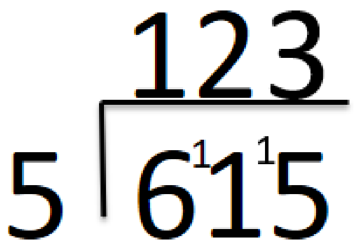
Short division using place value counters to group. 615 ÷ 5



Represent the place value counters pictorially. 615 ÷ 5



Children to the calculation using the short division scaffold.



Concrete and pictorial steps:

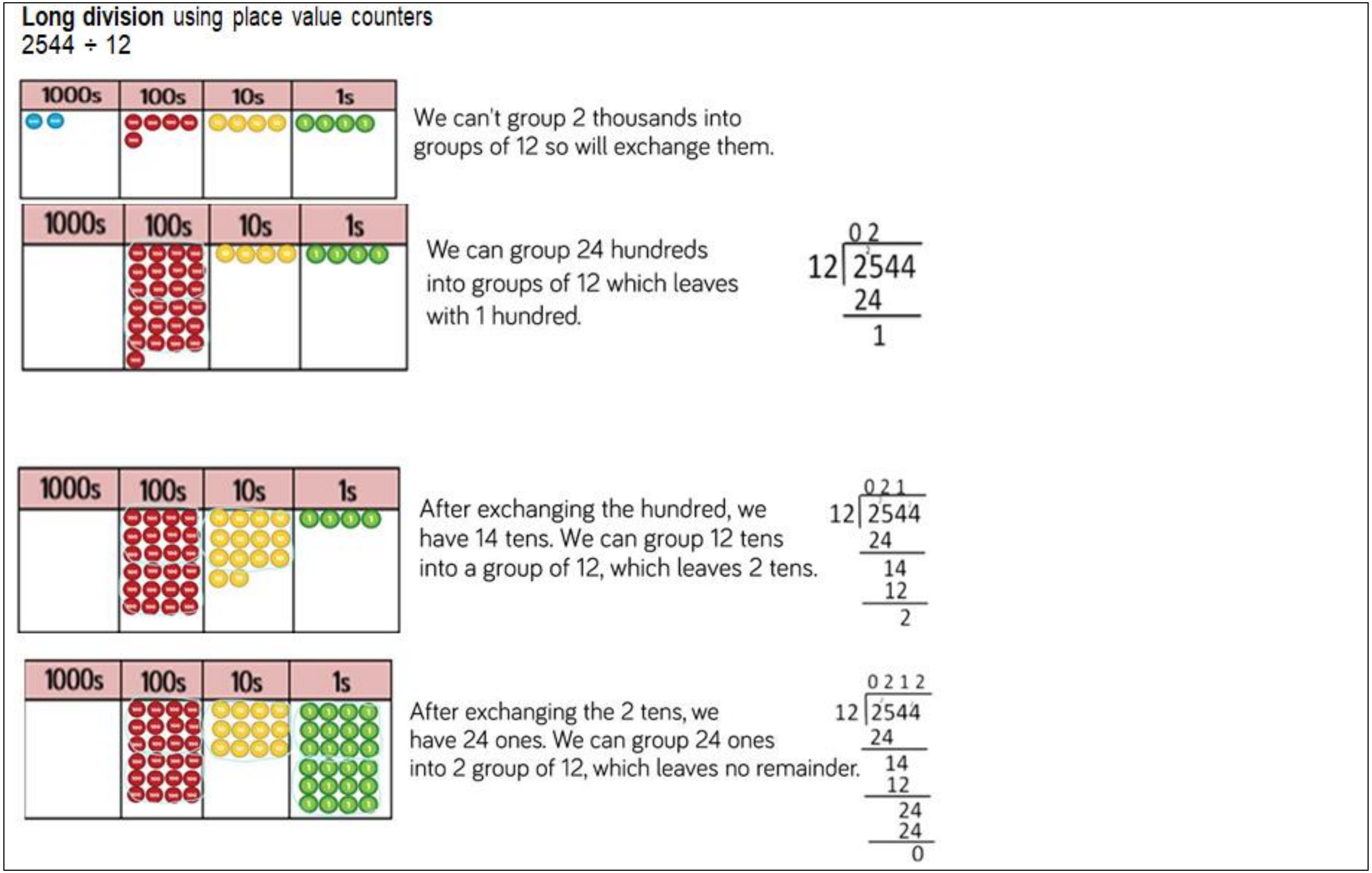
1. Make 615 with place value counters.
2. How many groups of 5 hundreds can you make with 6 hundred counters?
3. Exchange 1 hundred for 10 tens.
4. How many groups of 5 tens can you make with 11 ten counters?
5. Exchange 1 ten for 10 ones.

How many groups of 5 ones can you make with 15 ones?

Short Division steps:

1. How many groups of 5 hundreds are there in 6 hundred?
   1 with 1 left over.
2. How many groups of 5 tens are there in 11 tens?
   2 with 1 left over.
3. How many groups of 5 ones are there in 15 ones?
   3 with no remainders.

Year 6



Long division using place value counters

2544 ÷ 12

We can't group 2 thousands into groups of 12 so will exchange them.

We can group 24 hundreds into groups of 12 which leaves with 1 hundred.

```
    0 2
12 |2544
    24
     1
```

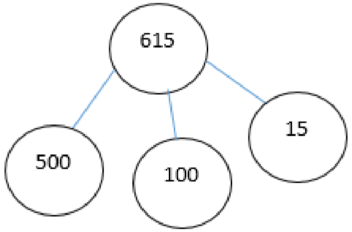
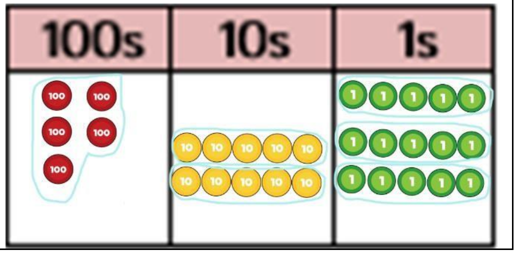
After exchanging the hundred, we have 14 tens. We can group 12 tens into a group of 12, which leaves 2 tens.

```
    0 2 1
12 |2544
    24
     14
     12
      2
```

After exchanging the 2 tens, we have 24 ones. We can group 24 ones into 2 group of 12, which leaves no remainder.

```
    0 2 1 2
12 |2544
    24
     14
     12
      24
      24
       0
```

Conceptual variation; different ways to ask children to solve 615 ÷ 5

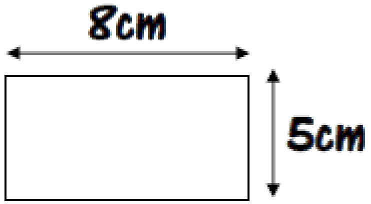
Using the part whole model below, how can you divide 615 by 5 without using short division?  	I have £615 and share it equally between 5 bank accounts. How much will be in each account? 615 pupils need to be put into 5 groups. How many will be in each group?	$5\overline{)615}$ 615 ÷ 5 = = 615 ÷ 5	What is the calculation? What is the answer? 

Real life maths

Mary has 50p coins and
Paul has four 20p coins.
Altogether they have £1.30.

50Kg + 80Kg = 130Kg

1300ml - 800ml = 500ml

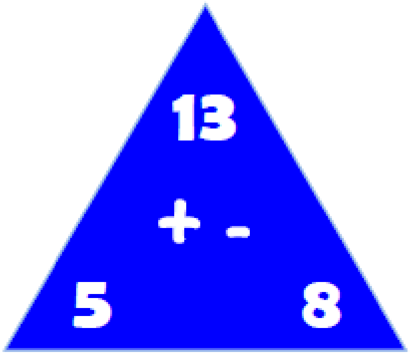


The total distance around this rectangle is 26cm

18 + 5 = 23

28 + 5 = 33

38 + 5 = 43



Related number facts

8 + 5 = 13
5 + 8 = 13
13 - 5 = 8
13 - 8 = 5

80 + 50 = 130
50 + 80 = 130
130 - 50 = 80
130 - 80 = 50

13000 - 5000 = 8000

0.8 + 0.5 = 1.3

0.05 + 0.08 = 0.13

The sum of 500 and 800 is 1300

The difference between 130 and 50 is 80

130 minus 50 equals 80

13 take away 8 is 5

The total of 5 and 8 is 13

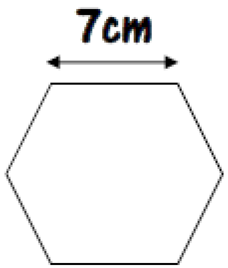
Using key vocabulary

Real life maths

The total cost of 6 mangoes at 70p each is £4.20

$7 \times 60_{g} = 420_{g} = 0.42_{Kg}$

$4200_{ml} \div 6 = 700_{ml}$

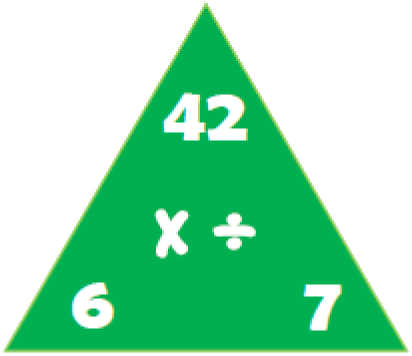


The perimeter of this regular hexagon is 42cm

420 ÷ 6 = 70

4200 ÷ 6 = 700

42000 ÷ 6 = 7000



Related number facts

6 x 7 = 42

7 x 6 = 42

42 ÷ 6 = 7

42 ÷ 7 = 6

6 x 70 = 420

70 x 6 = 420

420 ÷ 6 = 70

420 ÷ 70 = 6

6 x 0.7 = 4.2

6 x 0.07 = 0.42

60 x 70 = 4200

The product of 6 and 7 is 42

6 and 7 are both factors of 42

43 divided by 6 is 7 remainder 1

420 is a multiple of 6 and 7

Using key vocabulary

Examples of creative and efficient mental shortcuts (‘Freestyling’)

Subtraction: Adjusting the gap

426 - 198

Adding 2 to both numbers to keep the size of the gap the same!

It is now easy to ‘see’ the size of this gap so I can write down the answer – I do not need two jumps!

Addition: Round and adjust

56 + 98 → 56 + 100 - 2

Subtraction: Round and adjust

275 - 99 → 275 – 100 + 1

Multiplication: Round and adjust

69 x 7 → (70 x 7) - 7

This policy stresses the importance of a **high understanding** ‘catch-all’ agreed core method for mental calculation. As children become more confident with number they will develop greater ‘**number sense**’ – at one time what we called a ‘feel for number’. Consequently, they will learn that there are occasions when they can take more creative approaches if the numbers support this alternative strategy. These efficient shortcuts which we will call ‘**Freestyling**’ are particularly likely to be appropriate in problem solving and real life maths. For example to work out the total cost of two pens at 99p each, we would hope they would understand why it is much quicker to imagine that each pen costs £1 and then adjust, rather than using the core method for 2d + 2d, i.e. (90 + 90) + (9 +9)

Maths Vocabulary

Introduction - NCETM

This glossary has been developed by the National Centre for Excellence in the Teaching of Mathematics (NCETM) in response to a request from the Department for Education to support the publication of the new national curriculum for mathematics which will be implemented in schools in September 2014. The definitions refer to the words and terms as they are used in the programmes of study. This document is based on an earlier publication Mathematics glossary for teachers in key stages 1 to 4 published by the Qualifications and Curriculum Authority in 2003.

It is intended to be used alongside the 2014 National Curriculum for teachers to check the meaning of the terms. This glossary is part of a wider suite of support of materials from the NCETM for the new mathematics National Curriculum including a planning tool, videos, progression map and subject knowledge Self-Evaluation tool.

The words to be found in this glossary are of two kinds. The majority of the words relate to mathematics, and the naming of mathematical forms or geometrical constructs and objects. However, there are other words introduced into the curriculum that describe general competences and could in other settings be taken out of a mathematical context. These words are indicated in italics and an attempt is made to indicate what implications these words should have in the context of the mathematics curriculum. Underneath most entries in the glossary there is an indication of which key stage the concept in question is first introduced (though not necessarily the formality of the vocabulary). Obviously, once a concept has been introduced it will in all likelihood reappear at later stages of the curriculum; mathematics once learned does not suddenly go away. Words that are not indicated by a key stage are there to be used at a teacher’s discretion.

Introduction

This vocabulary list is published by the National Centre for Excellence in the Teaching of Mathematics. As such, we believe that it is the most accurate and relevant to use across the trust.

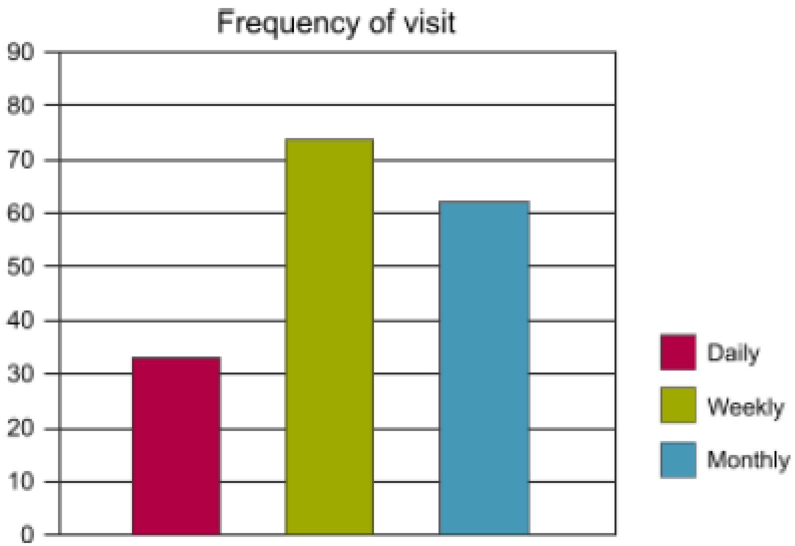
We have re-organised the list by Key Stage in order to help teachers to see the vocabulary needed. It is important that we do not only look at the vocabulary for our own Key Stage however. Staff must look at the vocabulary from the Key Stage before and ensure that they are using the correct language (as well as insisting on it from their pupils) during their teaching. Teachers should also be looking ahead to the next Key Stage in order to ensure that they are not contradicting future understanding or creating misconceptions that will need to be addressed later on. This is why the KS3 vocabulary has also been kept to support teaching, particularly for Year 5 and 6 teachers.

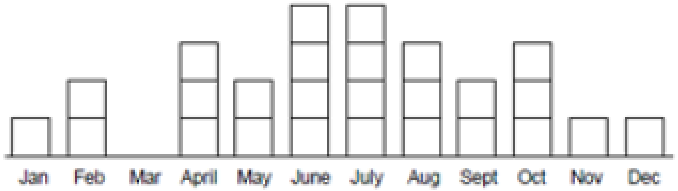
Key Stage 1

2-D; 3-D	Short for 2-dimensional and 3-dimensional. A figure is two-dimensional if it lies in a plane. A solid is three-dimensional and occupies space (in more than one plane). A plane is specified by ordered pairs of numbers called coordinates, typically (x,y). Points in 3-dimensional space are specified by an ordered triple of numbers, typically (x, y, z).
addition	The binary operation of addition on the set of all real numbers that adds one number of the set to another in the set to form a third number which is also in the set. The result of the addition is called the sum or total. The operation is denoted by the + sign. When we write 5 + 3 we mean ‘add 3 to 5’; we can also read this as ‘5 plus 3’. In practice the order of addition does not matter: The answer to 5 + 3 is the same as 3 + 5 and in both cases the sum is 8. This holds for all pairs of numbers and therefore the operation of addition is said to be commutative. To add three numbers together, first two of the numbers must be added and then the third is added to this intermediate sum. For example, (5 + 3) + 4 means ‘add 3 to 5 and then add 4 to the result’ to give an overall total of 12. Note that 5 + (3 + 4) means ‘add the result of adding 4 to 3 to 5’ and that the total is again 12. The brackets indicate a priority of sub-calculation, and it is always true that (a + b) + c gives the same result as a + (b + c) for any three numbers a, b and c. This is the associative property of addition. Addition is the inverse operation to subtraction, and vice versa. There are two models for addition: 1. Augmentation is when one quantity or measure is increased by another quantity. i.e. “I had £3.50 and I was given £1, then I had £4.50”. 2. Aggregation is the combining of two quantities or measures to find the total. E.g. “I had £3.50 and my friend had £1, we had £4.50 altogether.

analogue clock	A clock usually with 12 equal divisions labelled ‘clockwise’ from the top 12, 1, 2, 3 and so on up to 11 to represent hours. Commonly, each of the twelve divisions is further subdivided into five equal parts providing sixty minor divisions to represent minutes. The clock has two hands that rotate about the centre. The minute hand completes one revolution in one hour, whilst the hour hand completes one revolution in 12 hours. Sometimes the Roman numerals XII, I, II, III, IV, VI, VII, VIII, IX, X, XI are used instead of the standard numerals used today.
angle	An angle is a measure of rotation and is often shown as the amount of rotation required to turn one line segment onto another where the two line segments meet at a point (insert diagram). See right angle, acute angle, obtuse angle, reflex angle
anticlockwise	In the opposite direction from the normal direction of travel of the hands of an analogue clock.
array	An ordered collection of counters, numbers etc. in rows and columns.
axis of symmetry	A line about which a geometrical figure, or shape, is symmetrical or about which a geometrical shape or figure is reflected in order to produce a symmetrical shape or picture. Reflective symmetry exists when for every point on one side of the line there is another point (its image) on the other side of the line which is the same perpendicular distance from the line as the initial point. <u>Example:</u> a regular hexagon has six lines of symmetry; an equilateral triangle has three lines of symmetry. See reflection symmetry

<table>
<tr>
<td>bar chart</td>
<td>A format for representing statistical information. Bars, of equal width, represent frequencies and the lengths of the bars are proportional to the frequencies (and often equal to the frequencies). Sometimes called bar graph. The bars may be vertical or horizontal depending on the orientation of the chart.


</td>
</tr>
<tr>
<td>block graph</td>
<td>A simple format for representing statistical information. One block represents one observation. Example: A birthday graph where each child places one block, or colours one square, to represent himself / herself in the month in which he or she was born.


</td>
</tr>
</table>

<table>
<tr><td>capacity</td><td>Capacity – the volume of a material (typically liquid or air) held in a vessel or container.

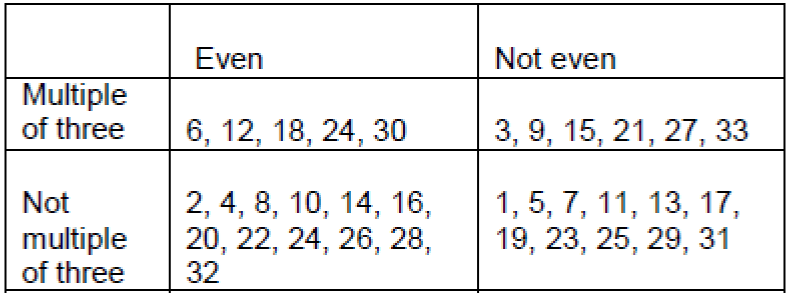
<u>Note:</u> the term ’volume’ is used as a general measure of 3-dimensional space and cannot always be used as synonymously with capacity. e.g. the volume of a cup is the space taken up by the actual material of the cup (a metal cup melted down would have the same volume); whereas the capacity of the cup is the volume of the liquid or other substance that the cup can contain. A solid cube has a volume but no capacity.

Units include litres, decilitres, millilitres; cubic centimetres (cm^3) and cubic metres (m^3). A litre is equivalent to $1000cm^3$.</td></tr>
<tr><td>cardinal number</td><td>A cardinal number denotes quantity, as opposed to an ordinal number which denotes position within a series.

1, 2, 5, 23 are examples of cardinal numbers

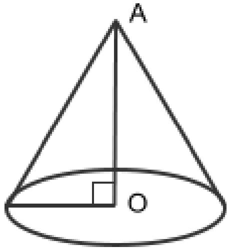
First (1st), second (2nd), third (3rd) etc denote position in a series, and are ordinals.</td></tr>
<tr><td>Carroll diagram</td><td>A sorting diagram named after Lewis Carroll, author and mathematician, in which numbers (or objects) are classified as having a certain property or not having that property

<u>Example:</u> Use the diagram below to classify all the integers from 1 to 33

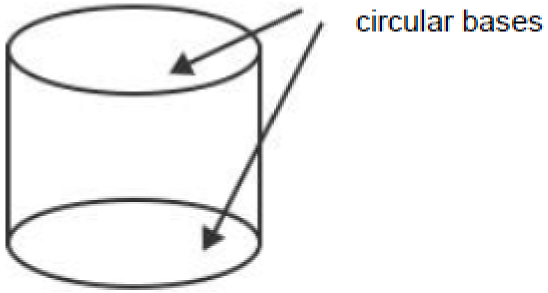

<table>
<tr><td></td><td>Even</td><td>Not even</td></tr>
<tr><td>Multiple of three</td><td>6, 12, 18, 24, 30</td><td>3, 9, 15, 21, 27, 33</td></tr>
<tr><td>Not multiple of three</td><td>2, 4, 8, 10, 14, 16, 20, 22, 24, 26, 28, 32</td><td>1, 5, 7, 11, 13, 17, 19, 23, 25, 29, 31</td></tr>
</table>
</td></tr>
</table>

categorical data	Data arising from situations where categories (unordered discrete) are used. Examples: pets, pupils’ favourite colours; states of matter – solids, liquids, gases, gels etc; nutrient groups in foods – carbohydrates, proteins, fats etc; settlement types – hamlet, village, town, city etc; and types of land use – offices, industry, shops, open space, residential etc.
centi–	Prefix meaning one-hundredth (of)
centilitre	A unit of capacity or volume equivalent to one-hundredth of a litre. Symbol: cl.
centimetre	A unit of linear measure equivalent to one hundredth of a metre. Symbol: cm.
centre	The middle point for example of a line or a circle
chart	Another word for a table or graph
chronological	Relating to events that occur in a time ordered sequence.
circle	The set of all points in a plane which are at a fixed distance (the radius) from a fixed point (the centre) also in the plane Alternatively, the path traced by a single point travelling in a plane at a fixed distance (the radius) from a fixed point (the centre) in the same plane. One half of a circle cut off by a diameter is a semi-circle. The area enclosed by a circle of radius r is πr^2.
circular	1. In the form of a circle. 2. Related to the circle, as in circular function.

clockwise	In the direction in which the hands of an analogue clock travel. Anti-clockwise or counter-clockwise are terms used for the opposite direction.
column graph	A bar graph where the bars are presented vertically.
common fraction	A fraction where the numerator and denominator are both integers. Also known as simple or vulgar fraction. Contrast with a compound or complex fraction where the numerator or denominator or both contain fractions.
commutative	A binary operation $*$ on a set S is commutative if $a * b = b * a$ for all a and $b \in S$. Addition and multiplication of real numbers are commutative where $a + b = b + a$ and $a \times b = b \times a$ for all real numbers a and b. It follows that, for example, $2 + 3 = 3 + 2$ and $2 x 3 = 3 x 2$. Subtraction and division are not commutative since, as counter examples, $2 – 3 \neq 3 – 2$ and $2 \div 3 \neq 3 \div 2$.
compare	In mathematics when two entities (objects, shapes, curves, equations etc.) are compared one is looking for points of similarity and points of difference as far as mathematical properties are concerned. <u>Example:</u> compare $y = x$ with $y = x2$. Each equation represents a curve, with the first a straight line and the second a quadratic curve. Each passes through the origin, but on the straight line the values of y always increase from a negative to positive values as x increases, but on the quadratic curve the y-axis is an axis of symmetry and $y \geq 0$ for all values of x. The quadratic has a lowest point at the origin; the straight line has no lowest point
concrete objects	Objects that can be handled and manipulated to support understanding of the structure of a mathematical concept. Materials such as Dienes (Base 10 materials), Cuisenaire, Numicon, pattern blocks are all examples of concrete objects.

cone	A cone is a 3-dimensional shape consisting of a circular base, a vertex in a different plane, and line segments joining all the points on the circle to the vertex. If the vertex A lies directly above the centre O of the base, then the axis of the cone AO is perpendicular to the base and the shape is a right circular cone. 
consecutive	Following in order. Consecutive numbers are adjacent in a count. Examples: 5, 6, 7 are consecutive numbers. 25, 30, 35 are consecutive multiples of 5. In a polygon, consecutive sides share a common vertex and consecutive angles share a common side.
corner	In elementary geometry, a point where two or more lines or line segments meet. More correctly called vertex, vertices (plural). Examples: a rectangle has four corners or vertices; and a cube has eight corners or vertices.

count (verb)	The act of assigning one number name to each of a set of objects (or sounds or movements) in order to determine how many objects there are. In order to count reliably children need to be able to: • Understand that the number words come in a fixed order • Say the numbers in the correct sequence; • Organise their counting (e.g. say one number for each object and keep track of which things they have counted); • Understand that the final word in the count gives the total • Understand that the last number of the count remains unchanged irrespective of the order (conservation of number)
counter example	Where a hypothesis or general statement is offered, an example that clearly disproves it.
cube	In geometry, a three-dimensional figure with six identical, square faces. Adjoining edges and faces are at right angles. In number and algebra, the result of multiplying to power of three, n^3 is read as ‘n cubed’ or ‘n to the power of three’ Example: Written 2^3, the cube of 2 is (2 x 2 x 2) = 8.
cuboid	A three-dimensional figure with six rectangular faces.

cylinder	A three-dimensional object whose uniform cross-section is a circle. A right cylinder can be defined as having circular bases with a curved surface joining them, this surface formed by line segments joining corresponding points on the circles. The centre of one base lies over the centre of the second. 
data	Information of a quantitative nature consisting of counts or measurements. Initially data are nearly always counts or things like percentages derived from counts. When they refer to measurements that are separate and can be counted, the data are discrete. When they refer to quantities such as length or capacity that are measured, the data are continuous. Singular: datum.
denomination (currency)	The face value of coins. In the smallest denomination of UK currency (known as Sterling) is 1p and the largest denomination of currency is a £50 note.
describe	When the curriculum asks pupils to ‘describe’ a mathematical object, transformation or the features of a graph, or anything else of a mathematical nature, it is asking pupils to refine their skills to hone in on the essential mathematical features and to describe these as accurately and as succinctly as possible. By KS3 pupils are expected to develop this skill to a good degree.
diagram	A picture, a geometric figure or a representation.

difference	In mathematics (as distinct from its everyday meaning), difference means the numerical difference between two numbers or sets of objects and is found by comparing the quantity of one set of objects with another. Example: the difference between 12 and 5 is 7; 12 is 5 more than 7 or 7 is 5 fewer than 12. Difference is one way of thinking about subtraction and can, in some circumstances, be a more helpful image for subtraction than ‘take-away’ – e.g. 102 - 98
digit	One of the symbols of a number system most commonly the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. Examples: the number 29 is a 2-digit number; there are three digits in 2.95. The position or place of a digit in a number conveys its value.
digital clock	A clock that displays the time as hours and minutes passed, usually since midnight. Example: four thirty in the afternoon is displayed as 16:30.
direction	The orientation of a line in space. Examples: north, south, east, west; up, down, right, left are directions.
distance between	A measure of the separation of two points. Example: A is 5 miles from B
divide	To carry out the operation of division.
division	1. An operation on numbers interpreted in a number of ways. Division can be sharing – the number to be divided is shared equally into the stated number of parts; or grouping – the number of groups of a given size is found. Division is the inverse operation to multiplication. 2. On a scale, one part. Example: Each division on a ruler might represent a millimetre.

double	1. To multiply by 2. Example: Double 13 is (13 × 2) = 26. 2. The number or quantity that is twice another. Example: 26 is double 13. In this context, a ‘near double’ is one away from a double. Example: 27 is a near double of 13 and of 14. (N.B. spotting near doubles can be a useful mental calculation strategy e.g. seeing 25 + 27 as 2 more than double 25.
edge	A line segment, joining two vertices of a figure. A line segment formed by the intersection of two plane surfaces. Examples: a square has four edges; and a cuboid has twelve edges.
equal	Symbol: =, read as ‘is equal to’ or ‘equals’. and meaning ‘having the same value as’. Example: 7 – 2 = 4 + 1 since both expressions, 7 – 2 and 4 + 1 have the same value, 5.
equilateral	Of equal length Example: an equilateral triangle is a triangle with all 3 sides of equal length.
equivalent fractions	Fractions with the same value as another. Example: 4/8, 5/10, 8/16 are all equivalent fractions and all are equal to ½.
estimate	1. Verb: To arrive at a rough or approximate answer by calculating with suitable approximations for terms or, in measurement, by using previous experience. 2. Noun: A rough or approximate answer.
even number	An integer that is divisible by 2.

face	One of the flat surfaces of a solid shape. <u>Example:</u> a cube has six faces; each face being a square
facts	i.e. Multiplication / division/ addition/ subtraction facts. The word 'fact' is related to the four operations and the instant recall of knowledge about the composition of a number. i.e. an addition fact for 20 could be 10+10; a subtraction fact for 20 could be 20-9=11. A multiplication fact for 20 could be 4 x 5 and a division fact for 20 could be 20÷5 = 4.
fluency	To be mathematically fluent one must have a mix of conceptual understanding, procedural fluency and knowledge of facts to enable you to tackle problems appropriate to your stage of development confidently, accurately and efficiently.
fraction	The result of dividing one integer by a second integer, which must be non- zero. The dividend is the numerator and the non-zero divisor is the denominator. See also common fraction, decimal fraction, equivalent fraction, improper fraction, proper fraction, simple fraction, unit fraction and vulgar fraction.
frequency	The number of times an event occurs; or the number of individuals (people, animals etc.) with some specific property.
general statement	A statement that applies correctly to all relevant cases. <u>Example:</u> the sum of two odd numbers is an even number.
generalise	To formulate a general statement or rule.
geometrical	Relating to geometry, the aspect of mathematics concerned with the properties of space and figures or shapes in space.
gram	The unit of mass equal to one thousandth of a kilogram. <u>Symbol:</u> g.

graph	A diagram showing a relationship between variables. Adjective: graphical.
grid	A lattice created with two sets of parallel lines. Lines in each set are usually equally spaced. If the sets of lines are at right angles and lines in both sets are equally spaced, a square grid is created.
hexagon	A polygon with six sides and six edges. Adjective: hexagonal, having the form of a hexagon
hour	A unit of time. One twenty-fourth of a day. 1 hour = 60 minutes = 3600 (60 x 60) seconds.
hundred square	A 10 by 10 square grid numbered 1 to 100. A similar grid could be numbered as a 0 – 99 grid.
inequality	When one number, or quantity, is not equal to another. Statements such as a ≠ b, a<b, a ≤, b, a > b or a≥b are inequalities. The inequality signs in use are: ≠ means 'not equal to'; A ≠ B means 'A is not equal to B" < means 'less than'; A < B means 'A is less than B' > means 'greater than'; A > B means 'A is greater than B' ≤ means 'less than or equal to'; A ≤ B means 'A is less than or equal to B' ≥ means 'greater than or equal to'; A ≥ B means 'A is greater than or equal to B'
infinite	Of a number, always bigger than any (finite) number that can be thought of. Of a sequence or set, going on forever. The set of integers is an infinite set.

inverse operations	Operations that, when they are combined, leave the entity on which they operate unchanged. Examples: addition and subtraction are inverse operations e.g. 5 + 6 – 6 = 5. Multiplication and division are inverse operations e.g. 6 × 10 ÷ 10 = 6. Squaring and taking the square root are inverse to each other: $\sqrt{x^2} = (\sqrt{x})^2 = x$; similarly with cube and cube root, and any integer power n and nth root. Some operations, such as reflection in the x-axis, or ‘subtract from 10’ are self-inverse i.e. they are inverses of themselves
kilo-	Prefix denoting one thousand
kilogram	The base unit of mass in the SI (Système International d’Unités). Symbol: kg. 1kg. = 1000g.
kilometre	A quadrilateral with two pairs of equal, adjacent sides whose diagonals consequently intersect at right angles.
kite	A quadrilateral with two pairs of equal, adjacent sides whose diagonals consequently intersect at right angles.
length	The extent of a line segment between two points. Length is independent of the orientation of the line segment
line	A set of adjacent points that has length but no width. A straight line is completely determined by two of its points, say A and B. The part of the line between any two of its points is a line segment.

litre	A metric unit used for measuring volume or capacity. <u>Symbol:</u> l. 1 l = 1000 cm^3.
mass	A characteristic of a body, relating to the amount of matter within it. Mass differs from weight, the force with which a body is attracted towards the earth's centre. Whereas, under certain conditions, a body can become weightless, mass is constant. In a constant gravitational field weight is proportional to mass.
maximum value (in a non-calculus sense)	The greatest value. <u>Example:</u> The maximum temperature in London yesterday was 18°C.
measure	1. The size in terms of an agreed unit. See also compound measure. 2. Measure is also used as a verb, to find the size.
measuring tools	These record numerical quantities of continuous variables, often by comparison with scaled calibrations on the device that is used, or using digital technology. <u>Example:</u> a ruler measures length, a protractor measures angles, a thermometer measures temperature; weighing scales measure mass, a stop watch measures time duration, measuring vessels to measure capacity, and so on.
mental calculations	Referring to calculations that are largely carried out mentally, but may be supported with a few simple written jottings.
metre	The base unit of length in SI (Système International d'Unités). <u>Symbol:</u> m.
milli-	Prefix. One-thousandth.

millilitre	One thousandth of a litre. Symbol: ml.
millimetre	One thousandth of a metre. Symbol: mm.
minimum value (in a non-calculus sense)	The least value. Example: The expected minimum temperature overnight is 6ºC.
minus	A name for the symbol **−**, representing the operation of subtraction.
minute	Unit of time. One-sixtieth of an hour. 1 minute = 60 seconds
missing number problems	A problem of the type 7 = ☐ − 9 often used as an introduction to algebra.
multiple	For any integers a and b, a is a multiple of b if a third integer c exists so that a = bc Example: 14, 49 and 70 are all multiples of 7 because 14 = 7 x 2, 49 = 7 x 7 and 70 = 7 x 10. -21 is also a multiple of 7 since -21 = 7 × -3.

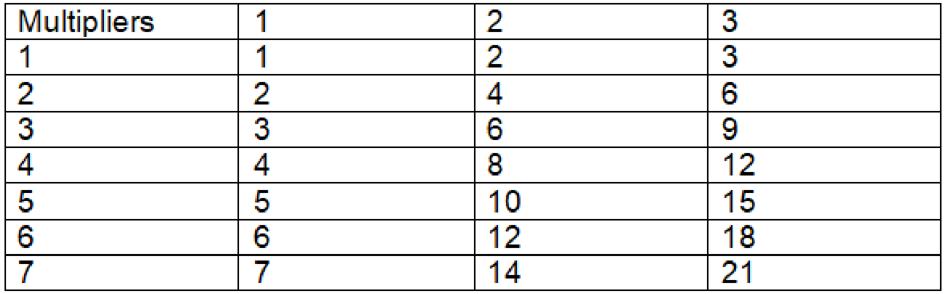
<table>
<tr><td>multiplication</td><td>Multiplication (often denoted by the symbol "×") is the mathematical operation of scaling one number by another.
It is one of the four binary operations in arithmetic (the others being addition, subtraction and division).

Because the result of scaling by whole numbers can be thought of as consisting of some number of copies of the original, whole-number products greater than 1 can be computed by repeated addition; for example, 3 multiplied by 4 (often said as "3 times 4") can be calculated by adding 4 copies of 3 together:

$3 \times 4 = 3 + 3 + 3 + 3 = 12$

Here 3 and 4 are the "factors" and 12 is the "product".
Multiplication is the inverse operation of division, and it follows that
$7 \div 5 \times 5 = 7$

Multiplication is commutative, associative and distributive over addition or subtraction.</td></tr>
<tr><td>multiplication table</td><td>An array setting out sets of numbers that multiply together to form the entries in the array, for example

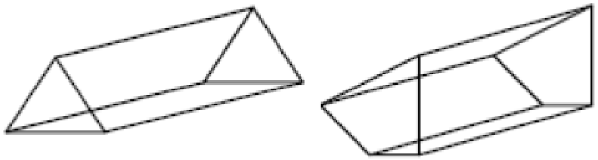

<table>
<tr><td>Multipliers</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>1</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>4</td><td>6</td></tr>
<tr><td>3</td><td>3</td><td>6</td><td>9</td></tr>
<tr><td>4</td><td>4</td><td>8</td><td>12</td></tr>
<tr><td>5</td><td>5</td><td>10</td><td>15</td></tr>
<tr><td>6</td><td>6</td><td>12</td><td>18</td></tr>
<tr><td>7</td><td>7</td><td>14</td><td>21</td></tr>
</table></td></tr>
<tr><td>multiply</td><td>Carry out the process of multiplication.</td></tr>
<tr><td>notation</td><td>A convention for recording mathematical ideas.

<u>Examples:</u> Money is recorded using decimal notation e.g. £2.50 Other examples of mathematical notation include $a + a = 2a$, $y = f(x)$ and $n \times n \times n = n^3$,</td></tr>
</table>

number bond	A pair of numbers with a particular total. Example: number bonds for ten are all pairs of whole numbers with the total 10.
number line	A line where numbers are represented by points upon it.
number sentence	A mathematical sentence involving numbers. Examples: 3 + 6 = 9 and 9 > 3
number square	A square grid in which cells are numbered in order.
number track	A numbered track along which counters might be moved. The number in a region represents the number of single moves from the start.
numeral	A symbol used to denote a number. The Roman numerals I, V, X, L, C, D and M represent the numbers one, five, ten, fifty, one hundred, five hundred and one thousand. The Arabic numerals 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 are used in the Hindu-Arabic system giving numbers in the form that is widely used today.
oblong	Sometimes used to describe a non-square rectangle – i.e. a rectangle where one dimension is greater than the other.
octagon	A polygon with eight sides. Adjective: octagonal, having the form of an octagon.
odd number	An integer that has a remainder of 1 when divided by 2.
operation	See binary operation

ordinal number	A term that describes a position within an ordered set. Example: first, second, third, fourth … twentieth etc.
partition	1. To separate a set into subsets. 2. To split a number into component parts. Example: the two-digit number 38 can be partitioned into 30 + 8 or 19 + 19. 3. A model of division. Example: 21 ÷ 7 is treated as 'how many sevens in 21?'
pattern	A systematic arrangement of numbers, shapes or other elements according to a rule.
pentagon	A polygon with five sides and five interior angles. Adjective: pentagonal, having the form of a pentagon.
pictogram	A format for representing statistical information. Suitable pictures, symbols or icons are used to represent objects. For large numbers one symbol may represent a number of objects and a part symbol then represents a rough proportion of the number.
pictorial representations	Pictorial representations enable learners to use pictures and images to represent the structure of a mathematical concept. The pictorial representation may build on the familiarity with concrete objects. Example: a square to represent a Dienes 'flat' (representation of the number 100). Pupils may interpret pictorial representations provided to them or create a pictorial representation themselves to help solve a mathematical problem.
pie-chart	Also known as pie graph. A form of presentation of statistical information. Within a circle, sectors like 'slices of a pie' represent the quantities involved. The frequency or amount of each quantity is proportional to the angle at the centre of the circle.

place holder	In decimal notation, the zero numeral is used as a place holder to denote the absence of a particular power of 10. Example: The number 105.07 is a shorthand for $1 \times 10^2 + 0 \times 10^1 + 5 \times 10^0 + 0 \times 10^{-1} + 7 \times 10^{-2}$.
place value	The value of a digit that relates to its position or place in a number. Example: in 1482 the digits represent 1 thousand, 4 hundreds, 8 tens and 2 ones respectively; in 12.34 the digits represent 1 ten, 2 ones, 3 tenths and 4 hundredths respectively.
plus	A name for the symbol +, representing the operation of addition.
polygon	A closed plane figure bounded by straight lines. The name derives from many angles. If all interior angles are less than 180º the polygon is convex. If any interior angle is greater than 180º, the polygon is concave. If the sides are all of equal length and the angles are all of equal size, then the polygon is regular; otherwise it is irregular. Adjective: polygonal.
positive number	A number greater than zero. Where a point on a line is labelled 0 positive numbers are all those to the left of the zero and are read 'positive one, positive two, positive three' etc. See also directed number and negative number.
position	Location as specified by a set of coordinates in a plane or in full 3-dimensional space. On the large scale, location on the earth is specified by latitude and longitude coordinates.
pound sterling (money)	A unit of money. £1 is commonly called a pound. Symbol: £. £1.00 = 100 pence.

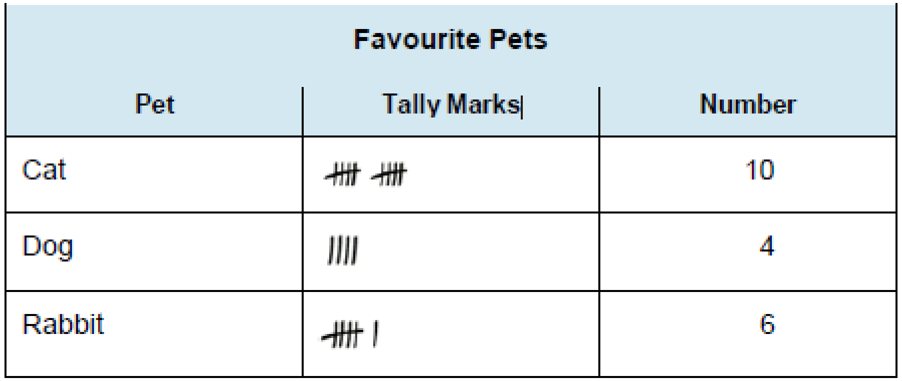
prism	A solid bounded by two congruent polygons that are parallel (the bases) and parallelograms (lateral faces) formed by joining the corresponding vertices of the polygons. Prisms are named according to the base e.g. triangular prism, quadrangular prism, pentagonal prism etc. Examples:  If the lateral faces are rectangular and perpendicular to the bases, the prism is a right prism.
product	The result of multiplying one number by another. Example: The product of 2 and 3 is 6 since 2 × 3 = 6.
property	Any attribute. Example: One property of a square is that all its sides are equal.
pyramid	A solid with a polygon as the base and one other vertex, the apex, in another plane. Each vertex of the base is joined to the apex by an edge. Other faces are triangles that meet at the apex. Pyramids are named according to the base: a triangular pyramid (which is also called a tetrahedron, having four faces), a square pyramid, a pentagonal pyramid etc.
quadrilateral	A polygon with four sides.
quantity	Something that has a numerical value. Example: 5 bananas.

quarter turn	A rotation through 90º, usually anticlockwise unless stated otherwise.
rectangle	A parallelogram with an interior angle of 90º. Opposite sides are equal. If adjacent sides are also equal the rectangle is a square. If adjacent sides are not equal, the rectangle is sometimes referred to as an oblong. A square is a (special) type of rectangle but a rectangle is not a square. The use of the word ‘oblong’ (favoured by some) resolves this issue. An oblong is a rectangle which is not square.
relation **relationship**	A common property of two or more items. An association between two or more items.
repeated addition	The process of repeatedly adding the same number or amount. One model for multiplication. <u>Example:</u> 5 + 5 + 5 + 5 = 5 x 4.
repeated subtraction	The process of repeatedly subtracting the same number or amount. One model for division. <u>Example:</u> 35 -5 - 5 - 5 - 5 - 5 - 5 - 5 = 0 so 35 ÷ 5 = 7 remainder 0.
rotation	In 2-D, a transformation of the whole plane which turns about a fixed point, the centre of rotation.
rule	Generally a procedure for carrying out a process. In the context of patterns and sequences a rule, expressed in words or algebraically, summarises the pattern or sequence and can be used to generate or extend it.
score	1. To earn points or goals in a competition. The running total of points or goals. 2. The number twenty.
second	1. A unit of time. One-sixtieth of a minute. 2. Ordinal number as in 'first, second, third, fourth …'.

sequence	A succession of terms formed according to a rule. There is a definite relation between one term and the next and between each term and its position in the sequence. Example: 1, 4, 9, 16, 25 etc.
set	A well-defined collection of objects (called members or elements).
share (equally)	Sections of this page that are currently empty will be filled over the coming weeks. One model for the process of division.
side	A line segment that forms part of the boundary of a figure. Also edge.
sign	A symbol used to denote an operation. Examples: addition sign +, subtraction sign −, multiplication sign ×, division sign ÷, equals sign = etc. In the case of directed numbers, the positive + or negative − sign indicates the direction in which the number is located from the origin along the number line.
simple fraction	A fraction where the numerator and denominator are both integers. Also known as common fraction or vulgar fraction.
sort	To classify a set of entities into specified categories.
square	1. A quadrilateral with four equal sides and four right angles. 2. The square of a number is the product of the number and itself. Example: the square of 5 is 25. This is written $5^2 = 25$ and read as five squared is equal to twenty-five. See also square number and square root.

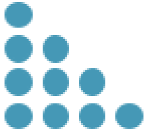
square number	A number that can be expressed as the product of two equal numbers. Example 36 = 6 x 6 and so 36 is a square number or “6 squared”. A square number can be represented by dots in a square array.
standard unit	Uniform units that are agreed throughout a community. Example: the metre is a standard unit of length. Units such as the handspan are not standard as they vary from person to person.
subtract	Carry out the process of subtraction
subtraction	The inverse operation to addition. Finding the difference when comparing magnitude. Also, take away.
sum	The result of one or more additions
surface	A set of points defining a space in two or three dimensions.
symbol	A letter, numeral or other mark that represents a number, an operation or another mathematical idea. Example: L (Roman symbol for fifty); > (is greater than).
symmetry	A plane figure has symmetry if it is invariant under a reflection or rotation i.e. if the effect of the reflection or rotation is to produce an identical-looking figure in the same position. See also reflection symmetry, rotation symmetry. Adjective: symmetrical.
table	1. An orderly arrangement of information, numbers or letters usually in rows and columns. 2. See multiplication table

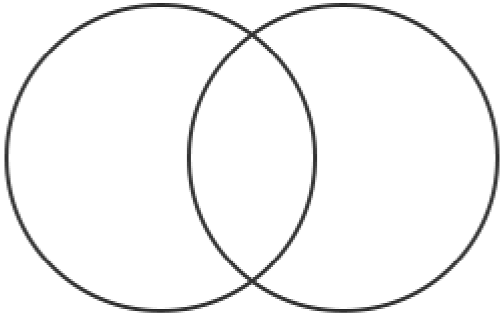
<table>
<tr><td>take away</td><td>1. Subtraction as reduction
2. Remove a number of items from a set.</td></tr>
<tr><td>tally</td><td>Make marks to represent objects counted; usually by drawing vertical lines and crossing the fifth count with a horizontal or diagonal strike through.

A Tally chart is a table representing a count using a Tally

<table>
<tr><th colspan="3">Favourite Pets</th></tr>
<tr><th>Pet</th><th>Tally Marks</th><th>Number</th></tr>
<tr><td>Cat</td><td>𝍸 𝍸</td><td>10</td></tr>
<tr><td>Dog</td><td>||||</td><td>4</td></tr>
<tr><td>Rabbit</td><td>𝍸 |</td><td>6</td></tr>
</table></td></tr>
<tr><td>temperature</td><td>A measure of the hotness of a body, measured by a thermometer or other form of heat sensor.

Two common scales of temperature are the Fahrenheit scale (ºF) and the Celsius (or centigrade scale) which measures in ºC. These scales have reference points for the freezing point of water (0ºC or 32ºF) and the boiling point of water (100ºC or 212ºF).

The relation between ºF and ºC is ºF = 9/5(ºC) + 32.</td></tr>
<tr><td>time</td><td>1. Progress from past, to present and to future
2. Time of day, in hours, minutes and seconds; clocks and associated vocabulary
3. Duration and associated vocabulary
4. Calendar time in days, weeks, months, years
5. Associated vocabulary such as later, earlier, sooner, when, interval of time, clock today, yesterday, tomorrow, days of the week, the 12 months of a year, morning, a.m., afternoon, p.m., noon, etc.</td></tr>
</table>

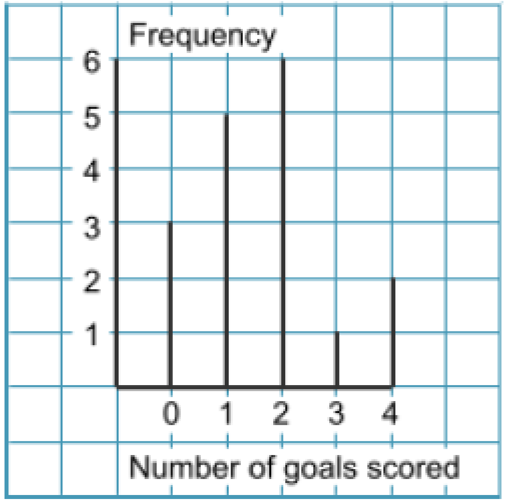
total	1. The aggregate. Example: the total population - all in the population. 2. The sum found by adding.
triangle	A polygon with three sides. Adjective: triangular, having the form of a triangle.
triangular number	1. A number that can be represented by a triangular array of dots with the number of dots in each row from the base decreasing by one. Example:  The triangular number 10 represented as a triangular array of dots. 2. A number in the sequence 1, 1 + 2, 1 + 2 + 3, 1 + 2 + 3 + 4 etc. 55 is a triangular number since it can be expressed as, 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10.
turn	A rotation about a point: a quarter turn is a rotation of 90º. A half turn is a rotation of 180º, a whole turn is a rotation of 360º.
unit	A standard used in measuring e.g. the metre is a unit of length; the degree is a unit of turn/angle, etc.
unit fraction	A fraction that has 1 as the numerator and whose denominator is a non-zero integer. Example: ½, ⅓

Venn diagram	A simple visual diagram to describe used to describe the relationships between two sets. With two or three sets each set is often represented by a circular region. The intersection of two sets is represented by the overlap region between the two sets. With more than three sets Venn diagrams can become very complicated. The boundary of the Venn Diagram represents the Universal Set of interest. 
vertex	The point at which two or more lines intersect. Plural: vertices.
vertical	The up-down direction on a graph or map. At right angles to the horizontal plane.
volume	A measure of three-dimensional space. Usually measured in cubic units; for example, cubic centimetres (cm^3) and cubic metres (m^3).
weight	In everyday English, weight is often confused with mass. In mathematics, and physics, the weight of a body is the force exerted on the body by the gravity of the earth, or any other gravitational body.

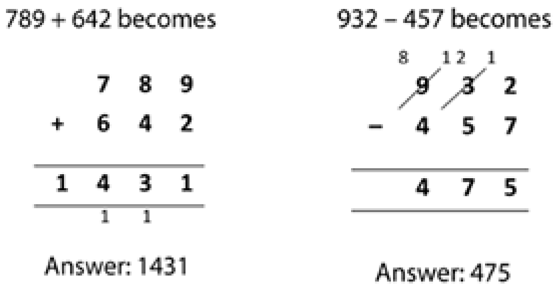
zero	1. Nought or nothing; zero is the only number that is neither positive nor negative. 2. Zero is needed to complete the number system. In our system of numbers : $a - a = 0$ for any number a. $a + (-a) = 0$ for any number a; $a + 0 = 0 + a = a$ for any number a; $a - 0 = a$ for any number a; $a \times 0 = 0 \times a = 0$ for any number a; division by zero is not defined as it leads to inconsistency. 3. In a place value system, a place-holder. Example: 105. 4. The cardinal number of an empty set.

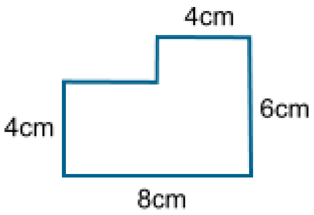
Key Stage 2

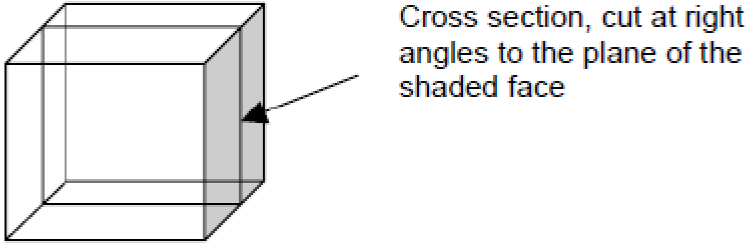
acute angle	An angle between 0º and 90º.
algebra	The part of mathematics that deals with generalised arithmetic. Letters are used to denote variables and unknown numbers and to state general properties. Example: a(x + y) = ax + ay exemplifies a relationship that is true for any numbers a, x and y. Adjective: algebraic. See also equation, inequality, formula, identity and expression.
angle at a point	The complete angle all the way around a point is 360º.
angle at a point on a line	The sum of the angles at a point on a line is 180º.
approximation	A number or result that is not exact. In a practical situation an approximation is sufficiently close to the actual number for it to be useful. Verb: approximate. Adverb: approximately. When two values are approximately equal, the sign ≈ is used.
area	A measure of the size of any plane surface. Area is usually measured in square units e.g. square centimetres (cm^2), square metres (m^2).
arithmetic mean	The sum of a set of numbers, or quantities, divided by the number of terms in the set. Example: The arithmetic mean of 5, 6, 14, 15 and 45 is (5 + 6 + 14 + 15 + 45) ÷ 5 i.e. 17.

arithmetic sequence	A sequence of numbers in which successive terms are generated by adding or subtracting a constant amount to the preceding term. <u>Examples:</u> 3, 11, 19, 27, 35, … where 8 is added; 4, -1, -6, -11, … where 5 is subtracted (or -5 has been added). The sequence can be generated by giving one term (usually the first term) and the constant that is added (or subtracted) to give the subsequent terms. Also called an arithmetic progression.
average	Loosely an ordinary or typical value, however, a more precise mathematical definition is a measure of central tendency which represents and or summarises in some way a set of data. The term is often used synonymously with ‘arithmetic mean', even though there are other measures of average – see median and mode
axis	A fixed, reference line along which or from which distances or angles are taken.
bar line chart / bar line chart	Similar to a bar chart, but for categorical data, the width of bars is reduced so that they appear as lines. The lengths of the bar lines are proportional to the frequencies. Sometimes called bar line graph. 

brackets	Symbols used to group numbers in arithmetic or letters and numbers in algebra and indicating certain operations as having priority. Example: 2 x (3 + 4) = 2 x 7 = 14 whereas 2 x 3 + 4 = 6 + 4 = 10. Example: 3(x + 4) denotes the result of adding 4 to a number and then multiplying by 3; $(x + 1)^2$ denotes the result of adding 1 to a number and then squaring the result
cancel (a fraction)	One way to simplify a fraction down to its lowest terms. The numerator and denominator are divided by the same number e.g. 4/8 = 2/4. Also to 'reduce' a fraction. Note: when the numerator and denominator are both divided by their highest common factor the fraction is said to have been cancelled down to give the equivalent fraction in its lowest terms. e.g.18/30 = 3/5 (dividing numerator and denominator by 6)
circumference	The distance around a circle (its perimeter). If the radius of a circle is r units, and the diameter d units, then the circumference is $2\pi r$, or πd units.
column	A vertical arrangement for example, in a table the cells arranged vertically.

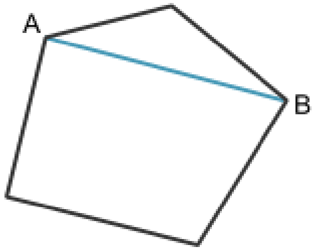
columnar addition or subtraction	A formal method of setting out an addition or a subtraction in ordered columns with each column representing a decimal place value and ordered from right to left in increasing powers of 10. With addition, more than two numbers can be added together using column addition, but this extension does not work for subtraction.  (Examples taken from Appendix 1 of the Primary National Curriculum for Mathematics)
common factor	A number which is a factor of two or more other numbers. <u>Example:</u> 3 is a common factor of the numbers 9 and 30 This can be generalised for algebraic expressions: <u>Example:</u> $(x – 1)$ is a common factor of $(x – 1)^2$ and $(x – 1)(x + 3)$.
common multiple	An integer which is a multiple of a given set of integers. <u>Example:</u> 24 is a common multiple of 2, 3, 4, 6, 8 and 12.
commutative	A binary operation ∗ on a set S is commutative if $a ∗ b = b ∗ a$ for all a and $b \in S$. Addition and multiplication of real numbers are commutative where $a + b = b + a$ and $a × b = b × a$ for all real numbers a and b. It follows that, for example, 2 + 3 = 3 + 2 and 2 x 3 = 3 x 2. Subtraction and division are not commutative since, as counter examples, $2 – 3 \neq 3 – 2$ and $2 ÷ 3 \neq 3 ÷ 2$.

compare	In mathematics when two entities (objects, shapes, curves, equations etc.) are compared one is looking for points of similarity and points of difference as far as mathematical properties are concerned. Example: compare $y = x$ with $y = x2$. Each equation represents a curve, with the first a straight line and the second a quadratic curve. Each passes through the origin, but on the straight line the values of y always increase from a negative to positive values as x increases, but on the quadratic curve the y-axis is an axis of symmetry and $y \geq 0$ for all values of x. The quadratic has a lowest point at the origin; the straight line has no lowest point
compasses (pair of)	An instrument for constructing circles and circular arcs and for marking points at a given distance from a fixed point.
compensation (in calculation)	A mental or written calculation strategy where one number is rounded to make the calculation easier. The calculation is then adjusted by an appropriate compensatory addition or subtraction. Examples: • 56 + 38 is treated as 56 + 40 and then 2 is subtracted to compensate. • 27 × 19 is treated as 27 × 20 and then 27 (i.e. 27 × 1) is subtracted to compensate. • 67 − 39 is treated as 67 − 40 and then 1 is added to compensate.
complement (in addition)	In addition, a number and its complement have a given total. Example: When considering complements in 100, 67 has the complement 33, since 67 + 33 = 100
composite shape	A shape formed by combining two or more shapes. 
conjecture	An educated guess (or otherwise!) of a particular result, which is as yet unverified.

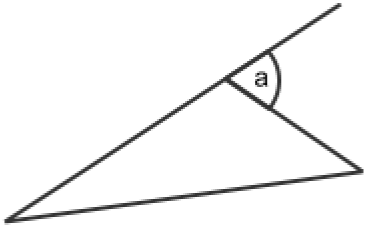
continuous data	Data arising from measurements taken on a continuous variable. Examples: lengths of caterpillars; weight of crisp packets. Continuous data may be grouped into touching but non-overlapping categories. Example: height of pupils [x cm] can be grouped into 130 ≤ x < 140; 140 ≤ x <150 etc. Compare with discrete data.
convert	Changing from one quantity or measurement to another. Example: from litres to gallons or from centimetres to millimitres etc.
coordinate	In geometry, a coordinate system is a system which uses one or more numbers, or coordinates, to uniquely determine the position of a point in space See cartesian coordinate system.
correspondence problems	Correspondence problems are those in which m objects are connected to n objects. Example: 3 hats and 4 coats, how many different outfits?; 12 sweets shared equally between 4 children; 4 cakes shared equally between 8 children.
cross-section	In geometry, a section in which the plane that cuts a figure is at right angles to an axis of the figure. Example: In a cube, a square revealed when a plane cuts at right angles to a face. 

cube	1. In geometry, a three-dimensional figure with six identical, square faces. Adjoining edges and faces are at right angles. 2. In number and algebra, the result of multiplying to power of three, n^3 is read as ‘n cubed’ or ‘n to the power of three’ Example: Written 2^3, the cube of 2 is (2 x 2 x 2) = 8.
cube number	A number that can be expressed as the product of three equal integers. Example: 27 = 3 × 3 × 3. Consequently, 27 is a cube number; it is the cube of 3 or 3 cubed. This is written compactly as 27 = 3^3, using index, or power, notation.
cubic centimetre	A unit of volume. The three-dimensional space equivalent to a cube with edge length 1cm. Symbol: cm^3.
cubic metre	A unit of volume. A three-dimensional space equivalent to a cube of edge length 1m Symbol: m^3..
curved surface	The curved boundary of a 3-D solid. Example: the curved surface of a cylinder between the two circular ends, or the curved surface of a cone between its circular base and its vertex, or the surface of a sphere.
decimal	Relating to the base ten. Most commonly used synonymously with decimal fractions where the number of tenths, hundredth, thousandths, etc. are represented as digits following a decimal point. The decimal point is placed at the right of the ones column. Each column after the decimal point is a decimal place. Example: The decimal fraction 0.275 is said to have three decimal places. The system of recording with a decimal point is decimal notation. Where a number is rounded to a required number of decimal places, to 2 decimal places for example, this may be recorded as 2 d.p.

decimal fraction	Tenths, hundredths, thousandths etc represented by digits following a decimal point. Example 0.125 is equivalent to 1/10 + 2/100 + 5/1000 or 125/1000 or 1/8. The decimal fraction representing 1/8 is a terminating decimal fraction since it has a finite number of decimal places. Other fractions such as 1/3 produce recurring decimal fractions. These have a digit or group of digits that is repeated indefinitely. In recording such decimal fractions a dot is written over the single digit, or the first and last digits of the group, that is repeated.
decimal system	The common system of numbering based upon powers of ten. <u>Example:</u> 152.34 is another way of writing $1 \times 10^2 + 5 \times 10^1 + 2 \times 10^0 + 3 \times 10^{-1} + 4 \times 10^{-2}$.
deductive reasoning	Deduction is typical mathematical reasoning where the conclusion follows necessarily from a set of premises (as far as the curriculum goes these are the rules of arithmetic and their generalisation in algebra, and the rules relating to lines, angles, triangles, circles etc. in geometry); if the premises are true then following deductive rules the conclusion must also be true.
degree	The most common unit of measurement for angle. One whole turn is equal to 360 degrees, written 360º See angle
degree of accuracy	A measure of the precision of a calculation, or the representation of a quantity. A number may be recorded as accurate to a given number of decimal places, or rounded to the nearest integer, or to so many significant figures.
denominator	In the notation of common fractions, the number written below the line i.e. the divisor. <u>Example:</u> In the fraction ⅔, the denominator is 3.

diagonal (of a polygon)	A line segment joining any two non-adjacent vertices of a polygon.  The line AB is one diagonal of this polygon.
diameter	Any of the chords of a circle or sphere that pass through the centre.
directed number	A number having a direction as well as a size e.g. -7, +10, etc. Such numbers can be usefully represented on a number line extending in both directions from zero.
discrete data	Data resulting from situations involving discrete variables Examples: value of coins in pupils' pockets; number of peas in a pod. Discrete data may be grouped. Example: Having collected the shoe sizes of pupils in the school, the data might be grouped into 'number of pupils with shoe sizes 3 – 5, 6 – 8, 9 – 11' etc.
dissection	To cut into parts.
distance between	A measure of the separation of two points. Example: A is 5 miles from B
divisibility	The property of being divisible by a given number. Example: A test of divisibility by 9 checks if a number can be divided by 9 with no remainder.

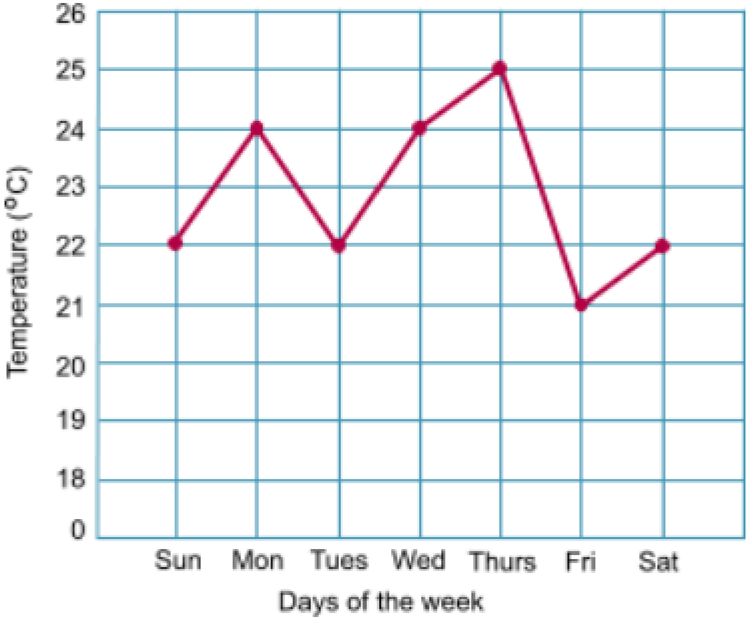
divisible (by)	A whole number is divisible by another if there is no remainder after division and the result is a whole number. Example: 63 is divisible by 7 because 63 ÷ 7 = 9 remainder 0. However, 63 is not divisible by 8 because 63 ÷ 8 = 7.875 or 7 remainder 7.
divisor	The number by which another is divided. Example: In the calculation 30 ÷ 6 = 5, the divisor is 6. In this example, 30 is the dividend and 5 is the quotient.
dodecahedron	A polyhedron with twelve faces. The faces of a regular dodecahedron are regular pentagons. A dodecahedron has 20 vertices and 30 edges.
efficient methods	A means of calculation (which can be mental or written) that achieves a correct answer with as few steps as possible. In written calculations this often involves setting out calculations in a columnar layout. If a calculator is used, the most efficient method uses as few key entries as possible.
equation	A mathematical statement showing that two expressions are equal. The expressions are linked with the symbol = Examples: $7 - 2 = 4 + 1$ $4x = 3$ $x^2 - 2x + 1 = 0$
equivalent expression	A numerical or algebraic expression which is the same as the original expression, but is in a different form which might be more useful as a starting point to solve a particular problem. Example: $6 + 10x$ is equivalent to $2(3 + 5x)$; 19 × 21 is equivalent to (20 – 1)(20 + 1) which is equivalent to 202 – 1 which equals 399. Equivalent expressions are identically equal to each other. Often a 3-way equals sign (≡) is used to denote ‘is identically equal to’.
evaluate	Find the value of a numerical or an algebraic expression. Examples: • Evaluate 28 ÷ 4 by calculating, 28 ÷ 4 = 7 • Evaluate $x^2 - 3$ when $x = 2$ by substituting this value for x and calculating, $2^2 - 3 = (2 \times 2) - 3 = 4 - 3 = 1$

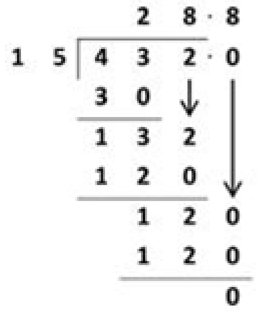
exchange	Change a number or expression for another of equal value. The process of exchange is used in some standard compact methods of calculation. Examples: ‘carrying figures’ in addition, multiplication or division; and ‘decomposition’ in subtraction.
expression	A mathematical form expressed symbolically. Examples: 7 + 3; $a^2 + b^2$.
exterior angle	Of a polygon, the angle formed outside between one side and the adjacent side produced. This is the angle that has to be turned at the vertex if you are travelling around a shape e.g. as in LOGO  The angle *a* is one exterior angle of this triangle.
factor	When a number, or polynomial in algebra, can be expressed as the product of two numbers or polynomials, these are factors of the first. Examples: 1, 2, 3, 4, 6 and 12 are all factors of 12 because 12 = 1 × 12 = 2 × 6 = 3 × 4; $(x – 1)$ and $(x + 4)$ are factors of $(x^2 + 3x − 4)$ because $(x – 1)(x + 4) = (x^2 + 3x – 4)$.

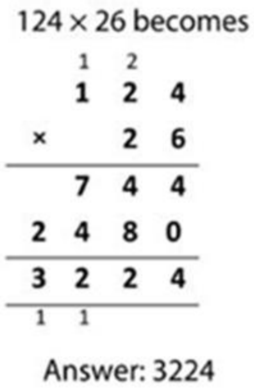
factorise	To express a number or a polynomial as the product of its factors. Examples: Factorising 12: 12 = 1 × 12 = 2 × 6 = 3 × 4 The factors of 12 are 1, 2, 3, 4, 6 and 12. 12 may be expressed as a product of its prime factors: 12 = 2 × 2 × 3 Factorising $x^2 - 4x - 21$: $x^2 - 4x - 21 = (x + 3)(x - 7)$ The factors of $x^2 - 4x - 21$ are $(x + 3)$ and $(x - 7)$
foot	An imperial measure of length. Symbol: ft. 1 foot = 12 inches. 3 feet = 1 yard. 1 foot is approximately 30 cm.
formal written methods	Setting out working in columnar form. In multiplication, the formal methods are called short or long multiplication depending on the size of the numbers involved. Similarly, in division the formal processes are called short or long division.
formula	An equation linking sets of physical variables. Example: $A=\pi r^2$ is the formula for the area of a circle. Plural: formulae.

gallon	An imperial measure of volume or capacity, equal to the volume occupied by ten pounds of distilled water. Symbol: gal. In the imperial system, 1 gallon = 4 quarts = 8 pints. One gallon is just over 4.5 litres.
graph	A diagram showing a relationship between variables. Adjective: graphical.
grid	A lattice created with two sets of parallel lines. Lines in each set are usually equally spaced. If the sets of lines are at right angles and lines in both sets are equally spaced, a square grid is created.
heptagon	A polygon with seven sides and seven edges.
highest common factor (HCF)	The common factor of two or more numbers which has the highest value. Example: • 16 has factors 1, 2, 4, 8, 16. • 24 has factors 1, 2, 3, 4, 6, 8, 12, 24. • 56 has factors 1, 2, 4, 7, 8, 14, 28, 56. The common factors of 16, 24 and 56 are 1, 2, 4 and 8. Their highest common factor is 8.
horizontal	Parallel to the horizon.
icosahedron	A polyhedron with 20 faces. In a regular Icosahedron all faces are equilateral triangles.
imperial unit	A unit of measurement historically used in the United Kingdom and other English speaking countries. Now largely replaced by metric units. Units include inch, foot, yard, mile, acre, ounce, pound, stone, hundredweight, ton, pint, quart and gallon.
improper fraction	An improper fraction has a numerator that is greater than its denominator. Example: 9/4 is improper and could be expressed as the mixed number 2¼

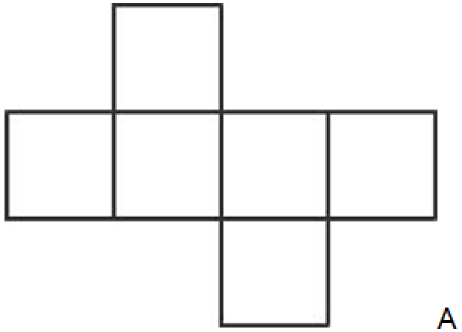
inch	An imperial unit of length. <u>Symbol:</u> in. 12 inches = 1 foot. 36 inches = 1 yard. 1 inch is approximately 2.54 cm. Unit of area is square inch, in^2. Unit of volume is cubic inch, in^3.
index notation	The notation in which a product such as a × a × a × a is recorded as a^4. In this example the number 4 is called the index (<u>plural:</u> indices) and the number represented by a is called the base. See also standard index form
integer	Any of the positive or negative whole numbers and zero. <u>Example:</u> …-2, -1, 0, +1, +2 … The integers form an infinite set; there is no greatest or least integer.
interior angle	At a vertex of a polygon, the angle that lies within the polygon.
interpret	Draw out the key mathematical features of a graph, or a chain of reasoning, or a mathematical model, or the solutions of an equation, etc.
interval [0,1]	All possible points in the closed continuous interval between 0 and 1 on the real number line, including the end points zero and 1.
isosceles triangle	A triangle in which two sides have the same length and consequently two angles are equal. This definition includes an equilateral triangle as a special case – i.e. an equilateral triangle is isosceles.

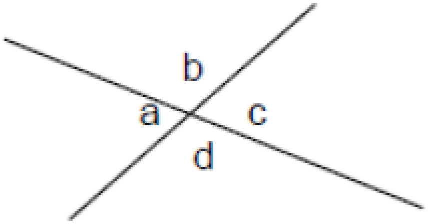
least common multiple (LCM)	The common multiple of two or more numbers, which has the least value. <u>Example:</u> • 3 has multiples 3, 6, 9, 12, 15, 18, 21, 24 … • 4 has multiples 4, 8, 12, 16, 20, 24 … • 6 has multiples 6, 12, 18, 24, 30 …. The common multiples of 3, 4 and 6 include 12, 24 and 36. The least common multiple of 3, 4 and 6 is 12.
level of accuracy	Often in reference to the number of significant figures with which a numerical quantity is recorded, and made more precise by stating the range of possible error. The degree of precision in the measurement of a quantity.
line graph	A graph in which adjacent points are joined by straight-line segments. Such a graph is better seen as giving a quick pictorial visualisation of variation between points rather than an accurate mathematical description of the variation between points. <u>Example:</u> 

long division	A columnar algorithm for division by more than a single digit, Example: 432 ÷ 15 becomes  Answer: 28·8 Why should one do division this way, when it can be done much more easily using a calculator? There are two reasons: a) it helps to understand the process, and can easily be generalised to algebraic division; b) calculators may go wrong, or may not be available, so the result has to be calculated ‘by hand’.

long multiplication	A columnar algorithm for performing multiplication by more than a single digit. Example:  124 × 26 becomes $\begin{array}{cccc} & {}^{1} & {}^{2} & \\ & 1 & 2 & 4 \\ \times & & 2 & 6 \\ \hline & 7 & 4 & 4 \\ 2 & 4 & 8 & 0 \\ \hline 3 & 2 & 2 & 4 \\ \hline {}^{1} & {}^{1} & & \end{array}$ Answer: 3224 Why should one do multiplication this way, when it can be done much more easily using a calculator? There are two reasons: a) it helps to understand the process, and can easily be generalised to algebraic multiplication; b) calculators may go wrong, or may not be available, so the result has to be calculated ‘by hand’.
mean	Often used synonymously with average. The mean (sometimes referred to as the arithmetic mean) of a set of discrete data is the sum of quantities divided by the number of quantities. Example: The arithmetic mean of 5, 6, 14, 15 and 45 is (5 + 6 + 14 + 15 + 45) ÷ 5 i.e. 17. More correctly called the arithmetic mean, as there are also other means in mathematics. See mode and median.
metric unit	Unit of measurement in the metric system. Metric units include metre, centimetre, millimetre, kilometre, gram, kilogram, litre and millilitre.
mile	An imperial measure of length. 1 mile = 1760 yards. 5 miles is approximately 8 kilometres.

milli-	Prefix. One-thousandth.
millilitre	One thousandth of a litre. Symbol: ml.
millimetre	One thousandth of a metre. Symbol: mm.
mixed fraction	A whole number and a fractional part expressed as a common fraction. Example: 1⅓ is a mixed fraction. Also known as a mixed number.
mixed number	A whole number and a fractional part expressed as a common fraction. Example: 2 ¼ is a mixed number. Also known as a mixed fraction.
natural number	The counting numbers 1, 2, 3, … etc. The positive integers. The set of natural numbers is usually denoted by N.
near double	See double.
negative integer	An integer less than 0. Examples: -1, -2, -3 etc.
negative number	1. A number less than zero. Example: − 0.25. Where a point on a line is labelled 0, negative numbers are all those to the left of the zero on a horizontal number line. 2. Commonly read aloud as ‘minus or negative one, minus or negative two’ etc. the use of the word ‘negative’ often used in preference to ‘minus’ to distinguish the numbers from operations upon them. See also directed number and positive number.

net	1. A plane figure composed of polygons which by folding and joining can form a polyhedron. Example:  A net of a cube 2. Remaining after deductions. Examples: The net profit is the profit after deducting all operating costs. The net weight is the weight after deducting the weight of all packaging.
numerator	In the notation of common fractions, the number written on the top – the dividend (the part that is divided). In the fraction ⅔, the numerator is 2.
obtuse angle	An angle greater than 90º but less than 180º.
octahedron	A polyhedron with eight faces. A regular octahedron has faces that are equilateral triangles.
operator	A mathematical action: In the lower key stages ‘half of’, ‘quarter of’, ‘fraction of’, ‘percentage of’ are considered as operations. In more advanced mathematics there are very many operators that can be defined, for example a ‘linear transformation’ or a ‘differential operator’.

opposite	1. In a triangle, an angle is said to be opposite a side if the side is not one of those forming the angle. 2. Angles formed where two line segments intersect. Example: In the diagram, a is opposite c and b is opposite d. Also called vertically opposite angles. 
order of magnitude	The approximate size, often given as a power of 10. Example of an order of magnitude calculation: 95 × 1603 ÷ 49 ≈ 10^2 × 16 × 10^2 ÷(5 × 10^1) ≈ 3 × 10^3
order of operation	This refers to the order in which different mathematical operations are applied in a calculation. Without an agreed order an expression such as 2 + 3 × 4 could have two possible values: • 2 + 3 = 5; 5 × 4 = 20 (if the operation of addition is applied first) • 3 x 4 = 12; 2 + 12 = 14 (if the operation of multiplication is applied first) The agreed order of operations is that: 1. If brackets are present, the operation contained therein always takes precedent over all others – (2 + 3) × 4 = 20 2. Powers or indices take precedent over multiplication or division – 2 × 3^2 = 18 not 36; 3. Multiplication or division takes precedent over addition and subtraction – 2 + 3 × 4 = 14 not 20 4. Where more than one multiplication & division, or addition and subtraction, is present, the convention is to work from left to right. This convention is often encapsulated in the mnemonic BODMAS or BIDMAS: Brackets Orders / Indices (powers) Division & Multiplication Addition & Subtraction
origin	A fixed point from which measurements are taken. See also Cartesian coordinate system.

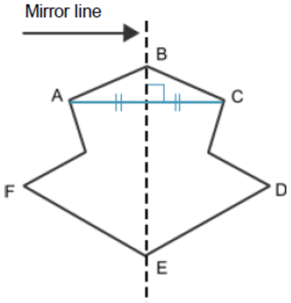
ounce	An imperial unit of mass. Symbol: oz. In the imperial system, 16 ounces = 1 pound. 1 ounce is just over 28 grams.
parallel	In Euclidean geometry, always equidistant. Parallel lines, curves and planes never meet however far they are produced or extended.
parallelogram	A quadrilateral whose opposite sides are parallel and consequently equal in length.
percentage	1. A fraction expressed as the number of parts per hundred and recorded using the notation %. Example: One half can be expressed as 50%; the whole can be expressed as 100% 2. Percentage can also be interpreted as the operator ‘a number of hundredths of’. Example: 15% of Y means 15/100 × Y Frequently, it is necessary to calculate a percentage increase, or a percentage decrease. Sometimes, given the result of an increase or decrease the original whole has to be calculated. Example 1: A salary of £24000 is increased by 5%; find the new salary. Calculation is £2400 × (1.05) = £25200. Example 2: The city population of 5 500 000 decreased by 13% over the last five years so that the present population is 5500000 × (0.87) = 4 785 000. (note: 1 – 13/100 = 0.87). Example 3: A sale item is on sale at £560 after a reduction of 20%, what was its original price? The calculation is: original price × 0.8 = £560. So, original price = £560/0.8 (since division is inverse to multiplication) = £700.
perimeter	The length of the boundary of a closed figure.`
perpendicular	A line or plane that is at right angles to another line or plane.
pie-chart	Also known as pie graph. A form of presentation of statistical information. Within a circle, sectors like ‘slices of a pie’ represent the quantities involved. The frequency or amount of each quantity is proportional to the angle at the centre of the circle.

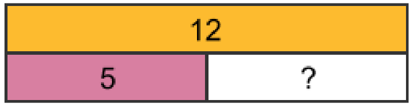
pint	An imperial measure of volume applied to liquids or capacity. In the imperial system, 8 pints = 4 quarts = 1 gallon. 1 pint is just over 0.5 litres.
plot	The process of marking points. Points are usually defined by coordinates and plotted with reference to a given coordinate system.
point	An element, in geometry, that has position but no magnitude.
polyhedron	A closed solid figure bounded by surfaces (faces) that are polygonal. Its faces meet in line segments called its edges. Its edges meet at points called vertices. <u>Plural:</u> polyhedra. For a polyhedron to be convex, it must lie completely to one side of a plane containing any face. If it is not convex it is concave. A regular polyhedron has identical regular polygons forming its faces and equal angles formed by its surfaces and edges. The Platonic Solids are the five possible convex regular polyhedra: tetrahedron with four equilateral-triangular faces; cube with six square faces; octahedron with eight equilateral-triangular faces; dodecahedron with twelve regular-pentagonal faces; and icosahedron with twenty equilateral-triangular faces.
pound (mass)	An imperial unit of mass <u>Symbol:</u> lb. In the imperial system, 14 lb = 1 stone. 1 lb is approximately 455 grams. 1 kilogram is approximately 2.2 lb.
power (of ten)	1. 100 (i.e. 10^2 or 10 x 10) is the second power of 10, 1000 (i.e.10^3 or 10 x 10 x 10) is the third power of 10 etc. Powers of other numbers are defined in the same way. Example: 2 (2^1), 4 (2^2), 8 (2^3), 16 (2^4) etc are powers of 2. 2. A fractional power represents a root. <u>Example:</u> $x^{½} = \sqrt{x}$ 3. A negative power represents the reciprocal. <u>Example:</u> $x^{-1} = 1/x$ 4. By convention any number or variable to the power 0 equals 1. i.e. $x^0 = 1$

prime factor	The factors of a number that are prime. Example: 2 and 3 are the prime factors of 12 (12 = 2 x 2 x 3). See also factor.
prime factor decomposition	The process of expressing a number as the product of factors that are prime numbers. Example: 24 = 2 × 2 × 2 × 3 or $2^3 \times 3$. Every positive integer has a unique set of prime factors.
prime number	A whole number greater than 1 that has exactly two factors, itself and 1. Examples: 2 (factors 2, 1), 3 (factors 3, 1). 51 is not prime (factors 51, 17, 3, 1).
priority of operations	Generally, multiplication and division are done before addition and subtraction, but this can be ambiguous, so brackets are used to indicate calculations that must be done before the remainder of the operations are carried out. See order of operation
proof	Using mathematical reasoning in a series of logical steps to show that if one mathematical statement is true then another that follows from it must be true. There are many forms of proof in mathematics, and some proofs are extremely complicated. Mathematics develops by using proof to develop evermore results that are true if certain basic axioms are accepted. Proof is fundamental to mathematics; it is important to be able to say that a result is true beyond any shadow of doubt. This power is unique to mathematics; no other discipline can do this. Example: Proof that the square of every even number is divisible by 4 Any even number by definition is divisible by 2, which means that every even number can be written as a multiple of 2. In symbols, this means that any even number has the form 2n, where n is some integer. Thus the square of this number is (2n) × (2n) and using the fact that multiplication is commutative this can be written as $2 \times 2 \times n \times n = 4 \times n^2 = 4n^2$ This is a multiple of 4 and so is divisible by 4.

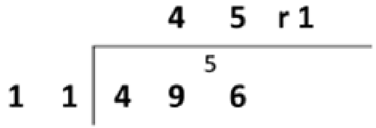
proper fraction	A proper fraction has a numerator that is less than its denominator. So ¾ is a proper fraction, whereas 4/3 is an improper fraction (i.e. not proper).
proportion	1. A part to whole comparison. Example: Where £20 is shared between two people in the ratio 3 : 5, the first receives £7.50 which is 3/8 of the whole £20. This is his proportion of the whole. 2. If two variables x and y are related by an equation of the form $y = kx$, then y is directly proportional to x; it may also be said that y varies directly as x. When y is plotted against x this produces a straight line graph through the origin. 3. If two variables x and y are related by an equation of the form $xy = k$, or equivalently $y = k/x$, where k is a constant and $x \neq 0$, $y \neq 0$ they vary in inverse proportion to each other
proportional reasoning	Using the mathematics and vocabulary of ratio, proportion and hence fractions and percentages to solve problems.
protractor	An instrument for measuring angles.
Prove	To formulate a chain of reasoning that establishes in conclusion the truth of a proposition. See proof.
quadrant	One of the four regions into which a plane is divided by the x and y axes in the Cartesian coordinate system.
radius	In relation to a circle, the distance from the centre to any point on the circle. Similarly, in relation to a sphere, the distance from the centre to any point on the surface of the sphere.
rate	A measure of how quickly one quantity changes in comparison to another quantity. Example: speed is a measure of how distance travelled changes with time; the average speed of a moving object is the total distance travelled/ time taken to travel that distance. Acceleration is a measure of the rate at which the speed of a moving object changes as time passes. The rate of inflation is a measure of the change in the buying power of money over a given time period.
ratio	A part to part comparison. The ratio of a to b is usually written a : b. Example: In a recipe for pastry fat and flour are mixed in the ratio 1 : 2 which means that the fat used has half the mass of the flour, that is amount of fat/amount of flour = ½. Thus ratios are equivalent to particular fractional parts.

ratio notation	a : b can be changed into the unitary ratio 1 : b/a , or the unitary ratio a/b : 1. Any ratio is also unchanged if any common factors can be divided out.
rational number	A number that is an integer or that can be expressed as a fraction whose numerator and denominator are integers, and whose denominator is not zero. Examples: − 1, ⅓, 3/5, 9, 235. Rational numbers, when expressed as decimals, are recurring decimals or finite (terminating) decimals. Numbers that are not rational are irrational. Irrational numbers include √5 and π which produce infinite, non-recurring decimals.
rectilinear	Bounded by straight lines. A closed rectilinear shape is also a polygon. A rectilinear shape can be divided into rectangles and triangles for the purpose of calculating its area.
recurring decimal	A decimal fraction with an infinitely repeating digit or group of digits. Example: The fraction ⅓ is the decimal 0.33333 …, referred to as nought point three recurring and may be written as 0.3 (with a dot over the three). Where a block of numbers is repeated indefinitely, a dot is written over the first and last digit in the block e.g. 1/7 = 0.˙142857˙
reflection	In 2-D, a transformation of the whole plane involving a mirror line or axis of symmetry in the plane, such that the line segment joining a point to its image is perpendicular to the axis and has its midpoint on the axis. A 2-D reflection is specified by its mirror line.

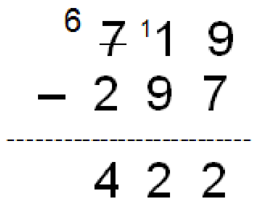
reflection symmetry	A 2-D shape has reflection symmetry about a line if an identical-looking object in the same position is produced by reflection in that line. <u>Example:</u>  In the shape ABCDEF, the mirror line runs through B and E. The part shape BCDE is a reflection of BAFE. Point A reflects onto C and F onto D. The mirror line is the perpendicular bisector of AC and of FD.
reflex angle	An angle that is greater than 180º but less than 360º.
regular	1. Describing a polygon, having all sides equal and all internal angles equal. 2. Describing a tessellation, using only one kind of regular polygon. <u>Examples:</u> squares, equilateral triangles and regular hexagons all produce regular tessellations.
remainder	In the context of division requiring a whole number answer (quotient), the amount remaining after the operation. <u>Example:</u> 29 divided by 7 = 4 remainder 1.

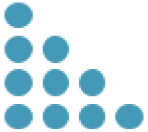
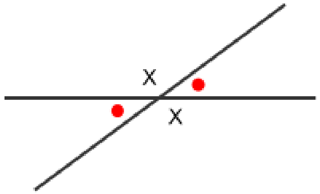
representation	The word ‘representation’ is used in the curriculum to refer to a particular form in which the mathematics is presented, so for example a quadratic function could be expressed algebraically or presented as a graph; a quadratic expression could be shown as two linear factors multiplied together or the multiplication could be expanded out; a probability distribution could be presented in a table or represented as a histogram, and so on. Very often, the use of an alternative representation can shed new light on a problem. An array is a useful representation for multiplication and division which helps to see the inverse relationship between the two. The Bar Model is a useful representation of for many numerical problems. e.g. Tom has 12 sweet and Dini has 5. How many more sweets does Tom have than Dini? 
rhombus	A parallelogram with all sides equal.
right	Used as an adjective, right-angled or erect. <u>Example:</u> In a right cylinder the centre of one circular base lies directly over the centre of the other.
right angle	One quarter of a complete turn. An angle of 90 degrees. An acute angle is less than one right angle. An obtuse angle is greater than one right angle but less than two. A reflex angle is greater than two right angles.

Roman numerals	The Romans used the following capital letters to denote cardinal numbers: I for 1; V for 5; X for 10; L for 50; C for 100; D for 500; M for 1000. Multiples of one thousand are indicated by a bar over a letter, so for example V with a bar over it means 5000. Other numbers are constructed by forming the shortest sequence with this total, with the proviso that when a higher denomination follows a lower denomination the latter is subtracted from the former. <u>Examples:</u> III =3; IV = 4; XVII =17; XC = 90; CX =110; CD = 400; MCMLXXII = 1972. A particular feature of the Roman numeral system is its lack of a symbol for zero and, consequently, no place value structure. As such it is very cumbersome to perform calculations in this number system.
rotation symmetry	1. A 2-D shape has rotation symmetry about a point if an identical-looking shape in the same position is produced by a rotation through some angle greater than 0º and less than 360º about that point. 2. A 2-D shape with rotation symmetry has rotation symmetry of order n when n is the largest positive integer for which a rotation of 360º/n produces an identical-looking shape in the same position. 3. A rotation of 360º, about any centre whatever, produces an identical-looking shape in the same position for all 2-D shapes including those without rotation symmetry. For this reason it is true, though not very informative, to say that the order of rotation symmetry is 1 for shapes that do not have rotation symmetry.
round (verb)	In the context of a number, express to a required degree of accuracy. <u>Example:</u> 543 rounded to the nearest 10 is 540.
sample	A subset of a population. In handling data, a sample of observations may be made from which to draw inferences about a larger population.

scale (verb)	To enlarge or reduce a number, quantity or measurement by a given amount (called a scale factor). <u>Example:</u> to have 3 times the number of people in a room than before; to find a quarter of a length of ribbon; to find 75% of a sum of money.
scale factor	For two similar geometric figures, the ratio of corresponding edge lengths.
scalene triangle	A triangle with no two sides equal and consequently no two angles equal.
set square	A drawing instrument for constructing parallel lines, perpendicular lines and certain angles. A set square may have angles 90º, 60º, 30º or 90º, 45º, 45º.
short division	A compact written method of division. <u>Example:</u> 496 ÷ 11 becomes  Answer: 45 1/11 (Example taken from Appendix 1 of the Primary National Curriculum for Mathematics)

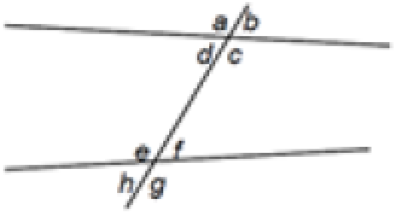
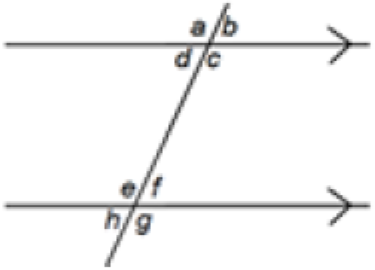
short multiplication	Essentially, simple multiplication by a one digit number, with the working set out in columns. Example: 342 x 7 becomes $\begin{array}{cccc} & 3 & 4 & 2 \\ \times & & & 7 \\ \hline 2 & 3 & 9 & 4 \\ \hline & {\scriptstyle 2} & {\scriptstyle 1} & \end{array}$ Answer: 2394 (Example taken from Appendix 1 of the Primary National Curriculum for Mathematics)
simplify (a fraction)	Reduce a fraction to its simplest form. See cancel (a fraction) and reduce (a fraction).
sphere	A closed surface, in three-dimensional space, consisting of all the points that are a given distance from a fixed point, the centre. A hemi-sphere is a half-sphere. Adjective: spherical
square centimetre	A unit of area. A square measuring 1 cm by 1 cm. Symbol: cm^2. 10000 cm^2 = 1 m^2
square metre	A unit of area. A square measuring 1m by 1 m. Symbol: m^2.

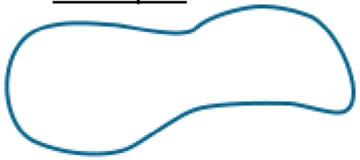
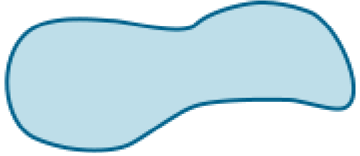
square millimetre	A unit of area. a square measuring 1 mm by 1 mm. Symbol: mm^2 One-hundredth part of a square centimetre and one-millionth part of a square metre.
square number	A number that can be expressed as the product of two equal numbers. Example: 36 = 6 x 6 and so 36 is a square number or “6 squared”. A square number can be represented by dots in a square array.
subtraction by decomposition	A method of calculation used in subtraction and particularly linked with one of the main columnar methods for subtraction. In this method the number to be subtracted from (the minuend) is re-partitioned, if necessary, in order that each digit of the number to be subtracted (the subtrahend) is smaller than its corresponding digit in the minuend. Example: in 739 – 297, only the digits in the hundreds and the ones columns are bigger in the minuend than the subtrahend. By re-partitioning 739 into 6 hundreds, 13 tens and 9 ones, each separate subtraction can be performed simply, i.e.: 9 – 7 13 (tens) – 9 (tens) and 6 (hundreds) – 2 (hundreds). 
terminating decimal	A decimal fraction that has a finite number of digits. Example: 0.125 is a terminating decimal. In contrast ⅓ is a recurring decimal fraction. All terminating decimals can be expressed as fractions in which the denominator is a multiple of 2 or 5.

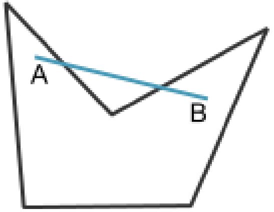
tetrahedron	A solid with four triangular faces. A regular tetrahedron has faces that are equilateral triangles. Plural: tetrahedra
translation	A transformation in which every point of a body moves the same distance in the same direction. A transformation specified by a distance and direction (vector).
trapezium	A quadrilateral with exactly one pair of sides parallel.
triangular number	1. A number that can be represented by a triangular array of dots with the number of dots in each row from the base decreasing by one. Example:  The triangular number 10 represented as a triangular array of dots. 2. A number in the sequence 1, 1 + 2, 1 + 2 + 3, 1 + 2 + 3 + 4 etc. 55 is a triangular number since it can be expressed as, 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10.
Vertically opposite angles	The pair of equal angles between two intersecting straight lines. There are two such pairs of vertically opposite angles 
vulgar fraction	A fraction in which the numerator and denominator are both integers. Also known as common fraction or simple fraction.

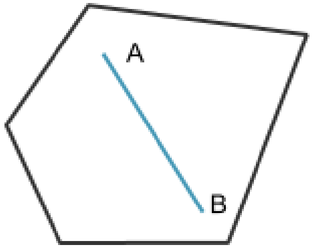
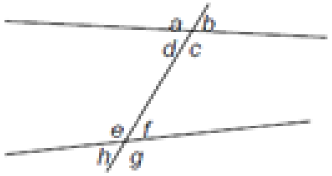
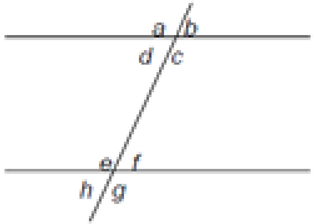
yard	An imperial measure of length. Symbol: yd. In relation to other imperial units of length, 1 yard = 3 feet = 36 inches. 1760yd. = 1 mile. One yard is approximately 0.9 metres.

Key Stage 3

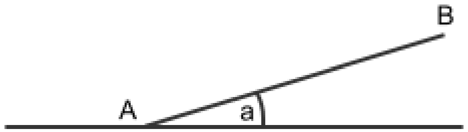
alternate angles	Where two straight lines are cut by a third, as in the diagrams, the angles d and f (also c and e) are alternate. Where the two straight lines are parallel, alternate angles are equal.  
arc	A portion of a curve. Often used for a portion of a circle.
bisect	In geometry, to divide into two equal parts.
bisector	A point, line or plane that divides a line, an angle or a solid shape into two equal parts. A perpendicular bisector is a line at right angles to a line-segment that divides it into two equal parts.
bivariate	Involving two random variables; used in statistics as a bivariate distribution.
cancel (a fraction)	One way to simplify a fraction down to its lowest terms. The numerator and denominator are divided by the same number. <u>Example:</u> 4/8 = 2/4. Also to 'reduce' a fraction. <u>Note:</u> when the numerator and denominator are both divided by their highest common factor, the fraction is said to have been cancelled down to give the equivalent fraction in its lowest terms. e.g.18/30 = 3/5 (dividing numerator and denominator by 6)
chord	A straight line segment joining two points on a circle or other curve.

closed	1. Of a curve (often in a plane), continuous and beginning and ending at the same point. Example:  2. A closed region consists of a closed curve and all the points contained within it. Example: 
coefficient	Often used for the numerical coefficient. More generally, a factor of an algebraic term. Example: in the term 4xy, 4 is the numerical coefficient of xy but x is also the coefficient of 4y and y is the coefficient of 4x. Example: in the quadratic equation $3x^2 + 4x – 2$, the coefficients of x^2 and x are 3 and 4 respectively
combined events	A combined (or compound) event is an event that includes several outcomes. Example: in selecting people at random for a survey a compound event could be ‘girl with brown eyes’.
compare	In mathematics when two entities (objects, shapes, curves, equations etc.) are compared, one is looking for points of similarity and points of difference as far as mathematical properties are concerned. Example: compare y = x with y = x2. Each equation represents a curve, with the first a straight line and the second a quadratic curve. Each passes through the origin, but on the straight line the values of y always increase from a negative to positive values as x increases, but on the quadratic curve the y-axis is an axis of symmetry and $y \geq 0$ for all values of x. The quadratic has a lowest point at the origin; the straight line has no lowest point

complementary angles	Two angles which sum to 90º. Each is the ‘complement’ of the other.
compound measures	Measures with two or more dimensions. Examples: speed calculated as distance ÷ time; density calculated as mass ÷ volume; car efficiency measured as litres per 100 kilometres; and rate of inflation measured as percentage increase in prices over a certain time period.
compound interest	See simple interest
concave	Curving inwards. A concave polygon has at least one re-entrant angle i.e. one interior angle greater than 180º. A line segment joining two points within the polygon may pass outside it. Example: A concave pentagon. The line segment, joining points A and B within the polygon, passes outside it. 
concentric	Used to describe circles in a plane that have the same centre.
congruent (figures)	Two or more geometric figures are said to be congruent when they are the same in every way except their position in space. Example: Two figures, where one is a reflection of the other, are congruent since one can be transposed onto the other without changing any angle or edge length.
congruent triangles	Two triangles are congruent if one can be exactly superimposed on the other. In practice, this may not be possible, but it is always true that two triangles are congruent if one of these conditions hold: • the lengths of the three sides of one triangle equal the lengths of the three sides of the other (the SSS condition) • each triangle has a right angle, their hypotenuses are equal and one other side is equal (the RHS condition) • the lengths of two sides and the angle between them are the same for the two triangles (the SAS condition) • the length of one side and the angles between this side and the other two sides are the same for both triangles (the ASA condition).

constant	A number or quantity that does not vary. <u>Example:</u> in the equation $y = 3x + 6$, the 3 and 6 are constants, where x and y are variables.
convex	Curved outwards. A convex polygon has all its interior angles less than or equal to 180º. The line segment joining any two points, A and B, inside a convex polygon will lie entirely within it. <u>Example:</u> Convex polygon (pentagon). For a polyhedron to be convex, it must lie completely to one side of a plane containing any face.  Compare with concave
correlation	A measure of the strength of the association between two variables. High correlation implies a close relationship and low correlation a less close one. If an increase in one variable results in an increase in the other, then the correlation is positive. If an increase in one variable results in a decrease in the other, then the correlation is negative. The term zero correlation does not necessarily imply ‘no relationship’ but merely ‘no linear relationship’
corresponding angles	Where two straight-line segments are intersected by a third, as in the diagrams, the angles a and e are corresponding. Similarly b and f, c and g and d and h are corresponding. Where parallel lines are cut by a straight line, corresponding angles are equal.  

cosine	See trigonometric functions
cube root	A value or quantity whose cube is equal to a given quantity. Example: the cube root of 8 is 2 since $2^3 = 8$. This is recorded as $^3\sqrt{8} = 2$ or $8^{1/3} = 2$
cubic	A mathematical expression of degree three; the highest total power that appears in this expression is power 3. Examples: a cubic polynomial is one of the type $ax^3 + bx^2 + cx + d$; x^2y is an expression of degree 3.
cubic curve	A curve with an algebraic equation of degree three.
cumulative frequency diagram	A graph for displaying cumulative frequency. At a given point on the horizontal axis the sum of the frequencies of all the values up to that point is represented by a point whose vertical coordinate is proportional to the sum.
cyclic quadrilateral	A four sided figure whose vertices lie on a circle.
density	A measure of mass per unit volume, which is calculated as total mass ÷ total volume. If mass is measured in kilograms and volume is measured in cubic metres then density is measured in the compound units of kg m^{-3} or kg/m^3
direct proportion	Two variables x and y are in direct proportion if the algebraic relation between them is of the form $y = kx$, where k is a constant. The graphical representation of this relationship is a straight line through the origin, and k is the gradient of the line.
disc	In geometry, a disc is the region in a plane bounded by a circle The area of a disc of radius (r) is πr^2.
distribution	For a set of data, the way in which values in the set are distributed between the minimum and maximum values.

elevation	1. The vertical height of a point above a base (line or plane). 2. The angle of elevation from one point A to another point B is the angle between the line AB and the horizontal line through A. Example: in the diagram, the angle a is the angle of elevation of point B from point A.  3. See projection
empty set	The set with no members, often denoted by the symbol Ø. Example: the set of pupils in our class older than 20 or the set of square numbers with an even number of factors are empty sets.
enlargement	A transformation of the plane in which lengths are multiplied whilst directions and angles are preserved. A centre and a positive scale factor are used to specify an enlargement. The scale factor is the ratio of the distance of any transformed point from the centre to its distance from the centre prior to the transformation. Any figure and its image under enlargement are similar.
equal class interval	See grouped (discrete) data.
equally likely	In an experiment (trial in statistics) the result is the outcome. Two outcomes are equally likely if they have the same theoretical probability of occurrence. Example: when an unbiased coin is tossed, the two outcomes ‘head’ or ’tail’ are equally likely.

equivalent expression	A numerical or algebraic expression which is the same as the original expression, but is in a different form which might be more useful as a starting point to solve a particular problem. Example: 6 + 10x is equivalent to 2(3 + 5x); 19 × 21 is equivalent to (20 – 1)(20 + 1) which is equivalent to $20^2 - 1$ which equals 399. Equivalent expressions are identically equal to each other. Often a 3-way equals sign (≡) is used to denote 'is identically equal to'.
error	1. The difference between an accurate calculation and an approximate calculation or estimate; the difference between an exact representation of a number and an approximation to it obtained by rounding or some other process. In a calculation, if all numbers are rounded to some degree of accuracy the errors become more significant. 2. A mistake
event	A possible outcome of a statistical trial. Example: 'heads' when a coin is tossed. A compound (or combined) event is an event that includes several outcomes. Example: in selecting people at random for a survey a compound event could be 'girl with brown eyes'.

exponent	• Also known as index, a number, positioned above and to the right of another (the base), indicating repeated multiplication when the exponent is a positive integer. Example 1: n^2 indicates n × n; and ‘n to the (power) 4’, that is n^4 means n × n × n × n. Example 2: since $2^5 = 32$ we can also think of this as ’32 is the fifth power of 2’. Any positive number to power 1 is the number itself; $x^1 = x$, for any positive value of x. • Exponents may be negative, zero, or fractional. Negative integer exponents are the reciprocal of the corresponding positive integer exponent. Example: $2^{-1} = ½$. • Any positive number to power zero equals 1: $x^0 = 1$, for any positive value of x. • The positive unit fractional powers represent roots, which are the inverse to the corresponding integer powers. Example: $8^{1/3} = \sqrt[3]{8} = 2$, since $2^3 = 8$ Note: Power notation is not used for zero, since division by zero is undefined.
exponential (function)	A function having variables expressed as exponents or powers. Example: $y = 2^x$ is an exponential function
frequency table	A table for displaying a set of observations showing how frequently each event or quantity occurs in a statistical trial. This is an example of a frequency distribution, which sometimes can also be represented algebraically or graphically.
function	A function is a relation between a set of inputs and a set of permissible outputs with the property that each input is related to exactly one output. Example: The function that relates each real number x to its square x^2. The output of a function f corresponding to an input x is denoted by f(x) (read "f of x"). In this example, if the input is −3, then the output is 9, and we may write $f(-3) = 9$.
functional relationship	See function.

geometric sequence	A series of terms in which each term is a constant multiple of the previous term (known as the common ratio) is called a geometric sequence, sometimes also called a geometric progression. Example 1: 1, 5, 25, 125, 625,…, where the constant multiplier is 5. Example 2: 1, -3, 9, -27, 81,…, where the constant multiplier is -3. A geometric sequence may have a finite number of terms or it may go on forever, in which case it is an infinite geometric sequence. In an infinite geometric sequence with a common ratio strictly between zero and one all the terms add to a finite sum.
gradient	A measure of the slope of a line. On a coordinate plane, the gradient of the line through the points (x1, y1) and (x2, y2) is defined as (y2 – y1) / (x2 – x1). The gradient may be positive, negative or zero depending on the values of the coordinates.
grouped (discrete) data	Observed data arising from counts and grouped into non-overlapping intervals. Example: score in test / number of children obtaining the scores 1 – 10, 11 – 20, 21 – 30, 31 – 40, 41 – 50 etc. In this example there are equal class intervals.
identity	An equation that holds for all values of the variables. The symbol ≡ is used. Example: $a^2 - b^2 \equiv (a + b)(a - b)$.
index laws	Where index notation is used and numbers raised to powers are multiplied or divided, the rules for manipulating index numbers. Examples: $2^a \times 2^b = 2^{a+b}$ and $2^a \div 2^b = 2^{a-b}$
inscribed	Describing a figure enclosed by another. Examples: a polygon, whose vertices lie on the circumference of a circle, is said to be inscribed in the circle. Where a circle is drawn inside a polygon so that the sides of the polygon are tangents to the circle, the circle is inscribed in the polygon. (In this case the circle is the ‘incircle’ of the polygon.)

intercept	1. To cut a line, curve or surface with another. 2. In the Cartesian coordinate system, the positive or negative distance from the origin to the point where a line, curve or surface cuts a given axis. OR On a graph, the value of the non-zero coordinate of the point where a line cuts an axis.
intersect	To have a common point or points. <u>Examples:</u> Two intersecting lines intersect at a point; two intersecting planes intersect in a line.
intersection of sets	The elements that are common to two or more sets.
inverse proportion	Two variables x and y are inversely proportional if the algebraic relation between them is of the form $xy = k$, where k is a constant; an alternative form of the equation is $y = k/x$ The relations are valid for $x \neq 0$ and $y \neq 0$. In the graph of this function the constraints on x and y indicate that both the x-axis and the y-axis are asymptotes to the curve. If y is inversely proportional to x then y is directly proportional to $1/x$. When x is inversely proportional to y then when x is doubled, y is halved, when x is multiplied by 10, y is divided by 10.
irrational number	A number that is not an integer and cannot be expressed as a common fraction with a non-zero denominator. <u>Examples:</u> $\sqrt{3}$ and π. Real irrational numbers, when expressed as decimals, are infinite, non-recurring decimals.
line of best fit	A line drawn on a scatter graph to represent the best estimate of an underlying linear relationship between the variables.
linear	In algebra, describing an expression or equation of degree one. <u>Example:</u> $2x + 3y = 7$ is a linear equation. All linear equations can be represented as straight line graphs.

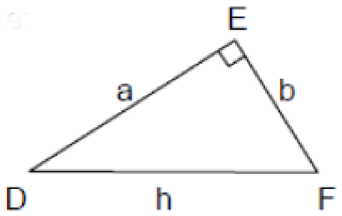
many-to-one correspondence	A way of describing a function y = f(x), where a value of y is associated with more than one value of x. Example: given the quadratic curve defined by $y = x^2$, the value y = 4 is associated with x = 2 and x = −2, since $2^2 = (-2)^2 = 4$. Other examples include the sine and cosine functions. A less numerical or algebraic example might be mapping the inhabitants of a house to the address of the house, or mapping a particular birthday to a large group of people at a gathering.
(mathematical) model	A mathematical model describes the behaviour of some system (which could be, for example, a physical system or something more abstract such as economic behaviour and so on) through a set of equations or some other mathematics; predictions based on the model can be tested against reality to see how good the 'model' actually is. Mathematics is extremely important in understanding how our world works. The use of models in a vast number of areas from aircraft design, to computer simulations, to survey analysis, to weather forecasting, to studying the rates of absorption of medicines into living tissue, to forensic science, to architecture, to communications and to an unending list, relies completely on developing appropriate mathematical models which allow future behaviour to be predicted, or past behaviour to be understood.
measure of central tendency	In statistics, a measure of how the values of a particular variable are located in terms of the values collected for a particular sample, or for the relevant population as a whole. In school mathematics up to key stage 4, there are three important measures of central tendency; the (arithmetic) mean, the median and the mode. These are all statistical averages and often one is more useful than another, depending on the spread of the values under consideration.

median	The middle number or value when all values in a set of data are arranged in ascending order. When there is an even number of values, the arithmetic mean of the two middle values is calculated. Examples: • The median of 5, 6, 14, 15 and 45 is 14. • The median of 5, 6, 7, 8, 14 and 45 is (7 + 8) ÷ 2 i.e. 7.5. The median is one example of an average. See also mean, arithmetic mean and mode.
mode	The most commonly occurring value or class with the largest frequency. Example: the mode of the data 2, 3, 3, 3, 4, 4, 5, 5, 6, 7, 8 is 3 Some sets of data may have more than one mode.
moving average	The mean of a set of adjacent observations of fixed size is taken. The mean is calculated for successive sets of the same size to give the moving average. Example: the moving average of six-month sales may be computed by taking the average of sales from January to June, then the average of sales from February to July, then of March to August, and so on.
mutually exclusive events	In probability, events that cannot both occur in one experiment. When the mutually exclusive events cover all possible outcomes the sum of their probabilities is 1.
nth term of a sequence	This is the name for the term that is in the nth position starting the count of terms from the first term. The nth term is sometimes represented by the symbol U_n.
orientation	How a line segment or other geometric shape is positioned with respect to a coordinate system.

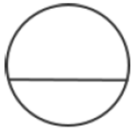
outcome	The result of a statistical trial. Example: when a coin is tossed there are two possible outcomes 'head' or 'tail'; when a cubic die is cast there are six possible outcomes if there is a different score on each face. What is meant as the outcome is dependent on what the trial sets out to do, Example: when two normal six-faced dice are rolled if the desired outcomes are the total scores on the two dice then the only possible outcomes are the scores 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12. These scores are not equally likely because the total may occur in different ways with different frequencies.
outlier	In statistical samples, an outlier is an exceptional trial result that lies beyond where most of the results are clustered. Example: Six people have the following salaries - £20000, £25600, £2000, £19000, £30000, £160000. The salary of £160000 is clearly out of line with the others and is an outlier. At the other end, £2000 is also well below the central cluster of values and so may also be considered as an outlier.
perpendicular distance	Given a point P and a line AB, the perpendicular distance of P from AB is the length of the perpendicular PN from the point meeting the line at N.
Pi	The ratio of the circumference of a circle to the length of its diameter is a constant called Pi. π is an irrational number and so cannot be written as a finite decimal or as a fraction. Symbol: π. One common approximation for π is 22/7 3.14159265 is a more accurate approximation, to 8 decimal places.
piece-wise linear function	A function that consists of number of straight line functions that have discontinuities (breaks) at certain points. Example: the integer function y =[x], which represents the greatest integer less than or equal to x. At each integer value of x there is a discontinuity as the function jumps to the next integer value.
plan	A 2-dimensional diagram of a 3-dimensional object, usually the view from directly above.

plane	A flat surface. A line segment joining any two points in the surface will also lie in the surface.
polynomial function	A function of the form $f(x) = a_n X^n + a_{n-1} X^{n-1} + a_{n-2} X^{n-2} + \dots + a_1X + a_0$ is a polynomial of order n
position-to-term rule	In a sequence, a rule that defines the value of each term with respect to its position. <u>Example:</u> the nth term of a sequence is defined by the relation $U_n = 2n + 3$. Then the terms of the sequence are: • first term, $U_1 = 2 \times 1 + 3 = 5$ • second term, $U_2 = 2 \times 2 + 3 = 7$ • third term, $U_3 = 2 \times 3 + 3 = 9$ • the hundredth term, $U_{100} = 2 \times 100 + 3 = 203$
probability	The likelihood of an event happening. Probability is expressed on a scale from 0 to 1. Where an event cannot happen, its probability is 0 and where it is certain its probability is 1. The probability of scoring 1 with a fair dice is 1/6. The denominator of the fraction expresses the total number of equally likely outcomes. The numerator expresses the number of outcomes that represent a ‘successful’ occurrence. Where events are mutually exclusive and exhaustive the total of their probabilities is 1.
probability scale	This is a scale between zero and 1, with zero representing the impossibility of an event and 1 representing the fact that the event must happen. The sum of all the probabilities for all the events in a sample space is 1, where the sample space is the set of all possible outcomes of a trial.
projection	A mapping of points on a 3-dimensional geometric figure onto a plane according to a rule. <u>Example:</u> A map of the world is a projection of some type such as Mercator’s projection. Plan and elevation are vertical and horizontal mappings.

proof	Using mathematical reasoning in a series of logical steps to show that if one mathematical statement is true then another that follows from it must be true. There are many forms of proof in mathematics, and some proofs are extremely complicated. Mathematics develops by using proof to develop evermore results that are true if certain basic axioms are accepted. Proof is fundamental to mathematics; it is important to be able to say that a result is true beyond any shadow of doubt. This power is unique to mathematics; no other discipline can do this. <u>Example:</u> Proof that the square of every even number is divisible by 4 Any even number by definition is divisible by 2, which means that every even number can be written as a multiple of 2. In symbols, this means that any even number has the form 2n, where n is some integer. Thus the square of this number is (2n) × (2n) and using the fact that multiplication is commutative this can be written as $2 \times 2 \times n \times n = 4 \times n^2 = 4n^2$ This is a multiple of 4 and so is divisible by 4.
proportion	1. A part to whole comparison. <u>Example:</u> Where £20 is shared between two people in the ratio 3 : 5, the first receives £7.50 which is 3/8 of the whole £20. This is his proportion of the whole. 2. If two variables x and y are related by an equation of the form y = kx, then y is directly proportional to x; it may also be said that y varies directly as x. When y is plotted against x this produces a straight line graph through the origin. 3. If two variables x and y are related by an equation of the form xy = k, or equivalently y = k/x, where k is a constant and x ≠ 0, y ≠ 0 they vary in inverse proportion to each other.
prove	To formulate a chain of reasoning that establishes in conclusion the truth of a proposition. See proof.

Pythagoras' theorem	In a right-angled triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the other sides i.e. the sides that bound the right angle. Example: When ∠DEF is a right angle, $a^2 + b^2 = h^2$ 
quadratic	Describing an expression of the form $ax^2 + bx + c$ where a, b and c are real numbers. The function $y = ax^2 + bx + c$ is a quadratic function; its graph is a parabola.
qualitative	Relating to a quality or attribute.
quantitative	Relating to quantity or amount.
random sample	In statistics, a selection from a population where each sample of this size has an equal chance of being selected.
random variable	In statistics, a discrete or continuous quantity which can take on a range of values each of which has a certain probability of occurrence. Example: the ages of a group of people (continuous), or the number of pets in different households (discrete).
range	A measure of spread in statistics. The difference between the greatest value and the least value in a set of numerical data.
raw data	Data as they are collected, unprocessed.
reduce (a fraction)	Divide the numerator and denominator by a common factor. To cancel a fraction. Example: divide the numerator and denominator by 5, to reduce 5/15 to ⅓, its simplest form.

RHS	1. Abbreviation for ‘right angle, hypotenuse, side’ describing one of the sets of conditions for congruence of two triangles. 2. Also sometimes used as an abbreviation for ‘right hand side; when referring to equations.
sample space	The sample space is the set of all possible outcomes of a trial. The sum of all the probabilities for all the events in a sample space is 1.
scale drawing or model	An accurate drawing, or model, of a representation of a physical object in which all lengths in the drawing are in the same ratio to corresponding lengths in the actual object (depending on whether the object exists in a plane or in 3 dimensions). Most maps are scaled drawings of some physical region. If the ratio of map distance to location distance is known any distance on the map can be converted to actual distance in the region represented by the map.
scatter graph	A graph on which paired observations are plotted and which may indicate a relationship between the variables. <u>Example:</u> The heights of a number of people could be plotted against their arm span measurements. If height is roughly related to arm span, the points that are plotted will tend to lie along a line.
section (plane section)	A plane geometrical configuration formed by cutting a solid figure with a plane. <u>Example:</u> A section of a cube could be a triangle, quadrilateral, pentagon or hexagon according to the direction of the plane cutting it.
sector	The region within a circle bounded by two radii and one of the arcs they cut off. <u>Example:</u>  The smaller of the two sectors is the minor sector and the larger one the major sector.

segment	The part of a line between two points. Within a circle, the region bound by an arc and the chord joining its two end points. Example:  The smaller of the two regions, is the minor segment and the larger is the major segment.
sign change key	The function key **+/−** of a calculator that changes a positive value to negative or vice versa.
significant figures	The run of digits in a number that are needed to specify the number to a required degree of accuracy. Additional zero digits may also be needed to indicate the number's magnitude. Examples: To the nearest thousand, the numbers 125 000, 2 376 000 and 22 000 have 3, 4 and 2 significant figures respectively; to 3 significant figures 98.765 is written 98.8
simple interest	In savings (or loans) banks pay (or charge) interest on the amount invested (or borrowed). An interest rate is usually specified, and this is applied at specified periods, for example annually. The simple interest is what is added to the savings (loan) at the end of the specified period. Example: a saver invests £10000 in a savings account that gives 1% interest per year. At the end of the year the simple interest is 1% of £10000 = £10000 × 1/100 = £100. Usually, this is then added to the original £10000, so that the amount now invested is £10100. When interest is added over and over again in this way it is called compound interest.
simultaneous equations	Two linear equations that apply simultaneously to given variables. The solution to the simultaneous equations is the pair of values for the variables that satisfies both equations. The graphical solution to simultaneous equations is a point where the lines representing the equations intersect. Example: $x + y = 6$ and $y = 2x$ is a set of simultaneous equations. The solution is the value of x and y which satisfies both simultaneously – i.e. $x = 2$ and $y = 4$
sine	See trigonometric functions

speed	A measure of how the distance travelled by a moving object changes with time. The average speed of a moving object is defined as the total distance travelled/ time taken to travel that distance. The units of speed are length/ time, for example kilometres per hour, or metres per second.
spread	In a series of measurements of a particular variable, the spread is the difference between the lowest value and the highest value of the variable.
square root	A number whose square is equal to a given number. <u>Example:</u> one square root of 25 is 5 since $5^2 = 25$. The square root of 25 is recorded as $\sqrt{25} = 5$. However, as well as a positive square root, 25 has a negative square root, since $(-5)^2 = 25$
standard index form	A form in which numbers are recorded as a number between 1 and 10 multiplied by a power of ten. Example: 193 in standard index form is recorded as 1.93×10^2 and 0.193 as 1.93×10^{-1} This form is often used as a succinct notation for very large and very small numbers.
subject of a formula	A formula relates different physical variables in a mathematical way. <u>Example:</u> A pendulum of length L takes a time T to complete one two and fro motion. T and L are related by the formula $T = 2\pi\sqrt{(L/g)}$, where g is a constant. As presented, T is the subject of this formula. However it is easy to make L the subject of the formula through the following manipulation: $T/2\pi = \sqrt{(L/g)}$ $(T/2\pi)^2 = \sqrt{(L/g)} \times \sqrt{(L/g)} = L/g$ $L = g(T/2\pi)^2$ <u>Note:</u> Here multiplication and division are inverse operations to each other; one undoes the other. Similarly, squaring and taking the square root are also inverses to each other, with one undoing the other.
substitution	Numbers can be substituted into an algebraic expression in x to get a value for that expression for a given value of x. <u>Example:</u> when $x = -2$, the value of the expression $5x^2 - 4x + 7$ is $5(-2)^2 - 4(-2) + 7 = 5(4) + 8 + 7 = 35$.

supplementary angles	Two neighbouring angles whose sum is 180º. When two lines intersect each other the resulting adjacent angles are supplementary.
surd	1. An irrational number expressed as the root of a natural number. Examples: $^3\sqrt{2}$. 2. A numerical expression involving irrational roots. Example: $3 + {}^2\sqrt{7}$.
tangent	A line is a tangent to a curve when it meets the curve in one and only one point. See trigonometric functions.
term-to-term rule	An algebraic rule to generate the successive terms of a sequence, in terms of the immediately preceding term or terms. The starting term (or terms) is (are) needed to set the sequence going. Commonly, a subscript is used to denote the position of the term, with Ur term in the rth position. Thus $Ur_{+1} = aUr$, with $U_1 = 1$ is the geometric series 1, a, a^2, a^3, and so on.
theorem	A mathematical statement derived from premises and established by means of a proof.
theoretical probability	The probability of the result of a trial calculated from a model based on theoretical considerations rather than on calculations of probability based on counting experimental frequencies of occurrence. Example: with an unbiased coin with two possible outcomes, ‘head’ or ‘tail’, on each toss it would be expected that each side of the coin had an equal probability of showing uppermost. The theoretical probability for a ‘head’ is 0.5, as is the theoretical probability for a ‘tail’. If the coin is actually tossed many, many times and the proportion of heads to the total number of outcomes is calculated from the observation, the experimental probability may differ from exactly 0.5, and if there is any major bias, it will differ significantly from the theoretically expected value.
transformation	A change that is, or is equivalent to, a change in the position or direction of the coordinate axes

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<td>trigonometric functions</td>
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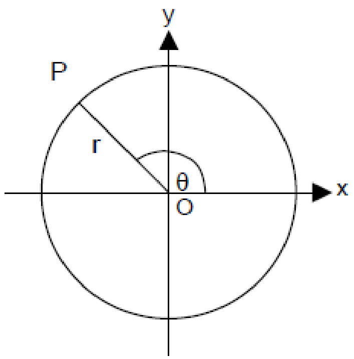
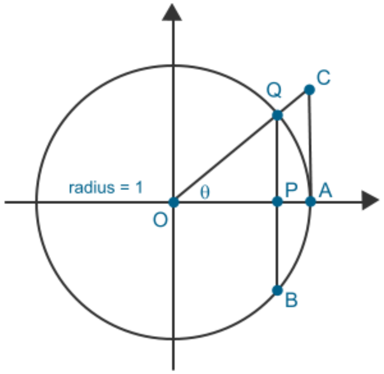
Functions of angles. The main trigonometric functions are cosine, sine and tangent. Other functions are reciprocals of these.



Trigonometric functions (also called the circular functions) are functions of an angle. They relate the angles of a triangle to the lengths of its sides. The most familiar trigonometric functions are the sine, cosine, and tangent In the context of the standard unit circle with radius 1 unit, where a triangle is formed by a ray originating at the origin and making some angle with the x-axis, the sine of the angle gives the length of the y-component (rise) of the triangle, the cosine gives the length of the x-component (run), and the tangent function gives the slope (y-component divided by the x-component). Trigonometric functions are commonly defined as ratios of two sides of a right triangle containing the angle, and can equivalently be defined as the lengths of various line segments from a unit circle.

$\cos A = {}^{b}/_{c}$ $\sin A = {}^{a}/_{c}$ $\tan A = \frac{\sin A}{\cos A} = \frac{a}{b}$



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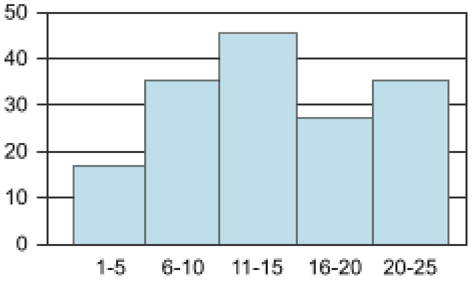
uniform	Not changing. Remaining constant.
unit pricing	Used in marketing and sales, the unit price is the price for one item, from which the price of any quantity of that item can easily be calculated by multiplication of the unit price by the number of items of that type that are required.
unitary ratio	See ratio.
union of two sets	The set of elements that belong to either, or both, of a given pair of sets The union of two sets A and B is written as A U B.
universal set	As far as the curriculum is concerned, the set that contains all the relevant items of interest in a given context. The union of any set and its complement set (all those elements not in the former set).
variable	A quantity that can take on a range of values, often denoted by a letter, x, y, z, t, … etc.

General Terms

addend	A number to be added to another. See also dividend, subtrahend and multiplicand.
associative	A binary operation ∗ on a set S is associative if a ∗ (b ∗ c) = (a ∗ b) ∗ c for all a, b and c in the set S. Addition of real numbers is associative which means a + (b + c) = (a + b) + c for all real numbers a, b, c. It follows that, for example, 1 + (2 + 3) = (1 + 2) + 3. Similarly multiplication is associative. Subtraction and division are not associative because: 1 – (2 – 3) = 1 – (−1) = 2, whereas (1 – 2) – 3 = (−1) – 3 = −4 and 1 ÷ (2 ÷ 3) = 1 ÷ 2/3 = 3/2, whereas (1 ÷ 2) ÷ 3 = (1/2) ÷ 3 = 1/6.
binary operation	A rule for combining two numbers in the set to produce a third also in the set. Addition, subtraction, multiplication and division of real numbers are all binary operations.
Cartesian coordinate system	A system used to define the position of a point in two- or three-dimensional space: 1. Two axes at right angles to each other are used to define the position of a point in a plane. The usual conventions are to label the horizontal axis as the x-axis and the vertical axis as the y-axis with the origin at the intersection of the axes. The ordered pair of numbers (x, y) that defines the position of a point is the coordinate pair. The origin is the point (0,0); positive values of x are to the right of the origin and negative values to the left, positive values of y are above the origin and negative values below the origin. Each of the numbers is a coordinate. The numbers are also known as Cartesian coordinates, after the French mathematician, René Descartes (1596 – 1650). 2. Three mutually perpendicular axes, conventionally labelled *x, y* and *z*, and coordinates (*x, y, z*) can be used to define the position of a point in space.

commutative	A binary operation ∗ on a set S is commutative if a ∗ b = b ∗ a for all a and b ∈ S. Addition and multiplication of real numbers are commutative where a + b = b + a and a × b = b × a for all real numbers a and b. It follows that, for example, 2 + 3 = 3 + 2 and 2 x 3 = 3 x 2. Subtraction and division are not commutative since, as counter examples, 2 – 3 ≠ 3 – 2 and 2 ÷ 3 ≠ 3 ÷ 2.
database	A means of storing sets of data.
distributive	One binary operation ∗ on a set S is distributive over another binary operation • on that set if a ∗ (b • c) = (a ∗ b) • (a ∗ c) for all a, b and c ∈ S. For the set of real numbers, multiplication is distributive over addition and subtraction since a(b + c) = ab + ac for all a, b and c real numbers. It follows that 4(50 + 6) = (4 x 50) + (4 x 6) and 4 x (50 – 2) = (4 x 50) – (4 x 2). For division $\frac{(a + b)}{c} = \frac{a}{c} + \frac{b}{c}$ (division is distributive over addition) But $\frac{c}{(a+b)} \neq \frac{c}{a} + \frac{c}{b}$ (addition is not distributive over division) Addition, subtraction and division are not distributive over other number operations.
dividend	In division, the number that is divided. Example: in 15 ÷ 3, 15 is the dividend See also Addend, subtrahend and multiplicand.

financial mathematics	Mathematics related to money: to include costing, pricing, handling money, profit, loss, simple interest, compound interest etc.
(the) four operations	Common shorthand for the four arithmetic operations of addition, subtraction, multiplication and division.
histogram	A particular form of representation of grouped data. Segments along the x- axis are proportional to the class interval. Rectangles are drawn with the line segments as bases. The area of the rectangle is proportional to the frequency in the class.  Where the class intervals are not equal, the height of each rectangle is called the frequency density of the class.
mensuration	In the context of geometric figures the process of measuring or calculating angles, lengths, areas and volumes.
multiplicand	A number to be multiplied by another. <u>Example:</u> in 5 × 3, 5 is the multiplicand as it is the number to be multiplied by 3. See also Addend, subtrahend and dividend.
multiplicative reasoning	Multiplicative thinking is indicated by a capacity to work flexibly with the concepts, strategies and representations of multiplication (and division) as they occur in a wide range of contexts. <u>Example:</u> From this: 3 bags of sweets, 8 sweets in each bag. How many sweets? To this and beyond: Julie bought a dress in a sale for £49.95 after it was reduced by 30%. How much would she have paid before the sale?

real numbers	A number that is rational or irrational. Real numbers are those generally used in everyday contexts, but in mathematics, or the physical sciences, or in engineering, or in electronics the number system is extended to include what are known as complex numbers. In school mathematics to key stage 4 all the mathematics deals with real numbers. Integers form a subset of the real numbers.
row	A horizontal arrangement.
scale (noun)	A measuring device usually consisting of points on a line with equal intervals.
subtraction by equal addition	A method of calculation used in subtraction and particularly linked with one of the main columnar methods for subtraction. This method relies on the understanding that adding the same quantity to both the minuend and the subtrahend retains the same difference. This is a useful technique when a digit in the subtrahend is larger than its corresponding digit in the minuend. <u>Example:</u> 7 > 2, therefore 10 has been added to the 2 (in the ones place) of the minuend to make 12 (ones) and also added to the 5 (tens) of the subtrahend to make 60 (or 6 tens) before the first step of the calculation can be completed. Similarly 100 has been added to the 3 (tens) of the minuend to make 13 (tens) and also added to the 4 (hundreds) of the subtrahend to make 5 (hundred). 932-457 becomes $\begin{array}{cccc} & 9 & {}^{1}3 & {}^{1}2 \\ - & \underset{5}{\cancel{4}} & \underset{6}{\cancel{5}} & 7 \\ \hline & 4 & 7 & 5 \\ \hline \end{array}$ Answer: 475 Example taken from Appendix 1 of the Primary National Curriculum for Mathematics

subtrahend	A number to be subtracted from another. See also Addend, dividend and multiplicand.