Vaughan Primary School Calculation Policy

This policy supports the teaching and learning and expectations at Vaughan Primary School. Throughout this policy it shows the progression of skills that pupils with obtain across their schooling at Vaughan Primary School. Children once grasping one concept will explore the next concept within each operation.

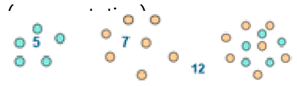
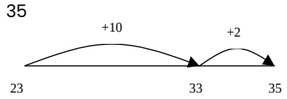
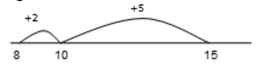
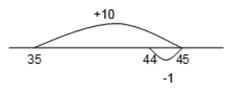
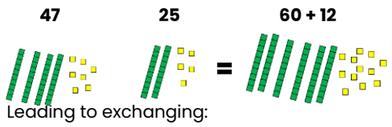
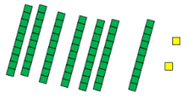
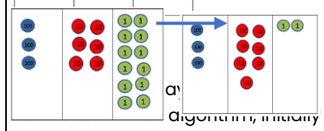
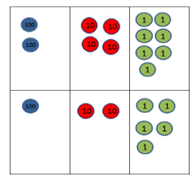
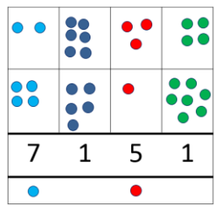
Concrete, Pictorial, Abstract (CPA) Approach

Children of all ages are first introduced to new mathematical learning by using real objects (concrete resources). They are offered a 'hands on' experience with manipulatives to support their fundamental knowledge as a foundation for their conceptual understanding. This is then followed by a pictorial representation which reflects the concrete manipulatives previously used. The children then make connections between the concrete resources and the pictorial representations. After sufficient foundation knowledge is gained, the pupils move onto an abstract representation using mathematical notations. To begin with, this concept is used parallel with the pictorial and concrete representations to secure the children's knowledge of all procedures. These skills are reinforced through all representations being used throughout school, irrespective of the year group.

Reasoning and Problem Solving

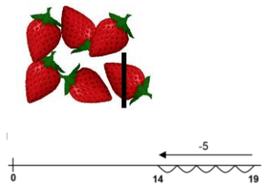
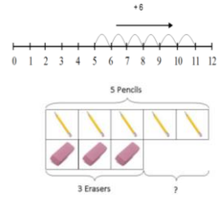
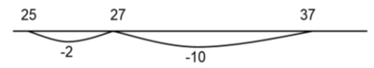
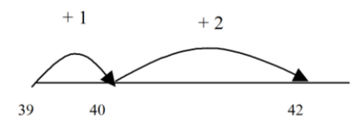
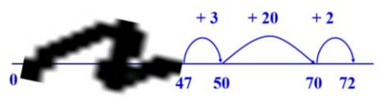
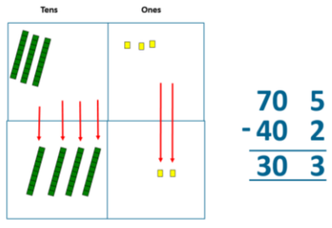
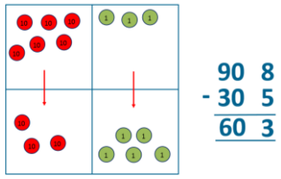
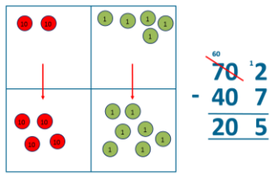
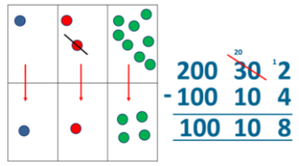
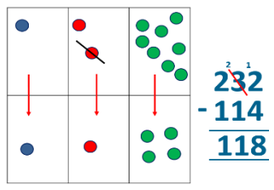
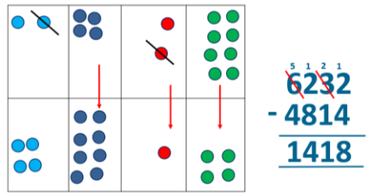
Each lesson, children are exposed to reasoning and problem solving questions to embed their understanding of the skills gained within the lesson. They use their learning in real-life contexts to solve complex and abstract problems, considering skills gained in previous areas of learning.

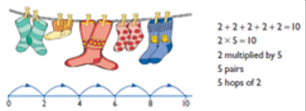
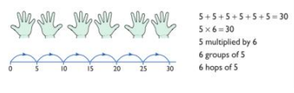
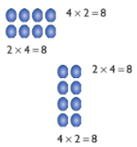
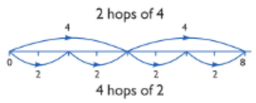
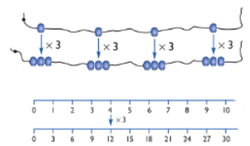
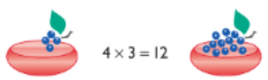
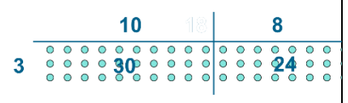
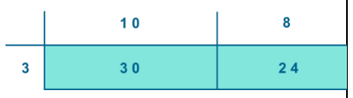
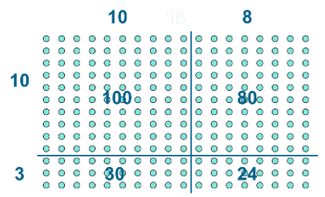
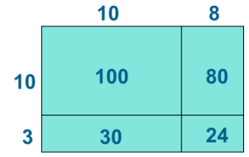
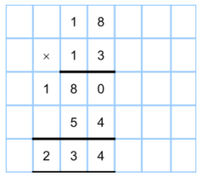
Addition

Addition Reception	Addition - Year 1	Addition - Year 2	Addition - Year 3	Addition - Year 4	Addition - Year 5	Addition - Year 6
Understanding of the Cardinal Principle the final number counted is the total. Subitise and then use counting to check (up to 10). O+O – combining objects 1 more than a given number up to 20. O+O –counting on from a given number. Compare numbers using language such as 'more than' and 'greater than' and have a good understanding of 'one more than'. Understand the composition of numbers to 10. Begin with numbers to 5 and understand the number bonds using a range of resources and physical objects, encouraging subitising. Move on to larger numbers as children develop a secure understanding. **Be able to recall number bonds to 10.** Use opportunities to encourage children to recall number bonds e.g. 'there are 3 children on the carpet and 3 children at the table. There are 6 children.' **Solve problems using concrete resources and pictorial images.** Children develop ways of recording calculations using numicon, bead strings, counters, part whole models, marks etc. Children experiment with combining different Numicon tiles together to find a total or match another piece.	**+ = signs and missing numbers** Children need to understand the concept of equality before using the '=' sign. Calculations should be written either side of the equality sign so that the sign is not just interpreted as 'the answer'. 2 = 1+ 1 2 + 3 = 4 + 1 Missing numbers need to be placed in all possible places. 3 + 4 = □ □ = 3 + 4 3 + □ = 7 7 = □ + 4 **Counting and Combining sets of Objects** Combining two sets of objects (aggregation) which will progress onto adding on to a set  Understanding of counting on with a numbertrack.  Understanding of counting on with a numberline (supported by models and images). 7+ 4  	Missing number problems e.g 14 + 5 = 10 + □ 32 + □ + □ = 100 35 = 1 + □ + 5 It is valuable to use a range of representations (also see Y1). Continue to use number lines to develop understanding of: Counting on in tens and ones 23 + 12 = 23 + 10 + 2 = 33 + 2 = 35  Partitioning and bridging through 10. The steps in addition often bridge through a multiple of 10 e.g. Children should be able to partition the 7 to relate adding the 2 and then the 5. 8 + 7 = 15  Adding 9 or 11 by adding 10 and adjusting by 1 e.g. Add 9 by adding 10 and adjusting by 1 35 + 9 = 44  **Towards a Written Method** Partitioning in different ways and recombine 47+25 **47** **25** **60 + 12**  Leading to exchanging: **72**  **Expanded written method** 40 + 7 + 20 + 5 = 40 + 7 + 20 + 5 60 + 12 = 72 40+20 + 7 + 5 = 60 + 12 = 72	Missing number problems using a range of equations as in Year 1 and 2 but with appropriate, larger numbers. **Partition into tens and ones** Partition both numbers and recombine. Count on by partitioning the second number only e.g. 247 + 125 = 247 + 100 + 20+ 5 = 347 + 20 + 5 = 367 + 5 = 372 Children need to be secure adding multiples of 100 and 10 to any three-digit number including those that are not multiples of 10. **Towards a Written Method** Introduce expanded column addition modelled with place value counters (Dienes could be used for those who need a less abstract representation)  inder ng en tens and  a algorithm, initially introduced alongside the expanded method. The formal method should be seen as a more streamlined version of the expanded method, not a new method. 247 +125 372 10	Missing number/digit problems: **Mental methods** should continue to develop, supported by a range of models and images, including the number line. Children should practise with increasingly large numbers to aid fluency e.g. 12462 + 2300 = 14762 **Written methods (progressing to more than 4-digits)** As year 4, progressing when understanding of the expanded method is secure, children will move on to the formal columnar method for whole numbers and decimal numbers as an efficient written algorithm. 172.83 + 54.68 227.51 1 11 Place value counters can be used alongside the columnar method to develop understanding of addition with decimal numbers.	Missing number/digit problems: **Mental methods** should continue to develop, supported by a range of models and images, including the number line. **Written methods (progressing to 4-digits)** Expanded column addition modelled with place value counters, progressing to calculations with 4-digit numbers.  200 + 40 + 7 100 + 20 + 5 300 + 60 +12 = 372 247 +125 12 60 300 372 **Compact written method** Extend to numbers with at least four digits.  2634 +4517 7151 1 1 **Children should be able to make the choice of reverting to expanded methods if experiencing any difficulty.** Extend to up to two places of decimals (same number of decimals places) and adding several numbers (with different numbers of digits). 72.8 + 54.6 127.4 1 1	Missing number/digit problems: **Mental methods** should continue to develop, supported by a range of models and images, including the number line. **Written methods** As year 5, progressing to larger numbers, aiming for both conceptual understanding and procedural fluency with columnar method to be secured. Continue calculating with decimals, including those with different numbers of decimal places **Problem Solving** Teachers should ensure that pupils have the opportunity to apply their knowledge in a variety of contexts and problems (exploring cross curricular links) to deepen their understanding. .
Key Vocabulary add, more, and make, sum, total altogether double one more, two more … ten more how	**Key Vocabulary** addition, near double, half, halve	**Key Vocabulary** one hundred more, Commutative	**Key Vocabulary** hundreds boundary Column Addition Estimate	**Key Vocabulary** Inverse	**Key Vocabulary** ones boundary, tenths boundary	**Key Vocabulary**

many more to make …? how many more is … than …? how much more is …?						

Subtraction

Subtraction- Reception	Subtraction- Year 1	Subtraction- Year 2	Subtraction- Year 3	Subtraction- Year 4	Subtraction- Year 5	Subtraction- Year 6
O-O (take –away) 1 less than a given number up to 20. O-O (comparison e.g. – 'how many more…'; 'how many less…') Compare numbers using language such as 'less than' and 'fewer than' and have a good understanding of 'one less than'. **Understanding of numbers to 10 and link this knowledge to subtraction.** Begin with numbers to 5 and understand the number bonds using a range of resources and physical objects, encouraging subitising. Move on to larger numbers as children develop a secure understanding. **Be able to recall number bonds to 10.** Use opportunities to encourage children to recall number bonds e.g. 'there were 5 children on the carpet but 2 have gone to play. There are now 3 children.' **Use touch counting to understand the concept of subtraction, encouraging the children to physically take concrete resources away.** Children develop ways of recording calculations using numicon, pictures, words, fingers, counters, part whole models, ten frames etc.	Missing number problems e.g. 7 = □ - 9; 20 - □ = 9; 15 – 9 = □; □ - □ = 11; 16 – 0 = □ Use concrete objects and pictorial representations. If appropriate, progress from using number lines with every number shown to number lines with significant numbers shown. Understand subtraction as take-away:  Understand subtraction as finding the difference:  The above model would be introduced with concrete objects which children can move (including cards with pictures) before progressing to pictorial representation. The use of other images is also valuable for modelling subtraction e.g. Numicon, bundles of straws, Dienes apparatus, multi-link cubes, bead strings	Missing number problems e.g. 52 – 8 = □; □ – 20 = 25; 22 = □ – 21; 6 + □ + 3 = 11 It is valuable to use a range of representations (also see Y1). Continue to use number lines to model take-away and difference. E.g.   The link between the two may be supported by an image like this, with 47 being taken away from 72, leaving the difference, which is 25.  The bar model should continue to be used, as well as images in the context of measures. **Towards written methods** Recording addition and subtraction in expanded columns can support understanding of the quantity aspect of place value and prepare for efficient written methods with larger numbers. The numbers may be represented with Dienes apparatus. E.g. 75 – 42  70 5 -40 2 30 3	Missing number problems e.g. □ = 43 – 27; 145 – □ = 138; 274 – 30 = □; 245 – □ = 195; 532 – 200 = □; 364 – 153 = □ **Mental methods** should continue to develop, supported by a range of models and images, including the number line. Children should make choices about whether to use complementary addition or counting back, depending on the numbers involved. **Written methods (progressing to 3-digits)** Introduce expanded column subtraction with no decomposition, modelled with place value counters (Dienes could be used for those who need a less abstract representation)  90 8 - 30 5 60 3 For some children this will lead to exchanging, modelled using place value counters or Dienes.  60 12 - 40 7 20 5 A number line and expanded column method may be compared next to each other. Some children may begin to use a formal columnar algorithm, initially introduced alongside the expanded method. The formal method should be seen as a more streamlined version of the expanded method, not a new method.	Missing number/digit problems: 456 + □ = 710; 1□7 + 6□ = 200; 60 + 99 + □ = 340; 200 – 90 – 80 = □; 225 - □ = 150; □ – 25 = 67; 3450 – 1000 = □; □ - 2000 = 900 **Mental methods** should continue to develop, supported by a range of models and images, including the number line. **Written methods (progressing to 4-digits)**  200 20 2 - 100 10 4 100 10 8 Expanded column subtraction with decomposition, modelled with place value counters, progressing to calculations with 4-digit numbers. If understanding of the expanded method is secure, children will move on to the formal method of decomposition, which again can be initially modelled with place value  2 1 232 - 114 118 counters or Dienes equipment.	Missing number/digit problems: 6.45 = 6 + 0.4 + □; 119 - □ = 86; 1 000 000 - □ = 999 000; 600 000 + □ + 1000 = 671 000; 12 462 – 2 300 = □ **Mental methods** should continue to develop, supported by a range of models and images, including the number line. **Written methods (progressing to more than 4-digits)** When understanding of the expanded method is secure, children will move on to the formal method of decomposition, which can be initially modelled with place value counters or Dienes equipment.  5 1 2 1 6232 - 4814 1418 Progress to calculating with decimals, including those with different numbers of decimal places.	Missing number/digit problems: □ and # each stand for a different number. # = 34. # + # = □ + □ + #. What is the value of □? What if # = 28? What if # = 21 10 000 000 = 9 000 100 + □ 7 – 2 x 3 = □; (7 – 2) x 3 = □; (□ - 2) x 3 = 15 **Mental methods** should continue to develop, supported by a range of models and images, including the number line. The bar model should continue to be used to help with problem solving. **Written methods** As year 5, progressing to larger numbers, aiming for both conceptual understanding and procedural fluency with decomposition to be secured. Continue calculating with decimals, including those with different numbers of decimal places.

Key Vocabulary take away how many are left/left over? how many have gone? one less, two less, ten less … how many fewer is … than …? how much less is …? difference between	**Key Vocabulary** Subtract, equals is the same as number bonds/pairs missing number	**Key Vocabulary** one hundred less, facts, tens boundary, Commutative	**Key Vocabulary** hundreds boundary, Column Subtraction, Exchange, Estimate,	**Key Vocabulary** inverse	**Key Vocabulary** ones boundary, tenths boundary	**Key Vocabulary**
			Multiplication			
Multiplication- Reception	**Multiplication - Year 1**	**Multiplication - Year 2**	**Multiplication - Year 3**	**Multiplication - Year 4**	**Multiplication Year 5**	**Multiplication -Year 6**
Counting in 2s and 10s Beginning to double single-digit numbers. Become exposed to language such as 'double' and 'half' and see this using concrete resources. Children will experience equal groups of objects using counting equipment, Numicon, Cuisenaire etc. Children begin to record doubles. Children use songs, games and real life contexts to count in repeated groups of the same size (2s, 10s). Children use number squares, tracks to begin counting in groups	Understand multiplication is related to doubling and combing groups of the same size (repeated addition) Washing line, and other practical resources for counting. Concrete objects. Numicon; bundles of straws, bead strings   Problem solving with concrete objects (including money and measures Use arrays to understand multiplication can be done in any order (commutative)   	Expressing multiplication as a number sentence using x Using understanding of the inverse and practical resources to solve missing number problems. 7 x 2 = □ □ = 2 x 7 7 x □ = 14 14 = □ x 7 □ x 2 = 14 14 = 2 x □ □ⓧ = 14 14 = □ⓧ Develop understanding of multiplication using array and number lines (see Year 1). Include multiplications not in the 2, 5 or 10 times tables. Begin to develop understanding of multiplication as scaling (3 times bigger/taller)   Doubling numbers up to 10 + 10 Link with understanding scaling Using known doubles to work out double 2 digit numbers (double 15 = double 10 + double 5)  	Missing number problems Continue with a range of equations as in Year 2 but with appropriate numbers. **Mental methods** Doubling 2 digit numbers using partitioning Demonstrating multiplication on a number line – jumping in larger groups of amounts 13 x 4 = 10 groups 4 = 3 groups of 4 **Written methods (progressing to 2d x 1d)** Developing written methods using understanding of visual images  Develop onto the grid method  Give children opportunities for children to explore this and deepen understanding using Dienes apparatus and place value counters	Continue with a range of equations as in Year 2 but with appropriate numbers. Also include equations with missing digits □2 x 5 = 160 **Mental methods** Counting in multiples of 6, 7, 9, 25 and 1000, and steps of 1/100. **Written methods (progressing to 3 digit x 2 digit)** Continue to use the grid method as in year 3 for 2 digit x 1 digit multiplications moving onto the short multiplication method 24x6 becomes 24 X 6 144 2 Children to embed and deepen their understanding of the grid method to multiply up 2 digit x 2 digit. Ensure this is still linked back to their understanding of arrays and place value counters.  	Continue with a range of equations as in Year 2 but with appropriate numbers. Also include equations with missing digits **Mental methods** X by 10, 100, 1000 using moving digits ITP Use practical resources and jottings to explore equivalent statements (e.g. 4 x 35 = 2 x 2 x 35) Recall of prime numbers up 19 and identify prime numbers up to 100 (with reasoning) Solving practical problems where children need to scale up. Relate to known number facts. Identify factor pairs for numbers **Written methods (progressing to 4d x 2d)** Long multiplication using place value counters Children to explore how the grid method supports an understanding of long multiplication (for 2d x 2d)   	Continue with a range of equations as in Year 2 but with appropriate numbers. Also include equations with missing digits **Mental methods** Identifying common factors and multiples of given numbers Solving practical problems where children need to scale up. Relate to known number facts. **Written methods** Continue to refine and deepen understanding of written methods including fluency for using long multiplication | X	**1000**	**300**	**40**	**2**
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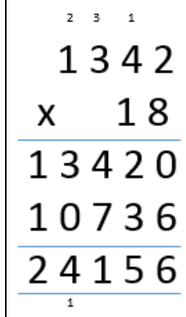
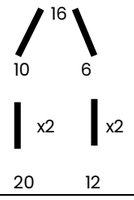
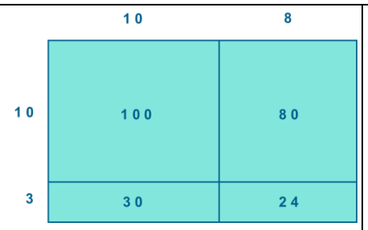
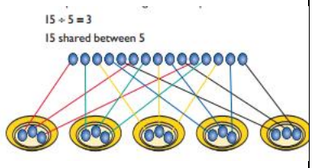
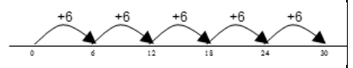
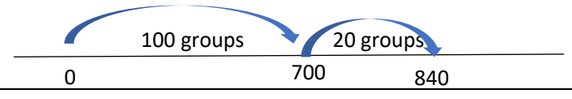
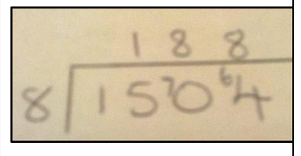
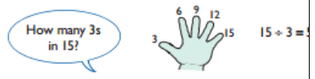
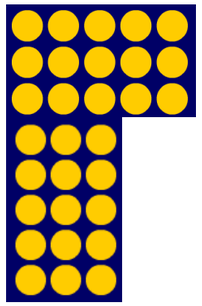
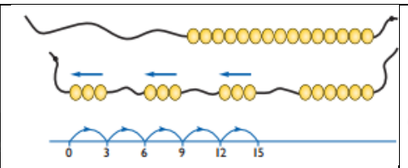
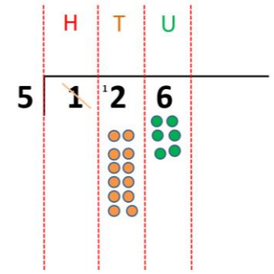
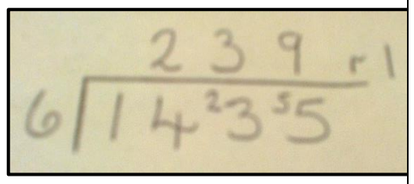
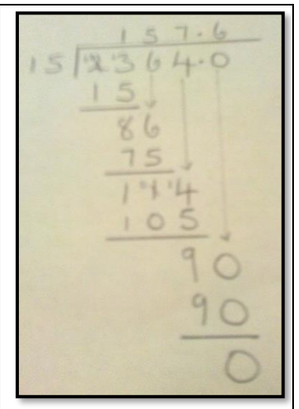
10	10000	3000	400	20
8	8000	2400	320	16	 Move on to: 

		Towards written methods Use jottings to develop an understanding of doubling two digit numbers. 				
Key Vocabulary doubling patterns	**Key Vocabulary** multiplication multiply multiplied by multiple	**Key Vocabulary** groups of times once, twice, three times … ten times repeated addition multiplication table multiplication fact,	**Key Vocabulary** Factor, product	**Key Vocabulary** inverse square, squared cube, cubed	**Key Vocabulary**	**Key Vocabulary**
Division						
Division- Reception	**Division - Year 1**	**Division - Year 2**	**Division - Year 3**	**Division - Year 4**	**Division- Year 5**	**Division -Year 6**
Creating equal groups of a set of objects. Sharing a set of objects Become exposed to language such as 'double' and 'half' and see this using concrete resources. Children will understand equal groups and share items out in play and problem solving. Explore sharing into equal groups and sets with counting equipment, Numicon, Cuisenaire.	Children must have secure counting skills- being able to confidently count in 2s, 5s and 10s. Children should be given opportunities to reason about what they notice in number patterns. **Group AND share small quantities- understanding the difference between the two concepts.** **Sharing** Develops importance of one-to-one correspondence.  Children should be taught to share using concrete apparatus. **Grouping**	**÷ = signs and missing numbers** 6 ÷ 2 = □ □ = 6 ÷ 2 6 ÷ □ = 3 3 = 6 ÷ □ □ ÷ 2 = 3 3 = □ ÷ 2 □ ÷ ∇ = 3 3 = □ ÷ ∇ Know and understand sharing and grouping- introducing children to the ÷ sign. Children should continue to use grouping and sharing for division using practical apparatus, arrays and pictorial representations. **Grouping using a numberline** Group from zero in jumps of the divisor to find our 'how many groups of 3 are there in 15?'. 15 ÷ 3 = 5	**÷ = signs and missing numbers** Continue using a range of equations as in year 2 but with appropriate numbers. **Grouping** How many 6's are in 30? 30 ÷ 6 can be modelled as:  **Becoming more efficient using a number line** Children need to be able to partition the dividend in different ways. 48 ÷ 4 = 12  **Remainders**	**÷ = signs and missing numbers** Continue using a range of equations as in year 3 but with appropriate numbers. **Sharing, Grouping and using a number line and/or chunking** Children will continue to explore division as sharing and grouping, and to represent calculations on a number line or through chunking until they have a secure understanding. Both the number line and the chunking methods include calculations with remainders as well as without. Remainders should be interpreted according to the context. (i.e. rounded up or down to relate to the answer to the problem) **Eg: 146 ÷ 8** 8 146 - 80 (8x10) ***Total all the chunks*** 66 ***of 8 to find the answer*** - 40 (8x5) 26 - 24 (8x3) **Answer: 18 r2** 2 **e.g. 840 ÷ 7 = 120** *Jottings* *7 x 100 = 700* *7 x 10 = 70* *7 x 20 = 140* 		**÷ = signs and missing numbers** Continue using a range of equations but with appropriate numbers Sharing and Grouping and using a number line Children will continue to explore division as sharing and grouping, and to represent calculations on a number line and /or chunking as appropriate. **Formal Written Methods – long and short division** E.g. 1504 ÷ 8  E.g. 2364 ÷ 15

	Children should apply their counting skills to develop some understanding of grouping.  Use of arrays as a pictorial representation for division. 15 ÷ 3 = 5 There are 5 groups of 3. 15 ÷ 5 = 3 There are 3 groups of 5.  Children should be able to find ½ and ¼ and simple fractions of objects, numbers and quantities.	 Continue work on arrays. Support children to understand how multiplication and division are inverse. Look at an array – what do you see?	49 ÷ 4 = 12 r1  Sharing – 49 shared between 4. How many left over? Grouping – How many 4s make 49. How many are left over? Place value counters can be used to support children apply their knowledge of grouping. For example: 60 ÷ 10 = How many groups of 10 in 60? 600 ÷ 100 = How many groups of 100 in 600?	**Formal Written Methods** Formal short division should only be introduced once children have a good understanding of division, its links with multiplication and the idea of 'chunking up' to find a target number (see use of number lines and chunking above) Short division to be modelled for understanding using place value counters as shown below. Calculations with 2 and 3-digit dividends. E.g. fig 1 	**Formal Written Methods** Continued as shown in Year 4, leading to the efficient use of a formal method. E.g. 1435 ÷ 6 Children begin to practically develop their understanding of how express the remainder as a decimal or a fraction. Ensure practical understanding allows children to work through this (e.g. what could I do with this remaining 1? How could I share this between 6 as well?) 	
Key Vocabulary Sharing, Halving, Number Patterns	**Key Vocabulary** division dividing grouping array	**Key Vocabulary** share, share equally left, left over one each, two each, three each … ten each group in pairs, threes … tens equal groups of divide, divided by, divided into row, column multiplication fact, division fact	**Key Vocabulary** remainder	**Key Vocabulary** inverse	**Key Vocabulary**	**Key Vocabulary**