Ridgeway Primary School

Written Calculation Policy

May 2021

The National Curriculum 2014 outlines that:

"Mathematics is a creative and highly interconnected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary for financial literacy and most forms of employment. A high-quality mathematics education therefore provides a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics, and a sense of enjoyment and curiosity about the subject."

At Ridgeway we value all areas of Mathematics, particularly the opportunity to develop problem solving skills and the ability for children to apply their knowledge in a variety of ways. In order to do this most effectively, it is important that children develop the calculation strategies necessary to be efficient and confident. In line with this, one of the national curriculum aims is that all pupils:

- become fluent in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately

The expectation is that:

"The majority of pupils will move through the programmes of study at broadly the same pace. However, decisions about when to progress should always be based on the security of pupils' understanding and their readiness to progress to the next stage. Pupils who grasp concepts rapidly should be challenged through being offered rich and sophisticated problems before any acceleration through new content. Those who are not sufficiently fluent with earlier material should consolidate their understanding, including through additional practice, before moving on."

Progression Through The Key Stages

Key Stage 1

The principal focus of mathematics teaching in key stage 1 is to ensure that pupils develop confidence and mental fluency with whole numbers, counting and place value. This should involve working with numerals, words and the 4 operations, including with practical resources [for example, concrete objects and measuring tools].

By the end of year 2, pupils should know the number bonds to 20 and be precise in using and understanding place value. An emphasis on practice at this early stage will aid fluency.

Lower Key Stage 2 (Years 3 and 4)

The principal focus of mathematics teaching in lower key stage 2 is to ensure that pupils become increasingly fluent with whole numbers and the 4 operations, including number facts and the concept of place value. This should ensure that pupils develop efficient written and mental methods and perform calculations accurately with increasingly large whole numbers.

At this stage, pupils should develop their ability to solve a range of problems, including with simple fractions and decimal place value.

By the end of year 4, pupils should have memorised their multiplication tables up to and including the 12 multiplication table and show precision and fluency in their work.

Upper Key Stage 2 (Years 5 and 6)

The principal focus of mathematics teaching in upper key stage 2 is to ensure that pupils extend their understanding of the number system and place value to include larger integers. This should develop the connections that pupils make between multiplication and division with fractions, decimals, percentages and ratio.

At this stage, pupils should develop their ability to solve a wider range of problems, including increasingly complex properties of numbers and arithmetic, and problems demanding efficient written and mental methods of calculation. With this foundation in arithmetic, pupils are introduced to the language of algebra as a means for solving a variety of problems.

By the end of year 6, pupils should be fluent in written methods for all 4 operations, including long multiplication and division, and in working with fractions, decimals and percentages.

Progression in Mental and Written Calculations (National Curriculum Expectations)

Addition and Subtraction:

Year 1	Year 2	Year 3

• read, write and interpret mathematical statements involving addition (+), subtraction (−) and equals (=) signs
• represent and use number bonds and related subtraction facts within 20
• add and subtract one-digit and two-digit numbers to 20, including 0
• solve one-step problems that involve addition and subtraction, using concrete objects and pictorial representations, and missing number problems such as 7 = ? – 9
	• solve problems with addition and subtraction:
	  ○ using concrete objects and pictorial representations, including those involving numbers, quantities and measures
	  ○ applying their increasing knowledge of mental and written methods
	• recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100
	• add and subtract numbers using concrete objects, pictorial representations, and mentally, including:
	  ○ a two-digit number and 1s
	  ○ a two-digit number and 10s
	  ○ 2 two-digit numbers
	  ○ adding 3 one-digit numbers
	• show that addition of 2 numbers can be done in any order (commutative) and subtraction of 1 number from another cannot
	• recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems
	
	(See appendix for Year 2 Framework which should be used alongside the National Curriculum)
		• add and subtract numbers mentally, including:
		  ○ a three-digit number and 1s
		  ○ a three-digit number and 10s
		  ○ a three-digit number and 100s
		• add and subtract numbers with up to 3 digits, using formal written methods of columnar addition and subtraction
		• estimate the answer to a calculation and use inverse operations to check answers
		• solve problems, including missing number problems, using number facts, place value, and more complex addition and subtraction

Year 4	Year 5	Year 6
• add and subtract numbers with up to 4 digits using the formal written methods of columnar addition and subtraction where appropriate • estimate and use inverse operations to check answers to a calculation • solve addition and subtraction two-step problems in contexts, deciding which operations and methods to use and why	• add and subtract whole numbers with more than 4 digits, including using formal written methods (columnar addition and subtraction) • add and subtract numbers mentally with increasingly large numbers • use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy • solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why	• perform mental calculations, including with mixed operations and large numbers • use their knowledge of the order of operations to carry out calculations involving the 4 operations • solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why • solve problems involving addition, subtraction, multiplication and division • use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy

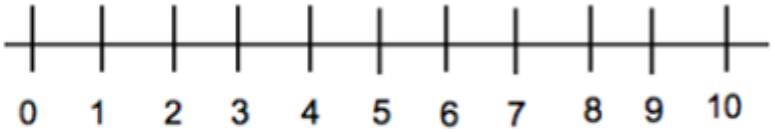
Multiplication and Division:

Year 1	Year 2	Year 3
• solve one-step problems involving multiplication and division, by calculating the answer using concrete objects, pictorial representations and arrays with the support of the teacher	• recall and use multiplication and division facts for the 2, 5 and 10 multiplication tables, including recognising odd and even numbers • calculate mathematical statements for multiplication and division within the multiplication tables and write them using the multiplication (×), division (÷) and equals (=) signs • show that multiplication of 2 numbers can be done in any order (commutative) and division of 1 number by another cannot • solve problems involving multiplication and division, using materials, arrays, repeated addition, mental methods, and multiplication and division facts, including problems in contexts	• recall and use multiplication and division facts for the 3, 4 and 8 multiplication tables • write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods • solve problems, including missing number problems, involving multiplication and division, including positive integer scaling problems and correspondence problems in which n objects are connected to m objects

Year 4	Year 5	Year 6
• recall multiplication and division facts for multiplication tables up to 12 × 12 • use place value, known and derived facts to multiply and divide mentally, including: multiplying by 0 and 1; dividing by 1; multiplying together 3 numbers • recognise and use factor pairs and commutativity in mental calculations • multiply two-digit and three-digit numbers by a one-digit number using formal written layout • solve problems involving multiplying and adding, including using the distributive law to multiply two-digit numbers by 1 digit, integer scaling problems and harder correspondence problems such as n objects are connected to m objects	• identify multiples and factors, including finding all factor pairs of a number, and common factors of 2 numbers • know and use the vocabulary of prime numbers, prime factors and composite (non-prime) numbers • establish whether a number up to 100 is prime and recall prime numbers up to 19 • multiply numbers up to 4 digits by a one- or two-digit number using a formal written method, including long multiplication for two-digit numbers • multiply and divide numbers mentally, drawing upon known facts • divide numbers up to 4 digits by a one-digit number using the formal written method of short division and interpret remainders appropriately for the context • multiply and divide whole numbers and those involving decimals by 10, 100 and 1,000 • recognise and use square numbers and cube numbers, and the notation for squared (^{2}) and cubed (^{3}) • solve problems involving multiplication and division, including using their knowledge of factors and multiples, squares and cubes • solve problems involving addition, subtraction, multiplication and division and a combination of these, including understanding the meaning of the equals sign • solve problems involving multiplication and division, including scaling by simple fractions	• perform mental calculations, including with mixed operations and large numbers • use their knowledge of the order of operations to carry out calculations involving the 4 operations • solve problems involving addition, subtraction, multiplication and division • use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy • multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication • divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division, and interpret remainders as whole number remainders, fractions, or by rounding, as appropriate for the context • divide numbers up to 4 digits by a two-digit number using the formal written method of short division where appropriate, interpreting remainders according to the context • identify common factors, common multiples and prime numbers

	and problems involving simple rates	

Progression of Number Lines:

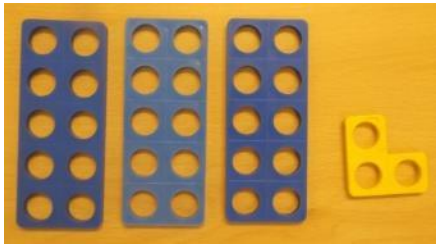
EYFS	Number Track	Has the numbers inside the sections, rather than on the divisions	
Moving towards end of Year 1 expectation	Scaled, Numbered Number Line	Equal divisions marked on the numberline and each division is numbered.	
Year 1 - National age related expectation	Unnumbered numberline	Equal divisions are marked, but left unnumbered for children to add relevant numbers.	
Year 2 - National age related expectation	Blank Numberline	No divisions or numbers marked for the children.	

Use of Practical Apparatus

It is very important to use practical apparatus at all ages and stages of children's development. Although the Foundation Stage and Key Stage One rely on this more closely, they also benefit the teaching and exploration of certain concepts in Key Stage Two. It can be motivating and more relevant for children to learn in this way, and should not be seen as immature or unnecessary, even with the most able children. Below are some examples of equipment we use in school and the ways it can be used to support children's learning:

Numicon:

- Used to represent number bonds
- Used to represent numbers
- Used to create number sentences
- Used to introduce the idea of place value with 2-digit numbers (image below shows 33)

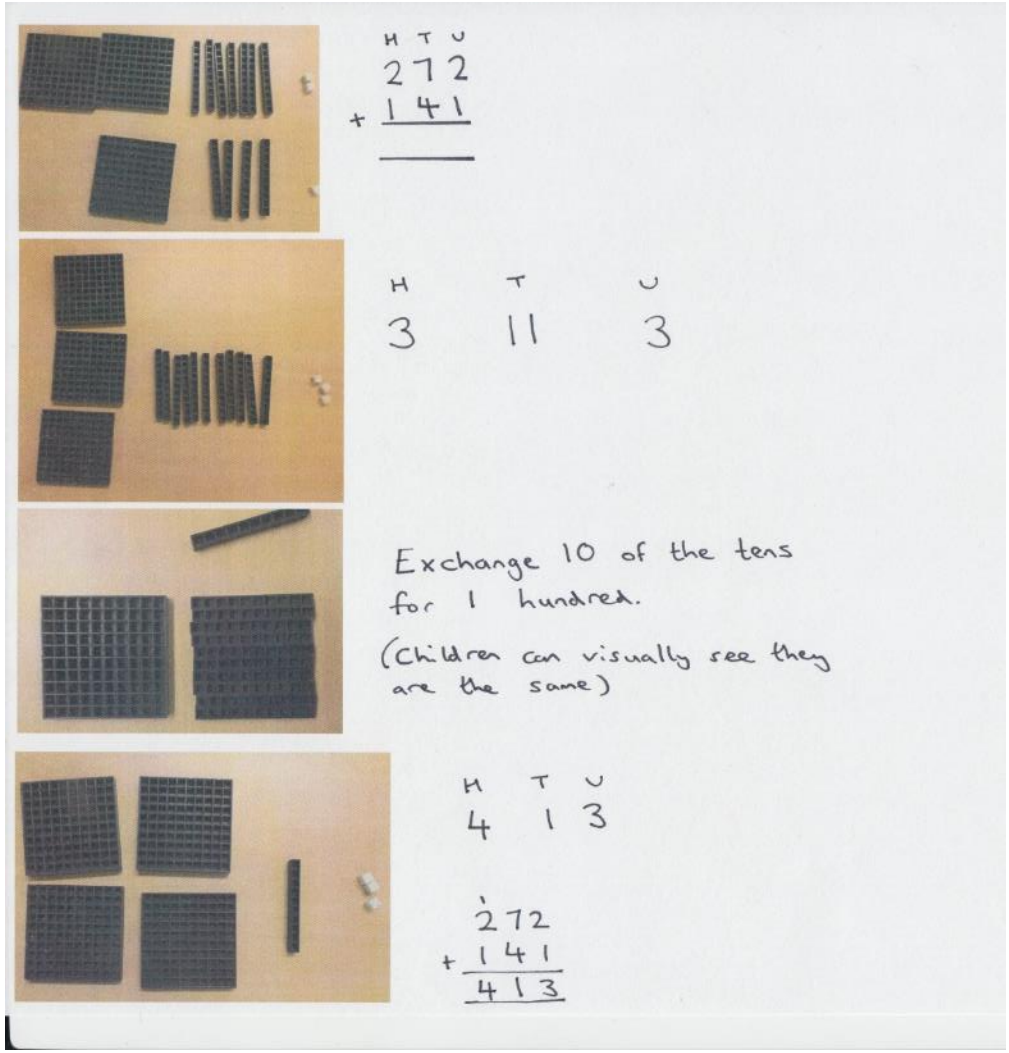


9-Sided Dice:

- Used to play maths games to recognise numbers and count accurately the number of moves
- Used to generate numbers randomly to ensure children are using all digits 0-9 when calculating.

Base 10

- Used to demonstrate number size
- Used to demonstrate the difference in a digit when it is in different place value column
- Used to demonstrate column methods of calculation (see below for example of how this is used)
- Used to show the relationship between whole numbers and decimals



Double Sided Counters

- Used with younger children to help represent numbers
- Used to help children group/share numbers when dividing
- Helps to demonstrate arrays
- Helps to demonstrate times tables and multiples
- Used with older children to explain algebra. E.g. **R + R + R = 9** "What number could the red counter represents?"

Enriching and Extending More Able Children

Children should **not** be extended by increasing the size of numbers used in calculations. For example, a child in year 3 would not be challenged to add 4-digit numbers as this in itself does not provide enrichment.

Children could be asked to check their answers using their estimation skills or calculating the inverse, as is shown below:

345 + 569 = 914 "I know 350 + 550 = 900. 345 is a bit below 350 but 569 is 19 above so I would expect my answer to be just above 900."

345 + 569 = 914 "I know that subtraction is the inverse of addition so I will work out 914 - 569 and if the answer is 345 then I am correct."

Children may be presented calculations in more unusual ways, for example empty box problems or in reverse. For example:

4 + ☐ *= 10*

12 - ☐ *= 9*

15 = ☐ *- 6*

Children should be presented with open ended problems in which they can really demonstrate their understanding and self-extend:

☐ + ☐ *= 100*

☐ + ☐ = ☐ - ☐

"What do you know about the number 16?" (This could include calculation from all 4 operation, odd/even, more than/less than, personal connections to the number, visual representations, connections to measure/shapes)

Through linking calculation based learning to problem solving (word problems, visual problems, logic, finding all possibilities) children are given lots of opportunities to consolidate, practise and extend their learning.

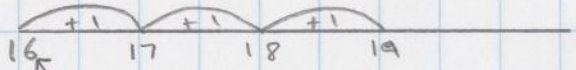
Children are encouraged to explain and reason their mathematical learning through the use of thought bubbles in their maths books in Key Stage Two, and verbally in Key Stage One (with written examples where appropriate). This takes the form of 'light bulb' moments/discoveries, making connections, suggesting extensions and explaining strategies.

Strategies for Addition:

Addition

Blank Number Line (with increasing efficiency):

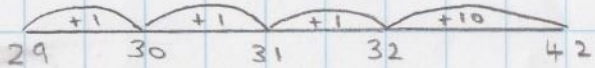
3 + 16 = 19 (Year 2)



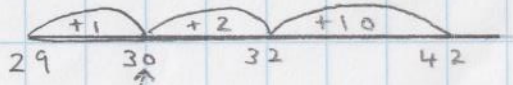
start at the bigger number

13 + 29 = 42 (Year 2)

13 + 29 = 42 (Year 2)



13 + 29 = (Year 2)



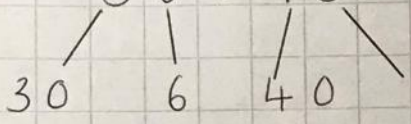
jump to the nearest 'friendly number' (multiple of 10)

Addition

Partitioning

(Year 2 and Year 3)

36 + 43 = 79



30 + 40 = 70

6 + 3 = 9

70 + 9 = 79

- Partition the tens
- Partition the units
- Add the tens together
- Add the units together
- Add the two answers together

Column Method:

(Year 3)

$$\begin{array}{r} {\scriptstyle 1\ 1\ \ } \\ 329 \\ +\ 483 \\ \hline 812 \end{array}$$

(Year 4)

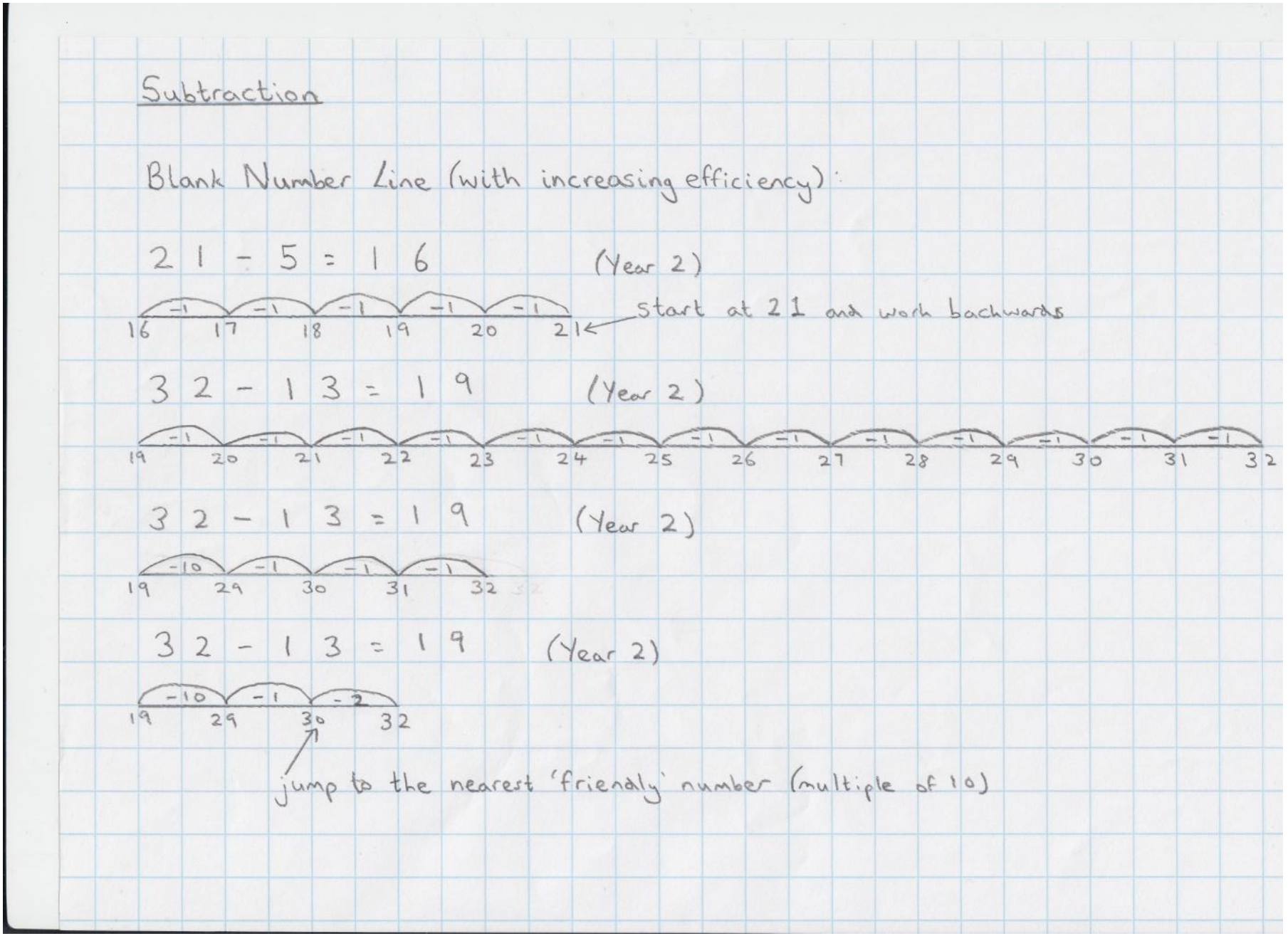
$$\begin{array}{r} {\scriptstyle \ 1\ 1\ \ } \\ 7129 \\ +\ 3384 \\ \hline 10513 \end{array}$$

(Year 5)

$$\begin{array}{r} {\scriptstyle \ 1\ 1\ \ } \\ 32493 \\ +\ 56586 \\ \hline 89079 \end{array}$$

(always start with the units)

Strategies for Subtraction:



Column Method:

$$\begin{array}{r} 5\,{}^{8}\!\not{9}\,{}^{14}4 \\ -\;3\;6\;6 \\ \hline 2\;2\;8 \end{array}$$ (Year 3)

$$\begin{array}{r} {}^{1}\!\not{2}\,{}^{16}\!\not{7}\,{}^{10}4 \\ -\;1\;9\;6\;2 \\ \hline 7\;4\;2 \end{array}$$ (Year 4)

$$\begin{array}{r} {}^{2}\!\not{5}\,{}^{16}\!\not{4}\,{}^{3}\!\not{9}\,{}^{18}\!\not{2} \\ -\;1\;8\;3\;9\;6 \\ \hline 1\;8\;0\;9\;6 \end{array}$$ (Year 5)

(always start with the units)

Year 3

Learning objective from National Curriculum:

- *Write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods.*

Strategies of Multiplication:

Example 1:

The Grid Method

22 x 4 = ?

	H T U
X	4
2 0	8 0
2	8
	8 8

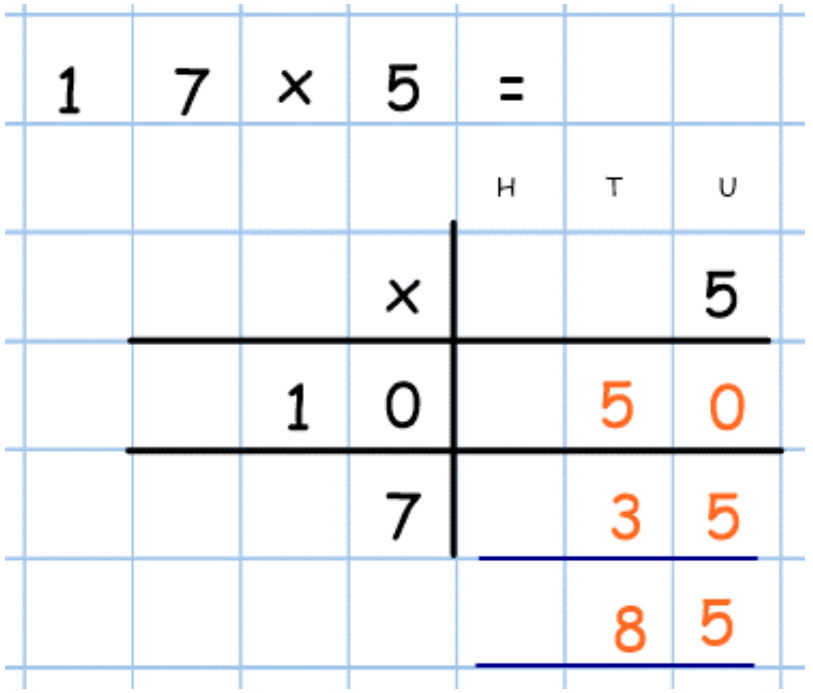
20 x 4 = 80

2 x 4 = 8

80 + 8 = 88

22 x 4 = 88

Example 2:



In year 4 the children then progress onto two digit and three digit numbers.

Learning objective from National Curriculum:

- *Multiply two-digit and three-digit numbers by a one-digit number using formal written layout.*

The Grid Method

32 x 44 = ?

	Th H T U	Th H T U
X	4 0	4
3 0	1 2 0 0	1 2 0
2	8 0	8
	1 2 8 0	1 2 8

Th	H	T	U
1	2	8	0
	1	2	8
1	4	0	8

30 x 40 = 1200

2 x 40 = 80

30 x 4 = 120

2 x 4 = 8

1280 + 128 = 1408 so 32 x 44 = 1408

Year 5 and 6

Expanded and compact strategies are learnt in years 5 and 6.

Multiplication

25 x 32

Expanded

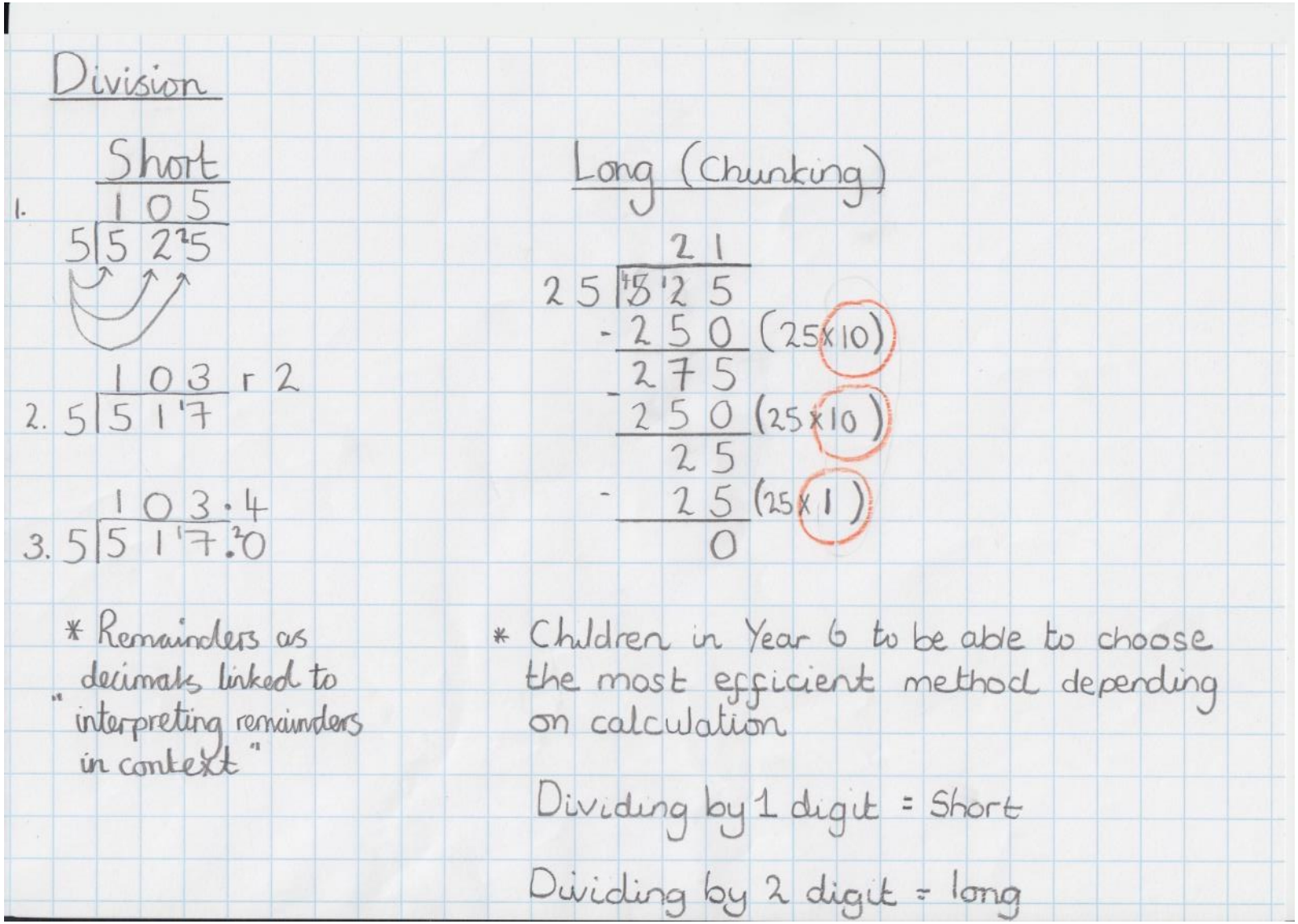
```
  25
x 32
  10 (2x5)
  40 (2x20)
 150 (30x5)
 600 (30x20)
 800
```

Compact

```
  25
x 32
  50
 750
 800
```

* Before moving from Grid to Expanded, ensure children are secure in partitioning number and multiplying by 10 and 100.

Strategies for Division:



Appendix

Year 2 Framework

Working towards the expected standard

The pupil can:

- read and write numbers in numerals up to 100
- partition a two-digit number into tens and ones to demonstrate an understanding of place value, though they may use structured resources[1] to support them
- add and subtract two-digit numbers and ones, and two-digit numbers and tens, where no regrouping is required, explaining their method verbally, in pictures or using apparatus (e.g. 23 + 5; 46 + 20; 16 – 5; 88 – 30)
- recall at least four of the six[2] number bonds for 10 and reason about associated facts (e.g. 6 + 4 = 10 , therefore 4 + 6 = 10 and 10 – 6 = 4)
- count in twos, fives and tens from 0 and use this to solve problems
- know the value of different coins
- name some common 2-D and 3-D shapes from a group of shapes or from pictures of the shapes and describe some of their properties (e.g. triangles, rectangles, squares, circles, cuboids, cubes, pyramids and spheres).

Working at the expected standard

The pupil can:

- read scales* in divisions of ones, twos, fives and tens
- partition any two-digit number into different combinations of tens and ones, explaining their thinking verbally, in pictures or using apparatus
- add and subtract any 2 two-digit numbers using an efficient strategy, explaining their method verbally, in pictures or using apparatus (e.g. 48 + 35; 72 – 17)
- recall all number bonds to and within 10 and use these to reason with and calculate bonds to and within 20, recognising other associated additive relationships (e.g. If 7 + 3 = 10, then 17 + 3 = 20; if 7 – 3 = 4, then 17 – 3 = 14; leading to if 14 + 3 = 17, then 3 + 14 = 17, 17 – 14 = 3 and 17 – 3 = 14)
- recall multiplication and division facts for 2, 5 and 10 and use them to solve simple problems, demonstrating an understanding of commutativity as necessary
- identify $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{2}{4}$, $\frac{3}{4}$ of a number or shape, and know that all parts must be equal parts of the whole
- use different coins to make the same amount
- read the time on a clock to the nearest 15 minutes
- name and describe properties of 2-D and 3-D shapes, including number of sides, vertices, edges, faces and lines of symmetry.

[1] For example, base 10 apparatus.

[2] Key number bonds to 10 are: 0+10, 1 + 9, 2 + 8, 3 + 7, 4 + 6, 5 + 5.

* The scale can be in the form of a number line or a practical measuring situation.

Working at greater depth

The pupil can:

- read scales* where not all numbers on the scale are given and estimate points in between
- recall and use multiplication and division facts for 2, 5 and 10 and make deductions outside known multiplication facts
- use reasoning about numbers and relationships to solve more complex problems and explain their thinking (e.g. 29 + 17 = 15 + 4 + □; 'together Jack and Sam have £14. Jack has £2 more than Sam. How much money does Sam have?' etc.)
- solve unfamiliar word problems that involve more than one step (e.g. 'which has the most biscuits, 4 packets of biscuits with 5 in each packet or 3 packets of biscuits with 10 in each packet?')
- read the time on a clock to the nearest 5 minutes
- describe similarities and differences of 2-D and 3-D shapes, using their properties (e.g. that two different 2-D shapes both have only one line of symmetry; that a cube and a cuboid have the same number of edges, faces and vertices, but different dimensions).

* The scale can be in the form of a number line or a practical measuring situation.