Calculation Policy

This policy was approved

October 2019

This policy should be reviewed annually

"Together unlocking the potential of every child, inspiring children, improving lives"

Calculation Policy

Introduction

Children are introduced to the processes of calculation through practical, oral and mental activities. 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. Over time children learn how to use models and images, such as empty number lines, to support their mental and informal written methods of calculation. As children's mental methods are strengthened and refined, so too are their informal written methods. These methods become more efficient and succinct and lead to efficient written methods that can be used more generally. By the end of Year 6 children are equipped with mental, written and calculator methods that they understand and can use correctly. When faced with a calculation, children are able to decide which method is most appropriate and have strategies to check its accuracy.

When faced with a calculation, children should be able to decide which method is most appropriate and will have strategies that can be used to check its accuracy. They will do this by asking themselves:

- Can I do this in my head?
- Can I do this in my head using a drawing or jottings?
- Do I need to use a pencil and paper procedure?
- Do I need a calculator?

At whatever stage in their learning, and whatever method is being used, it must still be underpinned by a secure and appropriate knowledge of number facts, along with those mental skills that are needed to carry out the process and judge if it was successful.

The overall aim is that when children leave primary school they:

- have a secure knowledge of number facts and a good understanding of the four operations;
- are able to use this knowledge and understanding to carry out calculations mentally and to apply general strategies when using one-digit and two-digit numbers and particular strategies to special cases involving bigger numbers;
- make use of diagrams and informal notes to help record steps and part answers when using mental methods that generate more information than can be kept in their heads;
- have an efficient, reliable, compact written method of calculation for each operation that children can apply with confidence when undertaking calculations that they cannot carry out mentally;
- use a calculator effectively, using their mental skills to monitor the process, check the steps involved and decide if the numbers displayed make sense.

NB: The arrows on the jumps along the number line are to demonstrate to the teacher which direction to model the jumping, but are not to be demonstrated to the children when teaching the method, children should not be drawing arrows when using the number lines themselves.

Addition

These notes show the stages in building up to using an efficient written method for addition.

To add successfully, children need to be able to:

- recall all addition pairs to 9 + 9 and complements in 10 e.g. 6 + 4 = 10;
- add mentally a series of one-digit numbers, such as 5 + 8 + 4;
- add multiples of 10 (such as 60 + 70) or of 100 (such as 600 + 700) using the related addition fact, 6 + 7, and their knowledge of place value;
- Partition two-digit and three-digit numbers into multiples of 100, 10 and 1 in different ways.

Stage 1

At first children will relate addition to the combining of 2 groups:

Count out 3, count out 2. Put together and count out 5

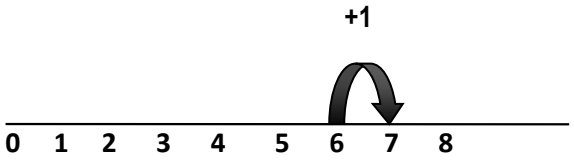
For example: 3 + 2 = 5

Alternatively, count out 3 and then count on 2 more to make 5

Stage 2

The next step is to be able to count one more, and then *several more*, on a number line:

For example: 6 + 1 = 7



For example: 7 = 6 + 1 and 6 + 1 = 7

Children need to understand the concept of the '=' sign, so that it is not just interpreted as the answer. For this reason, calculations should be written on either side of the '='.

(≈ Year 1)

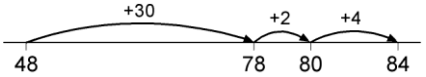
Stage 3

Steps in addition can be recorded on an empty number line. The steps often bridge through a multiple of 10.

8 + 7 = 15

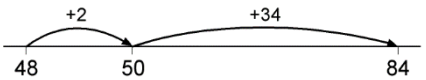
Mental methods involve partitioning, e.g. adding the tens and ones separately, often starting with the tens.

48 + 36 = 84



The empty number line helps to record the steps on the way to calculating the total.

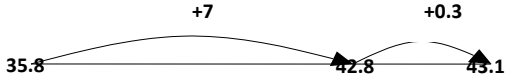
or:



(≈ Year 2)

35.8 + 7.3 = 43.1

This method can be used for the addition of larger numbers and decimals further up the school.



(≈ Year 5)

Stage 4

The next stage is to record steps in addition using partitioning (Horizontal Expansion)

Add the tens and then the ones to form partial sums and then add these partial sums.

The addition of the tens in the calculation 83 + 42 is described in the words 'eighty plus forty equals one hundred and twenty', stressing the link to the related fact 'eight plus four equals twelve'

(≈ Year 4)

83 + 42

80 + 3
40 + 2
---
120 + 5 = 125

367 + 185

300 + 60 + 7
100 + 80 + 5
---
400 + 140 + 12 = 552

Stage 5

Vertical expansion

(≈ Year 5/6)

367 + 185		367	
		185	
	Ones (7+5)	12	
	Tens	140	(60 + 80)
	Hundreds (300 + 100)	400	
		552	

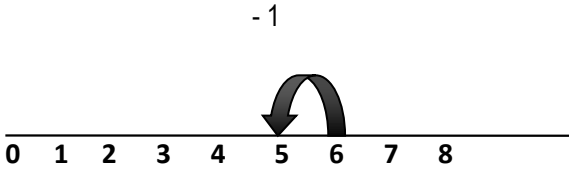
Stage 6	
In this method, recording is reduced further. Carried digits are recorded below the line, when teaching, pupils should be encouraged to use the appropriate mathematical language: 'carry ten' or 'carry one hundred', not 'carry one'. Extend to numbers with any number of digits and decimals with 2 and 3 decimal places. (≈ Year 6)	47 + 76 = 123 (11) 258 + 87 = 345 (11) 366 + 458 = 824 (11) 72.8 + 54.6 = 127.4 (1) 13.86 + 9.481 = 23.341 (11 1)

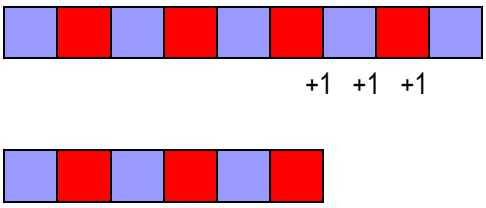
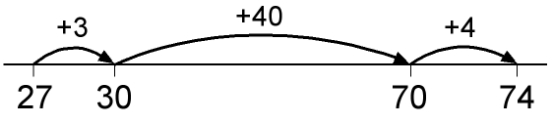
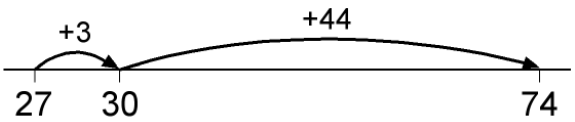
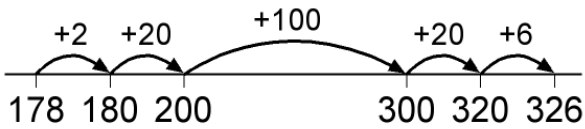
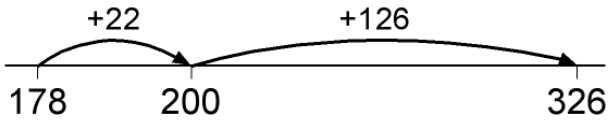
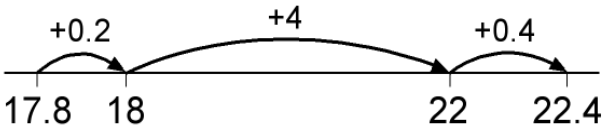
Subtraction

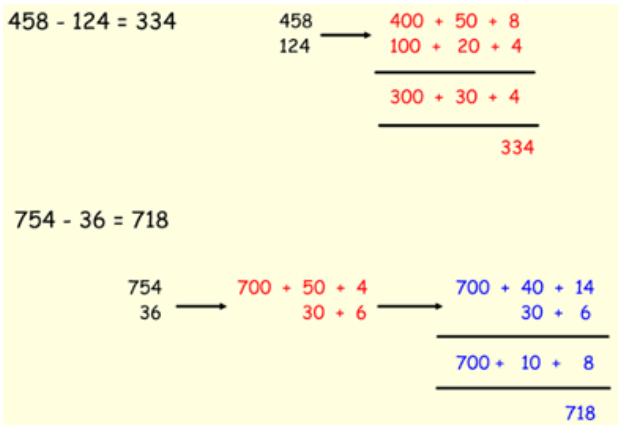
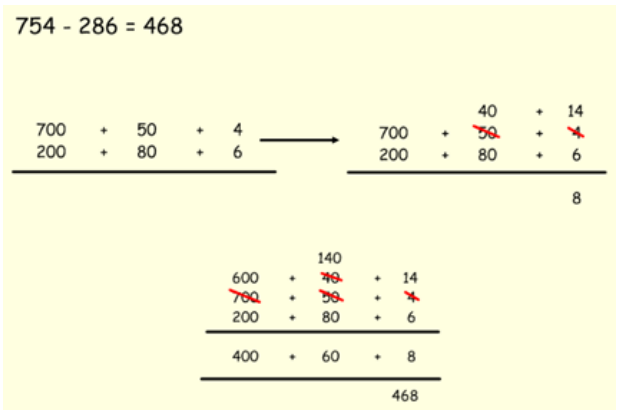
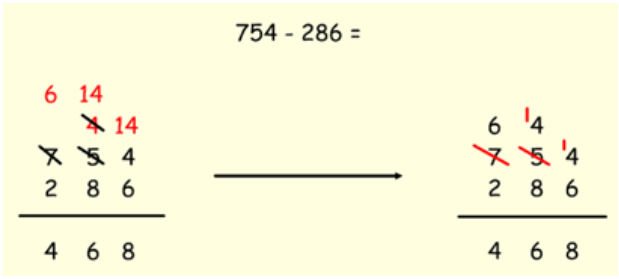
These notes show the stages in building up to using an efficient method for subtraction of two-digit and three-digit numbers.

To subtract successfully, children need to be able to:

- recall all addition and subtraction facts to 20;
- subtract multiples of 10 (such as 160 – 70) using the related subtraction fact,16 – 7, and their knowledge of place value;
- partition two-digit and three-digit numbers into hundreds, tens and ones in different ways (e.g. partition 74 into 70 + 4 or 60 + 14).

Stage 1	
In the early stages, children will be taught to 'take away' one or two objects and find the new total.	For example: 5-3=2  5 take 2 away is 3 
Stage 2	
The next stage is for children to be able to work out one less or several less on a number line	For example: 6 – 1 = 5 

Stage 3	
At an early stage children are introduced to the concept of difference. Children should be taught that subtraction can be worked out by counting on to find the difference between two numbers. (≈ Year 1)	For example: How much longer is this row of cubes than this one? 9 – 3 = 6 
Stage 4	
The counting up method The mental method of counting up from the smaller to the larger number can be recorded using blank number lines The number of rows (or steps) can be reduced by combining steps. With two-digit numbers, this requires children to be able to work out the answer to a calculation such as 30 + ☐ = 74 mentally. (≈ Year 2/3)	 or: 
Stage 5	
With three-digit numbers the number of steps can again be reduced, provided that children are able to work out answers to calculations such as 178 + ☐ = 200 and 200 + ☐ = 326 mentally. This can also be used for calculations involving decimals. (≈ Year 5/6)	 or:  

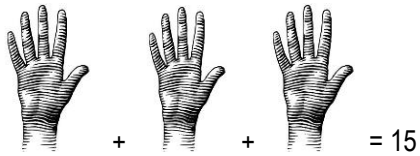
Stage 6	
	
Stage 7	
	
Stage 8	
	

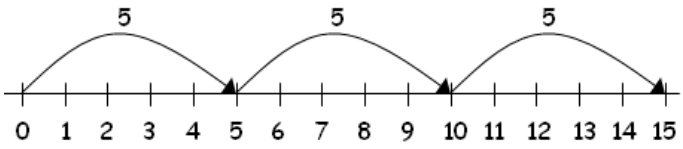
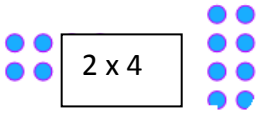
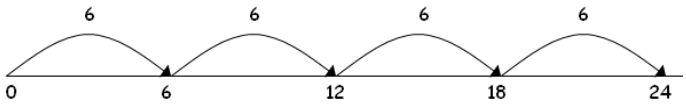
Multiplication

These notes show the stages in building up to using an efficient method for two-digit by one-digit multiplication, two-digit by two-digit multiplication, and three-digit by two-digit multiplication.

To multiply successfully, children need to be able to:

- recall all multiplication facts to 10 × 10;
- partition numbers into multiples of one hundred, ten and one;
- work out products such as 70 × 5, 70 × 50, 700 × 5 or 700 × 50 using the related fact 7 × 5 and their knowledge of place value;
- add two or more single-digit numbers mentally;
- add multiples of 10 (such as 60 + 70) or of 100 (such as 600 + 700) using the related addition fact, 6 + 7, and their knowledge of place value;
- add combinations of whole numbers

Stage 1	
First children are taught to count in 2's, 10's and 5's using practical objects.	For example: 2 x 3 = 6  5 x 3 = 15 

Stage 2	
Repeated addition on number lines 5 multiplied by 3 is 5 + 5 + 5 = 15 Repeated addition can be shown easily on a number line. Repeated addition using arrays, this knowledge will help to support the development of the grid method and will help children understand that calculations can be done either way, i.e. 2 x 4 or 4 x 2, according to the commutative law. Repeated addition on a blank number line. 6 multiplied by 4 is the same as 6 + 6 + 6 + 6 = 24, or 4 lots of 6, or 6 x 4.	 $a \times b = b \times a$ Example:  2 x 4 4 x 2 

Stage 3

Children will be taught the progression from the use of arrays to the more formal written method of multiplication, using a grid.

Children need a secure knowledge of the effect of multiplying a single digit by ten.

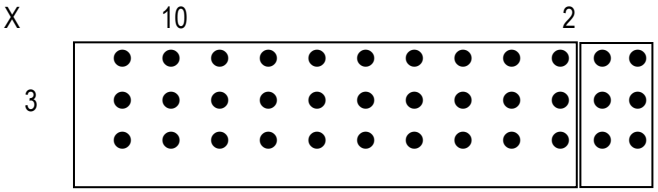
(≈ Year 2)

(Children will continue to use arrays…)

Grid method for TO x O (children should try to approximate the answer first.)

(≈ Year 4)

12 x 3



X	**10**	**2**
3	30	6

= 30 + 6 = 36

23 X 7

X	**20**	**3**
7	140	21

140 + 21 = 161

Stage 4

Grid method for HTO x O (children should try to approximate the answer first.)

(≈ Year 4/5)

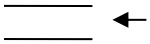
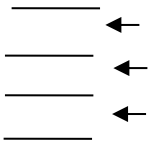
346 X 9

X	**300**	**40**	**6**
9	2700	360	54

2700 + 360 + 54
2700 + 360 = 3060
3060 + 54 = 3114

Stage 5	
Extend to TO × TO (children should try to approximate the answer first.) By the end of Year 5, children will be able to use an efficient method for two digit by two digit multiplication. (This method should be extended to incorporate simple decimals as appropriate) (≈ Year 5/6)	56 × 27 is approximately 60 × 30 = 1800. | X	**50**	**6**
---	---	---
20	1000	120
7	350	42

Stage 6	
Expanded Vertical method	38 x 7 38 X 7 --- 56 (8 x 7) + 210 (30 x 7) --- 266 56 x 27 56 X 27 --- 42 (6 X 7) 350 (50 X 7) 120 (6 X 20) + 1000 (50 X 20) --- 1512 The addition of the column of numbers at the end can also be completed using the methods shown in the addition section rather than the standard algorithm using 'carrying' shown here.

Stage 7	
Short Written method When children have secured written multiplication methods, children are taught efficient methods to allow children to multiply quickly and efficiently.  	H T O 4 6 3 X 8 3 7 0 4 Answer line TH H T O 8 7 X 4 6 5 2 2 Answer line 1 3 4 8 0 Answer line 2 4 0 0 2 Answer line 3

Division

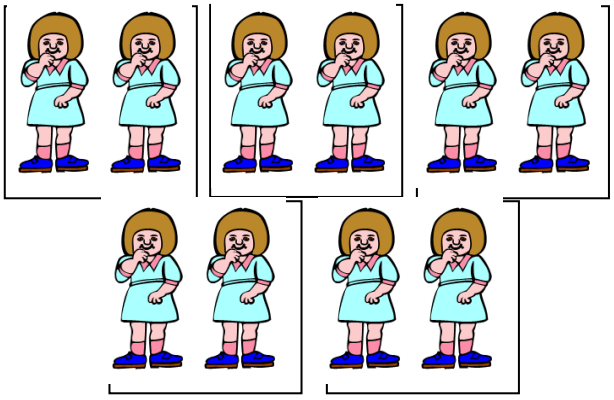
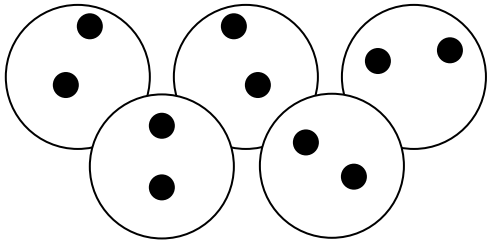
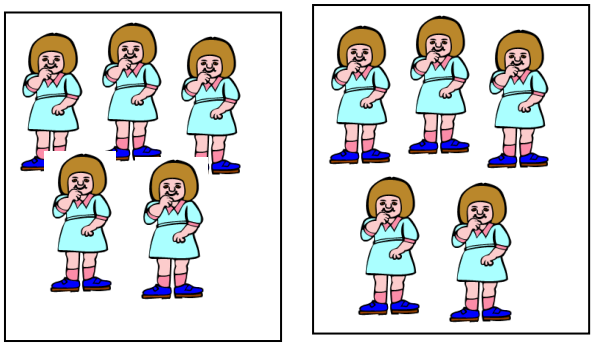
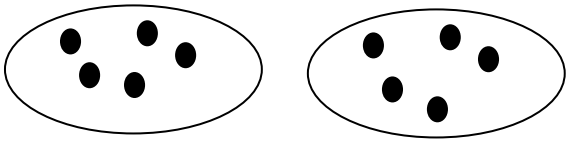
To successfully divide mentally, children need to be able to:

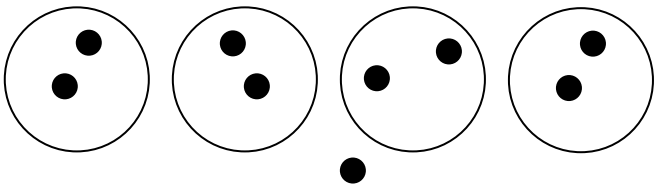
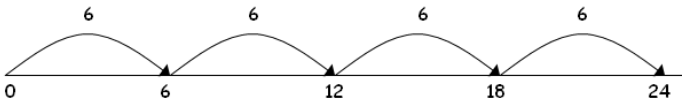
- understand and use the vocabulary of division – for example in 18 ÷ 3 = 6, the 18 is the dividend, the 3 is the divisor and the 6 is the quotient;
- partition two-digit and three-digit numbers into hundreds, tens and ones in different ways;
- recall multiplication and division facts to 10 × 10, recognise multiples of one-digit numbers and divide multiples of 10 or 100 by a single-digit number using their knowledge of division facts and place value;
- know how to find a remainder working mentally – for example, find the remainder when 48 is divided by 5;
- understand and use multiplication and division as inverse operations.

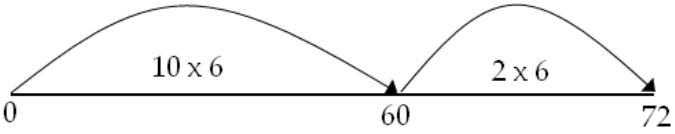
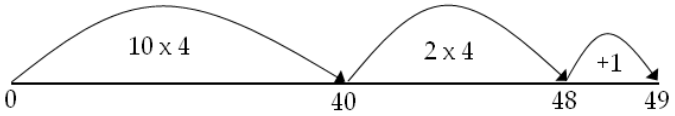
To carry out written methods of division successfully, children also need to be able to:

- understand division as repeated addition;
- estimate how many times one number divides into another – for example, how many sixes there are in 47, or how many 23s there are in 92;
- multiply a two-digit number by a single-digit number mentally;
- add numbers using an appropriate method.

Stage 1	
Children will be given the opportunity to share objects into equal groups, counting how many objects there are in each group. Understanding division as sharing	6 cakes are shared between 2 people. How many cakes do each receive? 

Stage 2	
Understanding division as grouping. Children will be given the opportunity to sort objects into 2s, 3s, 4s etc. (≈ Year 1)	10 children are grouped into teams of 2. How many teams will there be?  10 ÷ 2 = 5 As a jotting this could look like…  Or alternatively: 10 children were grouped into 2 teams. How many children are in each team?  10 ÷ 2 = 5 As a jotting this could look like… 

Stage 3	
Children will become more familiar with the use of practical and informal written methods and the related vocabulary to support division, including calculations with remainders. (≈ Year 2)	9 ÷ 2 = 4 r 1 As a jotting this could look like… 
Stage 4	
Counting on a number line An empty number line can be used to record grouping or sharing. (≈ Year 2)	For example: 24 ÷ 6 = 4  This could be 24 chocolate eggs that are to be shared between 6 children OR 24 chocolate eggs that are to be packed (grouped) in boxes of 6

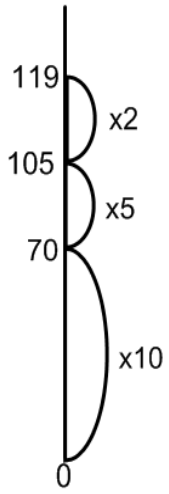
Stage 5	
Children will use their knowledge of multiplication facts to divide on an empty number line. (≈ Year 3) *NB This method should only be used once the children are able to confidently use multiplication facts.* Remainders 49 ÷ 4 = 12 r1 Grouping - How many 4's make 49, how many ones are left over? Sharing - 49 shared between 4, how many ones are left over? (≈ Year 3/4)	For example: 72 ÷ 6 = 12  10 groups of 6 + 2 groups of 6 = 12 groups of 6 For example: 49 ÷ 4 = 12 r 1  10 groups of 4 + 2 groups of 4 with one unit left over
Stage 6	

The target method, often referred to as 'chunking', is based on adding multiples of the divisor, or 'chunks' until the target number is reached.

Children will use known facts (such as 2x, 5x and 10x the divisor) to calculate the answer. Initially, children should note whether the target number is greater than the divisor multiplied by ten. If it is, this should be their first jump.

(≈ Year 4/5)

119 ÷ 7 = 17



It is helpful to have a 'ready reckoner' first.

This comprises establishing the key

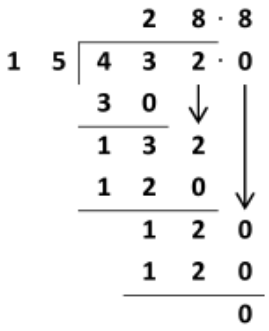
7 x 10 = 70

7 x 5 = 35

7 x 2 = 14

17 x 1 = 17

Stage 7	
	How many packs of 3 can we make from 72 biscuits? 3) 72 - 30 10 groups of 3 42 - 30 10 groups of 3 12 - 12 4 groups of 3 0 Answer 24 Short division can also be used to complete calculations where there is a remainder. 32 r 4 6) 196 - 180 30 groups of 6 16 - 12 2 groups of 6 4 Answer : 32 remainder 4 *or* 32 r 4

Stage 8	
Long division will only be taught to those children who are confident in the above methods, it is not expected that all children leaving KS2 will have experienced long division.	27 36) 972 - 720 20 groups of 36 252 - 252 7 groups of 36 0 Answer 27 Long division with decimal numbers: 432 ÷ 15 becomes  Answer: 28·8
Stage 9	
When children have secured written division methods, children are taught efficient methods to allow children to divide quickly and efficiently.