Tudor Grange Academies Trust

Primary

Maths

Calculation Policy

Last Updated: Monday 1st November 2022

Calculation Policy

Our calculation policy has been devised to meet requirements of the National Curriculum 2014 for the teaching and learning of mathematics. It gives pupils a consistent and smooth progression of calculation learning across the school. Early learning in number and calculation in EYFS 1 and 2 follows the "Development Matters" EYFS Document. This calculation policy is designed to build on progressively from the content and methods established in the Early Years Foundation Stage.

Choosing a calculation method:

Children need to be taught and encouraged to ask the following questions when deciding how to approach a calculation:

- Can I do it in my head using a mental strategy?
- Could I use a diagram to help me?
- Should I use a written method to work it out?

Mental Calculation

Addition

Mental recall of number bonds

6 + 4 = 10 $\boxed{}$ + 3 = 10

25 + 75 = 100 19 + $\boxed{}$ = 20

Use near doubles

6 + 7 = double 6 + 1 = 13

Addition using partitioning and recombining

34 + 45 = (30 + 40) + (4 + 5) = 79

Counting on or back in repeated steps of 1, 10, 100, 1000

86 + 57 = 143 (by counting on in tens and then in ones)

460 - 300 = 160 (by counting back in hundreds)

Add the nearest multiple of 10, 100 and 1000 and adjust

24 + 19 = 24 + 20 – 1 = 43

458 + 71 = 458 + 70 + 1 = 529

Use the relationship between addition and subtraction

36 + 19 = 55 19 + 36 = 55

55 – 19 = 36 55 – 36 = 19

Subtraction

Mental recall of addition and subtraction facts

10 – 6 = 4 17 - £? = 11

20 - 17 = 3 10 - £? = 2

Find a small difference by counting on

82 – 79 = 3

Counting on or back in repeated steps of 1, 10, 100, 1000

86 - 52 = 34 (by counting on/back in tens and then in ones)

460 - 300 = 160 (by counting on/back in hundreds)

Subtract the nearest multiple of 10, 100 and 1000 and adjust

24 - 19 = 24 - 20 + 1 = 5

458 - 71 = 458 - 70 - 1 = 387

Use the inverse relationship between addition and subtraction

36 + 19 = 55 19 + 36 = 55

55 – 19 = 36 55 – 36 = 19

Multiplication

Doubling and halving
Applying the knowledge of doubles and halves to known facts.
e.g. 8 x 4 is double 4 x 4

Using multiplication facts
Year 2 1, 2, 5 and 10 times tables
Year 3 3, 4, 8 times tables
Year 4, 5 & 6 Derive and recall all multiplication and division facts up to 12 x 12

Using and applying division facts
Children should be able to utilise their tables knowledge to derive other facts.
e.g. If I know 3 x 7 = 21, what else do I know?
30 x 7 = 210, 300 x 7 = 2100, 3000 x 7 = 21 000, 0.3 x 7 = 2.1 etc
£ □ x 7 = 21 300 x r□ = 2100 £ □ x .□ = 2.1

Use closely related facts already known
13 x 11 = (13 x 10) + (13 x 1)
= 130 + 13
= 143

Multiplying by 10 or 100
Knowing that the effect of multiplying by 10 is a shift in the digits one place to the left.
Knowing that the effect of multiplying by 100 is a shift in the digits two places to the left.

Partitioning
23 x 4 = (20 x 4) + (3 x 4)
= 80 + 12
= 102

Use of factors
8 x 12 = 8 x 4 x 3

Division

Doubling and halving
Knowing that halving is dividing by 2

Deriving and recalling division facts

Year 2 1, 2, 5 and 10 times tables
Year 3 3, 4, 8 times tables
Year 4, 5 & 6 Derive and recall all multiplication and division facts up to 12 x 12

Using and applying division facts
Children should be able to utilise their tables knowledge to derive other facts.
E.g. If I know 3 x 7 = 21, what else do I know?
30 x 7 = 210, 300 x 7 = 2100, 3000 x 7 = 21 000, 0.3 x 7 = 2.1 etc
£ □ ÷ 2 = 4 80 ÷ r□ = 40 £ □ ÷ r□ = 40

Dividing by 10 or 100
Knowing that the effect of dividing by 10 is a shift in the digits one place to the right.
Knowing that the effect of dividing by 100 is a shift in the digits two places to the right.

Use of factors
72 ÷ 18 72 ÷ **6** = 12 12 ÷ **3** = 4 72÷18=4
(6 and 3 are factors of 18)
Use related facts
Given that 1.4 x 1.1 = 1.54
What is 1.54 ÷ 1.4, or 1.54 ÷ 1.1?

Use of Bar Models

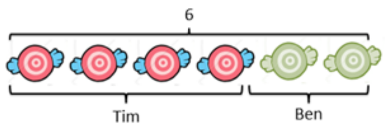
A bar model does not do any maths for us - it gives us a visual representation of the maths we are working on. If we are using different concrete and pictorial representations for each topic, it is important to have one representation that acts as a common spine through the curriculum.
By representing each of these topics with a bar model pupils don't need to remember different diagrams for each topic – they know that they can always use a bar model.

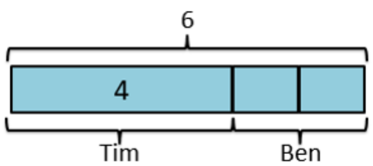
When introducing bar models, it is important that children start with the concrete object and transition to iconic representations (counters or cubes). The final stage would be to draw boxes to show a bar.

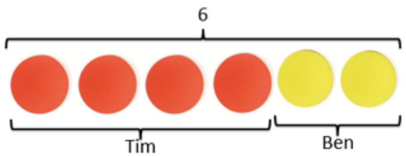
Below are the small steps used from Y1 onwards when introducing the bar model.

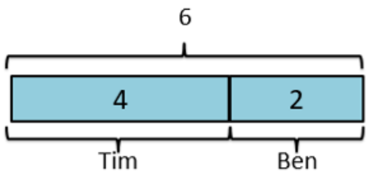
Tim has four sweets. Ben has two sweets.

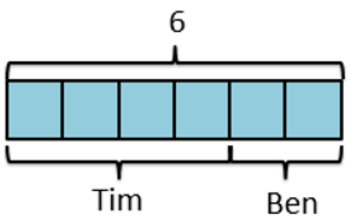
How many sweets do they have altogether?





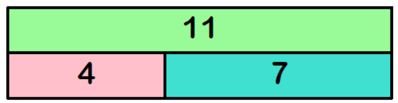






$$4 + 2 = 6$$

Use the bar model to help you write each fact family



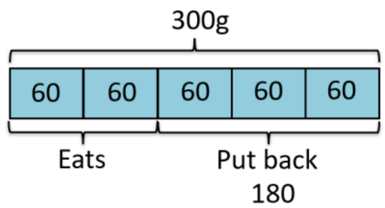
4+7=11

7+4=11

11-4=7

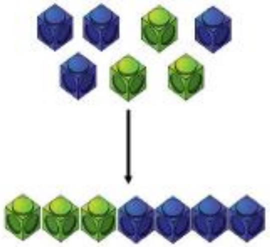
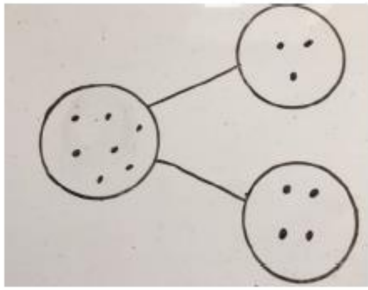
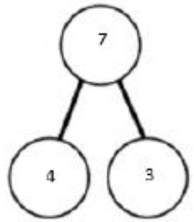
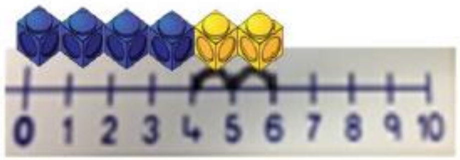
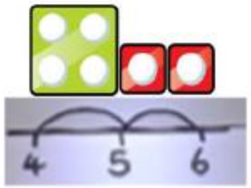
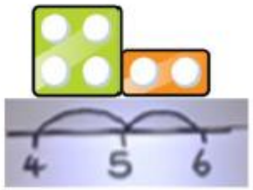
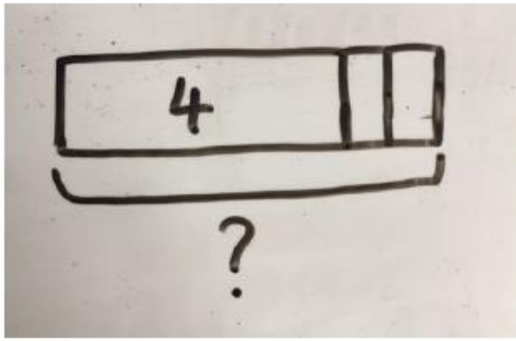
11-7=4

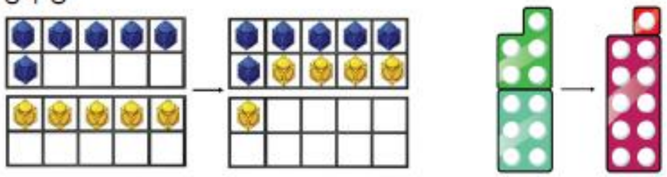
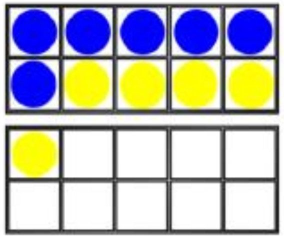
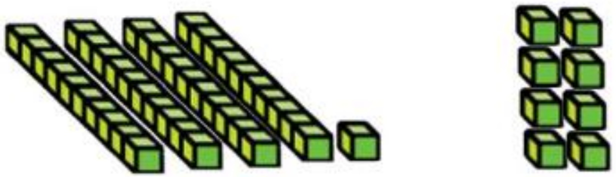
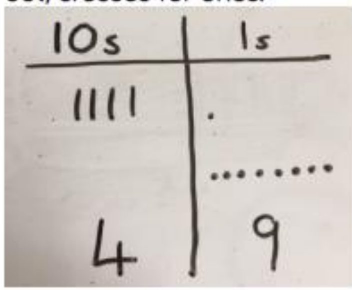
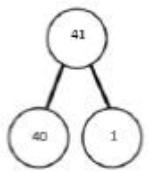
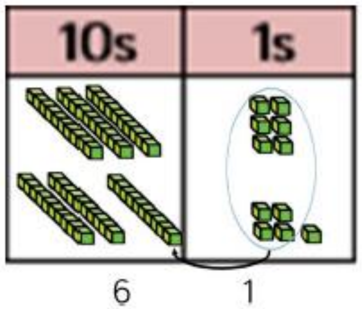
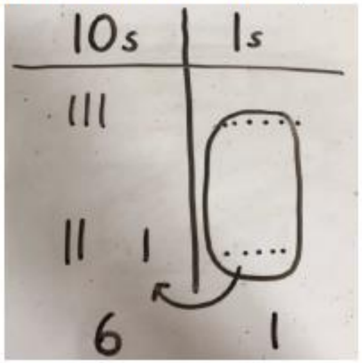
Matthew has a 300g block of cheese. He eats $\frac{2}{5}$ of the cheese and puts the rest back in the fridge. How much cheese did Matthew put back in the fridge?



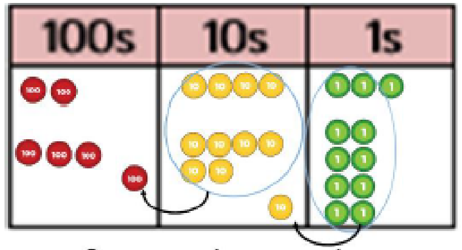
Calculation policy: Addition

Key language: sum, total, parts and wholes, plus, add, altogether, more, 'is equal to' 'is the same as'.

Concrete	Pictorial	Abstract
Combining two parts to make a whole (use other resources too e.g. eggs, shells, teddy bears, cars). 	Children to represent the cubes using dots or crosses. They could put each part on a part whole model too. 	4 + 3 = 7 Four is a part, 3 is a part and the whole is seven. 
Counting on using number lines using cubes or Numicon.   	A bar model which encourages the children to count on, rather than count all. 	The abstract number line: What is 2 more than 4? What is the sum of 2 and 4? What is the total of 4 and 2? 4 + 2 

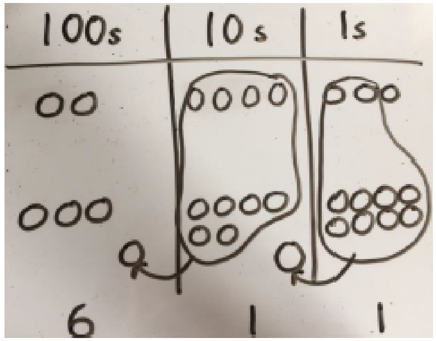
Regrouping to make 10; using ten frames and counters/cubes or using Numicon. 6 + 5 	Children to draw the ten frame and counters/cubes. 	Children to develop an understanding of equality e.g. $6 + \square = 11$ $6 + 5 = 5 + \square$ $6 + 5 = \square + 4$
TO + O using base 10. Continue to develop understanding of partitioning and place value. 41 + 8 	Children to represent the base 10 e.g. lines for tens and dot/crosses for ones. 	41 + 8  1 + 8 = 9 40 + 9 = 49 $\begin{array}{r} 41 \\ +\ \ 8 \\ \hline 49 \end{array}$
TO + TO using base 10. Continue to develop understanding of partitioning and place value. 36 + 25 	Chidlren to represent the base 10 in a place value chart. 	Looking for ways to make 10. 36 + 25= 1 5 30 + 20 = 50 5 + 5 = 10 50 + 10 + 1 = 61 Formal method: $\begin{array}{r} 36 \\ +25 \\ \hline 61 \\ \hline {}_{1} \end{array}$

Use of place value counters to add HTO + TO, HTO + HTO etc. When there are 10 ones in the 1s column- we exchange for 1 ten, when there are 10 tens in the 10s column- we exchange for 1 hundred.



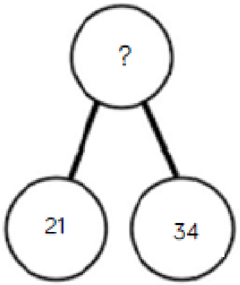
6 1 1

Chidren to represent the counters in a place value chart, circling when they make an exchange.



$$\begin{array}{r} 243 \\ +368 \\ \hline 611 \\ \hline 1\ 1\ \ \end{array}$$

Conceptual variation; different ways to ask children to solve 21 + 34



?	
21	34

Word problems:
In year 3, there are 21 children and in year 4, there are 34 children.
How many children in total?

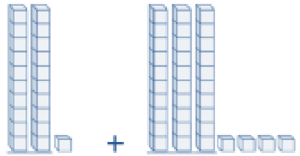
21 + 34 = 55. Prove it

$$\begin{array}{r} 21 \\ +34 \\ \hline \\ \hline \end{array}$$

21 + 34 =

$\boxed{}$ = 21 + 34

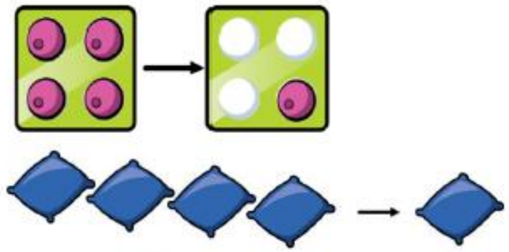
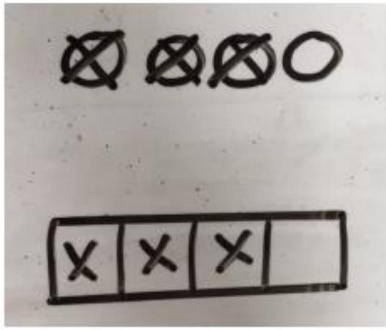
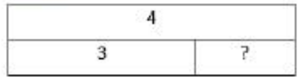
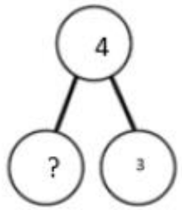
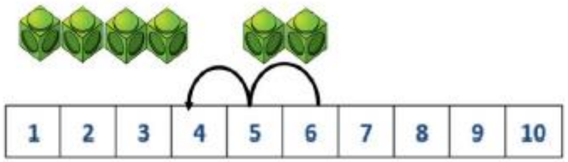
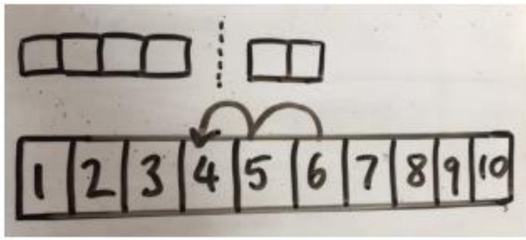
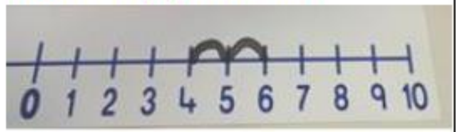
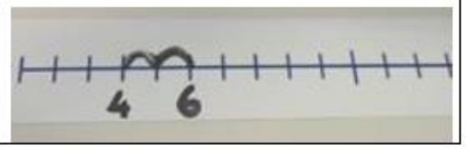
Calculate the sum of twenty-one and thirty-four.

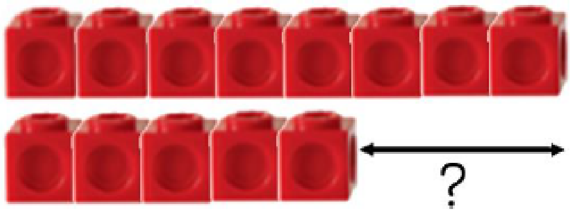
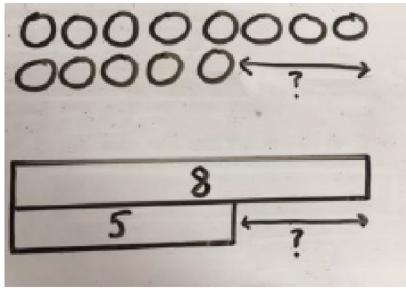
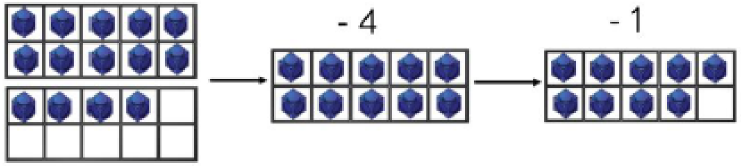
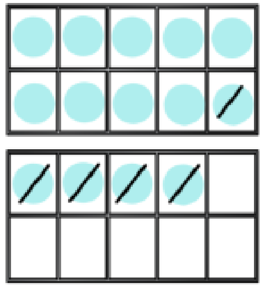
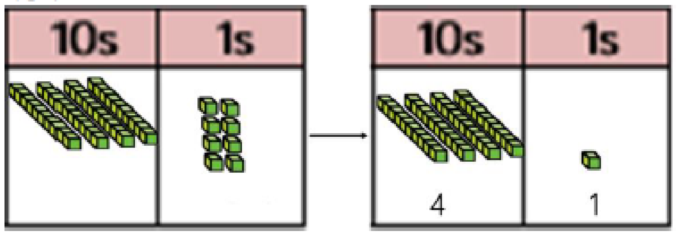
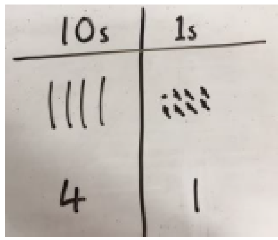


Missing digit problems:

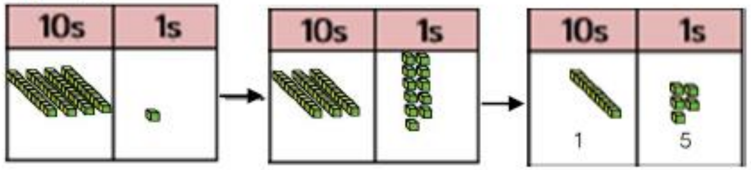
Calculation policy: Subtraction

Key language: take away, less than, the difference, subtract, minus, fewer, decrease.

Concrete	Pictorial	Abstract
Physically taking away and removing objects from a whole (ten frames, Numicon, cubes and other items such as beanbags could be used). 4 - 3 = 1 	Children to draw the concrete resources they are using and cross out the correct amount. The bar model can also be used. 	4- 3 = $\boxed{}$ = 4 - 3  
Counting back (using number lines or number tracks) children start with 6 and count back 2. 6 - 2 = 4 	Children to represent what they see pictorially e.g. 	Children to represent the calculation on a number line or number track and show their jumps. Encourage children to use an empty number line  

Finding the difference (using cubes, Numicon or Cuisenaire rods, other objects can also be used). Calculate the difference between 8 and 5. 	Children to draw the cubes/other concrete objects which they have used or use the bar model to illustrate what they need to calculate. 	Find the difference between 8 and 5. 8 – 5, the difference is $\boxed{}$ Children to explore why 9 - 6 = 8 – 5 = 7 – 4 have the same difference.
Making 10 using ten frames. 14 – 5 	Children to present the ten frame pictorially and discuss what they did to make 10. 	Children to show how they can make 10 by partitioning the subtrahend. $14 - \underbrace{5}_{4\ \ 1} = 9$ 14 – 4 = 10 10 – 1 = 9
Column method using base 10. 48-7 	Children to represent the base 10 pictorially. 	Column method or children could count back 7. $\begin{array}{r} 48 \\ -\ \ 7 \\ \hline 41 \end{array}$

Column method using base 10 and having to exchange.
41 – 26

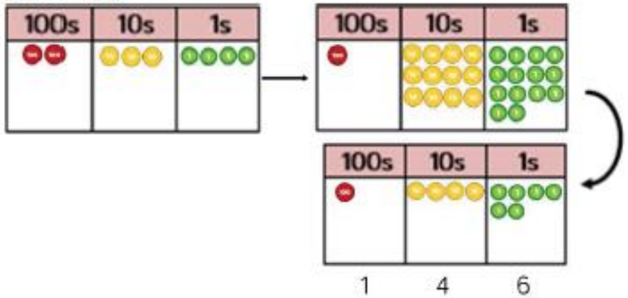


Represent the base 10 pictorially, remembering to show the exchange.

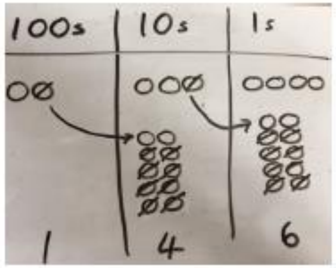
Formal column method. Children must understand that when they have exchanged the 10 they still have 41 because 41 = 30 + 11.

$$\begin{array}{rrr} & \cancel{4}^{3} & {}^{1}1 \\ - & 2 & 6 \\ \hline & 1 & 5 \end{array}$$

Column method using place value counters.
234 – 88



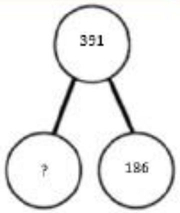
Represent the place value counters pictorially; remembering to show what has been exchanged.



Formal colum method. Children must understand what has happened when they have crossed out digits.

$$\begin{array}{rrrr} & 2 & \cancel{3}^{2} & {}^{1}4 \\ - & & 8 & 8 \\ \hline & & & 6 \\ \hline \end{array}$$

Conceptual variation; different ways to ask children to solve 391 - 186



391	
186	?

Raj spent £391, Timmy spent £186. How much more did Raj spend?

Calculate the difference between 391 and 186.

$\square$ = 391 – 186

$$\begin{array}{r} 391 \\ -186 \\ \hline \\ \hline \end{array}$$

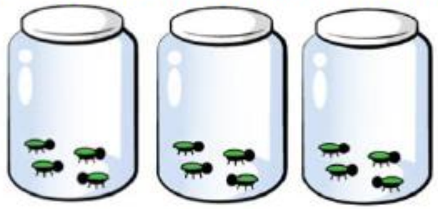
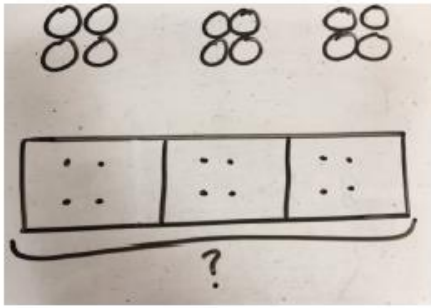
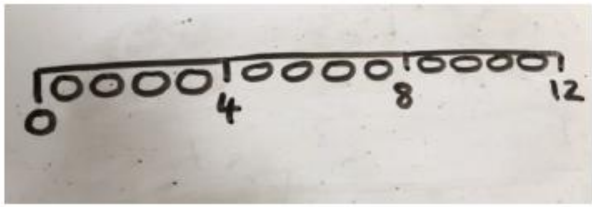
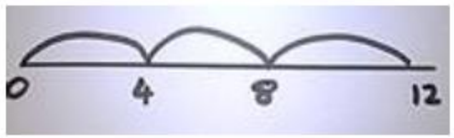
What is 186 less than 391?

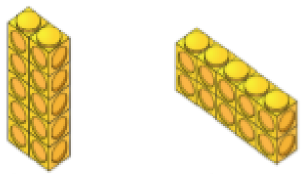
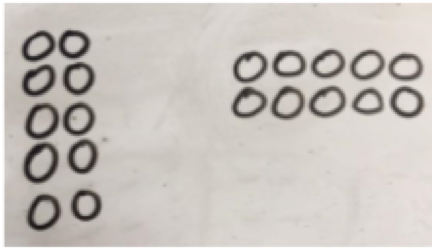
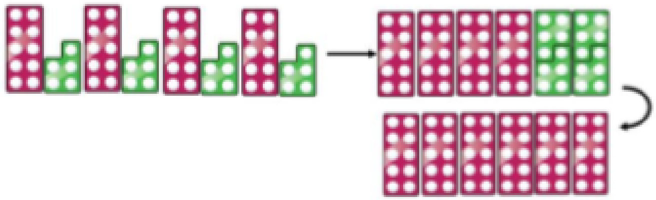
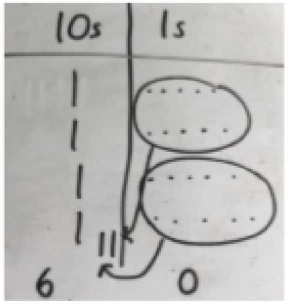
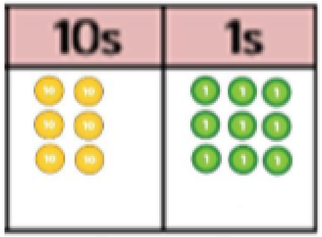
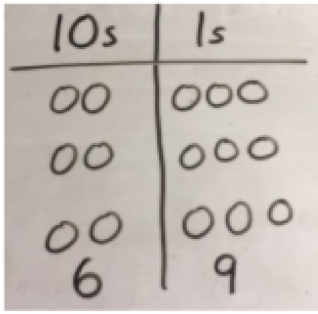
Missing digit calculations

$$\begin{array}{rrrr} & 3 & 9 & \square \\ - & \square & \square & 6 \\ \hline & \square & 0 & 5 \end{array}$$

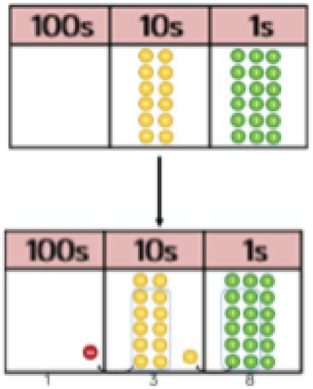
Calculation policy: Multiplication

Key language: double, times, multiplied by, the product of, groups of, lots of, equal groups.

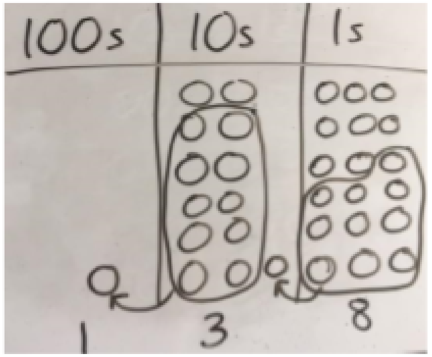
Concrete	Pictorial	Abstract
Repeated grouping/repeated addition 3×4 $4 + 4 + 4$ There are 3 equal groups, with 4 in each group.  	Children to represent the practical resources in a picture and use a bar model.  	$3 \times 4 = 12$ $4 + 4 + 4 = 12$
Number lines to show repeated groups- 3×4   Cuisenaire rods can be used too.	Represent this pictorially alongside a number line e.g.:  	Abstract number line showing three jumps of four. $3 \times 4 = 12$ 

Use arrays to illustrate commutativity counters and other objects can also be used. $2 \times 5 = 5 \times 2$  2 lots of 5 5 lots of 2	Children to represent the arrays pictorially. 	Children to be able to use an array to write a range of calculations e.g. $10 = 2 \times 5$ $5 \times 2 = 10$ $2 + 2 + 2 + 2 + 2 = 10$ $10 = 5 + 5$
Partition to multiply using Numicon, base 10 or Cuisenaire rods. 4×15 	Children to represent the concrete manipulatives pictorially. 	Children to be encouraged to show the steps they have taken. 4×15 10 5 $10 \times 4 = 40$ $5 \times 4 = 20$ $40 + 20 = 60$ A number line can also be used 
Formal column method with place value counters (base 10 can also be used.) 3×23  6 9	Children to represent the counters pictorially. 	Children to record what it is they are doing to show understanding. 3×23 $3 \times 20 = 60$ $3 \times 3 = 9$ 20 3 $60 + 9 = 69$ $\begin{array}{r} 23 \\ \times\ 3 \\ \hline 69 \\ \hline \end{array}$

Formal column method with place value counters.
6 x 23



Children to represent the counters/base 10, pictorially e.g. the image below.



Formal written method

6 x 23 =

$$\begin{array}{r} 23 \\ \times\ \ 6 \\ \hline 138 \\ \hline {}_{1\ 1} \end{array}$$

When children start to multiply 3d × 3d and 4d × 2d etc., they should be confident with the abstract:

To get 744 children have solved 6 × 124.
To get 2480 they have solved 20 × 124.

$$\begin{array}{r} 1\ 2\ 4 \\ \times\ \ \ 2\ 6 \\ \hline 7\ 4\ 4 \\ 2\ 4\ 8\ 0 \\ \hline 3\ 2\ 2\ 4 \\ \hline {}_{1\ 1\ \ \ \ } \end{array}$$

Answer: 3224

Conceptual variation; different ways to ask children to solve 6 × 23

23	23	23	23	23	23

?

Mai had to swim 23 lengths, 6 times a week.
How many lengths did she swim in one week?

With the counters, prove that 6 x 23 = 138

Find the product of 6 and 23

6 × 23 =

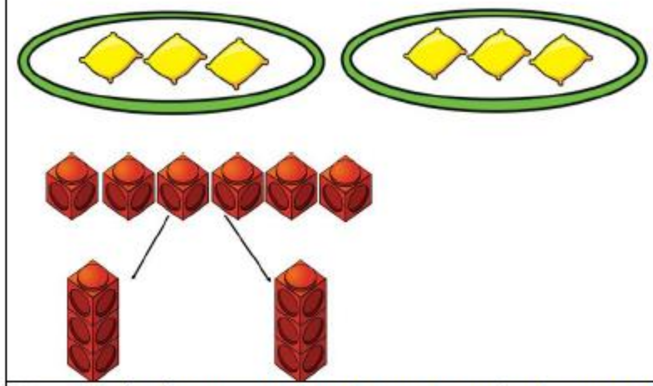
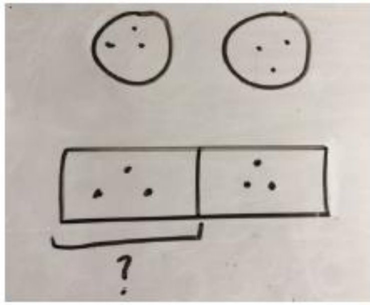
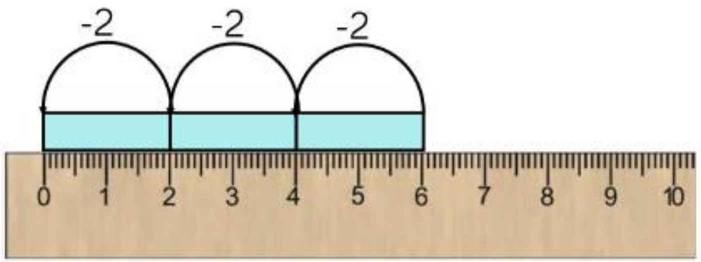
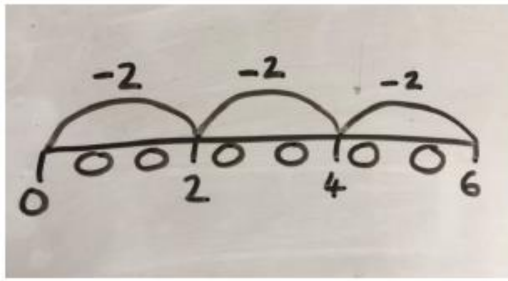
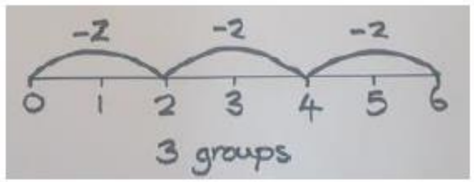
$\boxed{}$ = 6 × 23

$$\begin{array}{r} 6 \\ \times\ 23 \\ \hline \end{array} \qquad \begin{array}{r} 23 \\ \times\ \ 6 \\ \hline \end{array}$$

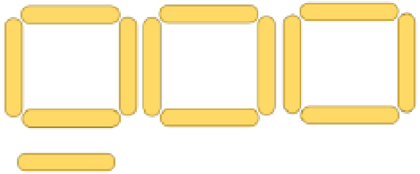
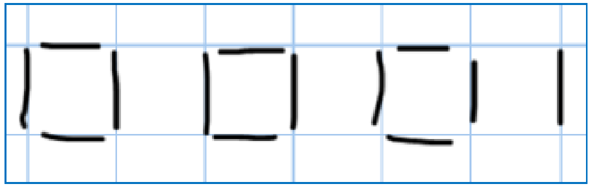
What is the calculation?
What is the product?

Calculation policy: Division

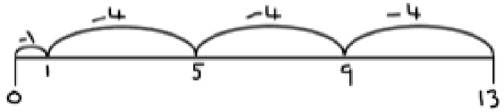
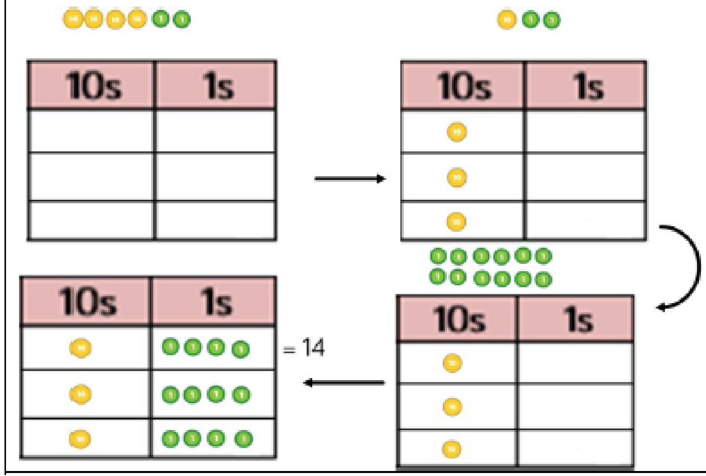
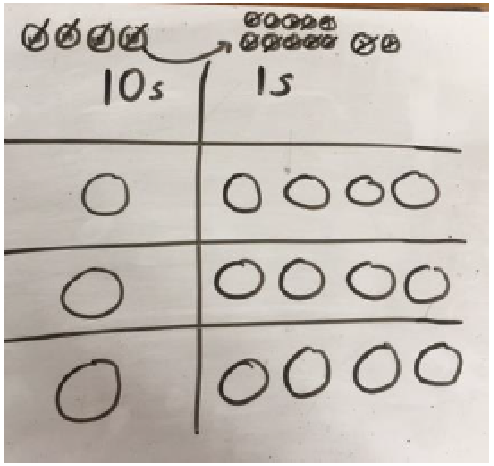
Key language: share, group, divide, divided by, half.

Concrete	Pictorial	Abstract
Sharing using a range of objects. 6 ÷ 2 	Represent the sharing pictorially.  	6 ÷ 2 = 3 3 | 3 Children should also be encouraged to use their 2 times tables facts.
Repeated subtraction using Cuisenaire rods above a ruler. 6 ÷ 2  3 groups of 2	Children to represent repeated subtraction pictorially.  	Abstract number line to represent the equal groups that have been subtracted. 

<table>
<tr>
<td>2d ÷ 1d with remainders using lollipop sticks. Cuisenaire rods, above a ruler can also be used.
13 ÷ 4

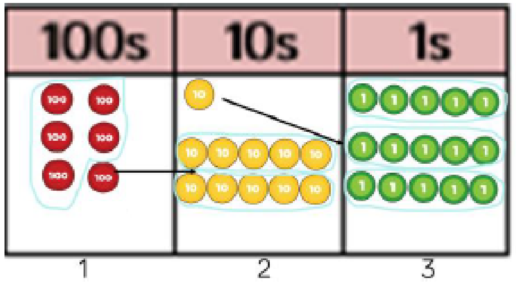
Use of lollipop sticks to form wholes- squares are made because we are dividing by 4.

There are 3 whole squares, with 1 left over.</td>
<td>Children to represent the lollipop sticks pictorially.

There are 3 whole squares, with 1 left over.</td>
<td>13 ÷ 4 – 3 remainder 1

Children should be encouraged to use their times table facts; they could also represent repeated addition on a number line.

‘3 groups of 4, with 1 left over’

</td>
</tr>
<tr>
<td>Sharing using place value counters.
42 ÷ 3 = 14

</td>
<td>Children to represent the place value counters pictorially.

</td>
<td>Children to be able to make sense of the place value counters and write calculations to show the process.

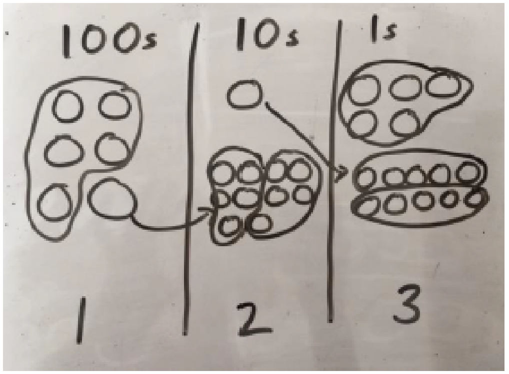
42 ÷ 3
42 = 30 + 12
30 ÷ 3 = 10
12 ÷ 3 = 4
10 + 4 = 14</td>
</tr>
</table>

Short division using place value counters to group.
615 ÷ 5



1. Make 615 with place value counters.
2. How many groups of 5 hundreds can you make with 6 hundred counters?
3. Exchange 1 hundred for 10 tens.
4. How many groups of 5 tens can you make with 11 ten counters?
5. Exchange 1 ten for 10 ones.
6. How many groups of 5 ones can you make with 15 ones?

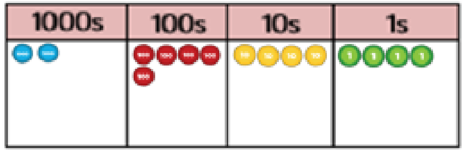
Represent the place value counters pictorially.



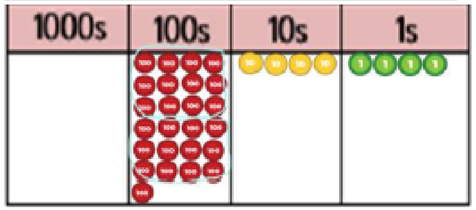
Children to the calculation using the short division scaffold.

$$\begin{array}{r} 1\,2\,3 \\ 5\overline{)\,6\,{}^{1}1\,{}^{1}5} \end{array}$$

Long division using place value counters
2544 ÷ 12

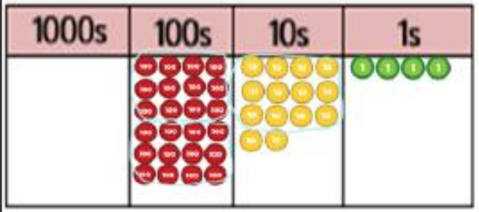


We can't group 2 thousands into groups of 12 so will exchange them.



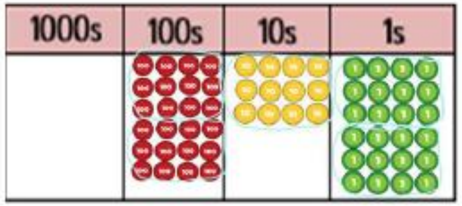
We can group 24 hundreds into groups of 12 which leaves with 1 hundred.

$$\begin{array}{r} 0\,2 \\ 12\overline{)\,2\,5\,4\,4} \\ \underline{2\,4} \\ 1 \end{array}$$



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

```
   021
12|2544
   24
    14
    12
     2
```

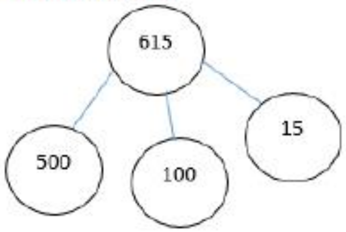


After exchanging the 2 tens, we have 24 ones. We can group 24 ones into 2 group of 12, which leaves no remainder.

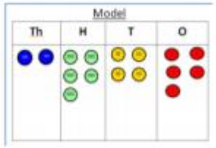
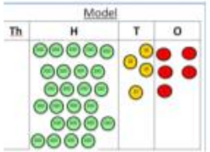
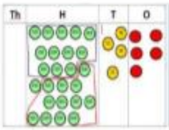
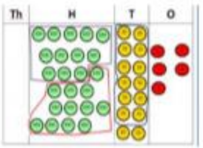
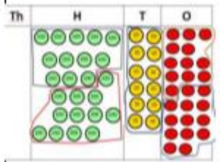
```
   0212
12|2544
   24
    14
    12
     24
     24
      0
```

Conceptual variation; different ways to ask children to solve 615 ÷ 5

Using the part whole model below, how can you divide 615 by 5 without using short division?	I have £615 and share it equally between 5 bank accounts. How much will be in each account? 615 pupils need to be put into 5 groups. How many will be in each group?	5 | 615 615 ÷ 5 = $\square$ = 615 ÷ 5	What is the calculation? What is the answer?



Long division

Concrete	Pictorial	Abstract
 $\begin{array}{r} 0212 \\ 12\overline{)2544} \\ 24 \\ \hline 14 \\ 12 \\ \hline 24 \\ 24 \\ \hline 0 \end{array}$ 2544 ÷ 12 How many groups of 12 thousands do we have? None  Exchange 2 thousand for 20 hundreds.  $\begin{array}{r} 02 \\ 12\overline{)2544} \\ 24 \\ \hline 1 \end{array}$ How many groups of 12 are in 25 hundreds? 2 groups. Circle them. We have grouped 24 hundreds so can take them off and we are left with one.  $\begin{array}{r} 021 \\ 12\overline{)2544} \\ 24 \\ \hline 14 \\ 12 \\ \hline 2 \end{array}$ Exchange the one hundred for ten tens so now we have 14 tens. How many groups of 12 are in 14? 1 remainder 2.  Exchange the two tens for twenty ones so now we have 24 ones. How many groups of 12 are in 24? 2	Children to represent the counters, pictorially and record the subtractions beneath.	$\begin{array}{r} 0 \\ 12\overline{)2544} \end{array}$ Step one- exchange 2 thousand for 20 hundreds so we now have 25 hundreds. $\begin{array}{r} 02 \\ 12\overline{)2544} \\ 24 \\ \hline 1 \end{array}$ 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. $\begin{array}{r} 021 \\ 12\overline{)2544} \\ 24 \\ \hline 14 \\ 12 \\ \hline 2 \end{array}$ 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. $\begin{array}{r} 0212 \\ 12\overline{)2544} \\ 24 \\ \hline 14 \\ 12 \\ \hline 24 \\ 24 \\ \hline 0 \end{array}$ Exchange the 2 tens for 20 ones. The 24 is how many ones I have grouped and the 0 is what I have left.

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