New Town Primary School Calculation Policy

2020-2021

Progression in Calculation

This policy guides New Town in progression for each operation to ensure smooth transition from one year group to the next. It is important that conceptual understanding, supported by the use of representation, is secure for procedures, and if at any point a child is struggling with a procedure; they should revert to concrete and/or pictorial resources and representations to solidify understanding.

At New Town, mathematical understanding is developed through use of representations that are first of all concrete (e.g. Numicon, Base 10, apparatus), then pictorial (e.g. array, place value counters), to then facilitate abstract working (e.g. columnar addition, long multiplication).

This policy shows the progression of methods for the four operations – addition, subtraction, multiplication and division. It is important that children are exposed to relevant vocabulary and understand the relationships, similarities and differences between these, in order to apply their mathematical knowledge to reason and solve problems. These include, but are not limited to:

Addition - add, plus, more than, total, sum of / Subtraction - take away, less than, the difference, subtract, minus, fewer, decrease / Multiplication -double, times, multiplied by, the product of, groups of, lots of, equal groups / Division - share, group, divide, divided by, half, divisor, dividend, quotient, remainder

Addition Calculation Policy

Year 1

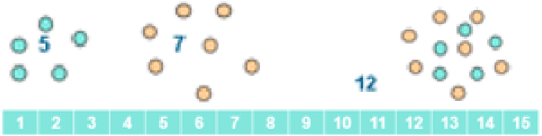
+ = signs and missing numbers
Children need to understand the concept of equality before using the '=' sign. Calculations should be written either side of the equality sign so that the sign is not just interpreted as 'the answer'.

2 = 1+ 1
2 + 3 = 4 + 1

Missing numbers need to be placed in all possible places.

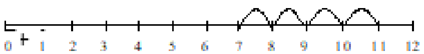
3 + 4 = ☐ ☐ = 3 + 4
3 + ☐ = 7 7 = ☐ + 4

Counting and Combining sets of Objects
Combining two sets of objects which will progress onto adding on to a set.



Understanding of counting on with a number line.

Understanding of counting on with a number line (supported by models and images).

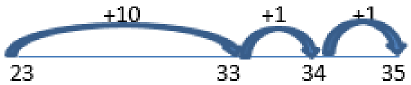


Year 2

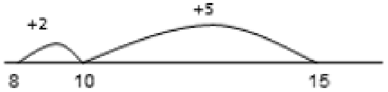
Missing number problems e.g 14 + 5 = 10 + ☐ 32 + ☐ + ☐ = 100
35 = 1 + ☐ + 5

It is valuable to use a range of representations (also see Y1).
Continue to use number lines to develop understanding of:
Counting on in tens and ones

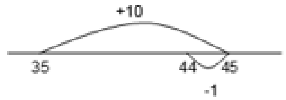
23 + 12 = 23 + 10 + 1+1
= 33 + 2
= 35



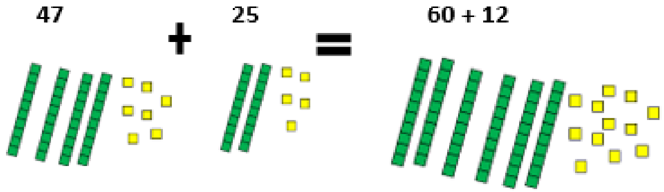
Partitioning and bridging through 10.
The steps in addition often bridge through a multiple of 10
e.g. Children should be able to partition the 7 to relate adding the 2 and then the 5.
8 + 7 = 15



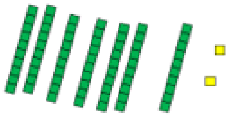
Adding 9 or 11 by adding 10 and adjusting by 1
e.g. Add 9 by adding 10 and adjusting by 1
35 + 9 = 44



Towards a Written Method
Partitioning in different ways and recombine
47+25



Leading to exchanging:
72



Expanded written method
40 + 7 + 20 + 5 =
40+20 + 7 + 5 =
60 + 12 = 72

$$\begin{array}{r} 40 + 7 \\ + \underline{20 + 5} \\ 60 + 12 = 72 \end{array}$$

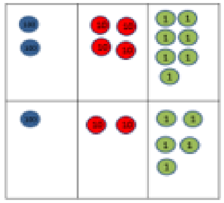
Year 3

Missing number problems using a range of equations as in Year 1 and 2 but with appropriate, larger numbers.

Partition into tens and ones
Partition both numbers and recombine.
Count on by partitioning the second number only e.g.
247 + 125 = 247 + 100 + 20+ 5
= 347 + 20 + 5
= 367 + 5
= 372

Children need to be secure adding multiples of 100 and 10 to any three-digit number including those that are not multiples of 10.

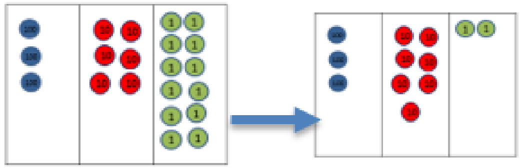
Towards a Written Method
Introduce expanded column addition modelled with use of Numicon or Dienes apparatus if required.



$$\begin{array}{r} 200 + 40 + 7 \\ \underline{100 + 20 + 5} \\ 300 + 60 + 12 = 372 \end{array}$$

$$\begin{array}{r} 247 \\ \underline{+125} \\ 12 \\ 60 \\ \underline{300} \\ 372 \end{array}$$

Leading to children understanding the exchange between tens and ones.



Some children may begin to use a formal columnar methods initially introduced alongside the expanded method. The formal method should be seen as a more streamlined version of the expanded method, not a new method.

$$\begin{array}{r} 247 \\ \underline{+125} \\ \underline{372} \\ {\scriptstyle 10} \end{array}$$

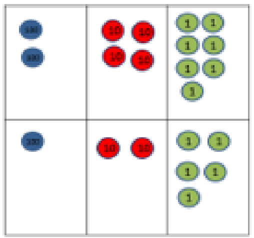
Addition calculation Policy

Year 4

Missing number/digit problems:

Mental methods should continue to develop, supported by a range of models and images, including the number line.

Written methods (progressing to 4-digits)
Expanded column addition progressing to calculations with 4-digit numbers.



Step 1

```
200 + 40 + 7
100 + 20 + 5
300 + 60 +12 = 372
```

Step 2

```
  247
 +125
   12
   60
  300
  372
```

Compact written method
Extend to numbers with at least four digits.

```
  2634
 +4517
  7151
  1  1
```

Children should be able to make the choice of reverting to expanded methods if experiencing any difficulty.

Extend to up to two places of decimals (same number of decimals places) and adding several numbers (with different numbers of digits).

```
   72.8
 + 54.6
  127.4
  1 1
```

Year 5

Missing number/digit problems:

Mental methods should continue to develop, supported by a range of models and images, including the number line. Children should practise with increasingly large numbers to aid fluency
e.g. 12462 + 2300 = 14762

Written methods (progressing to more than 4-digits)
As year 4, progressing when understanding of the expanded method is secure, children will move on to the formal columnar method for whole numbers and decimal numbers as an efficient written method.

```
   172.83
 +  54.68
   227.51
   1  1 1
```

Year 6

Missing number/digit problems:

Mental methods should continue to develop, supported by a range of models and images, including the number line.

Written methods
As year 5, progressing to larger numbers, aiming for both conceptual understanding and procedural fluency with columnar method to be secured.
Continue calculating with decimals, including those with different numbers of decimal places

Problem Solving
Teachers should ensure that pupils have the opportunity to apply their knowledge in a variety of contexts and problems (exploring cross curricular links) to deepen their understanding.

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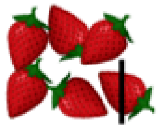
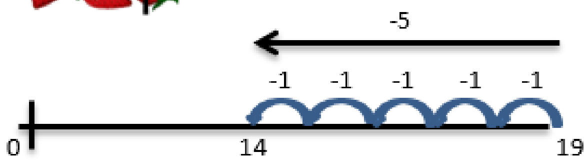
Subtraction Calculation Policy

Year 1

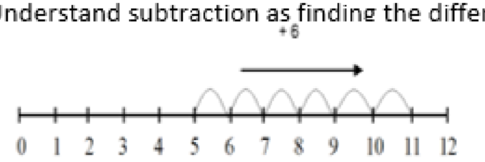
Missing number problems e.g. 7 = □ - 9; 20 - □ = 9; 15 – 9 = □; □ - □ = 11; 16 – 0 = □
Use concrete objects and pictorial representations. If appropriate, progress from using number lines with every number shown to number lines with significant numbers shown.

Understand subtraction as take-away:





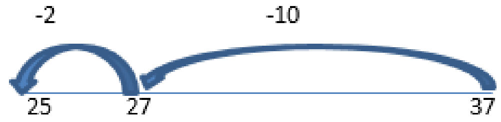
Understand subtraction as finding the difference:

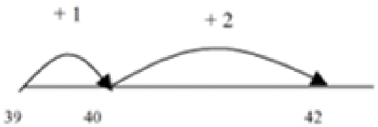


The above model would be introduced with concrete objects which children can move (including cards with pictures) before progressing to pictorial representation.
The use of other images is also valuable for modelling subtraction e.g. Numicon, bundles of straws, Dienes apparatus, multi-link cubes, bead strings

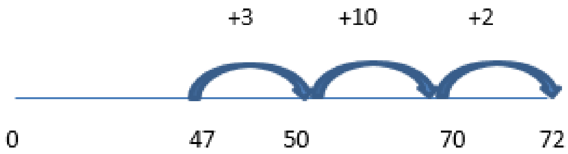
Year 2

Missing number problems e.g. 52 – 8 = □; □ – 20 = 25; 22 = □ – 21; 6 + □ + 3 = 11
It is valuable to use a range of representations (also see Y1).
Continue to use number lines to model take-away and difference. E.g.





The link between the two may be supported by an image like this, with 47 being taken away from 72, leaving the difference, which is 25.



Images to be used in the context of **measures**.

<u>Towards written methods</u>
Recording addition and subtraction in expanded columns can support understanding of the quantity aspect of place value and prepare for efficient written methods with larger numbers. The numbers may be represented with Dienes or Numicon apparatus. E.g. 75 – 42

	70	5
-	40	2
	30	3

Year 3

Missing number problems e.g. □ = 43 – 27; 145 – □ = 138; 274 – 30 = □; 245 – □ = 195; 532 – 200 = □; 364 – 153 = □
<u>Mental methods</u> should continue to develop, supported by a range of models and images, including the number line. Children should make choices about whether to use complementary addition or counting back, depending on the numbers involved.

<u>Written methods (progressing to 3-digits)</u>
Introduce expanded column subtraction with no decomposition, work could be modelled with Numicon or using Dienes apparatus for those who need a less abstract representation

	90	8
-	30	5
	60	3

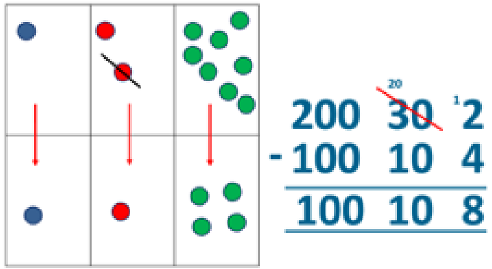
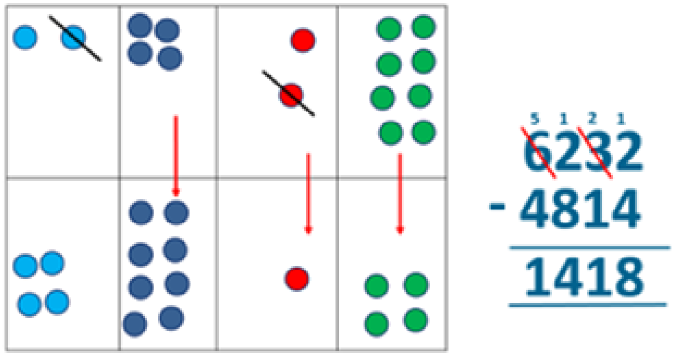
For some children this will lead to exchanging.

		60	1
	200	~~70~~	2
-	100	40	7
	100	20	5

A number line and expanded column method may be compared next to each other.

Some children may begin to use a formal columnar method initially introduced alongside the expanded method. The formal method should be seen as a more streamlined version of the expanded method, not a new method.

Subtraction Calculation Policy

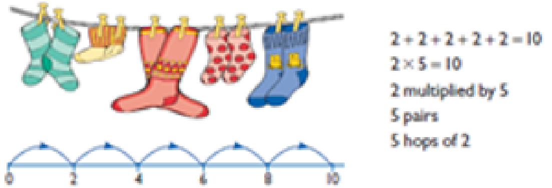
Year 4	Year 5	Year 6
Missing number/digit problems: 456 + □ = 710; 1□7 + 6□ = 200; 60 + 99 + □ = 340; 200 – 90 – 80 = □; 225 - □ = 150; □ – 25 = 67; 3450 – 1000 = □; □ - 2000 = 900 **<u>Mental methods</u>** should continue to develop, supported by a range of models and images, including the number line. The bar model should continue to be used to help with problem solving. **<u>Written methods (progressing to 4-digits)</u>** Expanded column subtraction with decomposition progressing to calculations with 4-digit numbers. Can be modelled using Numcion or Dienes apparatus if required.  If understanding of the expanded method is secure, children will move on to the formal method of decomposition. $\begin{array}{r} 2\overset{2}{\cancel{3}}{}^{1}2 \\ -\ \underline{112} \\ \underline{118} \end{array}$	Missing number/digit problems: 6.45 = 6 + 0.4 + □; 119 - □ = 86; 1 000 000 - □ = 999 000; 600 000 + □ + 1000 = 671 000; 12 462 – 2 300 = □ **<u>Mental methods</u>** should continue to develop, supported by a range of models and images, including the number line. The bar model should continue to be used to help with problem solving. **<u>Written methods (progressing to more than 4-digits)</u>** When understanding of the expanded method is secure, children will move on to the formal method of decomposition, which can be initially modelled with Numicon or Dienes apparatus.  Progress to calculating with decimals, including those with different numbers of decimal places.	Missing number/digit problems: □ and # each stand for a different number. # = 34. # + # = □ + □ + #. What is the value of □? What if # = 28? What if # = 21 10 000 000 = 9 000 100 + □ 7 – 2 x 3 = □; (7 – 2) x 3 = □; (□ - 2) x 3 = 15 **<u>Mental methods</u>** should continue to develop, supported by a range of models and images, including the number line. The bar model should continue to be used to help with problem solving. **<u>Written methods</u>** As year 5, progressing to larger numbers, aiming for both conceptual understanding and procedural fluency with decomposition to be secured. Teachers may also choose to introduce children to other efficient written layouts which help develop conceptual understanding. For example: $\begin{array}{r} 326 \\ -\underline{148} \\ -2 \\ -20 \\ \underline{200} \\ \underline{178} \end{array}$ Continue calculating with decimals, including those with different numbers of decimal places.

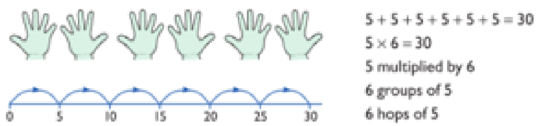
Multiplication Calculation Policy

Year 1

Understand multiplication is related to doubling and combining groups of the same size (repeated addition)

Washing line, and other practical resources for

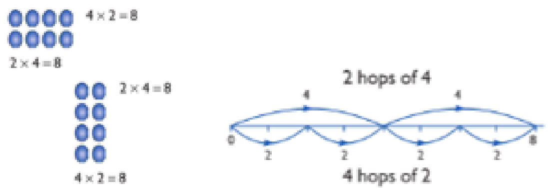




Problem solving with concrete objects (including money and measures)

Use practical apparatus such as Numicon to develop the vocabulary relating to 'times' – Pick up five, 4 times

Use arrays to understand multiplication can be done in any order (commutative)



Year 2

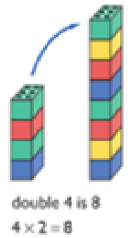
Expressing multiplication as a number sentence using x
Using understanding of the inverse and practical resources to solve missing number problems.

7 x 2 = ☐	☐ = 2 x 7
7 x ☐ = 14	14 = ☐ x 7
☐ x 2 = 14	14 = 2 x ☐
☐ x ◯ = 14	14 = ☐ x ◯

Develop understanding of multiplication using array and number lines (see Year 1). Include multiplications not in the 2, 5 or 10 times tables.

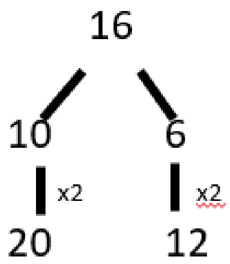
Begin to develop understanding of multiplication as scaling (3 times bigger/taller)

Doubling numbers up to 10 + 10
Link with understanding scaling
Using known doubles to work out double 2 digit numbers
(double 15 = double 10 + double 5)



Towards written methods

Use jottings to develop an understanding of doubling two digit numbers.



Year 3

Missing number problems
Continue with a range of equations as in Year 2 but with appropriate numbers.

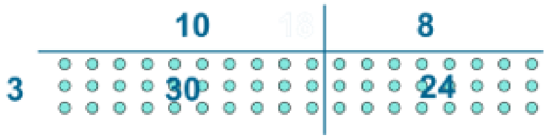
Mental methods
Doubling 2 digit numbers using partitioning

Demonstrating multiplication on a number line – jumping in larger groups of amounts

13 x 4 = 10 groups 4 = 3 groups of 4

Written methods (progressing to 2digit x 1digit)

Developing written methods using understanding of visual images



Develop onto the grid method

	10	8
3	30	24

Give children opportunities for children to explore this and deepen understanding using Numicon or Dienes apparatus .

Multiplication Calculation Policy

Year 4

Continue with a range of equations as in Year 2 but with appropriate numbers. Also include equations with missing digits

☐2 x 5 = 160

Mental methods

Counting in multiples of 6, 7, 9, 25 and 1000, and steps of 1/100.

Solving practical problems where children need to scale up. Relate to known number facts. (e.g. how tall would a 25cm sunflower be if it grew 6 times taller?)

Written methods (progressing to 3digit x 2digit)

Children to embed and deepen their understanding of the grid method to multiply up 2digit x 2digit.

e.g. 18x13=234

	10	8
10	100	80
3	30	24

Once confident, children to progress on to 2 or 3 digit numbers by 1 digit numbers using a formal written layout.

e.g. 26 x 6 becomes

```
  2 4
  x 6
1 4 4
  2
```

Answer = 144

Year 5

Continue with a range of equations as in Year 2 but with appropriate numbers. Also include equations with missing digits

Mental methods

X by 10, 100, 1000 using knowledge of how digits move

Use practical resources and jottings to explore equivalent statements (e.g. 4 x 35 = 2 x 2 x 35)

Recall of prime numbers up 19 and identify prime numbers up to 100 (with reasoning)

Solving practical problems where children need to scale up. Relate to known number facts.

Identify factor pairs for numbers

Written methods (progressing to 4digit x 2digit)

Children to multiply up to 4 digit numbers by a 1 or 2 digit number using formal written method, including long multiplication for 2 digit numbers.

Long multiplication

```
   1 8
 x 1 3
   5 4
 1 8 0
 2 3 4
```

Short multiplication

342 x 7 becomes

```
  3  4  2
  x     7
2 3  9  4
  2  1
```

Answer = 2394

Year 6

Continue with a range of equations as in Year 2 but with appropriate numbers. Also include equations with missing digits

Mental methods

Identifying common factors and multiples of given numbers

Solving practical problems where children need to scale up. Relate to known number facts.

Written methods

Continue to refine and deepen understanding of written methods including fluency for using long multiplication

X	1000	300	40	2
10	10000	3000	400	20
8	8000	2400	320	16

```
   2 3  1
   1 3 4 2
 x     1 8
 1 3 4 2 0
 1 0 7 3 6
 2 4 1 5 6
   1
```

Division Calculation Policy

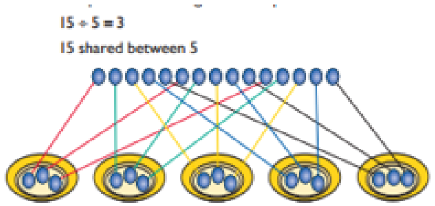
Year 1

Children must have secure counting skills- being able to confidently count in 2s, 5s and 10s.
Children should be given opportunities to reason about what they notice in number patterns.

<u>Group AND share small quantities- understanding the difference between the two concepts.</u>

<u>Sharing</u>

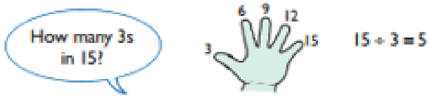
Develops importance of one-to-one correspondence.



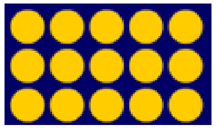
Children should be taught to share using concrete apparatus.

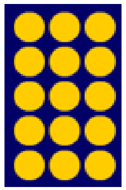
<u>Grouping</u>

Children should apply their counting skills to develop some understanding of grouping.



Use of arrays as a pictorial representation for division.
15 ÷ 3 = 5 There are 5 groups of 3.
15 ÷ 5 = 3 There are 3 groups of 5.





Children should be able to find ½ and ¼ and simple fractions of objects, numbers and quantities.

Year 2

<u>÷ = signs and missing numbers</u>

6 ÷ 2 = □	□ = 6 ÷ 2
6 ÷ □ = 3	3 = 6 ÷ □
□ ÷ 2 = 3	3 = □ ÷ 2
□ ÷ ∇ = 3	3 = □ ÷ ∇

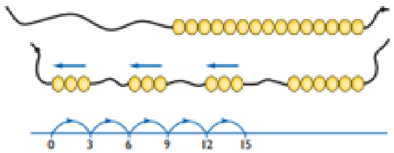
Know and understand sharing and grouping- introducing children to the ÷ sign.

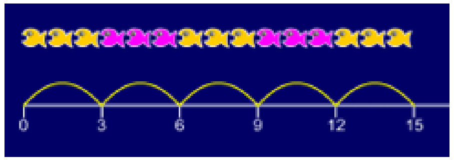
Children should continue to use grouping and sharing for division using practical apparatus, arrays and pictorial representations.

<u>Grouping using a number line</u>

Start at the larger number and jump back in groups of the divisor on a number line to find out 'how many groups of 3 are there in 15?'.

15 ÷ 3 = 5





Continue work on arrays. Support children to understand how multiplication and division are inverse. Look at an array – what do you see?

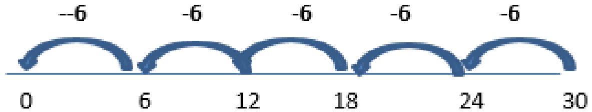
Year 3

<u>÷ = signs and missing numbers</u>

Continue using a range of equations as in year 2 but with appropriate numbers.

<u>Grouping</u>

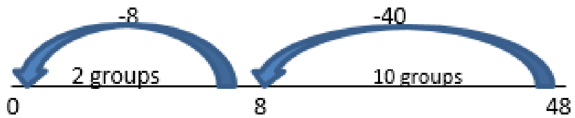
How many 6's are in 30?
30 ÷ 6 can be modelled as:



<u>Becoming more efficient using a number line</u>

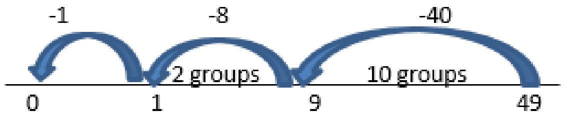
Children need to be able to partition the dividend in different ways.

48 ÷ 4 = 12



<u>Remainders</u>

49 ÷ 4 = 12 r1



Sharing – 49 shared between 4. How many left over?
Grouping – How many 4s make 49. How many are left over?

Place value knowledge can be used to support children when grouping.
For example:
60 ÷ 10 = How many groups of 10 in 60?
600 ÷ 100 = How many groups of 100 in 600?

Division Calculation Policy

Year 4 and Year 5

÷ = signs and missing numbers
Continue using a range of equations as in year 3 but with appropriate numbers.

Sharing, Grouping and using a number line
Children will continue to explore division as sharing and grouping, and to represent calculations on a number line until they have a secure understanding. Children should progress in their use of written division calculations:

- Using tables facts with which they are fluent
- Experiencing a logical progression in the numbers they use, for example:

1. Dividend just over 10x the divisor, e.g. 84 ÷ 7
2. Dividend just over 10x the divisor when the divisor is a teen number, e.g. 173 ÷ 15 (learning sensible strategies for calculations such as 102 ÷ 17)
3. Dividend over 100x the divisor, e.g. 840 ÷ 7
4. Dividend over 20x the divisor, e.g. 168 ÷ 7

All of the above stages should include calculations with remainders as well as without.
Remainders should be interpreted according to the context. (i.e. rounded up or down to relate to the answer to the problem)

e.g. 840 ÷ 7 = 120

Jottings
7 x 100 = 700
7 x 10 = 70
7 x 20 = 140

Year 4

Formal Written Methods
Formal short division should only be introduced once children have a good understanding of division, its links with multiplication and the idea of 'chunking' to find a target number (see use of number lines above)

Short division to be modelled once children have understood and applied the number line method. . In year 4 children should be able to solve calculations such as a 2 digit number divided by a 1 digit number.

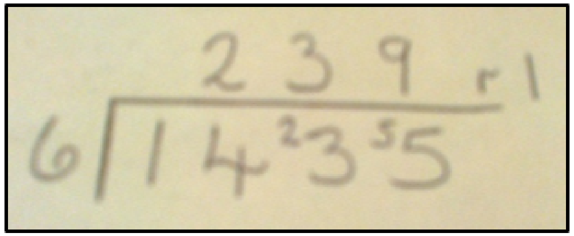
e.g. 98 divided by 7

$$\begin{array}{r|l} & 1\quad 4 \\ \hline 7 & 9\ {}^{2}8 \end{array}$$

Answer = 14

Year 5

Formal Written Methods
Continued as shown in Year 4, leading to the efficient use of a formal method when dividing numbers up to 4 digits by 1 digit. The language of grouping to be used (see link from fig. 1 in Year 4)
E.g. 1435 ÷ 6



Children begin to practically develop their understanding of how express the remainder as a decimal or a fraction. Ensure practical understanding allows children to work through this (e.g. what could I do with this remaining 1? How could I share this between 6 as well?)

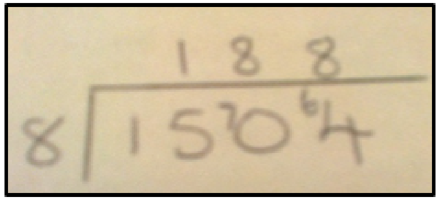
Year 6

÷ = signs and missing numbers
Continue using a range of equations but with appropriate numbers

Sharing and Grouping and using a number line
Children will continue to explore division as sharing and grouping, and to represent calculations on a number line as appropriate.

Quotients should be expressed as decimals and fractions

Formal Written Methods – long and short division
E.g. 1504 ÷ 8



E.g. 2364 ÷ 15