Calculation policy

Mathematics Mastery

At the centre of the mastery approach to the teaching of mathematics is the belief that all children have the potential to succeed. They should have access to the same curriculum content and, rather than being extended with new learning, they should deepen their conceptual understanding by tackling challenging and varied problems. Similarly, with calculation strategies, children must not simply rote learn procedures but demonstrate their understanding of these procedures through the use of concrete materials and pictorial representations. This policy outlines the different calculation strategies that should be taught and used in Year 1 to Year 6 in line with the requirements of the 2014 Primary National Curriculum.

Mathematical Language

The 2014 National Curriculum is explicit in articulating the importance of children using the correct mathematical language as a central part of their learning (reasoning). Indeed, in certain year groups, the non-statutory guidance highlights the requirement for children to extend their language around certain concepts. It is therefore essential that teaching using the strategies outlined in this policy is accompanied by the use of appropriate and precise mathematical vocabulary. New vocabulary should be introduced in a suitable context (for example, with relevant real objects, apparatus, pictures or diagrams) and explained carefully. High expectations of the mathematical language used are essential, with teachers only accepting what is correct. The school agreed list of terminology and discussion for reasoning questions are located at Appendix A to this document.

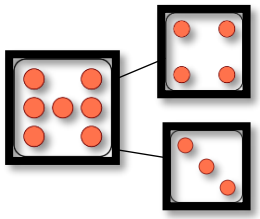
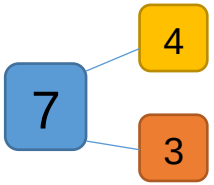
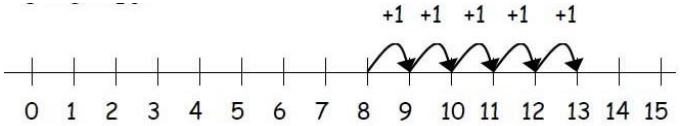
'The quality and variety of language that pupils hear and speak are key factors in developing their mathematical vocabulary and presenting a mathematical justification, argument or proof.'- 2014 Maths Programme of Study

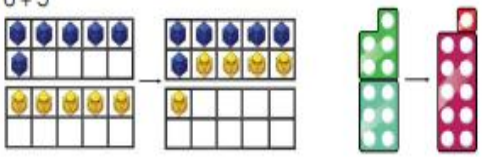
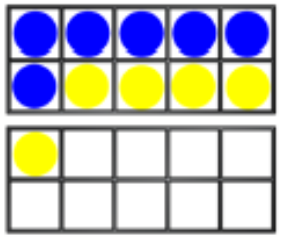
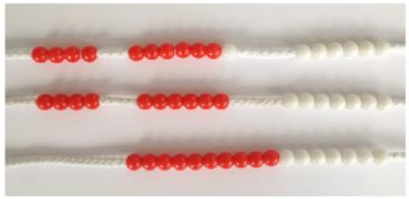
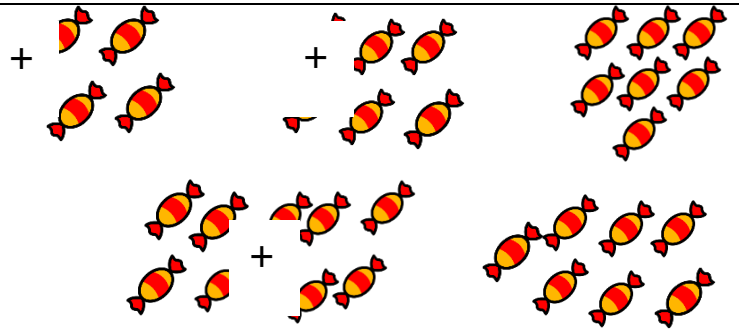
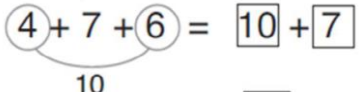
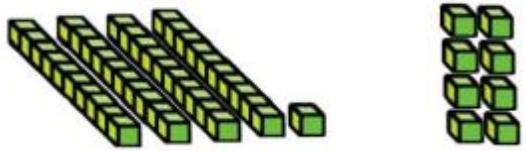
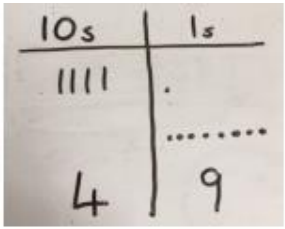
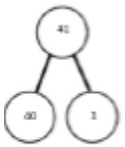
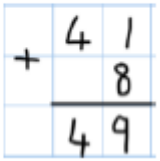
How to use the policy

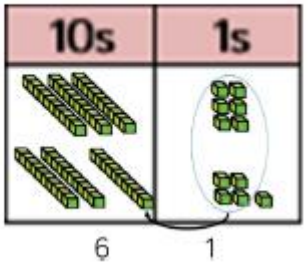
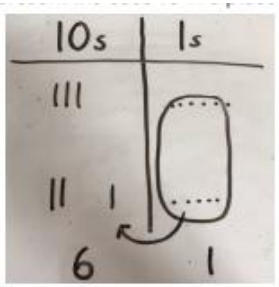
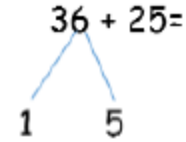
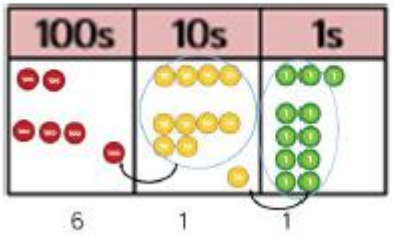
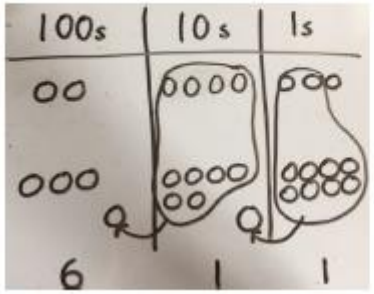
This mathematics policy is a guide for all staff at **Avanti House Primary school** and has been adapted from work by the NCETM. It is purposely set out as a progression of mathematical skills and not into year group phases to encourage a flexible approach to teaching and learning. It is expected that teachers will use their professional judgement as to when consolidation of existing skills is required or if to move onto the next concept. However, the focus must always remain on **breadth and depth** rather than accelerating through concepts. Children should not be extended with new learning before they are ready, they should **deepen** their conceptual understanding by tackling challenging and varied problems. All teachers have been given the scheme of work from the **White Rose Maths Hub** and are required to base their planning around their year groups modules and not to move onto a higher year groups scheme work. These modules use the Singapore Maths Methods and are affiliated to the workings of the 2014 Maths Programme of Study. Teachers can use any teaching resources that they wish to use and the policy does not recommend one set of resources over another, rather that, a variety of resources are used. For each of the four rules of number, different strategies are laid out, together with examples of what concrete materials can be used and how, along with suggested pictorial representations. The principle of the **concrete-pictorial-abstract (CPA)** approach [**Make it, Draw it, Write it**] is for children to have a true understanding of a mathematical concept, they need to master all three phases within a year group's scheme of work.

Progression in Calculations

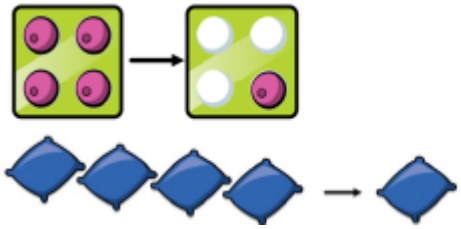
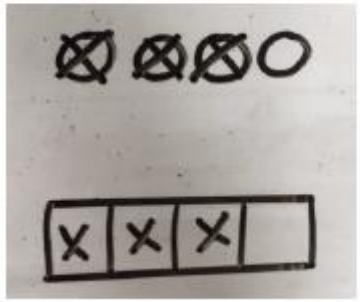
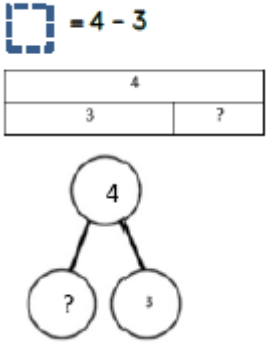
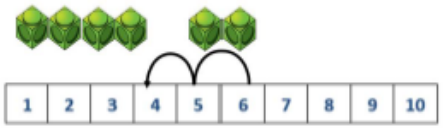
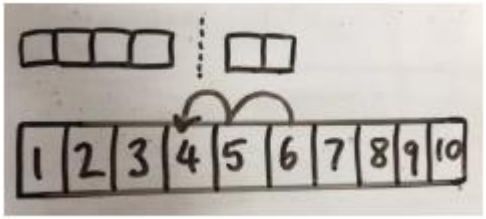
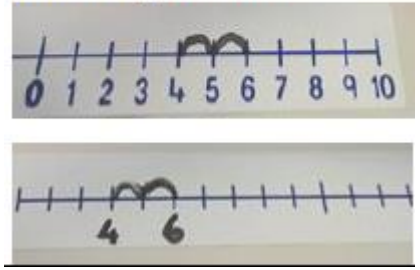
Addition

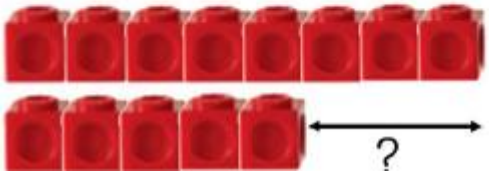
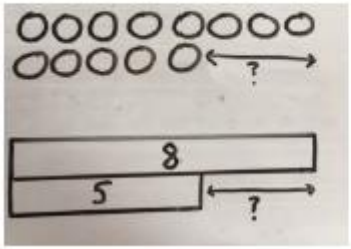
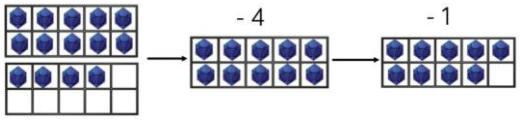
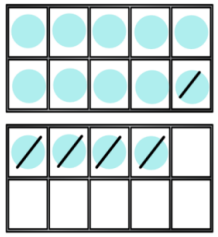
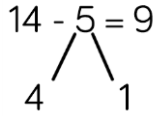
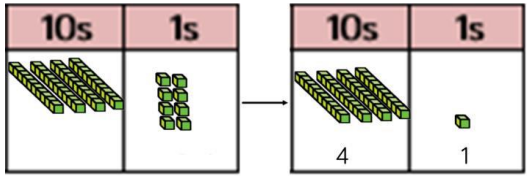
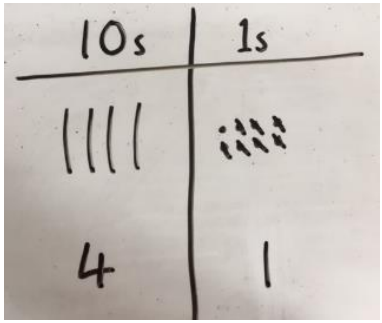
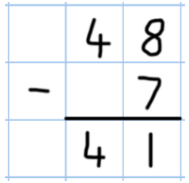
Objective and Strategies	Concrete	Pictorial	Abstract
Combining two parts to make a whole: part-whole model	   Use cubes or counters to add two numbers together as a group or in a bar. Part-part whole	 Use pictures to add two numbers together as a group or in a bar. 	4 + 3 = 7  Use the part-part whole diagram as shown above to move into the abstract.
Starting at the bigger number and counting on	 Start with the larger number on the bead string and then count on to the smaller number 1 by 1 to find the answer.	 Start at the larger number on the number line and count on in ones to find the answer.	8 + 5 = 13 Place the larger number in your head and count on the smaller number to find your answer.

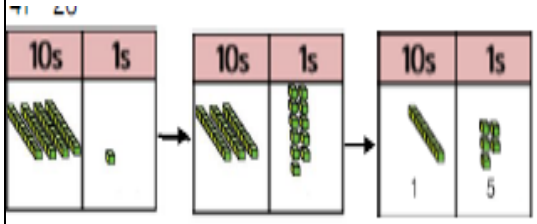
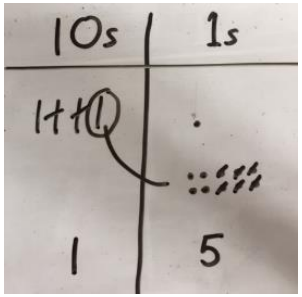
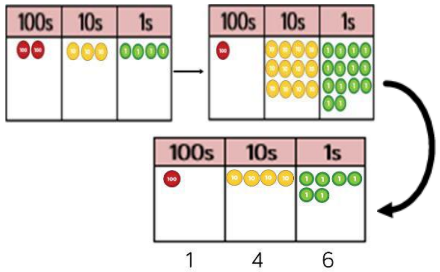
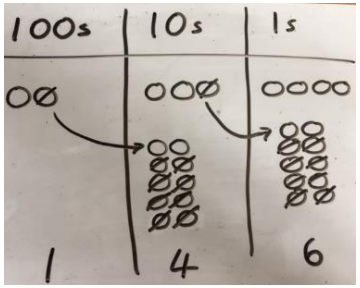
Regrouping to make 10.	**Regrouping to make 10;** using ten frames and counters/cubes or using Numicon. 6 + 5 	Children to draw the ten frame and counters/cubes. 	Children to develop an understandi of equality e.g. $6 + \square = 11$ $6 + 5 = 5 + \square$ $6 + 5 = \square + 4$
Adding three single digits	4 + 7 + 6= 17 Put 4 and 6 together to make 10. Add on 7.  Following on from making 10, make 10 with 2 of the digits (if possible) then add on the third digit.	 Add together three groups of objects. Draw a picture to recombine the groups to make 10.	 Combine the two numbers that make 10 and then add on the remainder.
Column method- no regrouping	TO + O using base ten. Continue to develop understanding of partitioning and place value 41 + 8 	Children to represent the base ten eg. Lines for tens and dot for ones 	41 + 8  1 + 8 = 9 40 + 9 = 49 

Column method- regrouping	**TO + TO using base 10.** Continue to develop understanding of partitioning and place value. 36 + 25 	Children to represent the base ten in a place value chart. 	Looking for ways to make 10.  30 + 20 = 50 5 + 5 = 10 50 + 10 + 1 = 6 Formal method: 36 +25 61 1
	Use of place value counters to add HTO + TO, HTO + HTO etc. When there are 10 ones in the 1s column- w exchange for 1 ten, when there are 10 tens in the 10s column- we exchange for 1 hundred. 	Chidren to represent the counters in a place value chart, circling when they make an exchange. 	243 +368 611 1 1

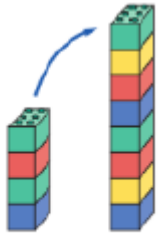
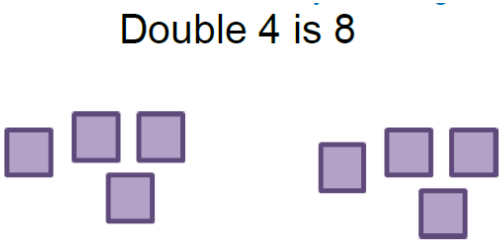
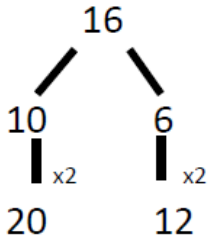
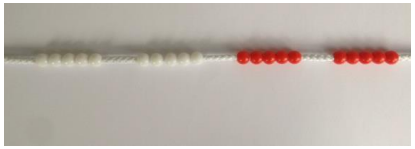
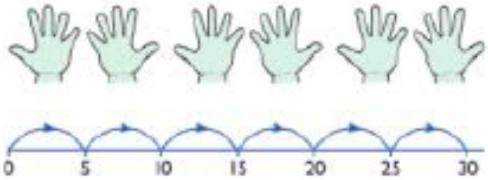
Subtraction

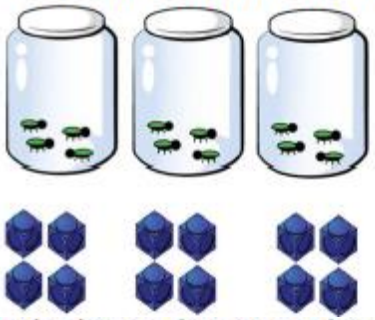
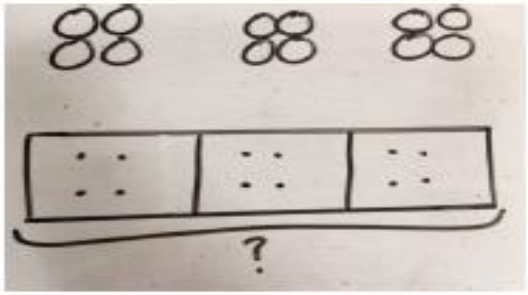
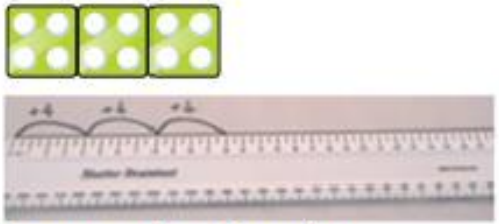
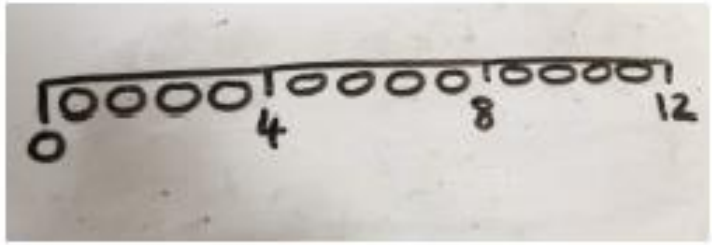
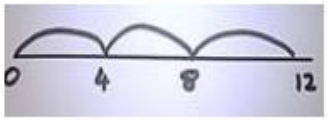
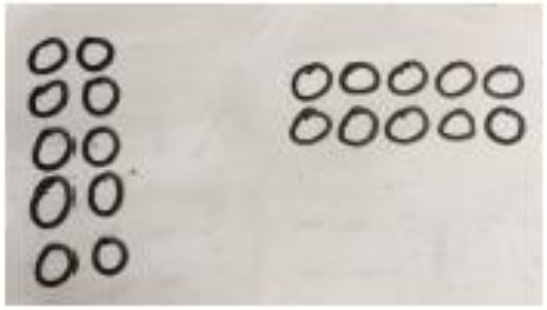
Objective and Strategies	Concrete	Pictorial	Abstract
Taking away ones	**Physically taking away and removing objects from** (ten frames, Numicon, cubes and other items such beanbags could be used). 4 – 3 = 1 	Children to draw the concrete resources they are using and cross out the correct amount. The bar model can also be used. 	4- 3 = 
Counting back	**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. 	Children to represent the calculation on a number line or number track and show their jumps. Encourage children to use an empty number line 

Find the difference	**Finding the difference** (using cubes, Numicon or Cu 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. 	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.
Make 10	Making 10 using ten frame 	Children to present the ten frame pictorially and discuss what they did to make 10. 	Children to show how they can make 10 by partitioning the subtrahend.  14 – 4= 10 10 – 1 = 9
Column method without regrouping	Column method using base ten 48 – 7 	Children to represent the base 10 pictorially. 	Column method or children could count back 7. 

Column method with regrouping	Column method using base 10 and having to exchange. 41 – 26 	Represent the base 10 pictorially, remembering to show the exchange. 	Formal colum method. Children must understand what has happened when they have crossed out digits. $\begin{array}{r} {}^{2}\not{3}\,{}^{1}4 \\ -\ 88 \\ \hline 6 \end{array}$
Column method	Column method using place value counters. 234 – 88 	Represent the place value counters pictorially; remembering to show what has been exchanged. 	Formal colum method. Children must understand what has happened when they have crossed out digits. $\begin{array}{r} {}^{2}\not{3}\,{}^{1}4 \\ -\ 88 \\ \hline 6 \end{array}$

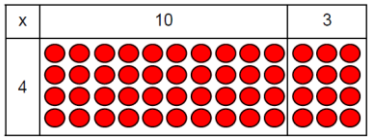
Multiplication

Objective and Strategies	Concrete	Pictorial	Abstract
Doubling	Use practical activities to show how to double a number.  	Draw pictures to show how to double a number.  	 Partition a number and then double each part before recombining it back together.
Counting in multiples	  Count in multiples supported by concrete objects in equal groups.	 Use a number line or pictures to continue support in counting in multiples.	Count in multiples of a number aloud. Write sequences with multiples of numbers. 2, 4, 6, 8, 10 5, 10, 15, 20, 25 , 30

Repeated addition	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 = 12 4 + 4 + 4 = 12
	Number lines to show repeated groups- 3 × 4  Cuisenaire rods can be used too.	Represent this pictorially alongside a number line e.g. 	Abstract number line showing three jumps of four. 3 × 4 = 12 
Arrays- showing commutative multiplication	Create arrays using counters/ cubes to show multiplication sentences. 2x5=5x2  2 lots of 5 5 Lots of 2	Draw arrays in different rotations to find **commutative** multiplication sentences. 2x5=5x2 	Use an array to write multiplication sentences and reinforce repeated addition. 10 = 2 × 5 5 × 2 = 10 2 + 2 + 2 + 2 + 2 = 10 10 = 5 + 5

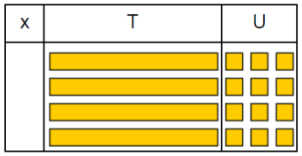
Grid Method

Show the link with arrays to first introduce the grid method.



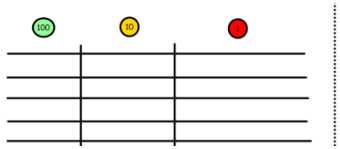
4 rows of 10
4 rows of 3

Move on to using Base 10 to move towards a more compact method.



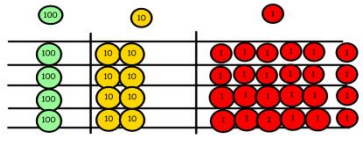
4 rows of 13

Move on to place value counters to show how we are finding groups of a number.We are multiplying by 4 so we need 4 rows.



Calculations
4 x 126

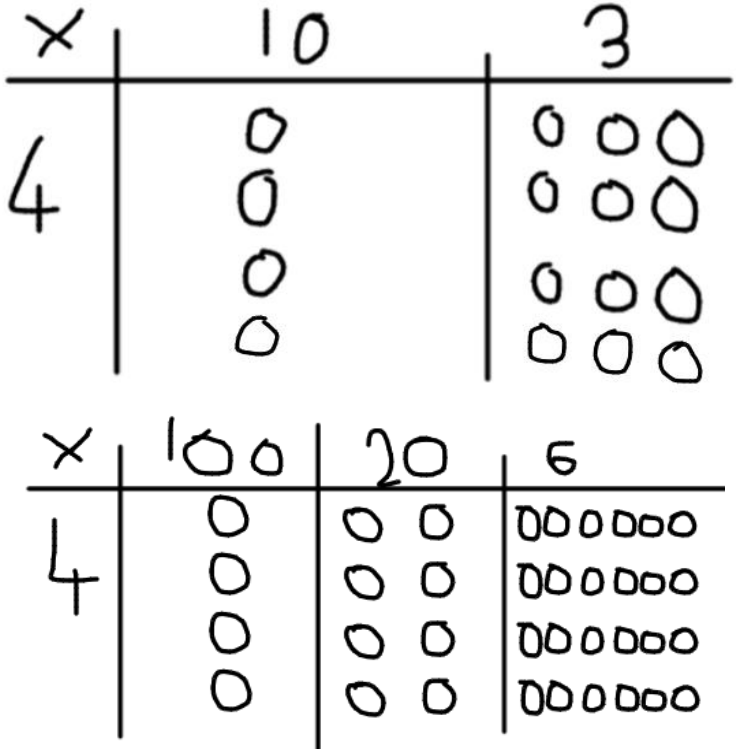
Fill each row with 126.



Calculations
4 x 126

Children can represent the work they have done with place value counters in a way that they understand.

They can draw the counters, using colours to show different amounts or just use circles in the different columns to show their thinking as shown below.



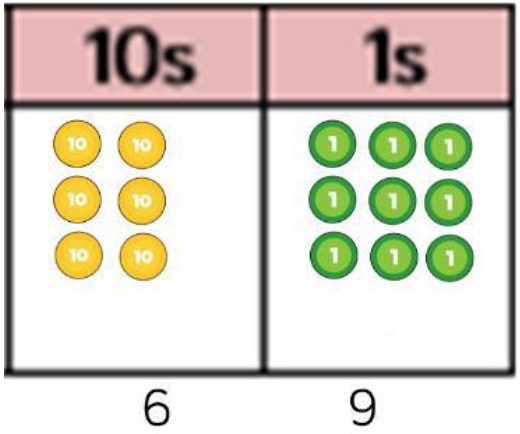
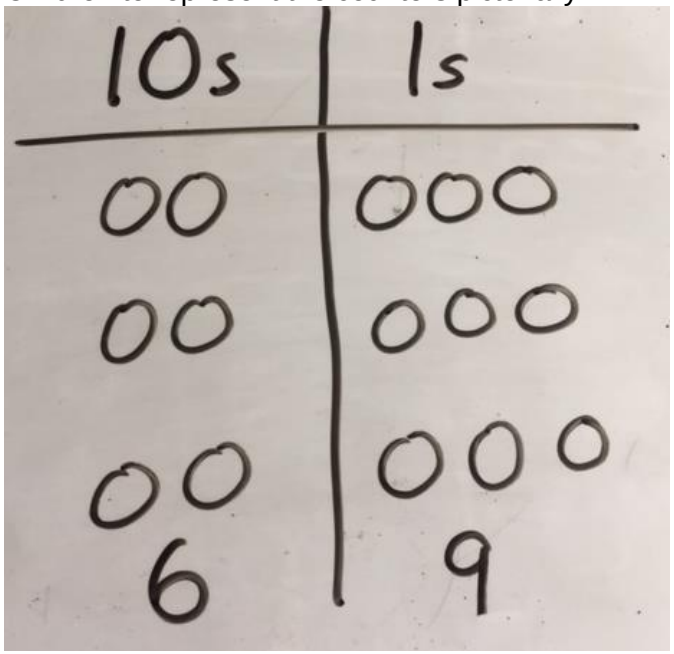
Start with multiplying by one digit numbers and showing the clear addition alongside the grid.

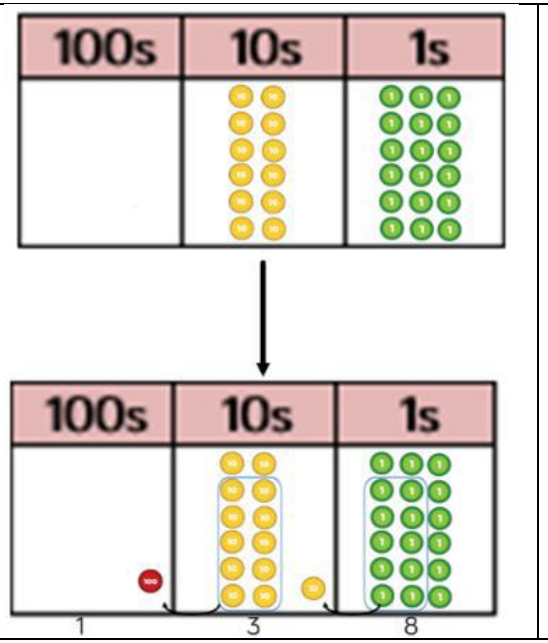
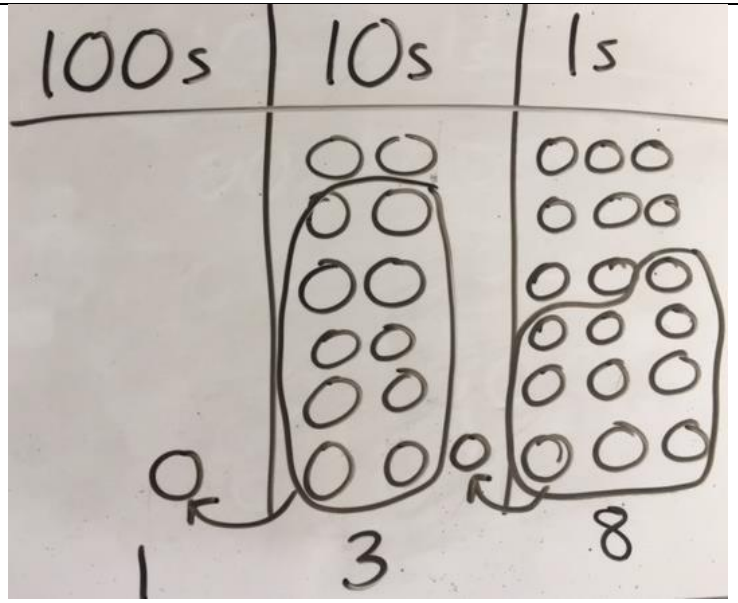
x	10	3
4	40	12

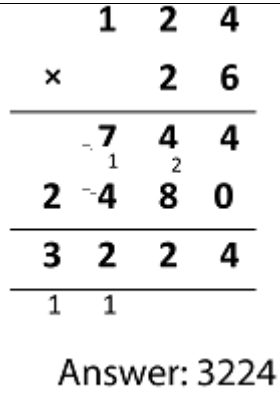
x	100	20
4	400	80

Moving forward, multiply by a 2 digit number showing the different rows within the grid method.

x	100	20	6	
40	4000	800	240	5040
2	200	40	12	252
				5292

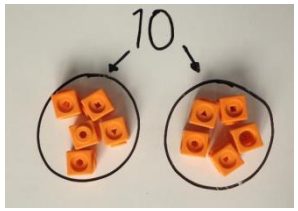
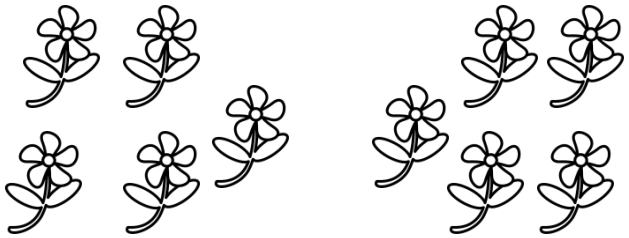
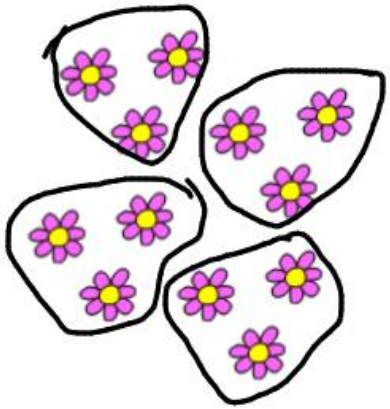
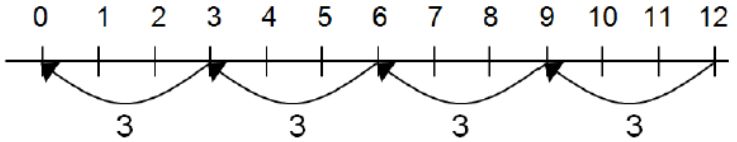
Column multiplication	Children can continue to be supported by place value counters at the stage of multiplication.  Formal column method with place value counters (base 10 can also be used.) 3 × 23	Children to represent the counters pictorially.  	Children to record what it is they are doing to show understanding. 23 × 3 69
	Formal column method with place value counters. 6 x 23	Children to represent the counters/base 10, pictorially e.g. the image below.	Formal written method 6 x 23 = 23 × 6 138 1 1

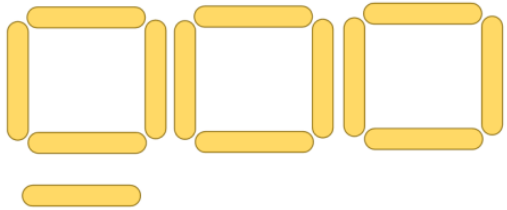
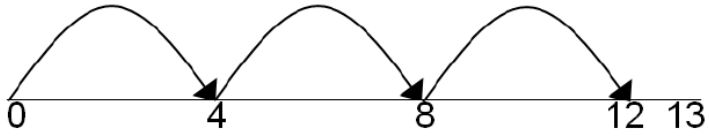
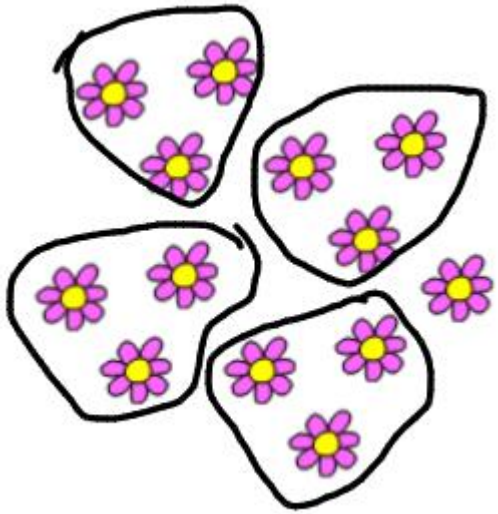
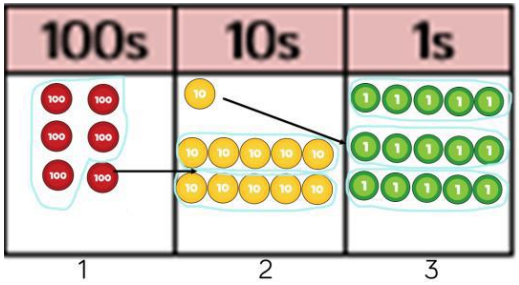
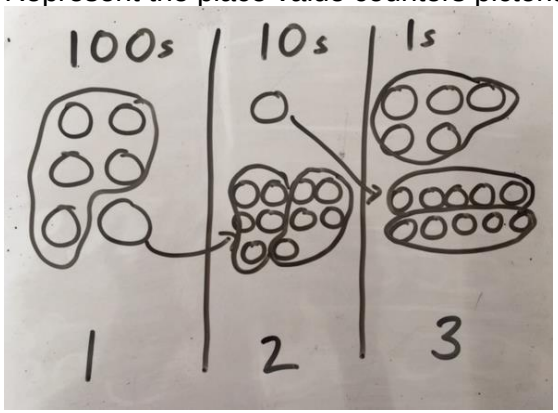
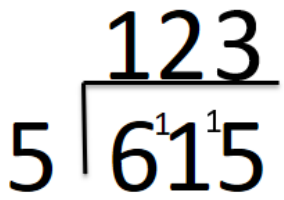
<table>
<tr>
<td></td>
<td> 
</td>
<td> 
</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When children start to multiply 3d × 3d and 4d × 2d etc., they should be confident with the abstract:

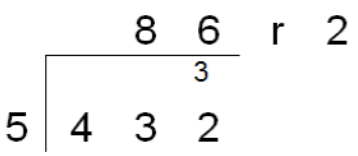
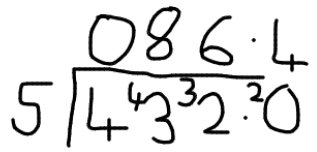
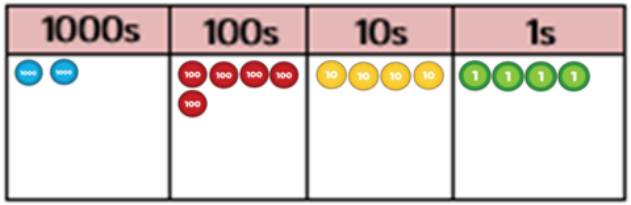
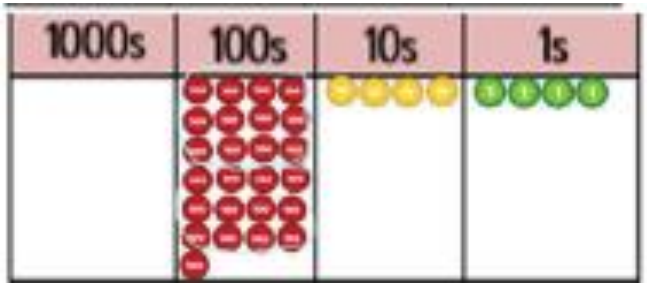
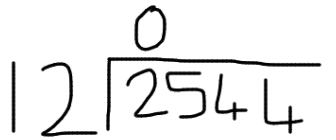
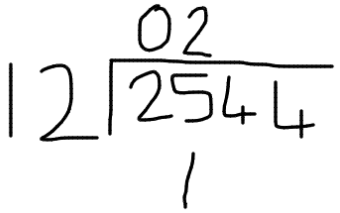
To get 744 children have solved 6 × 124.
To get 2480 they have solved 20 × 124.</td>
<td>


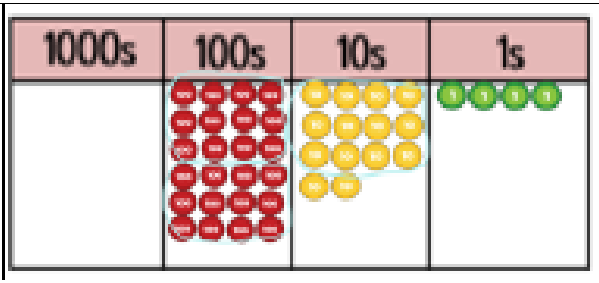
</td>
</tr>
</table>

Division

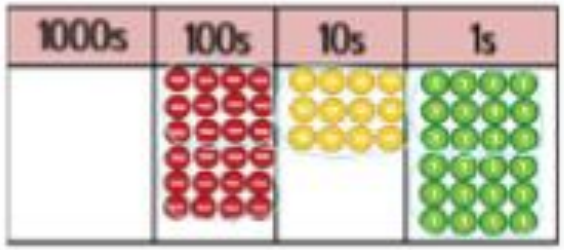
Objective and Strategies	Concrete	Pictorial	Abstract
Sharing objects into groups	 I have 10 cubes, can you share them equally in 2 groups? 	Children use pictures or shapes to share quantities.  10 ÷ 2 = 5	Share 9 buns between three people. 10 ÷ 2 = 5
Division as grouping	Divide quantities into equal groups. Use cubes, counters, objects or place value counters to aid understanding. 	Use a number line to show jumps in groups. The number of jumps equals the number of groups.  Think of the bar as a whole. Split it into the number of groups you are dividing by and work out how many would be within each group.	12 ÷ 4 = 3 Divide 12 into 4 groups. How many are in each group?

Division with a remainder	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.	Jump forward in equal jumps on a number line then see how many more you need to jump to find a remainder.  Draw dots and group them to divide an amount and clearly show a remainder. 	Complete written divisions and show the remainder using r. 13 ÷ 4 – 3 remainder 1 '3 groups of 4, with 1 left over'
Short division (bus stop)	Short division using place value counters to group. 615 ÷ 5  1. Make 615 with place value counters.	Represent the place value counters pictorially. 	Begin with divisions that divide equally with no remainder. 

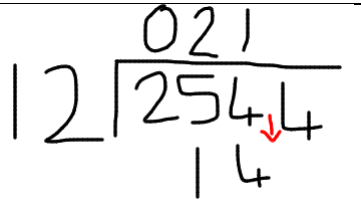
	2. How many groups of 5 hundreds can you make with 6 hundred counters? 3. Exchange 1 hundred for 10 tens. 4. How many groups of 5 tens can you make with 11 ten counters? 5. Exchange 1 ten for 10 ones. 6. How many groups of 5 ones can you make with 15 ones?		Move onto divisions with a remainder.  Finally move into decimal places to divide the total accurately. 
Long Division	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.	 

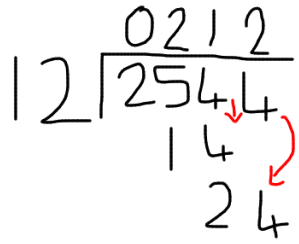


After exchanging the hundred, we have 14 tens. We can group 12 tens into a group of 12, which leaves 2 tens.



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





Appendix A

Mathematical Language:

High expectations of the mathematical language used are essential, with staff only accepting what is correct. Consistency across the school is key:

Correct Terminology	**Incorrect Terminology**
Ones	Units
Is equal to (is the same as)	Equals
Zero	Oh (the letter 'o')
Exchange Exchanging Regrouping	Stealing Borrowing
Calculation Equation	Generic term of 'sum' or 'number sentence'
Whole (bar model or cherry model) Part	

Encourage discussion and reasoning:

- What do you notice?
- True or false? θ Odd one out?
- Do, then explain
- Spot the mistake
- Give an example of
- Continue the pattern
- Convince me…prove it!
- What is the same…..what is different?
- Is this always, sometimes or never true? If sometimes, when?
- If this is my answer, what could the question be?