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 to support their mental and informal written methods of calculation. At whatever stage in their learning, and whatever method is being used, calculation is 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.

There is a considerable emphasis on teaching mental calculation strategies. Informal written recording takes place regularly and is an important part of learning and understanding. Some recording takes the form of jottings, which are used to support children's thinking. T

As children's mental methods are strengthened and refined, so too are their informal written methods. More formal written methods follow only when the child is able to use a wide range of mental calculation strategies. Informal written methods become more efficient and succinct and lead to efficient written methods that can be used more generally.

This policy contains the key pencil and paper procedures that will be taught within our school. It has been written to ensure consistency and progression throughout the school and reflects a whole school agreement.

Aims

The overall aims are that when children leave xxxxxxxx school they:

- have a secure knowledge of number facts and a good conceptual 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;
- are able, when faced with a calculation, to decide which method is most appropriate and have strategies to check its accuracy. They will do this by always asking themselves: Can I do this in my head? Can I do this in my head using drawings or jottings? Do I need to use a pencil and paper procedure? Do I need a calculator?'

Written methods for addition

To add successfully, children need to be able to:

- recall all addition pairs to 9 + 9 and complements in 10 and 100;
- 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.

The models of addition explored are:

- Combining of sets (Aggregation)
- Adding on more (Augmentation)

add addition total plus

more than and altogether

increase equals make sum

Stage 1

Using apparatus **Informal jottings** **Number tracks**

Combining groups

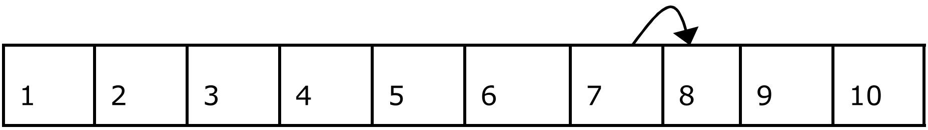
7 **add** 1 equals 8

Jen has seven oranges, Pete has 1 orange. How many do they have in total?

Adding on more

7 and 1 **more** is 8

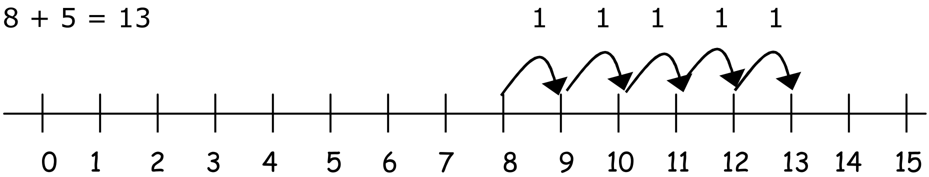
Jen has seven oranges, Pete gives her one more. How many oranges does she have now?



Stage 2

Number line

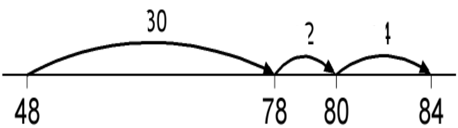
8 + 5 = 13



Stage 3

Empty number line

48 + 36 = 84



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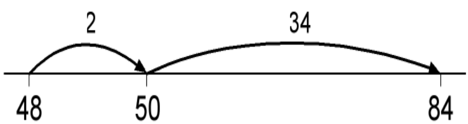


Stage 4

Partitioning

47 + 76

40 + 70 7+6

110 + 13 = 123

The tens and ones will be added to form partial sums and then these partial sums will be added together to find the total.

Stage 5

Expanded column method

$$\begin{array}{r} 67 \\ +\ 24 \\ \hline 80 \\ 11 \\ \hline 91 \\ \hline \end{array} \qquad \begin{array}{r} 67 \\ +\ 24 \\ \hline 11 \\ 80 \\ \hline 91 \\ \hline \end{array}$$

Initially children add the most significant numbers first, then move on very quickly to the least significant first.

Stage 6

Column method

$$\begin{array}{r} 258 \\ +\ 87 \\ \hline 345 \\ \hline 1\ 1\ \ \end{array}$$

Carry digits are recorded below the line, using the words 'carry ten' or 'carry one hundred'.

Children need to have number sense and make decisions about how to solve a calculation. 325 + 99 = may be best completed by adding 100 and subtracting 1.

Written methods for subtraction

To subtract successfully, children need to be able to:

- recall all addition and subtraction facts to 10, 100;
- 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 multiples of one hundred, ten and one in different ways (e.g. partition 74 into 70 + 4 or 60 + 14).

The models of subtraction explored are:

- Taking away (physical removal or reduction)
- Finding the difference (comparison)
- Complements of a set structure (knowing the whole and one part of a set) E.g. 12 children in a class, 4 are boys , how many are girls.

subtract subtraction

take away minus less than

difference decrease leave

How many left?

Stage 1

Using apparatus **Informal jottings** **Number tracks**

Taking away

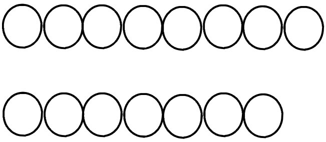
1 **less** than 8 is 7

8 **subtract** 1 equals 7

I have 8 oranges, If I eat one, how many oranges do I have left?

1	2	3	4	5	6	7	8	9	10

Finding the difference



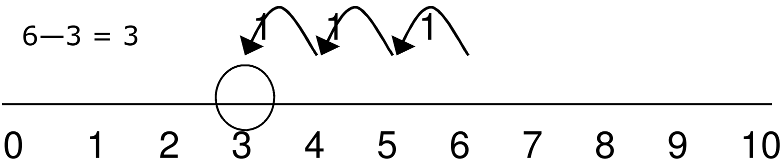
Using practical resources: I have 8 oranges, James has 7 oranges. How many more do I have?

Stage 2

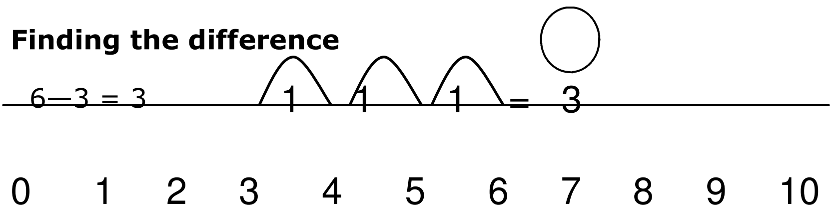
Number line

Taking away

6—3 = 3



Finding the difference

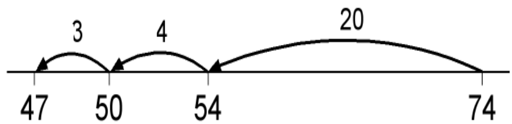


Stage 3

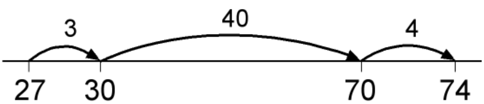
Empty number line

Counting back

74 – 27 = 47



Counting on



Where numbers are close together, calculations may best be solves by counting up.

E.g. 1007-993 = 14

Stage 4

Expanded layout for decomposition

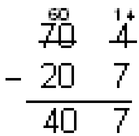
89—57 = 32

80 9

-50 7

30 2 =32

74—27 = 47



Where numbers are close together, calculations may best be solved by counting up.

Stage 5

Column method for decomposition

741—327 = 414

3 11

7 4 1

- 3 2 7

4 1 4

The terminology is exchanging or regrouping,

Calculations requiring a lot of exchanging would make the column method error prone. Number sense would suggest that a number line could still be used.

Written methods for multiplication

To multiply successfully, children need to be able to:

- recall all multiplication facts to 12 × 12;
- partition number 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 using the column method

The models of multiplication explored are:

- Repeated addition
- Arrays
- Scaling

multiply   multiplication

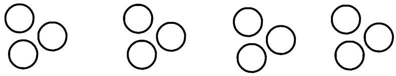
repeated addition   altogether

lots of   groups of   array

Stage 1

Using apparatus **Informal jottings**

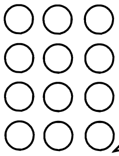
Repeated addition



4 lots of 3 is 12

3 x 4 = 12

3+3+3+3= 12



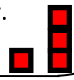
Arrays

3 four times

4 lots of 3

Scaling 1 x 3 =3

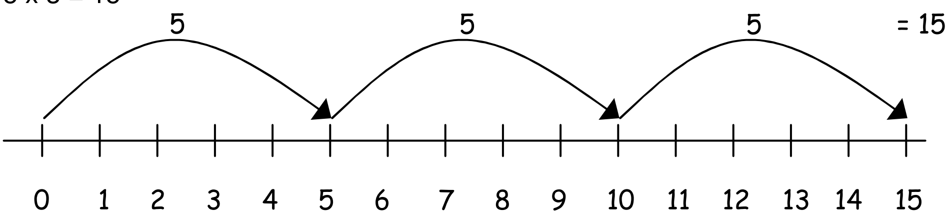
John’s tower is three times as tall as Graces tower.



Stage 2

Number line

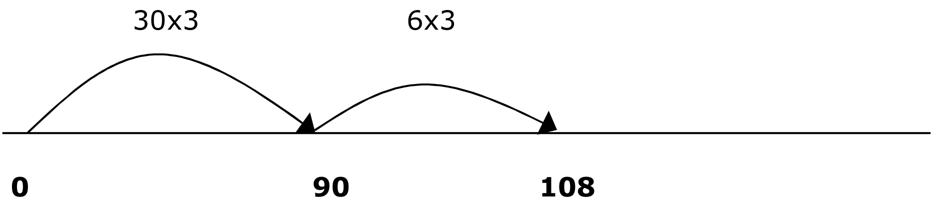
5 x 3 = 15



Stage 3

Empty number line / partitioning

36 x 3 = 108 30 x3 =90 6x3 = 18 90 +18= 108



Stage 4

Grid method

14 x 6 = 84

x	10	4
6	60	24

60
+24
84

286 × 29 = 8294

x	200	80	6
20	4000	1600	120
9	1800	720	54

4000
1800
1600
720
120
+ 54
8294
2

Stage 5

Expanded short multiplication / expanded long multiplication

38
x 7
210
56
266

23
X12
6
40
30
200
276

Stage 6

Short multiplication

342 × 7 becomes

	3	4	2
×			7
2	3	9	4
	2	1	

Answer: 2394

2741 × 6 becomes

	2	7	4	1
×				6
1	6	4	4	6
	4	2		

Answer: 16 446

Stage 7

Long multiplication

24 × 16 becomes

	2	
	2	4
×	1	6
2	4	0
1	4	4
3	8	4

Answer: 384

124 × 26 becomes

	1	2	
	1	2	4
×		2	6
2	4	8	0
	7	4	4
3	2	2	4
1	1		

Answer: 3224

Written methods for division

To divide successfully, children need to be able to:

- partition two-digit and three-digit numbers into multiples of 100, 10 and 1 in different ways;
- recall multiplication and division facts to 12 × 12;
- 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.
- 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

The models of division explored are:

- Sharing equally
- Grouping

divide division divided by

share equally equal

sharing equally

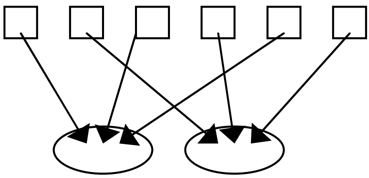
Stage 1

Using apparatus **Informal jottings**

Sharing equally

6 ÷ 2 = 3

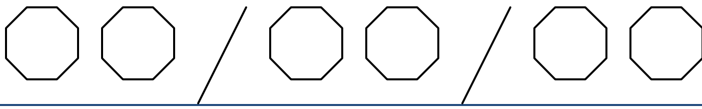
6 sweets shared between 2 people, how many do they each get?



Grouping or repeated subtraction

6 ÷ 2 = 3

There are 6 sweets, how many people can have 2 sweets each?

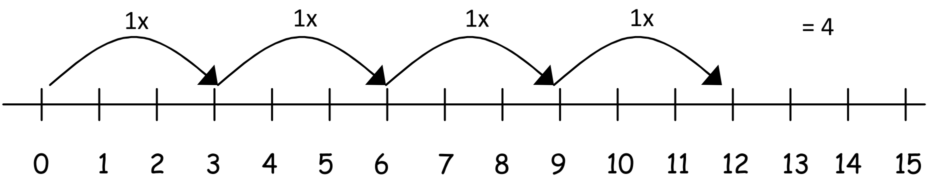


Stage 2

Number line

12 ÷ 3 = 4

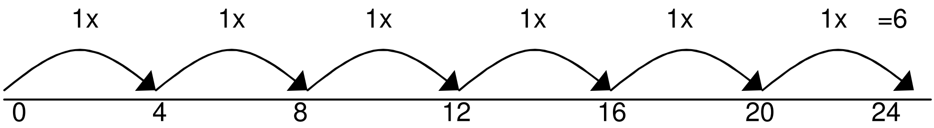
'How many 3s in 12?'



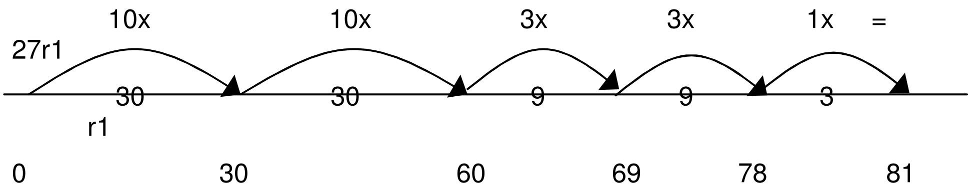
Stage 3

Empty number line

24 ÷ 4 = 6



82 ÷ 3 = 27r1



Stage 4

Chunking

96 ÷ 6 = 16

6	96	
	- 60	10x
	36	
	- 36	6x
	0	= 16

82 ÷ 3 = 27r1

3	82	
	- 60	20x
	22	
	- 21	7x
	1	= 27r1

Chunking is inefficient if too many subtractions need to be carried out. Reduce the number of steps to encourage finding the largest possible multiples.

Stage 5

Short division

98 ÷ 7 becomes

	1	4
7	9	$^{2}8$

Answer: 14

432 ÷ 5 becomes

		8	6	r 2
5	4	3	$^{3}2$	

Answer: 86 remainder 2

Stage 6

Long division

432 ÷ 15 becomes

			2	8	r 12
1	5	4	3	2	
		3	0	0	
		1	3	2	
		1	2	0	
			1	2	

Answer: 28 remainder 12