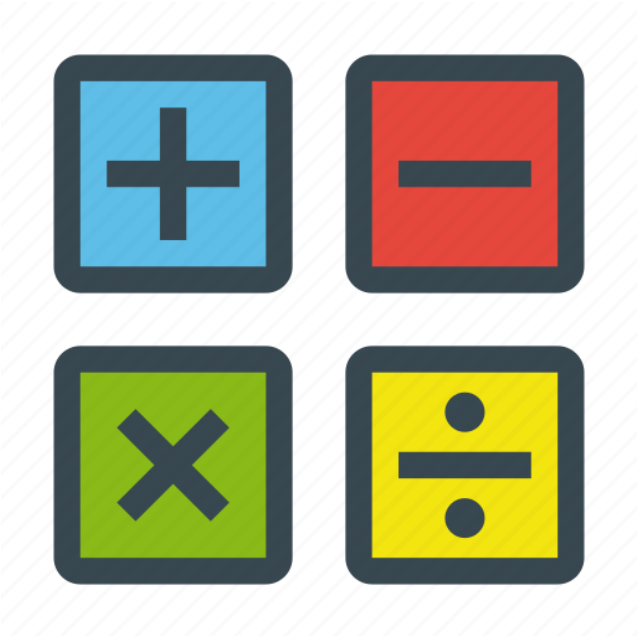
'Always our best for God, each other and ourselves'

# Holy Family Catholic Primary School

Mathematics
Calculation Policy



At Holy Family School, we aim for pupils to develop a mastery of maths by allowing them to develop a long, deep and secure understanding of mathematical concepts.

We do this by:

- Taking small, manageable steps each lesson to help pupils access more difficult concepts.
- Exposing pupils to a variety of representations for different areas of maths
- Helping pupils make connections, spot patterns and ask questions.
- Encouraging pupils to be clear in their reasoning about mathematics through self-explanations and written reasoning, using key vocabulary.
- Be fluent in the fundamentals of mathematics, such as number bonds and times tables.

Because we want our pupils to develop a deep understanding of calculation, we believe that children need to understand the structure of the relationships between addition, subtraction, multiplication, and division. This means that children should be introduced to these calculations through practical manipulatives, discussing relationships and looking at representations such as part-whole models or bar models. As children begin to understand the underlying ideas, they develop ways of recording to support their thinking and calculation methods, use particular methods that apply to special cases, and learn to interpret and use the signs and symbols involved.

A secure understanding of each calculation allows pupils to develop secure mental methods. Written methods are complementary to mental methods and should not be seen as separate from them. It is important children acquire secure mental methods of calculation and one efficient written method for each calculation, which they know they can rely on when mental methods are not appropriate.

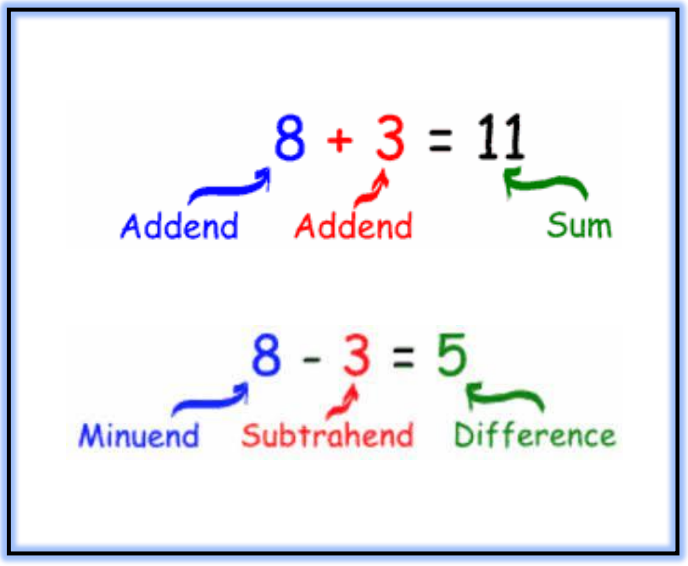
This document identifies progression in calculation strategies rather than specifying which method should be taught in a particular year group.
Children should not be made to go onto the next stage if:

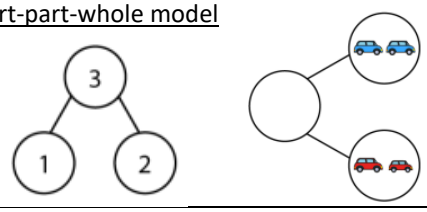
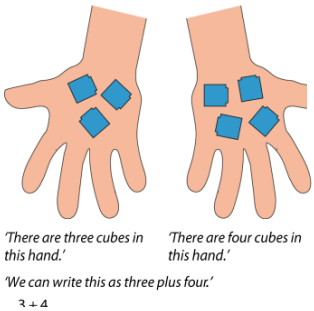
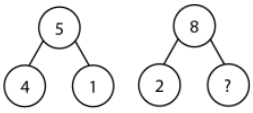
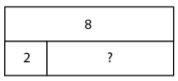
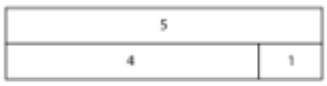
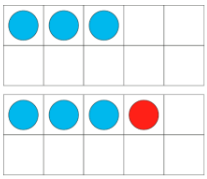
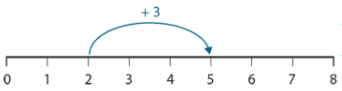
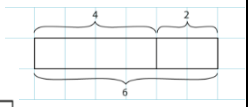
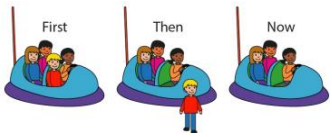
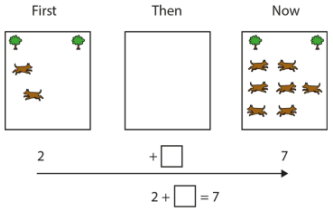
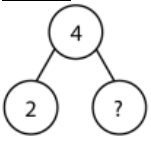
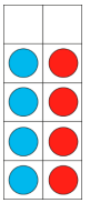
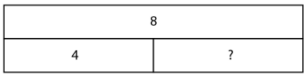
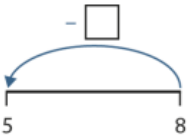
1) they are not ready.
2) they are not confident.

The policy is split into two relationships: additive (addition and subtraction) and multiplicative (multiplication and division). This follows the NCETM's guidance found here: https://www.ncetm.org.uk/teaching-for-mastery/mastery-materials/primary-mastery-professional-development/

# Additive Relationship

(Addition and Subtraction)



| Step | Explanation | Examples/ representations used |
|---|---|---|
| 1 | Part-part-whole model<br><br>Children are introduced to the part-part-whole, understanding that wholes can be split in different ways. | Part-part-whole model<br>  |
| 2 | Introduction to the additive relationship<br><br>Pupils learn that aggregation is combining parts to make a whole; partitioning is breaking up the whole.<br>2 addends combined can be represented by the addition symbol (+) whereas partitioning can be represented using the subtraction symbol (-).<br>The equals symbol (=) shows equivalence. | Using manipulatives<br>  <br>Part-part-whole model<br>  <br>Bar Model<br>  <br>8 – 2 = 6<br>6 = 8 - 2<br>  <br>5 = 4 + 1<br>5 = 1 + 4<br>5 = 4 + 1<br>5 = 1 + 4 |
| 3 | Further introduction to the additive relationship<br><br>Pupils then learn about addition as augmentation (something is changed) and subtraction as reduction (taking something away). This is learnt through a 'first, then, now' story context e.g. first 4 children were on a bus, then 2 more got on, now there are 8 children. Pupils also begin to learn that these are inverse operations (we can use one to find a missing part) | Tens frames<br>*'**First**, James wrote three sentences.*<br>*'**Then**, he wrote one more sentence.*<br>*'**Now**, he has four sentences written down.'*<br>  <br>Number line<br>  <br>Bar model<br>  <br>Pictorial<br>  <br>  |
| 4 | Basic additive strategies<br><br>Pupils should learn some useful strategies for mental addition and subtraction, including:<br>• addition is commutative (order does not matter),<br>• number bonds to 10,<br>• odd and even patterns, adding and subtracting 0,<br>• doubles and halves. | Part-part-whole model<br>  <br>Tens frames<br>  <br>Bar model<br>  <br>Number line<br>  |

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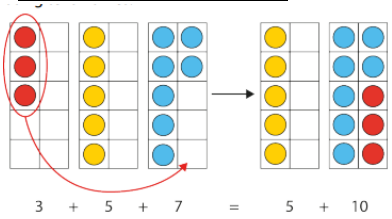
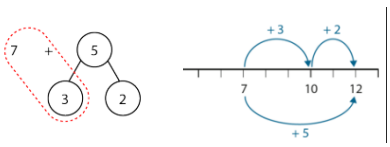
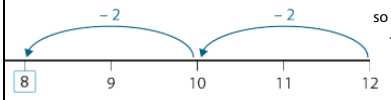
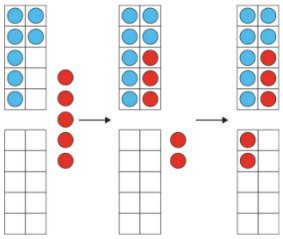
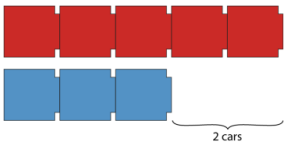
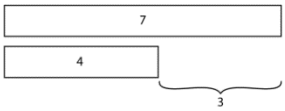
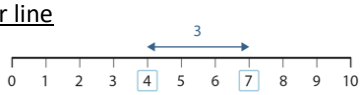
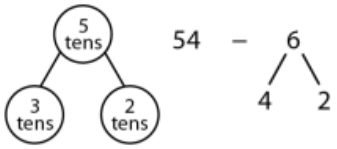
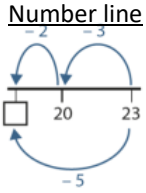
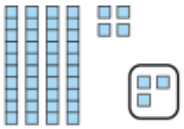
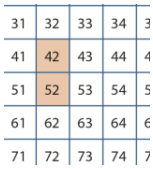
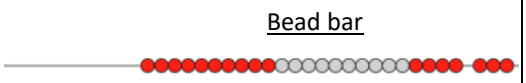
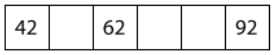
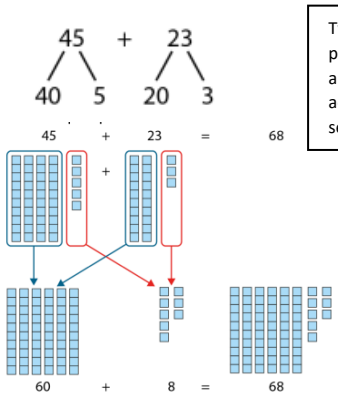
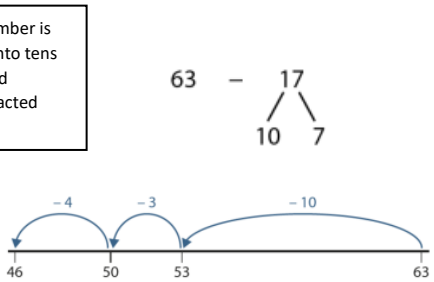
| 5 | <u>Bridging 10</u><br><br>Pupils learn that when adding more than 1 number, we can combine to make 10 to aid mental calculation.<br>Pupils also begin to bridge 10 by making 10 (addition) or subtracting through or from 10, using their knowledge of number bonds to 10. | <u>Tens frames – 3 addends</u><br>  <br><br><u>Part-part-whole model</u><br>  <br><br><u>Number line</u><br>  <br><br>12 – 2 = 10<br>10 – 2 = 8<br>so<br>12 – 4 = 8<br><u>Tens frames - addition</u><br>  |
| 6 | <u>Subtraction as difference</u><br><br>Children are introduced to the third and final subtraction structure: difference. This compares two sets of objects or two measures e.g. how many more cubes does Emma have than Gian? | <u>Using manipulatives</u><br>  <br><br><u>Bar Model</u><br>  <br><br><u>Number line</u><br>  <br> |
| 7 | <u>Adding and subtracting two-digit numbers with ones or tens</u><br><br>Building on previous steps, pupils learn to use strategies of adding single-digits and multiples of ten to two-digit numbers. They learn to bridge through 10, and how the place value system changes, for example when adding multiples of tens, the ones remain the same. | <u>Part-part-whole model</u><br>  <br><br><u>Number line</u><br>  <br><br><u>Dienes</u><br>  <br><u>Number square</u><br>  <br><br><u>Bead bar</u><br>  <br><u>Number tracks</u><br>  <br><br><u>Place value grid</u><br>10s \| 1s<br>4 + 3 \| 5 |
| 8 | <u>Adding and subtracting two-digit numbers with two-digit numbers</u><br><br>Pupils can begin to apply the strategies they have learnt (such as bridging through 10 and partitioning) to add two larger numbers together.<br>They learn to do this first by partitioning tens and ones and adding/subtracting these separately. | <u>Dienes</u><br>  <br><br>Two digit number is partitioned into tens and ones, and added/subtracted separately<br><u>Number line</u><br>  <br> |

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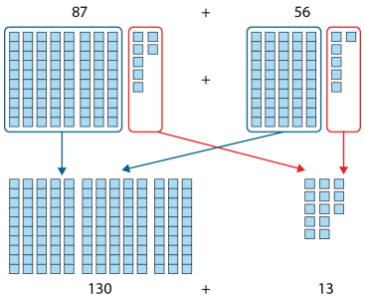
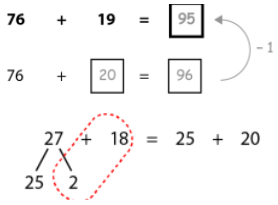
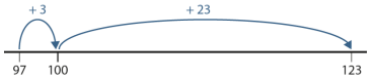
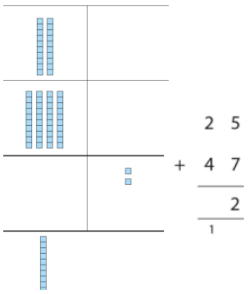
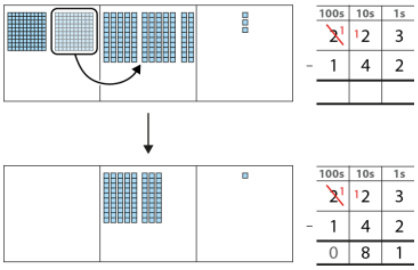
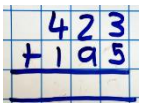
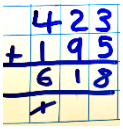
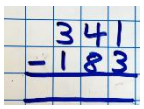
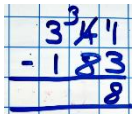
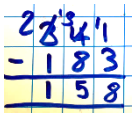
| 9 | <u>Applying strategies to three-digit numbers (and above)</u><br><br>Pupils begin to apply known strategies (such as partitioning) for efficient mental addition and subtraction to larger numbers, as well as some new strategies including 'adding on' for different problems, and redistribution (manipulating parts of the equation to make it easier mentally – see right). Once pupils have mastered these strategies, they are then applied to larger numbers as pupils move through year groups (up to 10 million by end of KS2). | <u>Dienes</u><br>  <br><br><br><u>Using place value</u><br>370 + 260 = 37 tens + 26 tens<br>= 63 tens<br>= 630<br><br><u>Redistribution</u><br>  <br><br><br><u>Number line</u> (adding on to find difference)<br>125 - 97<br>  <br> |
| 10 | <u>Columnar Addition and Subtraction</u><br><br>Children are now introduced to the formal written method – columnar method. They explore how to use column method, starting from the right and working in values, linking to structure. They then learn to use regrouping (addition) and exchanging (subtraction).<br><br>As above, this strategy will be applied to larger numbers in subsequent year groups (up to 6 digits). | <u>Moving from dienes to column method</u><br><br>*Addition*<br>  <br><br><br>*Subtraction.*<br>  <br><br><br><u>Column addition</u><br>  <br>1. numbers are placed in columns, lining up values.<br><br>  <br>2. starting from the right, we add the columns. If there is a sum greater than 10, we regroup this in the next column.<br><br>  <br>3. Any regrouped ten is added onto the next column. This is repeated until we have our sum.<br><br><u>Column subtraction</u><br>  <br>1. numbers are placed in columns, lining up values.<br><br>  <br>2. starting from the right, we subtract the columns. If we cannot subtract, we can exchange a ten from the next column.<br><br>  <br>3. This is repeated until we have our difference. |

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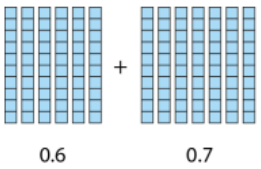
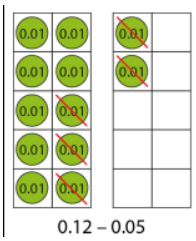
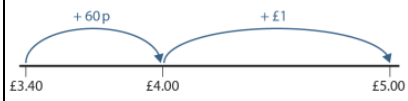
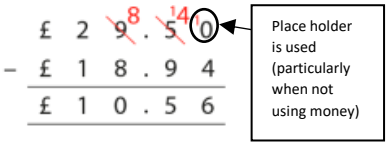
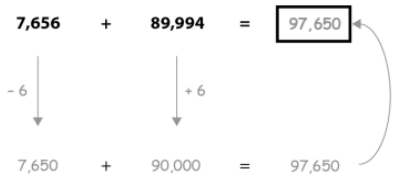
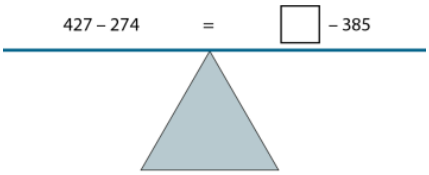
|---|---|---|
| 11 | <u>Using mental and written strategies with decimals</u><br><br>As pupils progress, they apply their strategies to decimal numbers, for example bridging through 1. They apply through money contexts too, through efficient mental strategies when combining money, or finding the difference. Finally, they apply column method to decimal and money contexts. | <u>Dienes</u><br>  <br><br><u>Tens frames</u><br>  <br><br><u>Redistribution</u><br>  <br><br><u>Number line (difference)</u><br>  <br><br><u>Column method</u><br>  <br> |
| 13 | <u>Advanced manipulation of additive relationship</u><br><br>Once pupils have mastered addition and subtraction, they can fully manipulate equations to solve problems.<br>Pupils can begin to change parts of an equation to see what happens and notice patterns. This allows efficient mental calculations through redistribution e.g.<br>392 – 74 = 400 – 82 (added 8 to both) | <u>Redistribution and compensation</u><br>  <br><br><u>Balancing equations</u><br>  <br> |

# Multiplicative Relationship

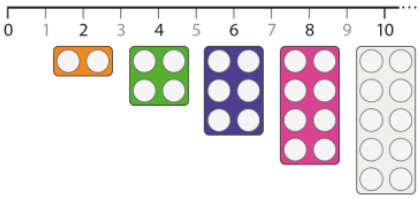
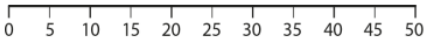
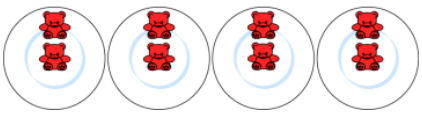
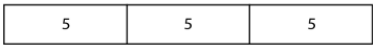
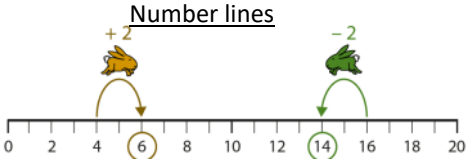
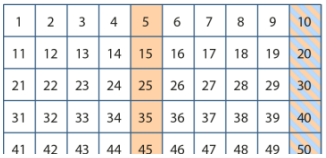
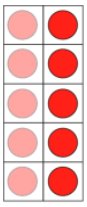
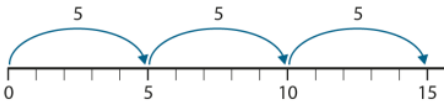
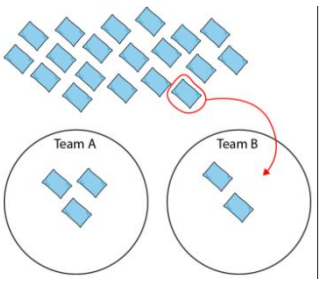
(Multiplication and Division)

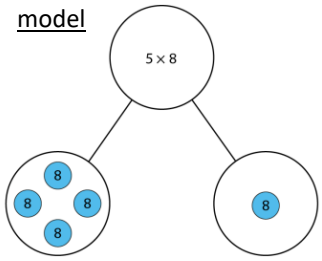
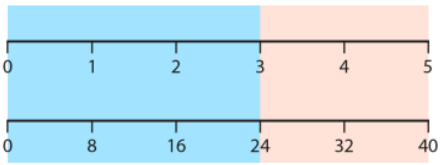
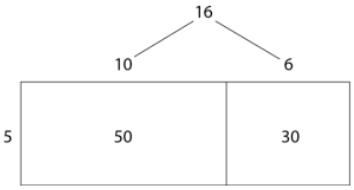
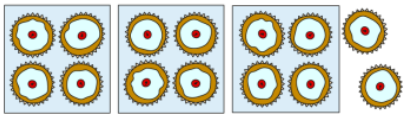
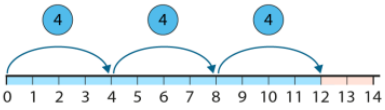
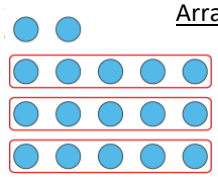
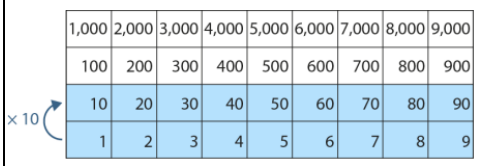
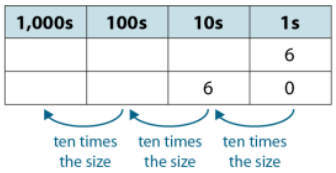
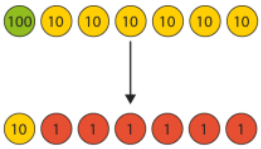
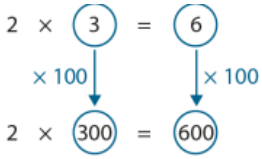
$$2 \times 7 = 14$$

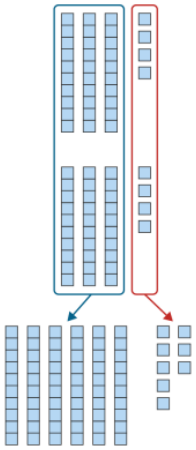
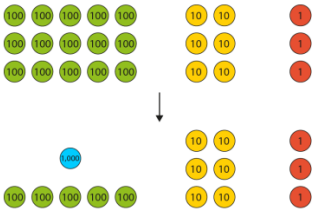
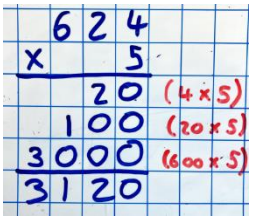
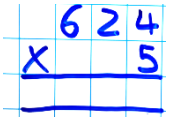
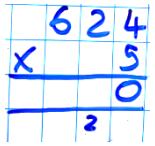
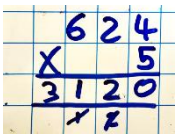
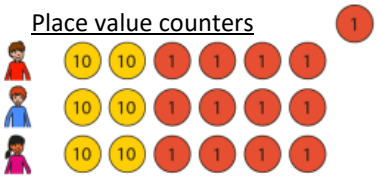
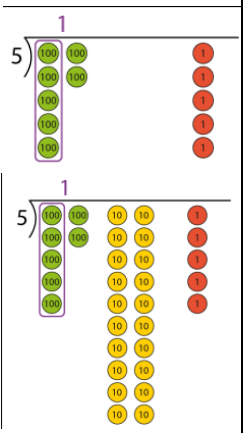
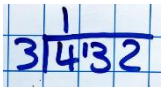
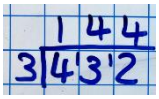
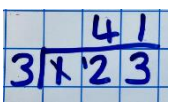
$$\text{factor} \times \text{factor} = \text{product}$$

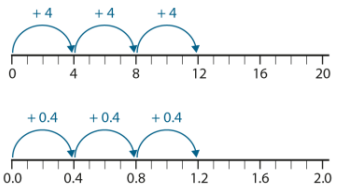
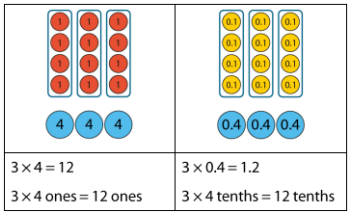
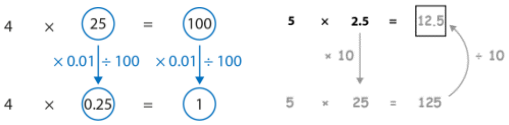
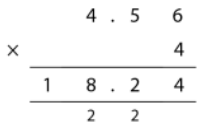
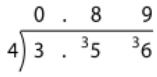
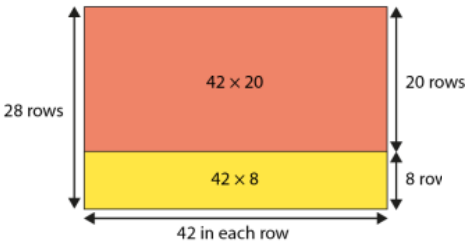
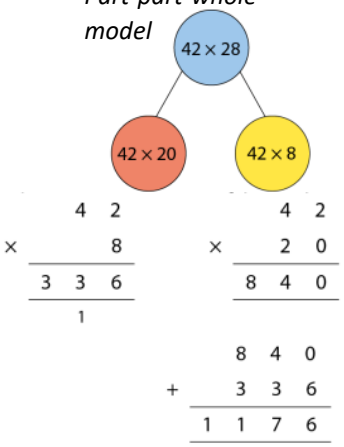
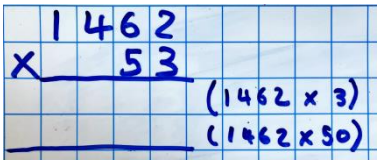
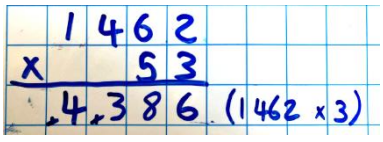
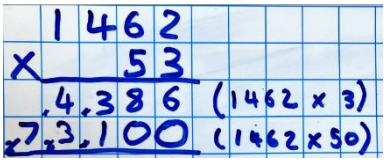
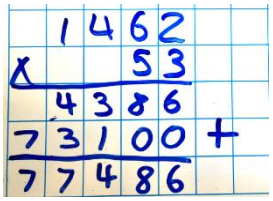
$$\text{Divisor} \overline{)\ \text{Dividend}}\ \text{Quotient}$$

Calcworkshop.com

| Step | Explanation | Examples/ representations used |
|---|---|---|
| 1 | Introuduction to unitising<br><br>Children are first introduced to multiplication through exploring the concept of unitising – counting in units of two, five or ten. | Numicon<br>  <br><br>Using manipulatives/pictures<br>  <br>Number lines<br>  <br> |
| 2 | Exploring equal groups<br><br>Pupils explore how objects can be arranged in equal groups and how these groups can be described. They connect multiplication to repeated addition, representing groups with both e.g. 2 + 2 + 2 = 2 x 3. | Using manipulatives/pictures<br>  <br>There are 4 groups of 2.<br>We can write this as 2+2+2+2 or 4 x 2.<br>Bar models<br>  <br><br>There are 3 groups of 5.<br>We can write this as 5+5+5 or 3 x 5 |
| 3 | Times table knowledge<br><br>Children begin to build up their times table knowledge through combining counting in units and equal groups.<br>They learn that multiplication is commutative (can be in any order); what happens when a factor is 0/1; and make connections between times tables (e.g. 5/10, 3/6 etc.).<br>As pupils move from year groups, they learn new times tables. | Using manipulatives/pictures<br>  <br>$3 \times 2 = 6$<br>Number lines<br>  <br><br>Number squares<br>  <br><br>Tens frames/ arrays<br>  <br>Progression of tables<br>Year / Times Tables<br>2 / 2, 5, 10<br>3 / 4, 8<br>4 / 3, 6, 9<br>7, 11, 12<br>5+ / All tables |
| 4 | Introducing division<br><br>Children are introduced to division as grouping equally (quotative division) which can be calculated using skip counting.<br>They are then shown sharing problems (partitive division).<br>Pupils use the term dividend ÷ divisor = quotient.<br>They make the connection between multiplying and dividing through repeated addition/subtraction and missing factor problems<br>e.g. 5 x ? = 15 | Using manipulatives/pictures - grouping<br>  <br>Number lines<br>  <br><br>$5+5+5=15$<br>$15 \div 5 = 3$<br>Using manipulatives/pictures - sharing<br>  <br> |

| | | |
|---|---|---|
| 5 | <u>The distributive law</u><br><br>Pupils learn to partition factors and use this to derive multiplication facts mentally. For example, 5 x 8 = (3 x 8) + (2 x 8).<br>They learn to apply this understanding:<br>e.g. 8 x 7 can be solved by doing (8 x 5) + (8 x 2).<br>16 X 5 can be solved by doing (10 x 5) + (6 x 5).<br>This comes useful for solving larger factor problems later e.g. using 37 x 41 = 1517 to solve 37 x 42 (one more 37) | <u>Part-part-whole model</u><br>  <br><br><u>Number lines</u><br>  <br><br><u>Distributive law</u><br>$7 \times 9 = 9 \times 7$<br>$9 \times 7 = 9 \times 5 + 9 \times 2$<br>$= 45 + 18$<br>$= 63$<br>$7 \times 9 = 7 \times 10 - 7$<br>$= 70 - 7$<br>$= 63$<br><br><u>Distributive law with bar model</u><br>  <br> |
| 6 | <u>Remainders in division</u><br><br>Children explore how quantities can be split into equal groups with a remainder and interpret this in contexts. | <u>Using manipulatives/pictures</u><br>  <br><u>Number lines</u><br>  <br><br><u>Arrays</u><br>  <br>$17 \div 5 = 3 \text{ r } 2$ |
| 7 | <u>Multiplying and dividing by 10 and 100</u><br><br>In order to develop good mental strategies, pupils need to be able to multiply/divide by 10 and 100, understanding what happens to the product/quotient.<br>In later years, this is applied to decimals (and x/÷ 1000). | <u>Gattegno chart</u><br>  <br><br><u>Place value grid</u><br>  <br><br><u>Place value counters</u><br>  <br><br><u>Making connections</u><br>  <br> |

| | | |
|---|---|---|
| 8 | **Short multiplication**<br><br>Pupils are now introduced to a formal written strategy in short multiplication.<br>Firstly, pupils learn to partition into hundreds/tens/ones and multiply these by 1 digit, adding the parts together.<br>This supports moving into column multiplication, applying regrouping.<br><br>*It is important that children add the regrouped ten, rather than multiply (common mistake).* | **Dienes**<br>  <br>**Place value counters**<br>  <br>**Distributive law**<br>86 x 4<br>$80 \times 6 = 480$<br>$4 \times 6 = 24$<br>$480 + 24 = 504$<br>  <br>Expanded form is taught first, and often used alongside so pupils understand what they are doing in short multiplication.<br>  <br>1. numbers are placed in columns, lining up values.<br>  <br>2. starting from the right, we multiply by the single digit. Values over ten are regrouped into the next column.<br>  <br>3. The regrouped ten is **added** onto the next product. This is repeated until the final product. |
| 9 | **Short division**<br><br>Pupils are now introduced to the short division method (often referred to as the bus stop method).<br><br>They make links to skip counting in previous steps to solve division problems.<br>Remainders should also be interpreted here too.<br>Pupils learn to partition numbers into hundreds/tens/ones and divide each by the divisor. | **Using manipulatives/ pictures**<br>  <br>8 tens ÷ 4 = 2 tens<br>4 ones ÷ 4 = 1 one<br>84 ÷ 4 = 21<br>**Place value counters**<br>  <br>6 tens ÷ 3 = 2 tens<br>13 ones ÷ 3 = 4 one r 1 one<br>73 ÷ 3 = 24 r 1<br>**Place value counters in short division**<br>Pupils will learn to use counters first, and often alongside short division to help pupils understand the method.<br><br>In this context, we can group the counters before exchanging to the next column (e.g. 2 hundreds = 20 tens)<br>  <br>**Short division**<br>1. the dividend goes inside the 'bus stop', the divisor on the outside. The quotient on top.<br>  <br>2. Starting from the left, we divide each value by the divisor. Any remainders are exchanged into the next value.<br>  <br>3. We then divide the next value + any remainders. Continue until we have the quotient.<br>  <br>Any remainder at the end is shown as r no.<br>  <br>If no equal group remains, the remainder is exchanged (here 100 for 10 tens).<br>  |

| | | |
|---|---|---|
| 10 | X/÷ decimals by whole numbers<br><br>Pupils develop strategies for multiplying and dividing decimal fractions by whole numbers, using known facts including unitising and x/÷ by 10 and 100.<br>Pupils should also know how to use written methods of short multiplication and division with decimals. | Number lines<br>  <br><br>Place value counters<br>  <br><br>Scaling facts<br>6 × 4 ones = 24 ones<br>6 × 4 hundredths = 24 hundredths<br>6 × 0.04 = 0.24<br>  <br><br>Short multiplication<br>  <br><br>Short division<br>  <br> |
| 11 | Long multiplication<br><br>One of the more difficult strategies pupils learn is long multiplication: multiply two numbers with 2 or more digits together. Firstly, pupils need to secure their understanding of multiplying multiples of 10, 100 and 1000.<br><br>They are introduced to the method through partitioning again, which supports their understanding. | Partitioning<br>*Area model*<br>  <br><br>*Part-part-whole model*<br>  <br><br>Long multiplication<br>  <br><br>1. numbers are placed in columns, lining up values. We partition our factor into tens and ones.<br>  <br><br>2. First, we multiply by the ones, following short multiplication.<br>  <br><br>3. Next we multiply by the ten. We add a 0 to the ones column to show this.<br>  <br><br>4. Finally we add the partial products to get a final product. |

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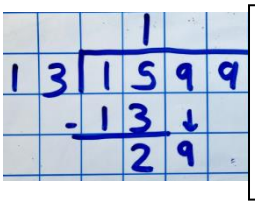
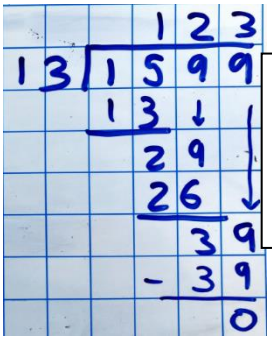
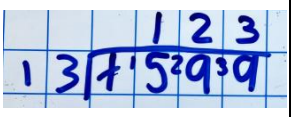
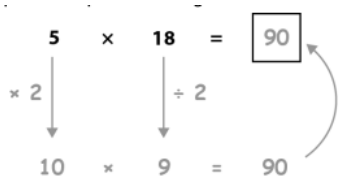
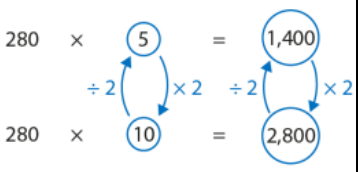
| 12 | <u>Long division</u><br><br>Pupils learn to divide by two-digit divisors. There are 2 methods – long division and short division. Pupils need to be able to work out multiples of 2-digit numbers, and interpret remainders from these. This can often be very challenging for pupils and requires time to master. | <u>Long division</u><br>  <br>1. As with short division, we position the numbers.<br><br>We can solve how many groups of 13 we can make. We subtract this, leaving a remainder. We 'bring down' the next value to aid the next calculation.<br><br>  <br>2. This process continues, subtracting the multiple to give another remainder (29-26 = 3).<br><br>This continues until all values have been divided, leaving 0 or a remainder.<br><br><u>Short division</u><br>  <br>Short division can also be used, following the same method of exchanging the remainders, albeit with more tricky calculations<br><br>Whichever method is preferred, pupils need to calculate multiples of the divisor. Partitioning into tens and ones and recombining to find these is a method pupils will need to learn.<br><br>  |
| 13 | <u>Manipulating the multiplicative relationship</u><br><br>Once pupils have mastered the multiplicative relationship, they can begin to manipulate to aid mental calculation, including using equivalence facts and compensation. | <u>Equivalence strategies</u><br>  <br><br><br><u>Compensation strategies</u><br>  <br> |