Calculation Policy 2022

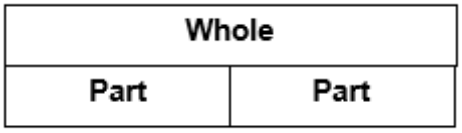
Rationale

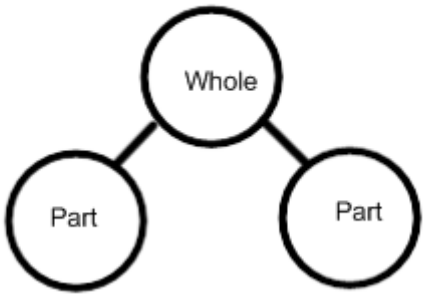
The following calculation policy aims to encourage consistent teaching and learning of the four operations throughout KS1 and KS2 in line with the National Curriculum 2014. We aim to link manipulatives and written methods so that the children build on previous teaching and learning, using manipulatives that they recognise. We aim to teach the links between addition and subtraction as well as multiplication and division and encourage our children to make deep connections between these operations. This should involve learning subtraction as the inverse of addition and division as the inverse of multiplication.

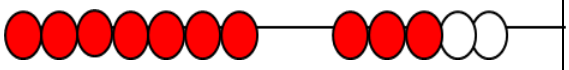
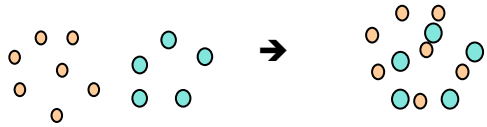
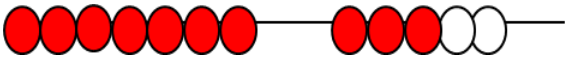
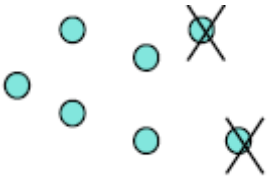
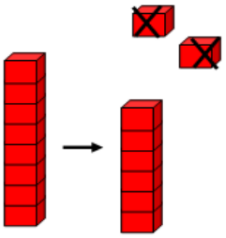
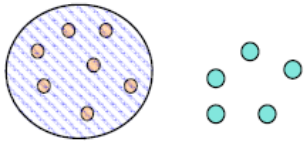
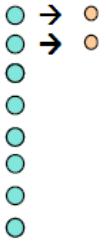
Within the policy, we aim to outline the importance of fluency of maths skills through highlighting the areas of partitioning and place value, inverse relationships and increasing complexity in number. We aim to encourage our children to learn key facts and retrieve them with automaticity so to enable children to reduce cognitive load in more complex mathematical situations.

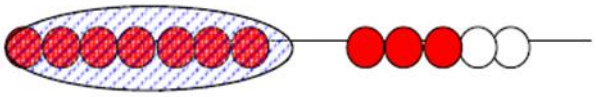
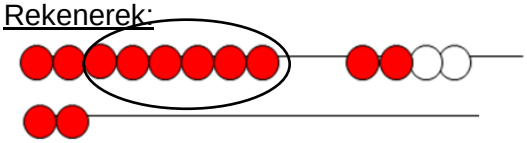
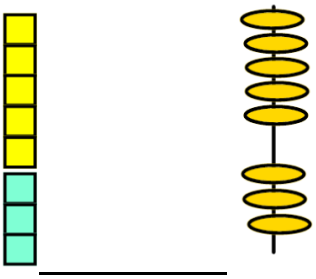
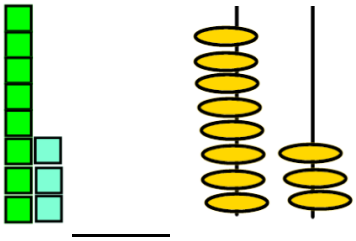
Addition and subtraction

Addition names the whole in terms of the parts and **subtraction** names a missing part of the whole. This should be referred to when addition and subtraction are taught. Pupils should see this demonstrated in both the bar model and the part-part-whole model as shown below:





Addition	Subtraction
Using subitising to combine two sets (this links to Mastering Number) Children should use subitising to recognise quantities. They should then be able to recognise that when adding 5, 3 more would make 10 which would leave 2 more to add, making 12.  Children should be taught to add and subtract numbers within 20 as number facts and with automaticity.	**Using subitising to subtract one set from a whole (this links to Mastering Number)** Children should use subitising to recognise quantities. They should then be able to recognise that when subtracting 5 from 12, 2 less would make 10 which would leave 3 more to subtract from 10, making 7.  Children should be taught to add and subtract numbers within 20 as number facts and with automaticity.
Combining two sets (aggregation) Putting together – two or more amounts or numbers are put together to make a total 7 + 5 = 12  Count one set, then the other set. Combine the sets and count again. Starting at 1. Counting along the bead bar, count out the 2 sets, then draw them together, count again. Starting at 1. 	**Taking away (separation model)** Where one quantity is taken away from another to calculate what is left. 7 – 2 = 5  Multilink towers - to physically take away objects. 
Combining two sets (augmentation) Where one quantity is increased by some amount. Count on from the total of the first set, e.g. put 3 in your head and count on 2. Always start with the largest number. Counters:  Start with 7, then count on 8, 9, 10, 11, 12	**Finding the difference (comparison model)** Two quantities are compared to find the difference. 8 – 2 = 6 Counters:  Bead strings:

Bead strings:  Make a set of 7 and a set of 5. Then count on from 7.	Rekenerek:  Make a set of 8 and a set of 2. Then count the gap.
Addition **Explore practically using multilink, Numicon, lines and beads.**  Count the total. The calculation should be represented in a bar model or using rods.  	**Subtraction** **Explore practically using multilink, Numicon, lines and beads.**  Count the gap. The calculation should be represented in a bar model or using rods. 

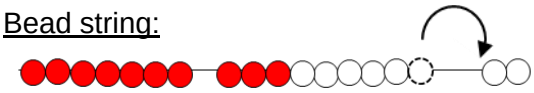
Bridging through 10s

Compensation model (adding 9 and 11)

This stage is to aid mental fluency

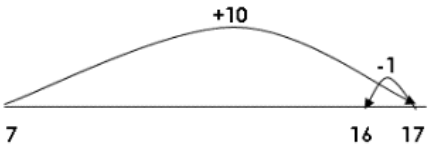
7 + 9

Bead string:



Children find 7, then add on 10 and then adjust by removing 1.

Number line:

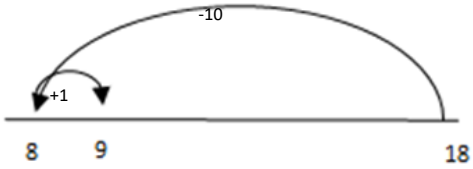


18 – 9

Bead string:

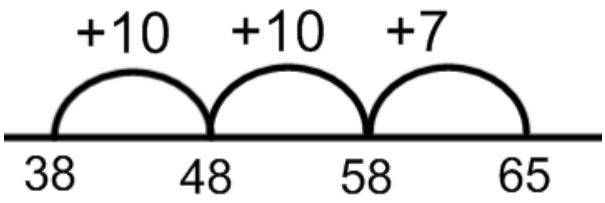
Children find 18, then subtract 10 and then adjust by adding 1.

Number line:



Working with larger numbers
Tens and ones + tens and ones

Numberline

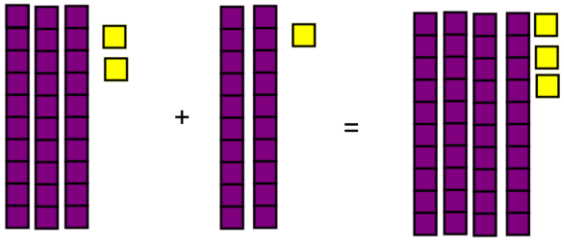


Add tens first, followed by ones.

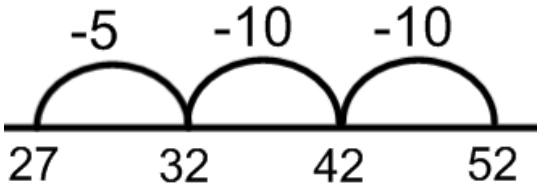
Partitioning (Aggregation model)

32 + 21 = 53

Base 10 equipment:



Numberline



Subtract tens first, followed by ones.

Subtraction (Separation model)

53 - 21 = 32

Base 10 equipment:

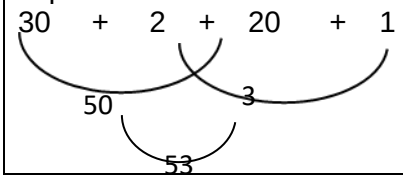
Children remove the lower quantity from the larger set, starting with the ones and then the tens. In preparation for formal decomposition.

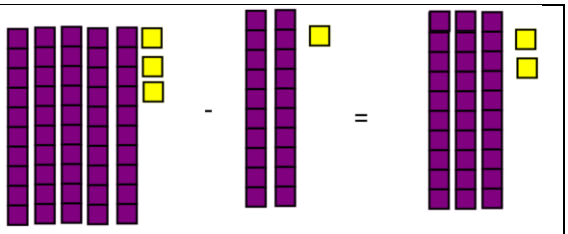
Children create the two sets with Base 10 equipment and then combine; ones with ones, tens with tens.

Begin counting with the ones in preparation for formal columnar method.

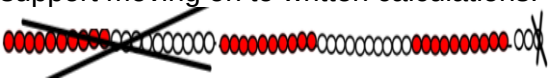
Show partitioning using number beads to support moving on to written calculations.

At this stage, children can begin to use an informal method to support, record and explain their method.

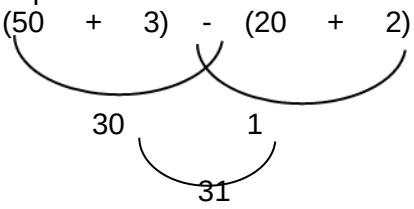




Show partitioning using number beads to support moving on to written calculations.



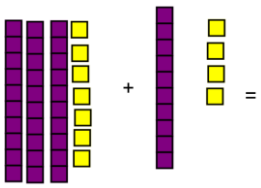
At this stage, children can began to use an informal method to support, record and explain their method.

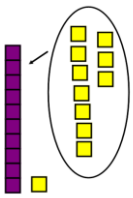


Bridging with larger numbers

Base 10 equipment:

37 + 14 = 51

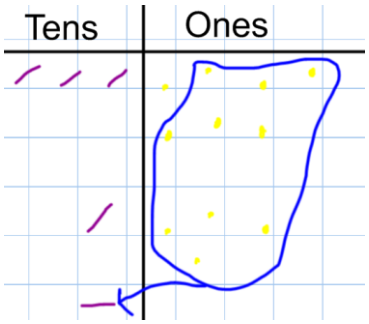




Exchange ones for tens.

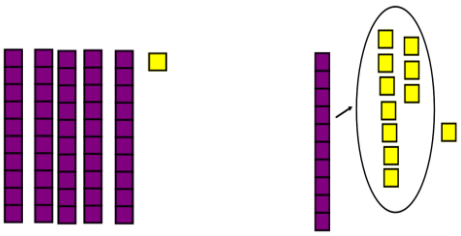
Count on from the biggest number.

Move onto pictorial:

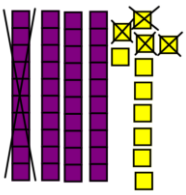


Base 10 equipment:

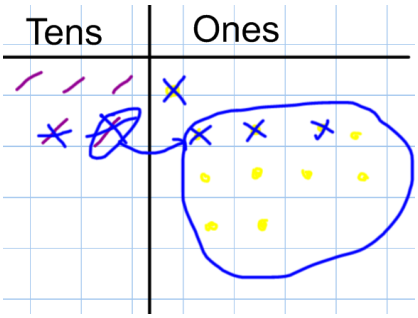
51 – 14 = 37



Exchange tens for ones.

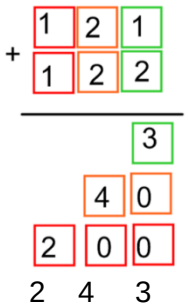


Move onto pictorial

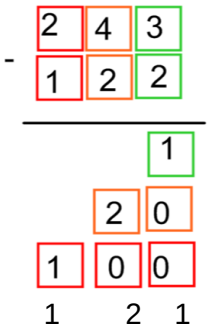


Expanded Vertical Method (optional)

Expanded Method

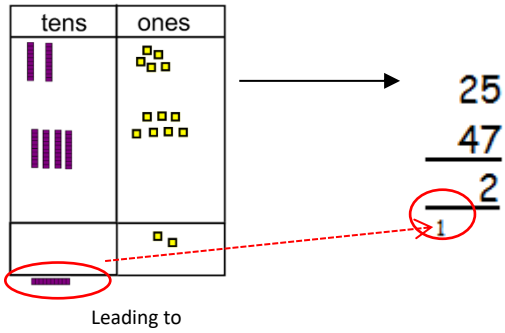


Expanded Method

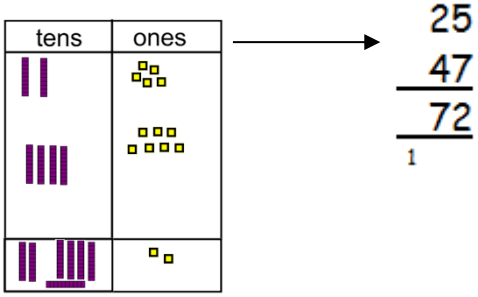


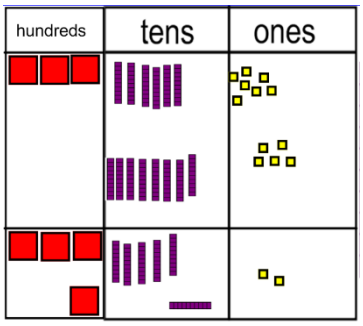
Addition

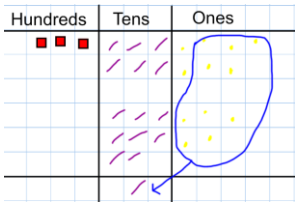
Compact method



Leading to



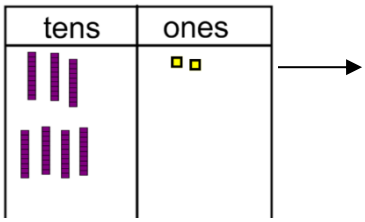


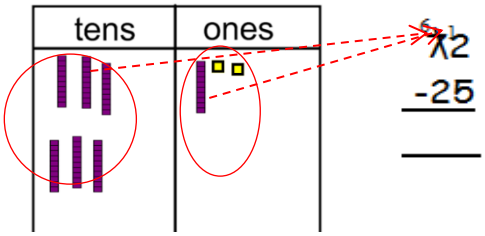


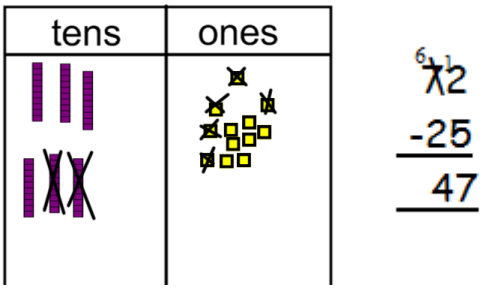
Children can also show this pictorially.

Subtraction

Compact decomposition



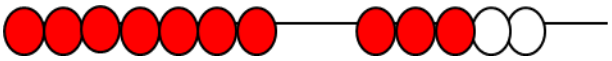




Decimals

Ensure that children are confident in counting forwards and backwards in decimals – using bead strings to support.

Bead strings:



Each bead represents 0.1, each different block of colour equal to 1.0

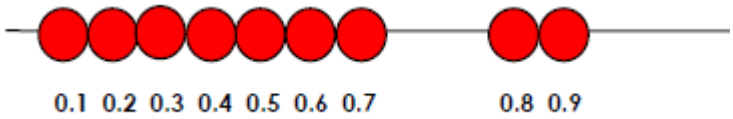
Base 10 equipment:

Addition of decimals

Aggregation model of addition

Counting both sets – starting at zero.

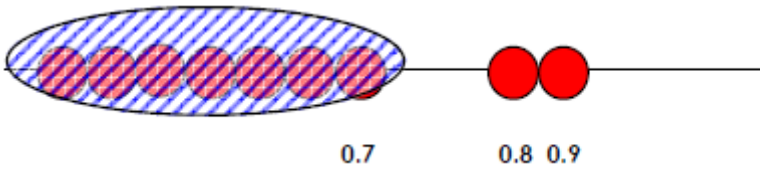
0.7 + 0.2 = 0.9



Augmentation model of addition

Starting from the first set total, count on to the end of the second set.

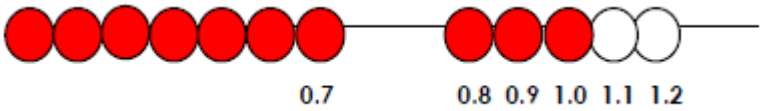
0.7 + 0.2 = 0.9



Bridging through 1.0

Encouraging connections with number bonds.

0.7 + 0.5 = 1.2



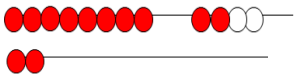
Subtraction of decimals

Take away model

0.9 – 0.2 = 0.7

Finding the difference (or comparison model):

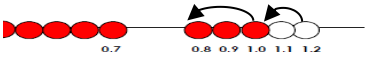
0.8 – 0.2 =



Bridging through 1.0

Encourage efficient partitioning.

1.2 – 0.5 = 1.2 – 0.2 – 0.3 = 0.7

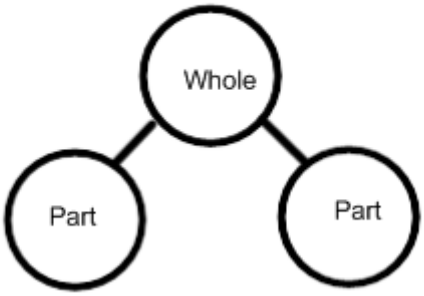


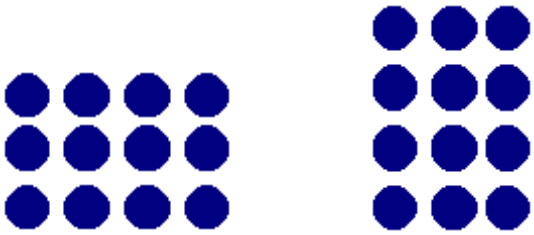
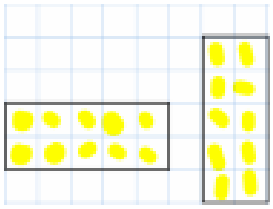
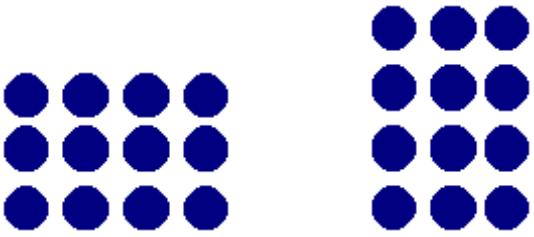
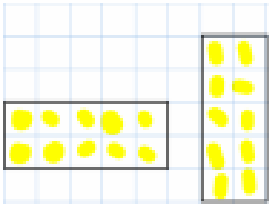
Gradation of difficulty- addition:	**Gradation of difficulty- subtraction:**
1. No exchange. 2. Breaking through ten. 3. Exchanging ones to tens. 4. Exchanging tens to hundreds. 5. Exchanging ones to tens and tens to Hundreds. 6. More than two numbers in calculation, including use of exchange. 7. As 6 but with different number of digits 8. Decimals up to 2 decimal places (same number of decimal places) 9. Add two or more decimals with a range of decimal places.	1. No exchange. 2. Fewer digits in the answer. 3. Exchanging tens for ones. 4. Exchanging hundreds for tens 5. Exchanging hundreds to tens and tens to ones. 6. As 5 but with different number of digits. 7. Decimals up to 2 decimal places (same number of decimal places). 8. Subtract two or more decimals with a range of decimal places.

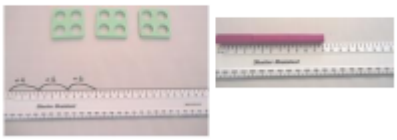
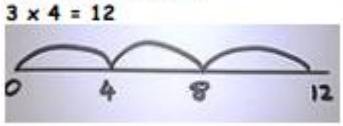
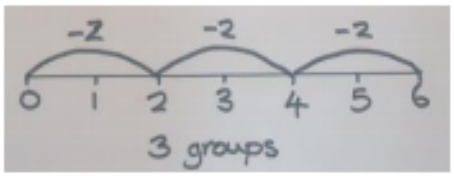
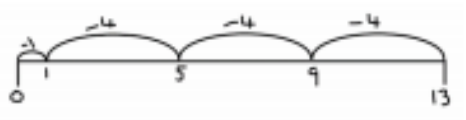
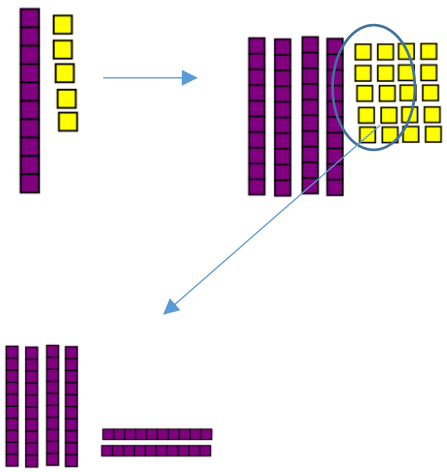
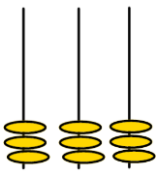
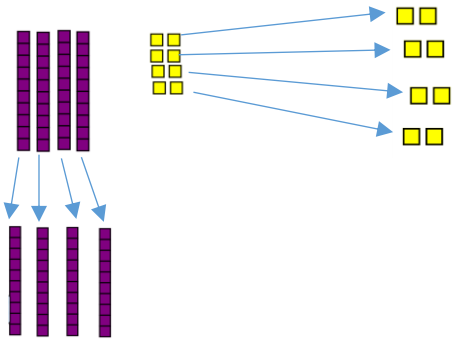
Multiplication and Division

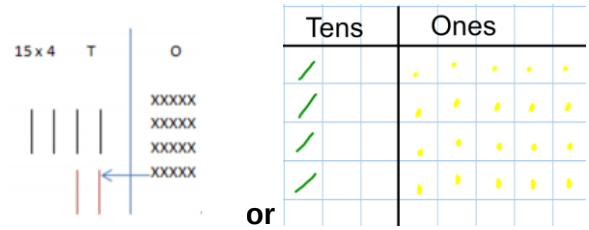
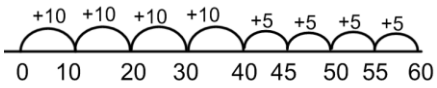
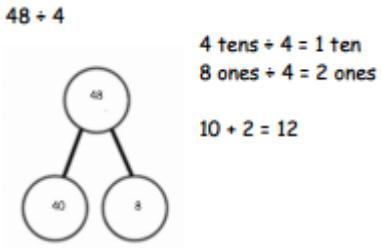
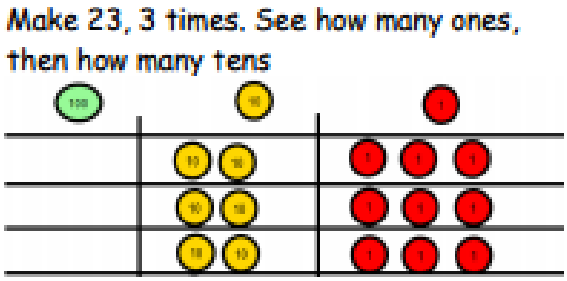
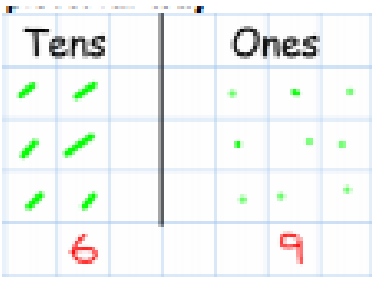
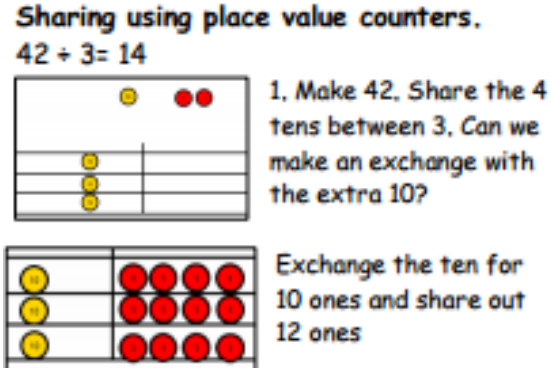
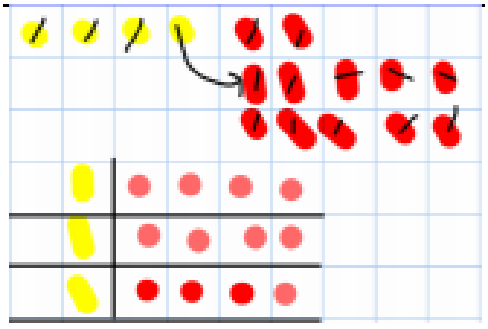
Division should be taught as the inverse to multiplication. Pupils should see multiplication and division demonstrated in arrays, the bar model and the part-part-whole model as shown below:

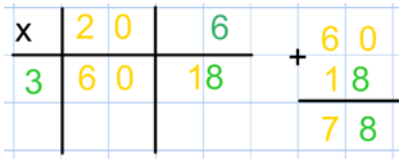
Part	Part	Part	Part
Whole			



Multiplication	Division
Children should begin to write multiplication calculations such as 3 x 4 and recognise this as repeated addition, e.g. 4 + 4 + 4 **Repeated grouping/repeated addition** (does not have to be restricted to cubes) 3 x 4 or 3 lots of 4  Children to represent the practical resources in a picture e.g. XX XX XX XX XX XX Use of a bar model for a more structured method  Use arrays to write a range of calculations, e.g. 3 x 4, 4 x 3… These can be referred to as multiplication families.  Children to draw the arrays 	Children should begin by halving or sharing between two.  This can also be done in a bar so all 4 operations have a similar structure:  **Understand division as repeated grouping and subtracting** 6 ÷ 2  Use arrays to write a range of calculations, e.g. 12 divided by 4, 12 divided by 3… These can be referred to as multiplication families.  Children to draw the arrays 

Multiplication	Division
Use number lines to demonstrate calculations.  Use number lines to show repeated groups- 3 x 4  Abstract number line 3 x 4 = 12  	**Use number lines and find remainders when using repeated subtraction.**  Use of lollipop sticks to form wholes   
Partition to multiply Begin with Base 10 	**Sharing** Begin sharing in ones:  Use lines to do this. Begin sharing tens and ones: 

Multiplication	**Division**
Move onto pictorial  **or** Children can also use a numberline.  10 x 4 = 40 5 x 4 = 20 40 + 20 = 60	**Move onto pictorial** 
Begin formal methods of multiplication  Moving onto pictorial  	**Begin formal methods of division**  Move onto pictorial 

Multiplication	Division
3 x 23 20 3 3 x 20 = 60 3 x 3 = 9 60 + 9= 69 23 x 3 69 The grid method can be used as an interim step in LKS2.  	
Move onto symbolic  6 x 23 = 23 x 6 138 1 1	**Move onto symbolic** **Use of the 'bus stop method'** using grouping and counters. Key language for grouping- how many groups of X can we make with X hundreds'- *this can also be done using sharing!* 615 ÷ 5  Step 1: make 615  Step 2: Circle your groups of 5  Step 3: Exchange 1H for 10T and circle groups of 5  Step 4: exchange 1T for 10ones and circles groups of 5 123 5 ⟌ 615

Multiplication

Long Multiplication

At this point, children should be confident with the abstract in order to move on.

3digits x 3digits; 4digitsx 2digits

$$\begin{array}{rrrr} & 1 & 2 & 4 \\ \times & & 2 & 6 \\ \hline & {\scriptstyle 1}7 & 4 & 4 \\ 2 & {\scriptstyle 2}4 & 8 & 0 \\ \hline 3 & 2 & 2 & 4 \\ \hline {\scriptstyle 1} & {\scriptstyle 1} & & \end{array}$$

Answer: 3224

Division

Long Division

Use the counters to demonstrate each stage of the division calculation so that children fully understand the exchange.

$$\begin{array}{r} {\scriptstyle 0} \\ 12\overline{)\,2544} \end{array}$$

Step one- exchange 2 thousand for 20 hundreds so we now have 25 hundreds.

$$\begin{array}{r} 02 \\ 12\overline{)\,2544} \\ \underline{24} \\ 1 \end{array}$$

Step two- How many groups of 12 can I make with 25 hundreds? The 24 shows the hundreds we have grouped. The one is how many hundreds we have left.

$$\begin{array}{r} 021 \\ 12\overline{)\,2544} \\ \underline{24} \\ 14 \\ \underline{12} \\ 2 \end{array}$$

Exchange the one hundred for 10 tens. How many groups of 12 can I make with 14 tens? The 14 shows how many tens I have, the 12 is how many I grouped and the 2 is how many tens I have left.

$$\begin{array}{r} 0212 \\ 12\overline{)\,2544} \\ \underline{24} \\ 14 \\ \underline{12} \\ 24 \\ \underline{24} \\ 0 \end{array}$$

Exchange the 2 tens for 20 ones. The 24 is how many ones I have grouped and the 0 is what I have left.

Children should be taught to systematically write down the multiples related to the divisor. E.g.
1x12 = 12
2x12 =24
3x12=36…
As children become more confident they could just list multiples to save time. They need only write up to the highest multiple they need.

Gradation of difficulty (short multiplication)	**Gradation of difficulty (short division)**
1. TO x O no exchange 2. TO x O extra digit in the answer 3. TO x O with exchange of ones into tens 4. HTO x O no exchange 5. HTO x O with exchange of ones into tens 6. HTO x O with exchange of tens into hundreds 7. HTO x O with exchange of ones into tens and tens into hundreds 8. As 4-7 but with greater number digits x O 9. O.t x O no exchange 10. O.t with exchange of tenths to ones 11. As 9 - 10 but with greater number of digits which may include a range of decimal places (hundredths and thousandths) x O 12. Use place value adjustments to multiply a decimal number by an integer.	1. TO ÷ O no exchange no remainder 2. TO ÷ O no exchange with remainder 3. TO ÷ O with exchange no remainder 4. TO ÷ O with exchange, with remainder 5. Zero in the quotient e.g. 816 ÷ 4 = **204** 6. As 1-5 HTO ÷ O 7. As 1-5 greater number of digits ÷ O 8. As 1-5 with a decimal dividend e.g. 7.5 ÷ 5 or 0.12 ÷ 3 9. Where the divisor is a two digit number 10. Involve fraction and decimal remainders.

Place Value Progression

Recognising Values	Counting in Steps	Comparing and Ordering
Count to and across 100, forwards and backwards, beginning with 0 or 1, or from any given number. Identify and represent numbers using objects and pictorial representations including the number line	Count, read and write numbers to 100 in numerals; count in multiples of twos, fives and tens	Compare and order numbers from 0 up to 100; use <, > and = signs
Recognise the place value of each digit in a two-digit number (tens, ones). Recognise the place value of each digit in a three-digit number (hundred, tens, ones).	Count in steps of 2, 3, and 5 from 0, and in tens from any number, forward or backward Count from 0 in multiples of 4, 8, 50 and 100;	
Recognise the place value of each digit in a four-digit number (thousands, hundreds, tens, and ones).	Count in multiples of 6, 7, 9, 25 and 1000	Round any number to the nearest 10, 100 or 1 000
Read, write, order and compare numbers to at least 1 000 000 and determine the value of each digit.	Count forwards or backwards in steps of powers of 10 for any given number up to 1 000 000	Round any number up to 1 000 000 to the nearest 10, 100, 1 000, 10 000 and 100 000
Read, write, order and compare numbers to at least 10 000 000 and determine the value of each digit.		Round any whole number to a required degree of accuracy
