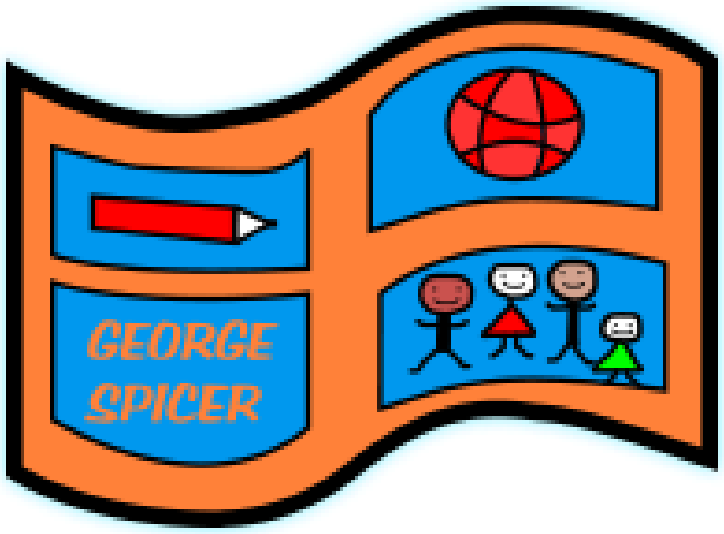


Calculation Policy

2021

At George Spicer Primary School teaching and learning is a process of co-operative team work. The involvement of all staff, parents, governors and others in the community is actively sought and valued. We aim to enable our children to respond positively to the opportunities and challenges of a rapidly changing world. We are a Rights Respecting School with three core values: Respect, Responsibility and Perseverance which underpin our ethos and purpose. Our values support learning and social and emotional development of the whole child.

When teaching Maths, the pedagogy of the methods is essential. Both the teachers and the children need to demonstrate understanding of a method by constant articulation of the steps. Children should be constantly questioned verbally as to why they have elected to make a choice or what the next step of the method is. They must be proficient in explaining their reasoning.

Implementation of the Policy

Each teacher has to take on a commitment to moving children onto the next 'step' as and when they are ready. We have to foster a culture of pushing the more able children to achieve even more. Consistency in approach throughout the school is the key to success.

How Stages Develop

The methods in this document rely on each other to a degree, and also place a great emphasis on the children's understanding of place value. As children move from one step to another, the focus moves from:

1) Concrete understanding using manipulatives.
2) Pictorial representations and mental arithmetic of concepts where appropriate.
3) Written methods.
4) Speed, fluency and efficiency.

All stages of the calculation policy should work alongside the development of reasoning skills and articulation of understanding. Pupils should be using mathematical language when using calculations to solve problems, make generalisations, find patterns and justify or prove ideas.

Transition

At the end of each year, the class teacher must make the following teacher aware of the methods that each child is able to use accurately. Teachers have a responsibility to share strategies which have worked throughout the year and information on intervention groups which have targeted children's arithmetic skills.

Addition

Step 1

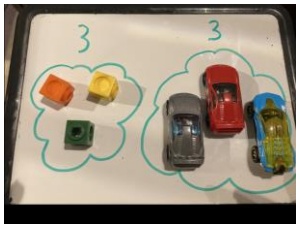
(Practical Maths)

Objectives

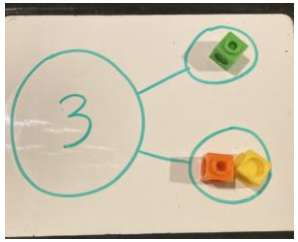
- Recognising numerals 1-20 and relating the numerals to practical amounts
- Representing and recording numerals to 10.
- Counting to 20.
- Using objects to find one more than a given amount.
- Ordering numbers to 20

Representations

Recognising the value of a number using concrete objects/manipulatives e.g. cars, multilink, numicon



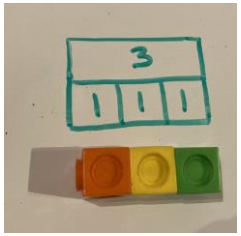
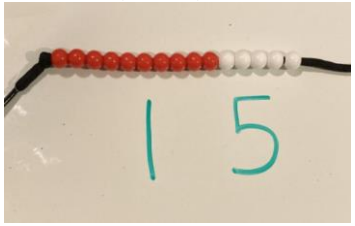
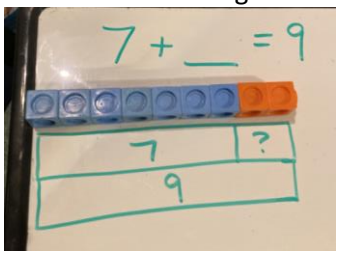
Exploring part-part-whole –
Pictures of two groups making one whole, part part wholes and bar model

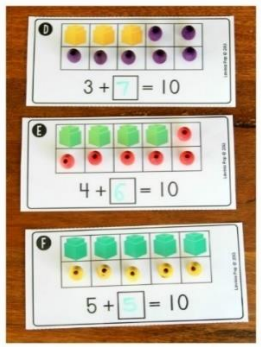
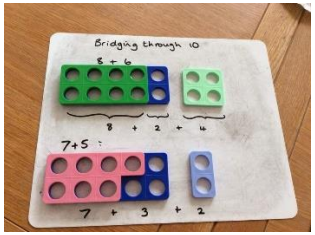
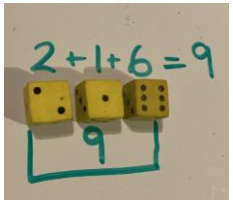
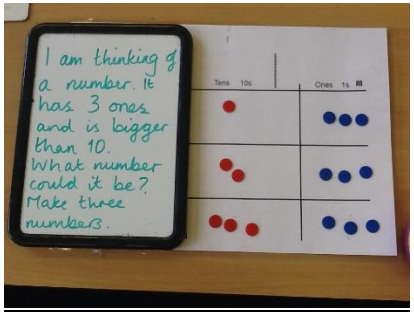
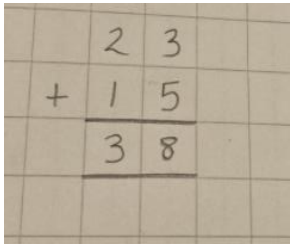


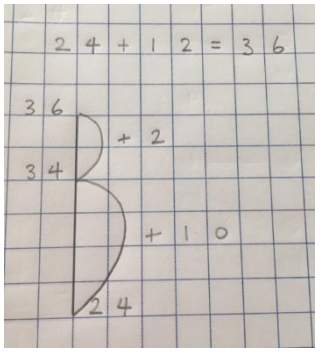
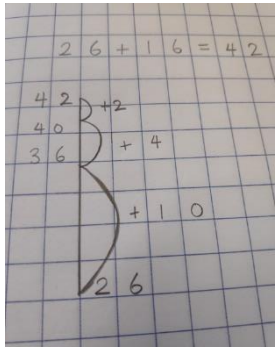
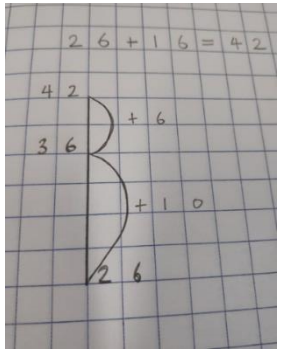
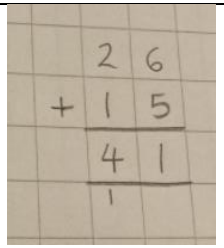
Support adding single digit numbers – use numicon, vertical numberlines, tens frames and fingers used to count on

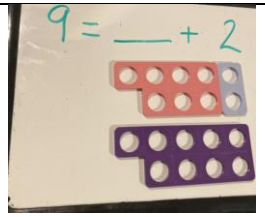
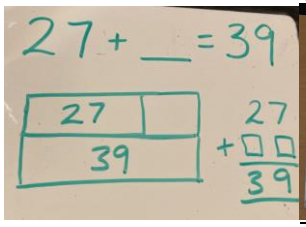
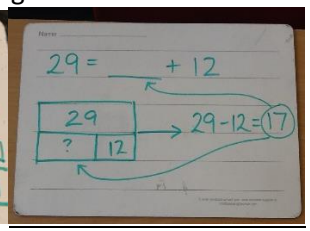
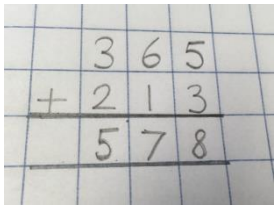
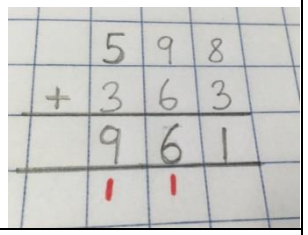
Abstract – procedural calculation method

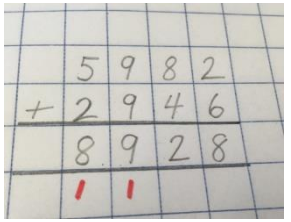
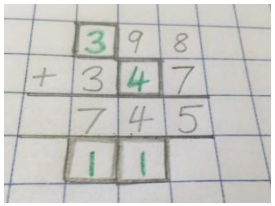
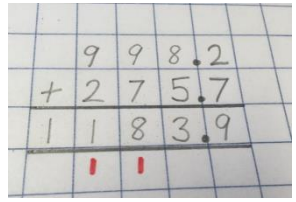
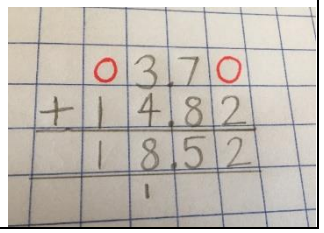
Writing the figures 0-20
Ordering figures from smallest to largest
Ordering figures from largest to smallest

	Solving problems – pictorial using objects and pictures of making bar models out of objects/multilink 	
Step 2 (Add 1-digit number to 1 or 2-digit numbers or adding three single digit numbers) **Objectives** ➢ To count on from a given number using the bigger number first and adding the smaller number. (Children to have a secure knowledge of ordering numbers, which will allow them to select the bigger number) ➢ Represent numbers up to 20. ➢ Given a number, identify 1 more with numbers up to 100. ➢ Read and write numbers from 1 to 20 in numerals and words. ➢ Add together three single digit numbers	**Representations** ➢ Identify and represent numbers using objects and pictorial representations including bead strings, straw bundles of ten, dienes, 100 square, vertical number lines and multilink, and use the language of: equal to, more than, less than (fewer), most, least, moving onto the symbols  ➢ Model and explore combining parts to make a whole - Use part-part-whole and bar models to support their understanding e.g for missing digit questions, using dienes/counters/place value/multilink/counters within them before moving on completing them with figures  ➢ Use tens frames/numicon/straw bundles of ten to support recall of number facts (such a number bonds) and bridging 10 or multiples of 10, linking to numberlines	Abstract – procedural calculation metho Use script to support steps of working out the addition sum. 8 + 7 = 15 67+1 = 68 ___ + 1 =26 42 = 41 +1

	   ➢ Count on from objects e.g. numicon, to show we don't have to count the first number ➢ Using fingers to count on, (ensure children put up the number of fingers they are counting on and put them down when counting).	
Step 3 (Add up to 2-digit and 2-digit numbers) **Objectives** ➢ Ensure knowledge of 2-digit + 1-digit counting on from a given number. ➢ Adding 3 one-digit numbers by counting on and understanding commutative relationship. (Can be done in any order). ➢ Having a secure knowledge of number bonds to 10, 20 and 100. ➢ Counting on from a given number using knowledge of	**Representations** As for step 2 and including the following: ➢ Recognise the value of 2 digit numbers using dienes, place value counters and blank counters in a place value chart.  ➢ Using hundred square to count on across tens ➢ Use a **vertical number line (**first with numbers then blank) to help with counting, moving on to children creating their own.	Abstract – procedural calculation method Children to be confident using column addition without carrying first.  ➢ Once children are secure, they are to begin carrying across place value boundaries but **ALWAYS** carry below. Ensure place value is written in correct order, tens first then ones.

number bonds where appropriate (two-digit + one-digit). ➢ Using a range of manipulatives to show an understanding of 2-digit numbers (including partitioning into tens and ones e.g. 37 = 30 + 7 which is the same as 3 tens and 7 ones ➢ Using knowledge of place value to add a 2-digit number and tens using manipulatives and building onto mental strategies. ➢ Using knowledge of partitioning to add 2-digit add 2-digit numbers.	➢ Begin with using the vertical number line (not crossing a ten) to support conceptual understanding.  Once confident using the vertical number line, introduce crossing a ten. When crossing tens children to 'land' on a ten then add remaining ones. If children are confident making the ones step over a ten, allow them to do so. .   Move onto using dienes in place value charts to represent the numbers and add the ones first then the tens, then followed up with showing them how to regroup and carry whole groups of ten to the next column. Once they are confident in their understanding, move onto the procedural method Use manipulative/bar models to develop their understanding of missing numbers in questions e.g. __ + 7 = 15	

		
Step 4 (Focus on adding numbers up to 3-digits). **Objectives** ➢ Add numbers up to three-digits using column addition, including carrying. ➢ Estimate the answer to a calculation and use inverse operations to check answers.	**Representations** ➢ Recap place value with dienes, place value counters and place value charts – demonstrate that ten ones =ten and that ten tens = 100. ➢ Revise how to regroup and then carry a whole group of ten or hundred to the next column. ➢ Use bar models to support pupils understanding of how to work out missing digit/number questions and support their understanding of how to use the inverse operation to check their understanding.  	Abstract – procedural calculation method Children to be confident using column addition without carrying first.  ➢ Once children are secure, they are to begin carrying across place value boundaries but **ALWAYS** carry below. Ensure place value is written in correct order, tens first then ones. 
Step 5 (Focus on adding numbers with up to 4-digits) **Objectives** ➢ See **Step 4** strategies (use up to 4-digits) and consolidate understanding of the column method. **See Example**.	**Representations** As step 4, but include that ten hundreds = a thousand.	Abstract – procedural calculation method ➢ Column addition including carrying. (**ALWAYS** carry below.) ➢ Ensure place value is written in correct order, tens first then ones etc. ➢ Check understanding through missing numbers.

		 
Step 6 (Add whole numbers with more than 4-digits using column addition, introduce addition of money and decimals). **Objectives** ➢ Continue with the column addition method with up to 4-digits and or decimals. ➢ Estimate and use inverse operations to check answers to a calculation	**Representations** As step 4, but place value counters or plain counters (not dienes as they are too large to be efficient).	Abstract – procedural calculation method Ensure that the decimal point **DOES NOT** move  Ensure if adding decimals with different place values, a place holder is used. 

Subtraction

Step 1 (Practical Maths) **Objectives** ➢ Finding 1 less than a given amount using objects/manipulatives.	**Representations** Exploring part-part-whole – Pictures of two groups making one whole, part part wholes and bar models Support subtracting single digit numbers – numicon and tens frames, fingers used to count on/back to find the difference.	Abstract – procedural calculation method Writing the figures 0-20 Ordering figures from largest to smallest

➢ Subtracting amounts within 10 using objects/manipulatives. ➢ Understanding of bigger and smaller vocabulary.	Solving problems – pictorial using objects and pictures of making bar models out of objects/multilink Numicon, multi-link, dienes, tens frames, part-part-whole, bar models and other objects to make links between addition and subtraction i.e. If I know 2+3 = 5, then I know 5 – 3 = 2.	

Step 2

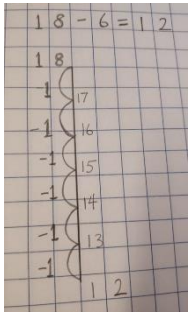
(Subtract 1-digit and 2-digit numbers to 20, including 0)

Objectives

- Represent and use number bonds and related subtraction facts within 20
- Subtract 1-digit and 2-digit numbers to 20, including zero.
- Given a number, identify 1 less with numbers up to 100.

Representations

- Identify and represent numbers using objects and pictorial representations including straw bundles of ten, dienes, 100 square, vertical number lines and multilink, and use the language of: equal to, more than, less than (fewer), most, least, as with addition
- Model and explore combining parts to make a whole - Use part-part-whole and bar models to support their understanding e.g for missing digit questions, using dienes/counters/place value/multilink/counters within them before moving on to completing them with figures
- Use tens frames/numicon/straw bundles of ten to support recall of number facts and bridging 10 or multiples of 10, linking to vertical numberlines, making links back to addition e.g. If I know 15 + 5 = 20, then 20 -5 = 15
- Using fingers to count back, (ensure children put up the number of fingers they are counting down/taking away and put them down as they count).
- To count back from a given number using the bigger number first and subtracting the smaller number using a vertical number line.

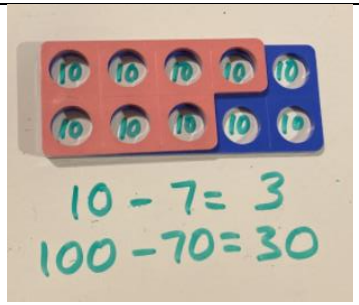
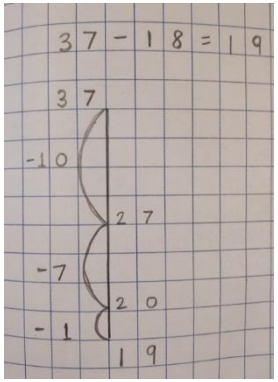
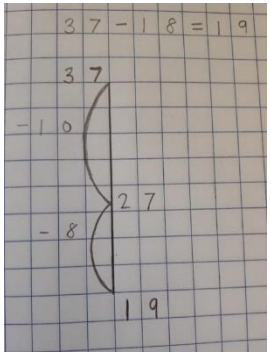


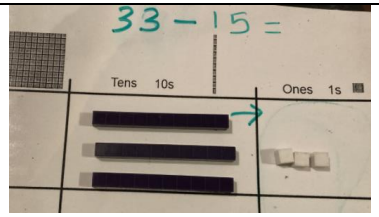
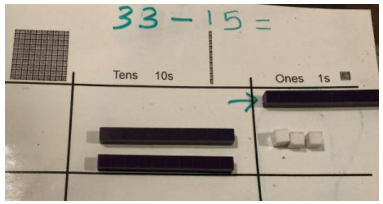
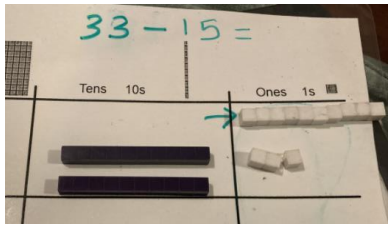
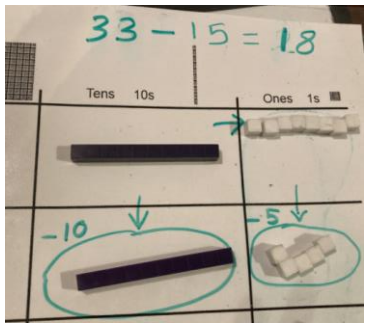
Abstract – procedural calculation method

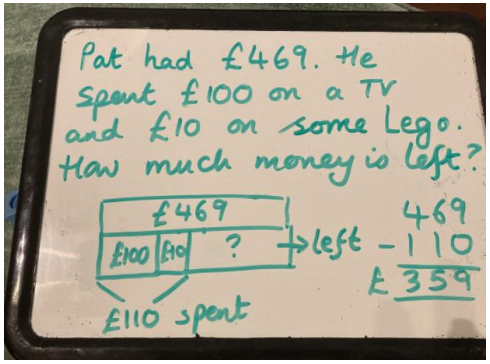
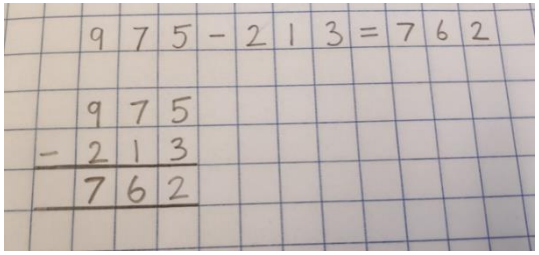
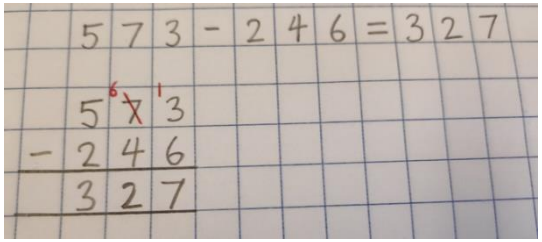
Simple number sentences (including missing number questions):

10 – 5 = 5
10 - __ = 2
18 – 5 = 13
12 – 6 = 6 (know doubles/halves to support with this)
11 – 5 = 6 (bridge 10 by taking 1 from 11 then 4 from 10 when teaching, explaining that how number bonds to ten can help me)

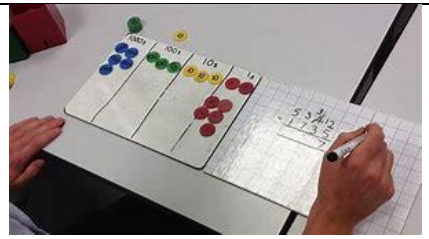
	➢ Children to have a secure knowledge of ordering numbers, which will allow them to select the bigger number. ➢ Pupils showing a secure understanding then move onto subtraction with missing numbers using the inverse.	
Step 3 (Subtract up to 2-digit by 2-digit numbers) **Objectives** ➢ Subtracting by counting back from a given number ➢ Use inverse to check calculations and solve missing number problems ➢ 2-digit by 2-digit numbers	**Representations** Use knowledge of number bonds to 10, 20 and 100 (in multiples of 10) to subtract e.g. 10 - 7 = 3 so 100 – 70 = 30 (using a range of manipulatives to support concrete understanding).	Abstract – procedural calculation method Once pupils are secure with the idea of subtraction and how to take ones and tens away separately, move onto the column method, as below. Teachers/ children **must** use correct language:

➢ Subtract numbers using concrete objects, pictorial representations, and mentally, including: • a 2-digit number and ones • a 2-digit number and tens	 Use a bar model to show that we are finding the difference and support their understanding of missing digit questions: ➢ Subtractive 2-digit by 2-digit numbers using <u>vertical number line</u>, including crossing tens. ➢ Children to use whichever method they feel most comfortable doing once understanding has been demonstrated.   ➢ Use dienes/place value counters and a place value chart to demonstrate exchanging before starting the abstract column method:	Teacher: "Why can't we do this subtraction?" Student: "It wouldn't help us because it would give us a negative number." (NOT "We can't do that") Teacher: "What can we do?" Student: "We can exchange from the next place value column." **<u>Place value must be written in order e.g. tens first then ones etc.</u>**

	   	
Step 4 (Subtract numbers with up to 3-digits using column subtraction) **Objectives**	**Representations** **Use place value counters/blank counters to demonstrate the value of each digit on a place value grid, then use as below to demonstrate exchanging:**	Abstract – procedural calculation method ➢ As above, but with three digits.

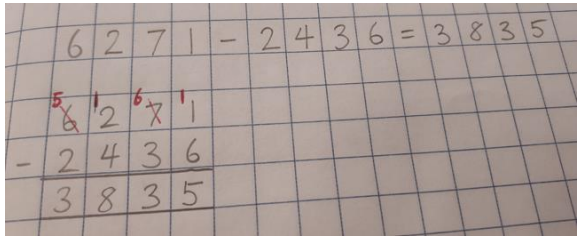
➢ Subtract numbers with up to three digits, using formal written methods of columnar subtraction. ➢ Estimate the answer to a calculation and use inverse operations to check answers ➢ Subtract numbers mentally, including: • a 3-digit number and ones • a 3-digit number and tens • a 3-digit number and hundreds	**Include opportunities for using the manipulatives or matching pictorial images to support problem solving, such as missing numbers, including bar models:** 	➢ Exchanging to happen from tens to ones, and hundreds to tens once they have mastered the former   ➢ If subtracting money or other numbers with many zeros, encourage pupils to try quicker and more accurate alternatives e.g.
Step 5 (Subtract numbers with up to 4-digits using column subtraction) **Objectives**	**Representations** **Use place value counters/blank counters to demonstrate the value of each digit on a place value grid, then use as below to demonstrate exchanging, including decimal points for money:**	Abstract – procedural calculation method ➢ Continue with the column subtraction method using 4-digit numbers.

- Subtract with up to 4-digits and or decimals.
- Subtract numbers mentally, including:
  - a 3-digit number and ones
  - a 3-digit number and tens
  - a 3-digit number and hundreds

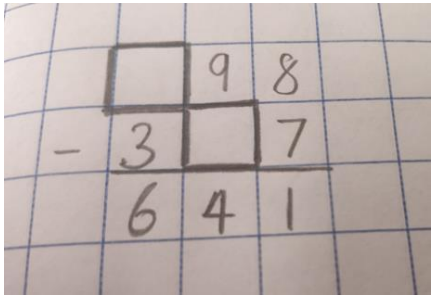


Again, using the manipulatives or matching pictorial images, such as place value charts or bar models, to support their problem solving:

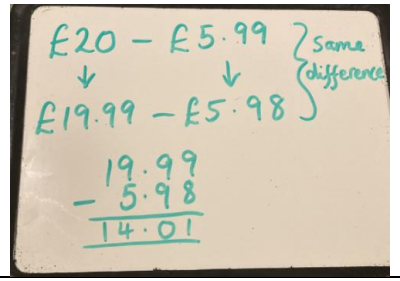
- Continue to encourage children to explain the steps they have taken.

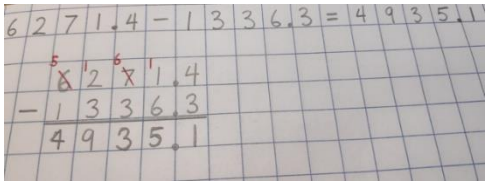
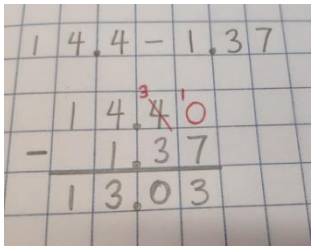


- Check understanding of column subtraction through missing numbers,

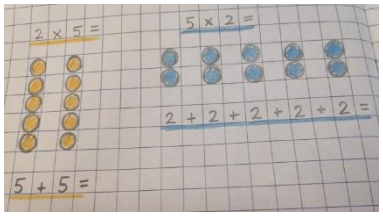


- Encourage the use of alternative strategies, as in step 4, for numbers with many zeros at the end,



Step 6 (Subtract whole numbers with more than 4-digits including decimals) **Objectives** ➢ Use written formal methods to subtract up to 4-digit numbers and introduce money and decimals.	**Representations** **As for step 5, but with 5 digit numbers**	Abstract – procedural calculation method ➢ Continue with column subtraction. ➢ Ensure that the decimal point **DOES NOT** move 
Step 7 (Subtract whole numbers with more than 4-digits including decimals) **Objectives** ➢ Continue with formal written methods, including decimals with different number of decimal places.	**Representations** **As for step 5, but up up to digit numbers, and 4 digit decimal numbers**	Abstract – procedural calculation method ➢ Continue with column subtraction with decimals. ➢ Ensure that the decimal point **DOES NOT** move ➢ Ensure decimal point is lined up and use place holders. 

Multiplication

Step 1 (Practical maths) **Objectives** ➢ Doubling and making equal groups using practical objects and within play.	**Representations** ➢ Using a range of manipulatives (Numicon, multi-links, other objects etc.) to demonstrate repeated addition. ➢ Pictorial representations to show repeated addition, including multi link and bar models that match	Abstract – procedural calculation method Repeated addition number sentences e.g. 2+2+2+2 = 8
Step 2 (Making equal groups to solve multiplication calculations). **Objectives** ➢ Doubling numbers up to 20. ➢ Counting on in 2s, 5s and 10s.	**Representations** ➢ Using a range of manipulatives (Numicon, multi-links etc.) to represent repeated addition and then move onto arrays ➢ Model and then ask pupils to create pictorial representations to demonstrate – including concrete objects alongside bar models	Abstract – procedural calculation method ➢ Record repeated addition number sentences using the mathematical symbols + and =.
Step 3 (Multiply two-digit by one-digit numbers) **Objectives** ➢ Recall and use multiplication and division facts for the 2,3,4 5, 6 and 10 multiplication tables. ➢ Record methods and use the symbols x and = ➢ Show that multiplication of two numbers can be done in any order (commutative).	**Representations** ➢ Use manipulatives to count on in regular groups (2s, 3s, 4s, 5s, 6s and 10s) and relate this to numberlines ➢ Relate practical objects to repeated addition.  ➢ Create/draw arrays and related bar models, and use this to link repeated addition to the x symbol for multiplication. ➢ Use the arrays/bar models as mentioned above to help solve missing number problems e.g. __ x 3 = 16	Abstract – procedural calculation method ➢ Record multiplication as a number sentence with the x symbol e.g. 3x4=12. ➢ Practise finding the missing number as well – ➢ __ x 5 =20

Step 4

(Multiply 2-digit by 1-digit numbers)

Objectives

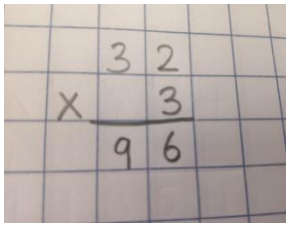
- Recall and use multiplication facts for times tables up to 10.
- Multiply 2-digit numbers by 1-digit numbers, using written formal method.

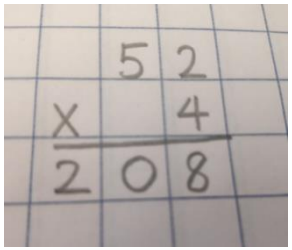
Representations

- When recall number facts, practise using arrays for unknown facts, numberlines for counting on in multiples as in step 3.
- When multiplying a number larger than 12 by a single digit number, use partitioning to show that we multiply the ones by the ones and then the tens by the ones and then totalling (support each stage by using arrays of dienes or place value counters).
- Use partitioning in conjunction with the expanded multiplication method:
- Use the manipulatives/matching pictorial representations (such as bar models and arrays) to support problem solving:

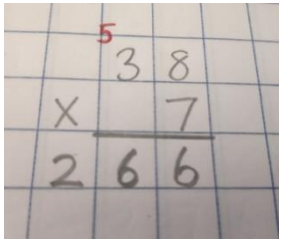
Abstract – procedural calculation method

- Written formal method,
- Move onto adding an extra digit,

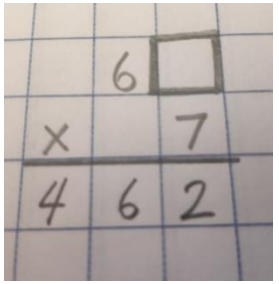


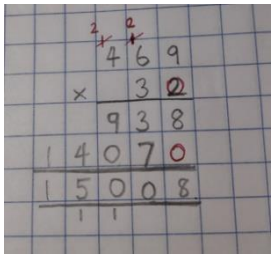


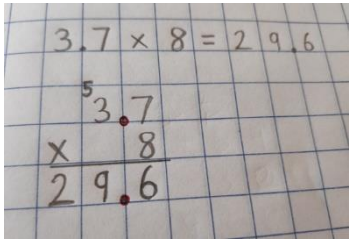
- To extend pupils move onto carrying,



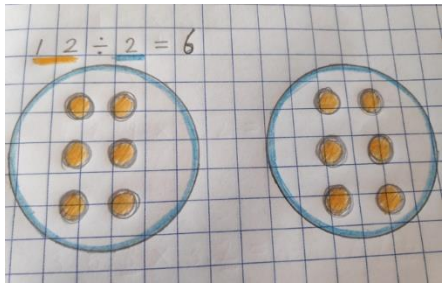
- In multiplication, you must **ALWAYS** carry at the top.
- Once children are confident carrying, identify missing numbers using the inverse.

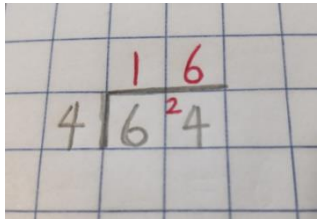


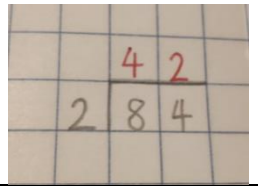
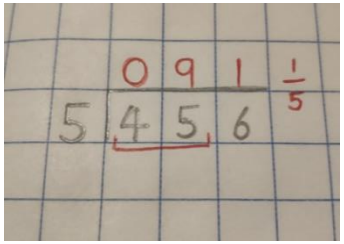
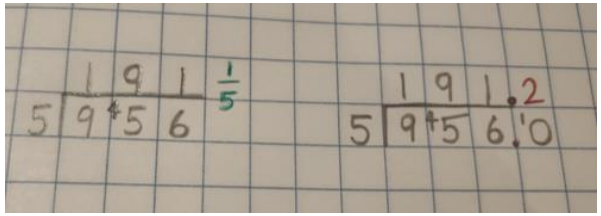
Step 5 (Multiply 2-digit and 3-digit numbers by 1-digit number) **Objectives** ➢ Children must know their multiplication tables up to 12. ➢ Multiply decimals by 10, 100, 1000.	**Representations** ➢ As for step 4 ➢ Model moving digits when multiplying by 10, 100 and 100 – use digit cards and place value charts (see Moving Digits game in Top Marks for a screen version) ➢ Use the digit cards and place value charts to support their problem solving:	Abstract – procedural calculation method ➢ Continue to write and calculate mathematical statements for multiplication using formal written methods, but including three digit numbers
Step 6 (Multiply numbers up to 4-digits by a 1-digit or 2-digit number) **Objectives** ➢ Identify multiples and factors, including finding all factor pairs of a number, and common factors of two numbers. ➢ Establish whether a number is prime up to 100. ➢ Multiply whole numbers and those involving decimals by 10, 100 and 1000.	**Representations** ➢ Use arrays (concrete or pictorial) to support their understanding of multiples and factors ➢ Use bar models to model problem solving, particularly multi-step ➢ Use a 100 square and numberlines to spot patterns when discussing multiples and factors ➢ Use an array to demonstrate what a prime number is (cannot be put into a rectangle that doesn't have one as a row/column) ➢ Identify prime numbers on a 100 square, discussing patterns ➢ Model moving digits when multiplying decimals by 10, 100 and 100 – use digit cards and place value charts (see Moving Digits game in Top Marks for a screen version) ➢ Use the digit cards to support their problem solving:	Abstract – procedural calculation method ➢ Using a formal written method, including long multiplication for 2-digit numbers.  ➢ Multiplication **ALWAYS** carry at the top. ➢ When the ones digit has been calculated **3 things MUST** be done • Cross out any carried numbers (at the top) • Circle the digit which has been used. • Place holder to show you are multiplying by 10. ➢ If multiplying by hundreds repeat **three things**, however two place holders will be needed.

Step 7 (Multiply numbers up to 4-digits by a 2-digit numbers including decimals). **Objectives** ➢ Identify common factors, common multiples and prime numbers.	**Representations** As for Step 6, continuing to use numberlines and 100 squares to identify patterns	Abstract – procedural calculation method ➢ Apply the same method for multiplying decimals, ensure the decimal point remains in the same place. 

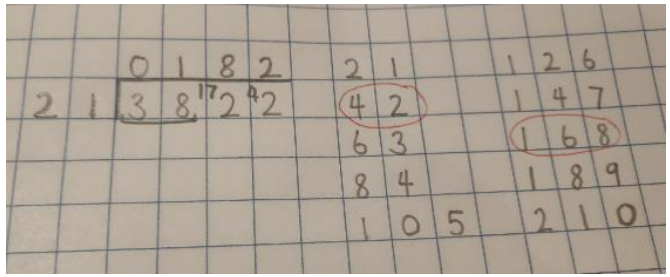
Division

Step 1 (Practical Maths) **Objectives** ➢ Halving and sharing using a range objects in different contexts.	**Representations** ➢ Using a range of manipulatives (Numicon, multi-links, other objects etc.) to create equal groups. ➢ Pictorial representations.	Abstract – procedural calculation method
Step 2 (Creating equal groups) **Objectives** ➢ Halving and sharing into equal groups using manipulatives.	**Representations** ➢ Using a range of manipulatives (Numicon, multi-links, other objects etc.) to create equal groups. ➢ Division as arrays, moving onto bar models. 	Abstract – procedural calculation method Record as dividend divided by divisor to find the quotient: ___ ÷ _____ =

Step 3 (Dividing numbers by creating equal groups) **Objectives** ➢ Division by sharing and grouping equally using manipulatives.	**Representations** ➢ Division recorded using arrays and bar models. **See Examples from Step 2.**	Abstract – procedural calculation method ➢ As above for step 2 ➢ Division using inverse of multiplication facts mentally.
Step 4 (Dividing 2-digit by 1-digit numbers). **Objectives** ➢ Divide 2-digit numbers by 1-digit.	**Representations** ➢ Model using manipulatives/pictorial images as above for how many groups in a single digit, showing whole amounts and remainders: ➢ Use place value counters on a place value grid (with bus stop frame) to demonstrate finding groups of a digit and then carrying over the remainder: ➢ Use arrays and bar models to support problem solving	Abstract – procedural calculation method ➢ Use short division without manipulatives/pictorial images ➢ Once children are able to divide whole numbers equally move onto numbers with a remainder **Script** 1) How many 2's in 8? 8 ÷ 2 = 4 2) Place the 4 above the 8 in the tens column. 3) How many 2's in 4? 4 ÷ 2 = 2 4) Place the 2 above the 4 in the ones column. 5) Children to read the answer using an understanding of place value as 42. ➢ . 

		
Step 5 (Dividing 2-digit by 1-digit numbers) **Objectives** ➢ Divide 2-digit by 1-digit, interpreting remainders appropriately for the context. ➢ Dividing numbers, including decimals by 10, 100, 1000.	**Representations** ➢ As step 4, using place value charts with decimal numbers too	Abstract – procedural calculation method ➢ Short division including remainders as fractions and decimals.  ➢ If the number is not divisible, then the amount is carried across and underlined, with a 0 place holder placed above.  ➢ Remainder should always be left as a **fraction** or **decimal**, **NOT** using an “r”.

Step 6 **Objectives** ➢ Divide up to 4-digits by 1-digit using short division, interpret remainders as fractions and decimals.	**Representations** ➢ As Step 5	Abstract – procedural calculation method ➢ Short division including remainders as fractions and decimals. **See Examples in Step 5.**

Step 7 **Objectives** ➢ Divide numbers up to 4-digits by a 2-digit whole number.	**Representations** ➢ As step 5	Abstract – procedural calculation method Short division including remainders as fractions and decimals. **See Example in Step 5.** ➢ Long division.  Script 1) First begin to write out your 21 times table. 2) Next look at how many 21's in 3? The answer is 0, therefore you have to carry (underline)the 3. 3) The 3 is carried to the 8, making 38. How many 21's in 38? The answer is 1, place the 1 above the 8. You now need to work out the remainder. 38 – 21 = 17 4) This stage requires you to carry 17 over to the 2, making 172. 5) How many 21's in 172? Closest answer is 21 x 8 = 168, therefore you place 8 above 172. 6) Now work out the remainder, 172 – 168 = 4, therefore you have to carry the 4 over to the 2, making 42. 7) Finally, how many 21's in 42? The answer is 2 and there are no remainders, which means the 2 needs to go above the 42, making the answer of 182.

		8) If the answer doesn't divide exactly, you may interpret the remainders in the same way as shown in Step 5.