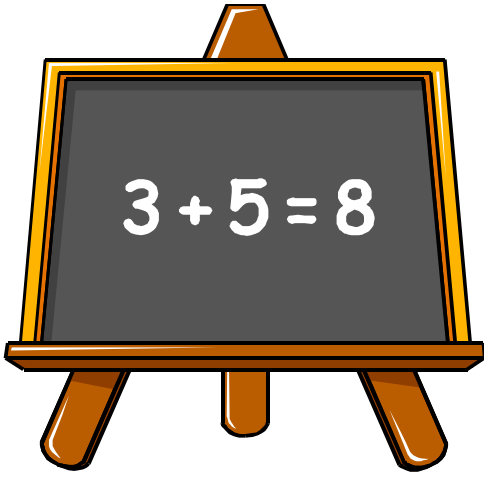
Rothwell Junior School

POLICY FOR WRITTEN CALCULATIONS



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INTRODUCTION

Purpose of this policy:

The purpose of this policy is to ensure a clear progression of the written calculation methods we use throughout the school. We aim that by the end of Year 6 children will be able to use an efficient written method for each of the operations of addition, subtraction, multiplication and division. The policy will limit the number of methods we teach and ensure consistency across the school, leading to greater confidence and success for all our children. Our calculation methods will also build upon the methods taught in the Infant School

Although it is assumed that children will follow the pathway outlined in this policy some children may not be ready for strategies outlined here at the suggested time, and care must be taken to ensure that children are not rushed through stages before they are fully ready. There is a danger that if more abstract methods are imposed upon children too early, without ensuring their understanding, they can lose the more informal methods with which they were previously confident. Some children may benefit from being introduced to alternative methods and more able children may be taught a greater range of strategies to extend their mathematical understanding.

Importance of Mental Skills and understanding of Place Value

The strategies outlined in this policy are dependent on the children developing and being able to apply their mental skills. They need to be secure in their knowledge of basic facts, such as knowing their number bonds, addition and subtraction facts to 20, double and half facts and multiplication tables. They also need to have secure knowledge of place value and a full understanding of the value of digits within the numbers they are working with.

Children will be taught and given opportunities to use and apply a wide variety of mental strategies. The use of jottings is encouraged as a key part of mental calculation. Children also need to recognise that written methods are not always the best approach and should be able to make decisions as to the most efficient method to use, depending on the numbers involved. Recognising near multiples of 10, 100 and 1000 and near doubles is important, as rounding and adjusting can be used. This is a very useful mental strategy and can be far quicker than using a written method. The calculations below are good examples of when rounding and adjusting is a more efficient strategy than using a written method.

56 + 9	**57- 9**
125 + 48	**125 - 48**
839 + 199	**834 - 299**

It is also important for the children to be able to approximate their answers and check that answers are reasonable.

Mathematical Thinking

The school have adopted the use of talk to help children reason in maths.
"What's the same, what's different?", "What do you notice?", "What relationships are there..?" are all used to stimulate discussion and extend children's thinking skills. These types of stimulus should be used regularly throughout lessons; the message that no answer is silly as long as it can be explained or supported by a reason is the basis of encouraging ALL pupils to take part in the discussion and thinking.

Introducing new written methods

When introducing new written methods it is beneficial to show previously used jottings or methods, alongside new ones. This helps to explain the stages within calculations and supports thinking. Less able children particularly find this useful when making the jump from jottings to more formal ways of recording. The children will be encouraged to continue to use the strategy with which they are secure, alongside a new strategy, until they are confident enough to drop the one used previously.

It is helpful to use smaller numbers initially when introducing new written methods. However, it is important to emphasise those calculations which should really be done mentally. Children also need to have lots of practise in applying their skills to problem solving and real life problems.

The Renewed Framework for numeracy

The Renewed Framework contains the range of written calculation methods; strategies to teach these methods should be applied in line with this policy.

Transition from KS1 to KS2.

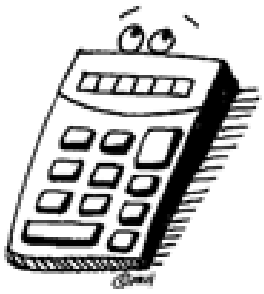
Full records are passed on to Year 3 teachers he by the Year 2 teachers at transition meetings.The subject co-ordinators from both settings meet regularly to review policy and ensure continuity between the two key stages.

Calculators

Calculators are an important tool in mathematics and, although children need to be able to compute competently at all levels and explain their working, there are times where the use of a calculator is appropriate. This may be for several reasons:

- The child knows the type of calculation that is required, but the numbers are too large or complex and their chances of arriving at the correct solution will be limited.
- In a trail and improvement situations where repeated calculations are necessary but where children may become demotivated if they have to make these calculations mechanically.
- Time is short and the calculator is therefore an efficient use of time.
- As a proof or checking tool.
- When needed to handle large amounts of numbers efficiently e.g. adding lists.

Children need to be taught when it is appropriate to use calculators and should be able to justify their use, this will continue to be done, although from 2014 the end of KS2 SATs will no longer include a calculator paper; calculators may be used only in the Level 6 paper.



Supporting pupils with Special Educational Needs

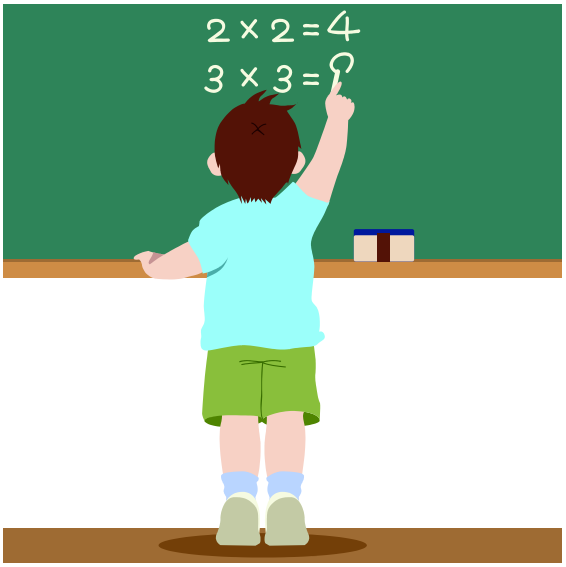
Children who have difficulty in acquiring mathematical skills can often find the more abstract formal methods of recording calculations confusing. It is essential that the more succinct methods are not imposed on children, without ensuring their understanding, otherwise they can lose the more primitive methods, with which they were previously confident. It is important that they be given access to a variety of resources and opportunities to find a method which works for them.

Gifted and talented pupils

Children who are judged to be gifted in mathematics will be introduced to alternative calculation methods in addition to those outlined in this policy. The NNS Renewed Framework for teaching mathematics contains a range of alternative methods to extend the more able. They should also be given a wide range of experiences in applying their skills in different situations and in explaining their methods and reasoning.

Renewed NNS Framework for Teaching Mathematics

Learning in mathematics is organised into seven strands. The appendix to this Policy contains the two strands which relate directly to the teaching of calculations; Strand 3: Knowing and Using number facts" and Strand 4: "calculating"



OUR WRITTEN CALULATION METHODS

ADDITION -Year 3

Counting On - jottings for mental calculation

- Much work is done on mental addition.
- Children should mentally be able to + 10, and then multiples of 10, to any 2 digit number.
- When adding, the 2nd number is partitioned initially. Add on tens and then ones.
- Children may come from the infant school adding tens to 100 plus excess (e.g.86 + 54 = 100+ 30 + 6 +4) before moving on to next step.
- Encourage bridging through multiples of 10, when appropriate. This is an excellent mental strategy.

A: counting on in multiples of 100, 10 or 1

86 + 57 = 86 + 50 + 7 = 136 + 7 = 143

or 86 + 57
86 + 50 = 136
136 + 7 = 143

or 86 + 57 = 86 + 50 + 7
= 136 + 7
= 143

Children should be encouraged to do this for mental calculation. If not, they can use a range of jottings to support their thinking. Empty number lines provide an excellent resource. However, it is not necessary for the children to record the long addition shown above the number line. When they are able to do this mentally there is no need for them to record working.

Partitioning

- Move onto partitioning both numbers. Always deal with the most significant digit first. (This is a more natural mental strategy and ensures that children maintain an idea of the size of the numbers.) Encourage approximation of the answer.
- Examples of recording methods are shown below and are used both for the written and the mental calculation.

67 + 24 = 91

80 + 11

Jottings are used efficiently to support the mental calculation. The value of each digit is always stressed.

67 + 24 = 91

60 + 7 + 20 + 4

80 + 11

Each number has been expanded to reinforce place value. This may be helpful for less able pupils.

67 + 24

60 + 20 = 80

7 + 4 = 11

80 + 11 = 91

Here jottings have started to become more formal. Although recording in this way takes more time, place value is reinforced.

Children **must** have a full understanding of the place value of these numbers. Always refer to the tens digit using its full value, ie 6 tens or 60, never 6!

126 + 56 = 182

100 + 70 + 12 = 182

ADDITION
Year 4

The expanded method of vertical addition

Introduce pupils to vertical setting out, but **only** when children have a secure understanding of place value and can add two digit numbers mentally, with or without jottings to support their thinking.

67		83		
+ 24		+ 42		
80	(60 + 20)	120		add mentally from top
11	(7 + 4)	5		
91	(80 + 11)	125		

- There is no need for carrying. Each part is totalled mentally.
- Children use brackets to explain reasoning at each stage of the calculation and support thinking for as long as necessary. Encourage them to stop using the brackets when competent in this method, as they are inefficient.
- Introduce this method with 2 digit numbers (although stress that they should be able to add two digit numbers mentally) and progress to using 3 digit numbers by the end of Year 4.

ADDITION
Years 5-6

- Work continues using partitioning, leading to this sort of calculation in Y6:

ThHTU + ThHTU, then numbers with any number of digits
For example:

A: adding the most significant digits first

7648		6584		
+ 1486		+ 5848		
8000		11000	]	
1000		1300	]	add mentally
120		120	]	from top
14		12	]	
9134		12432		

Addition of Decimals

E.g: £34.25 + £17.82

£	
34.25	
+17.82	
40.00	**(30 + 10)**
11.00	**(4 + 7)**
1.00	**(0.2 + 0.8)**
0.07	**(0.05 + 0.02)**
52.07	

This looks complicated but builds upon understanding of place value!

Carrying:

This should be adopted very early on in Year 5 for the majority of children.

- The more efficient method of 'carrying' will be introduced from Year 5 to children who are very secure in their understanding of place value.
- When first introducing carrying, it is helpful to demonstrate that the expanded method previously taught will achieve the same result if the units are added first.
- Introduce the carrying digit in one column only, moving onto more complex calculations.

```
  435          257.06
+ 327        +   32.5
  762          671.98
   1           961.54
               1 1 1 1
```

SUBTRACTION
Year 3

- Much work is done on mental subtraction.
- Children should be confident in subtracting small numbers mentally
- Work is done to derive new facts from known facts

E.g. $8 - 3 = 5$

So $80 - 30 = 50$

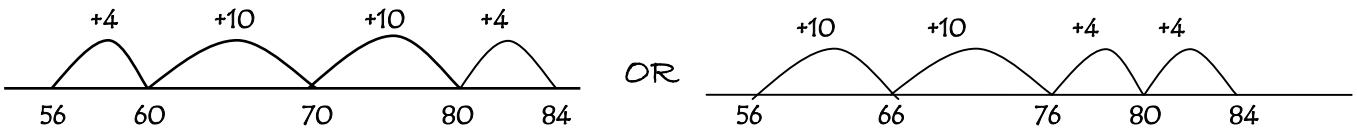
- Children should mentally be able to - 10, and then multiples of 10, from any 2 digit number.
- It is essential that children are **not** taught to partition the numbers at this stage, as this method does not always work. For calculations such as 52-38 the children will tend to work out 50 – 30 and then switch the units digits around to give 8 – 2, which will result in the wrong answer. It is counter-productive to only provide examples which do work, i.e. 58 – 33 as few children at this stage are sophisticated enough in their thinking to be selective in the methods they choose to use.

Counting on-jotting for mental calculation .

- We will start with counting on as our method for subtraction for the less able in Year 3. Children tend to find it much easier to add than subtract when dealing with bigger numbers, and is a useful mental strategy.
- The addition / subtraction relationship is reinforced.
- Pupils use number lines to 'count on' from the smaller to the larger number to find the difference between the two.
- Again, children are encouraged to bridge through multiples of 10.

E.g.

$84 - 56 = 28$



Jottings are used efficiently to support the mental calculation.
As children become more proficient they can add on 20 in one jump.

- Don't use this method if numbers are very far apart, eg 62-8. Encourage children to count back (this can be done in 1's, or as minus 10, add 2).

Counting on will continue to be used in later years as it is an excellent method to use for problems, especially those involving time and finding change.

Partitioning

Subtraction can be recorded using partitioning to write equivalent calculations that can be carried out mentally.

e.g 74 – 27 = 74 – 20 – 7 = 47 150 -25 = 150 – 20 – 5 =125

This requires children to subtract a single digit number or a multiple of ten from a 2-digit number. Some children may need a number line to bridge across tens, some may progress to subtracting from 3 digit numbers.

SUBTRACTION
Year 4

'The Minus Method'

- Negative numbers are used from Y4, so the 'Minus Method' can be introduced.
- Much work needs to be done making calculations involving positive and negative numbers using a number line. Children need to know which calculations will result in a negative answer.
- Both numbers are partitioned, as in the method used for addition.
- The vocabulary of 'negative numbers' should be used. If we also use the vocabulary 'minus numbers' this will aid final stages of the calculation.
- Develop using an expanded vertical method. Start with 2 digit numbers. Many children should be able to progress to using 3 digit numbers by the end of Year 4.
- Emphasise the importance of taking the bottom number from the top and not "switching"

E.g.

436		
255		
200	**(400-200)**	
- 20	**(30-50)**	
+ 1	**(6-5)**	
181	**(200-20+1)**	

NB: The final step of this calculation should be done mentally, top down. Encourage the children to verbalise as they complete the final calculation in stages, eg "100 minus 20 is 80, add 1 equals 81." **It is essential that + or – is recorded at each stage** to ensure that errors are not made during the final calculation.

772		
– 356		
400	(700–300)	
+ 20	(70–50)	
420		
– 4	(2–6)	
416		

If children struggle with the final step They could try recording the calculation this way.

SUBTRACTION

Year 5-6

Work continues using the 'minus method, including decimals in Year 6.

34.25m - 17.82m

34.25
- 17.82
20.00 (30 - 10)
- 3.00 (4 - 7)
- 0.60 (0.2 - 0.8)
+ 0.03 (0.05 - 0.02)
16.43m

As soon as pupils are confident in the use of decomposition in the extended form, the contracted method will be taught.

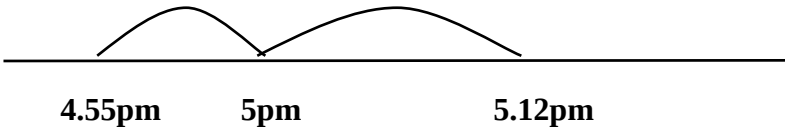
```
  5 1
  7/6 4
- 3 2 9
  ------
  4 3 5
```

Counting on – revisited!

- Counting on should still be used in Years 4-6. Use of an empty number line is an excellent strategy to support thinking during problem solving activities, especially those involving time and finding change.. This should support and lead to children calculating mentally.

EG

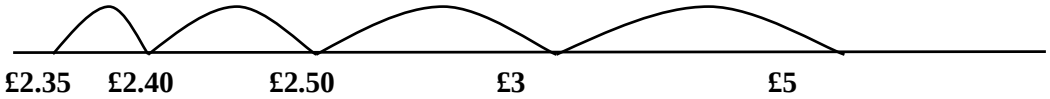
I watched a cartoon that started at 4.55 pm and finished at 5.12pm. How long did it last?



5 + 12 = 17 mins

I had £5 and bought a book for £2.35. How much change would I get?

+5p **+10p** **+50p** **+£2** **£2+ 50p + 10p + 5p = £2.65**



As children become more numerate they will need to make fewer jumps, with the aim of doing such calculations mentally.

Decomposition

- Decomposition will be taught as a method of subtraction only to children who are able to cope with the more abstract nature of this method.
- Children need to be able to demonstrate a full understanding of the process and the place value involved.
- When teaching this method it is helpful to use an expanded method in the early stages of teaching, which then becomes more compact.

50 + 2 **is the** **40 + 12**
- 20 + 7 **same as** **- 20 + 7**
20 + 5

40 12
5 ~~0~~ + ~~2~~
- 20 + 7
20 +5

4 12
~~5~~ ~~2~~
2 7
2 5

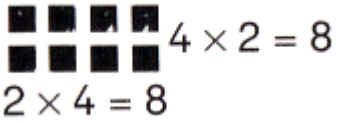
MULTIPLICATION
Year 3

- Multiplication is introduced as repeated addition in Key Stage 1
- The Renewed Framework suggests that children in Year 3 should be able to derive and recall multiplication facts for the **2, 3, 4 5, 6 and 10 times tables** and corresponding division facts.
- The relationship between multiplication and division is stressed.
- Less able children can support mental calculations pictorially.

Children should verbalise calculations: 3 x 2 means 3 groups of 2 or 3 lots of 2.

Show symbolically:

- Work is done on arrays to teach that multiplication can be done in any order.
- This is an excellent and vital strategy that supports children's ability to visualise times tables.



Division questions should be posed frequently when learning tables!

- Introduce the **grid method** of multiplication for **TU x U**
- Partition into tens and units (more able will have been introduced to this in Year 2).

Eg 23 x 5

x	20	3
5	100	15

100 + 15 = 115

MULTIPLICATION

Year 4

Reinforce work from Year 3

- The renewed framework suggests that children in year 4 should be able to derive and recall multiplication facts up to **10 x 10** and corresponding division facts.
- Consolidate use of the **grid method** of multiplication for **TU x U** (HTU x U and TU x TU for more able).

MULTIPLICATION

Years 5 - 6

- Continue with partitioning and recall quickly multiplication facts up to 10 x 10 and corresponding division facts.
- The grid method extends to HTU x U and TU x TU in Year 5

72 x 38 is approximately 70 x 40 = 2800

72 x 38 = 2736

x	70	2
30	2100	60
8	560	16

2660 + 76 = 2736

- Use this method with decimals: U x one decimal point
- Extend to ThHTU x U and HTU x TU in Year 6

4346 × 8 is approximately 4500 × 10 = 45000.

4346 × 8

×	4000	300	40	6
8	32000	2400	320	48

= 34768

372 × 24 is approximately 400 × 20 = 8000.

372 × 24

×	300	70	2	
20	6000	1400	40	7440
4	1200	280	8	+ 1488
				8928

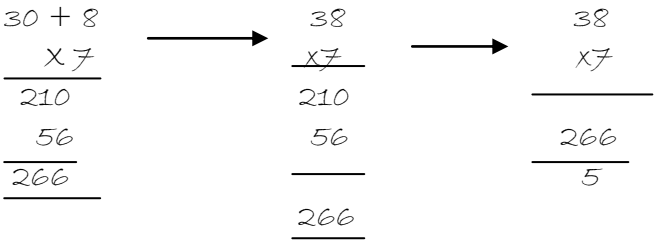
7200 + 1680 + 48 = 8928

Use vertical addition, with horizontal addition as a check.

- ...and with decimals:
  Multiplication by two decimal points

By the end of year 4, those children who are on target to achieve level 4 at the end of KS2 should be using the grid method. Those predicted a higher attainment (high Level 4/ Level 5) should start to use the expanded short multiplication method for 2 digit x 1 digit numbers..

e.g. 38 x 7



By the end of year 5 those pupils predicted a level 4B and above at the end of key stage 2 should be using the following method:

56 x 27 (estimate 60 x 30)

56 x 27
1000 (50 x 20)
120 (6 x 20)
350 (50 x 7)
42(6x7)

1512

When secure in this method, pupils can move on to the same method for HTU x TU

56
X 27
---
42 (6 x 7)
350 (50 x 7)
120 (6 x 20)
1000 (50 x 20)

1512

And finally: 56
X 27
1120 (56 x 20)
392 (56 x 7)
1512

DIVISION

Year 3

- Division is the inverse of multiplication and is taught as equal sharing and as grouping.
- The use of sharing or grouping is determined by the context of the problem set, but children need to understand that using either method will achieve the correct answer.
- Some children will still use pictorial jottings or apparatus.

Sharing

E.g. 15 sweets are shared equally between 5 children. How many sweets does each child get?

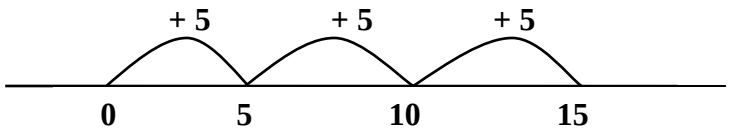
- Children should be familiar with equal sharing. They may draw pictures/ symbols to support their thinking.

Grouping / Repeated addition

E.g. There are 15 apples in a box. ***How many bags can be filled if each bag has 5 apples?***

- Encourage counting on in groups, using fingers
- **Empty number lines** can be used to demonstrate jumps, although it is important to stress that these calculations should be done mentally.

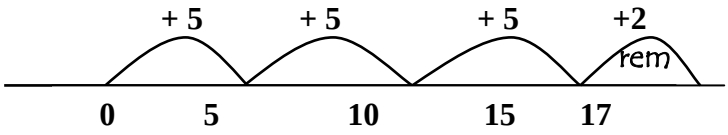
Eg 15 ÷ 5 = 3



Encourage the children to verbalise this calculation. How many groups of 5 can we make from 15? How many times can we add 5 until we reach 15?

- Work also begins on remainders.

Eg 17 ÷ 5 = 3 rem 2



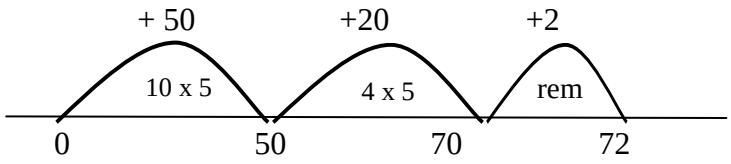
DIVISION

Year 4

Repeated addition - Chunking

- Revise method started in Year 3 of adding on groups of the divisor using a number line
- Introduce **'chunking'** , whereby multiples of the divisor are added to divide larger numbers more efficiently- encourage children to find the largest possible multiples that they know to subtract in order to reduce the number of steps, and thus make the most efficient calculation.
- Use a **'Bank'** to help record the multiples of the divisor as they are added.
- Encourage children to add 10 lots of the divisor as the initial step.

Eg



Introduce vertical recording:

72 ÷ 5 = 14 rem 2

		Bank
0		10
+ 50	(10 x 5)	4
50		14
+ 20	(4 x 5)	
70		
+ 2	rem.	
72		

It is not necessary to record the bracketed part of this calculation as well as the 'Bank', although some children find it helpful during the early stages of teaching.

NB: 'Repeated subtraction' is often taught as a method for dividing. This is very similar, but multiples of the divisor are subtracted from the number being divided, rather being added up. As a school, we have decided to adopt repeated addition as our method of division. Children are generally far more confident in adding and tend to make fewer errors than when subtracting. This method is also easier to use when dividing numbers when a remainder is involved.

DIVISION
Year 5 - 6

Vertical recording of repeated addition is extended further using approximation/estimation.

Eg **196 ÷ 6** is approximately 200 ÷ 5 = 40

120	**(20 x 6)**
+ 60	**(10 x 6)**
180	
+ 60	**(10 x 6)**
180	
+ 12	**(2 x 6)**
192	
+ 4	**rem.**
196	

Bank
20
10
2
32

NB: As children become more proficient they should be able to add e.g.180, (ie 30 x 6) in one step.

180	**(30 x 6)**
+ 12	**(2 x 6)**
192	
+ 4	**rem.**
196	

196 ÷ 6 = 32 rem 4

Children will move away from banking as they become more confident.

Getting even harder in Year 6:

977 ÷ 36 is approximately 1000 ÷ 40 = 25

360	**(10 x 36)**
+ 360	**(10 x 36)**
720	
+ 180	**(5 x 36)**
900	
+ 72	**(2 x 36)**
972	
+ 5	**rem.**
977	

Bank
10
10
5
2
27

977 ÷ 36 = 27 rem 5 = $27\ ^{5}/_{36}$

Compact Division

Compact or short division involves Level 5 skills and a very secure understanding of place value. As such this method will only be taught to the more able pupils In Year 5 or 6. Children must be able to explain each stage of the calculation:

$$
\begin{array}{r}
9387 \\
\hline
6\,\big)\,5^{5}6^{2}3^{5}2^{4}2 \\
\;\;\cancel{6}\;\;56398
\end{array}
$$

A longer version of this may support children working towards the most compact form of this calculation:

$$
\begin{array}{r}
9387 \\
\hline
6\,\big)\,56322 \\
-\,\underline{54}\;\downarrow \\
\;\;23\;\;\downarrow \\
-\,\underline{18}\;\downarrow \\
\;\;52\;\;\downarrow \\
-\,\underline{48}\;\downarrow \\
\;\;42
\end{array}
$$

SUMMARY

Addition

- To be done by partitioning.
- Initially partition only the second number, leading to partitioning of both.
- Calculations to be supported by number lines and jottings.
- Introduce vertical recording in Year 4 (Expanded method)
- Carrying to be introduced in Yr 5/6 for the majority of pupils.

Subtraction

- Initially to be done by counting on (Complimentary addition)
- Use jottings in the form of number lines to support thinking.
- Move to partitioning both numbers in Yr 4, introducing the minus method.
- Develop use of minus method involving larger numbers, recording vertically.
- Decomposition to be introduced to the more able children in Years 5/6.
- SEN children may benefit from only using number lines to count up.

Multiplication

- To be introduced as repeated addition.
- Multiplication to be represented as pictures, symbols and words for less able children.
- Use arrays to show that multiplication can be done in any order
- Begin to multiply larger numbers by partitioning. Use informal jottings to support thinking.
- Introduce grid method from Yr 4.
- Use expanded short multiplication , leading to short multiplication for the \able children in years 5 and 6.

Division

- To be done as both sharing and grouping using pictorial/ symbolic representations and jottings for less able children.
- Extend to repeated addition using number lines and then develop the use of 'chunking' and vertical recording in Year 4.
- Use a 'Bank' to record multiples of the divisor
- Compact division to be taught only to the more able in Years 5/6