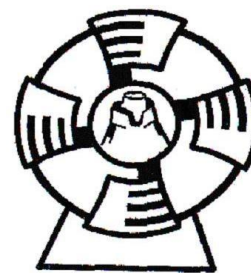# *Windmill Hill Academy*

Upper KS2 Calculation Policy for Addition, Subtraction, Multiplication and Division

Updated for September 2014

Calculations Policy for Mathematics

The following calculations policy has been devised to meet the requirements of the National Curriculum 2014 for the teaching and learning of mathematics, and also to give pupils a consistent and smooth progression of learning in calculation across the school. Please note that early learning in number and calculation in YF follows the 'Development Matters EYFS document and this calculation policy is designed to build on progression from the content and methods established in the Early Years Foundation Stage.
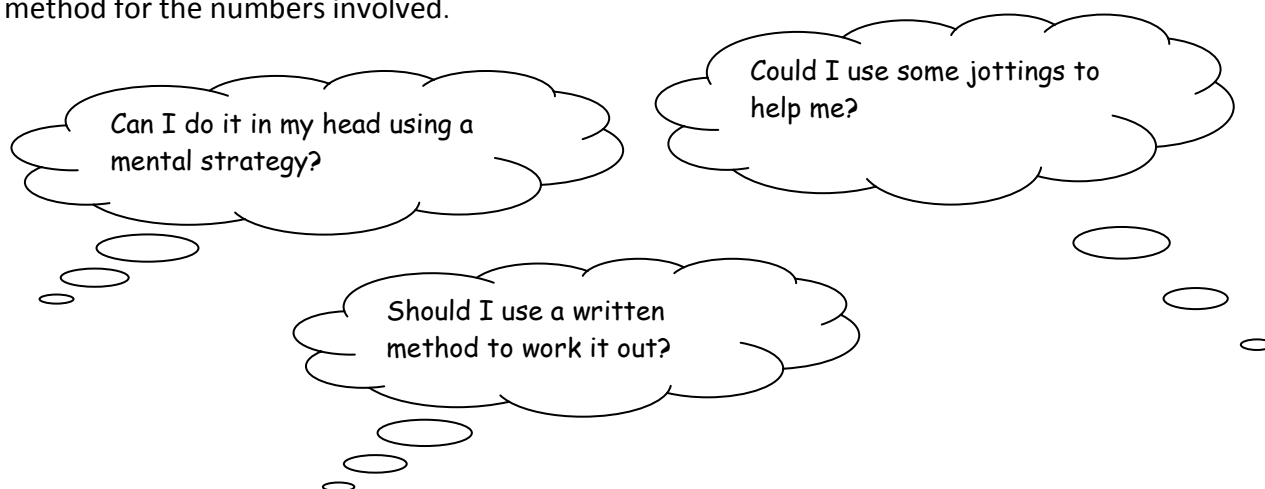
Age stage expectations

The calculation policy is organised according to age stage expectations as set out in the National Curriculum 2014, however it is vital that pupils are taught according to the stage that they are currently working at, working at a lower stage until they are secure enough to move on. Children must consolidate their learning with mathematical challenges in various contexts before moving on to the next stage.

Providing a context for calculation

It is important that any calculation is given a real life context or problem solving approach to help build children's understanding of the purpose of calculation, and to help them recognise when to use certain operations and methods when faced with problems. This must be a priority within calculation lessons.

Choosing a method:

Children need to be taught and encouraged to use the following processes in deciding what approach they will take at solving a calculation, to ensure they select the most appropriate method for the numbers involved.

Can I do it in my head using a mental strategy?

Could I use some jottings to help me?

Should I use a written method to work it out?

To work out a tricky calculation	Approximate	Calculate	Check it!

Overview of Upper KS2

Children move on from dealing mainly with whole numbers to performing arithmetic operations with both decimals and fractions. They will consolidate their use of written procedures in adding and subtracting whole numbers with up to 6 digits and also decimal numbers with up to two decimal places. Mental strategies for adding and subtracting increasingly large numbers will also be taught. These will draw upon children's robust understanding of place value and knowledge of number facts. Efficient and flexible strategies for mental multiplication and division are taught and practised, so that children can perform appropriate calculations even when the numbers are large, such as 40,000 x 6 or 40,000 ÷ 8. In addition, it is in Y5 and Y6 that children extend their knowledge and confidence in using written algorithms for multiplication and division. Fractions and decimals are also added, subtracted, divided and multiplied, within the bounds of children's understanding of these more complicated numbers, and they will also calculate simple percentages and ratios. Negative numbers will be added and subtracted.

✚ Addition ✚

Children should not be made to go onto the next stage if:

1) they are not ready.

2) they are not confident.

- ✓ Children should be taught through real life experiences and word problems.
- ✓ Children should be encouraged to consider if a mental calculation would be appropriate before using written methods.
- ✓ Children should be encouraged to approximate their answers before calculating.
- ✓ Children should be encouraged to check their answers after calculation using an appropriate strategy.

Year 5 ✚

Key vocabulary: add, more, plus, and, make, altogether, total, equal to, equals, double, most, count on, number line, sum, tens, units, partition, plus, addition, column, tens boundary, hundreds boundary, increase, „carry", expanded, compact, vertical, thousands, hundreds, digits, inverse & **decimal places, decimal point, tenths, hundredths, thousandths**

Key skills for addition at Y5:

- ➢ Add numbers mentally with increasingly large numbers, using and practising a range of mental strategies ie. add the nearest multiple of 10, 100, 100 and adjust; use near doubles, inverse, partitioning and re-combining; using number bonds.
- ➢ Use rounding to check answers and accuracy.
- ➢ Solve multi-step problems in contexts, deciding which operations and methods to use and why.
- ➢ Read, write, order and compare numbers to at least 1 million and determine the value of each digit.
- ➢ Round any number up to 1 000 000 to the nearest 10, 100, 1000, 10 000 and 100 000.
- ➢ Use column addition to add two or three whole numbers with up to 5 digits
- ➢ Use column addition to add any pair of two-place decimal numbers including amounts of money.
- ➢ Begin to add related fractions using equivalences. (E.g. $\frac{1}{2} + \frac{1}{6} = \frac{3}{6} + \frac{1}{6}$)
- ➢ Choose the most efficient method in any given situation

Informal
Pupils will continue to use pencil and paper methods, e.g. number lines, to support, record or explain calculations when necessary.

Formal
Add numbers with more than 4-digits, including money, measures and decimals with different numbers of decimal places.

e.g. £23.59 + 7.55 = £31.14

Carry above the line

£	2	3	.	5	9
		7	.	5	5
±	1	1	.	1	
£	3	1	.	1	4

The decimal point should be aligned in the same way as other place value columns, and must be in the same column in the answer

	2	3	4	8	1	
		1	3	6	2	
	±		1			
	2	4	8	4	3	

Numbers should exceed 4-digits

1	9	.	0	1		
	3	.	6	5		
±	0	.	7	*0*		
1	1					
2	3		3	6		

They should add more than two values, carefully aligning place value

Say '6 tenths and 7 tenths to reinforce place value'.

Empty decimal places can be filled with a zero to show the place value in each column

Children should understand the place value of tenths and hundreds and use this to align numbers with different numbers of decimal places.

Year 6 ✚

Key vocabulary: add, more, plus, and, make, altogether, total, equal to, equals, double, most, count on, number line, sum, tens, units, partition, plus, addition, column, tens boundary, hundreds boundary, increase, „carry", expanded, compact, vertical, thousands, hundreds, digits, inverse, decimal places, decimal point, tenths, hundredths, thousandths

Key skills for addition at Y6:
➢ Perform mental calculations, including with mixed operations and large numbers, using and practising a range of mental strategies.
➢ Solve multi-step problems in context, deciding which operations and methods to use and why.
➢ Use estimation to check answers to calculations and determine, in the context of a problem, levels of accuracy.
➢ Read, write, order and compare numbers up to 10 million and determine the value of each digit.
➢ Round any whole number to a required degree of accuracy.
➢ Pupils understand how to add mentally with larger numbers and calculations of increasing complexity.
➢ Use column addition to add numbers with up to 5 digits.
➢ Use column addition to add decimal numbers with up to 3-digits
➢ Add mixed numbers and fractions with different denominators.

2	3	.	3	6	1		
	9	.	0	8	*0*		
5	9	.	7	7	*0*		
	1	.	3	0	*0*		
2	1	.	2	*0*	*0*		
9	3	.	5	1	1		

Adding several numbers with different numbers of decimal places (including money and measures).
➢ Tenths. Hundredths and thousandths should be properly aligned, with the decimal point lined up vertically including the answer row.

Empty decimal places can be filled with a zero to show the place value in each column

✓ **Children must add several numbers with more than 4-digits.**

By the end of year 6, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.

Subtraction

Children should not be made to go onto the next stage if:
1) **they are not ready.**
2) **they are not confident**

- ✓ **Children should be taught through real life experiences and word problems.**
- ✓ **Children should be encouraged to consider if a mental calculation would be appropriate before using written methods.**
- ✓ **Children should be encouraged to approximate their answers before calculating.**
- ✓ **Children should be encouraged to check their answers after calculation using an appropriate strategy.**

ARE STANDARDS THAT WE EXPECT THE MAJORITY OF CHILDREN TO ACHIEVE.

Year 5

Approximate, Calculate, Check it mate!

Key vocabulary: equal to, take, take away, less, minus, subtract, leaves, distance between, how many more, how many fewer / less than, most, least, count back , how many left, how much less is_? difference, count on, strategy, partition, tens, units exchange, decrease, hundreds, value, digit, inverse, **tenths, hundredths, decimal point, decimal**

Key skills for subtraction at Y5:

- ➤ Subtract numbers mentally with increasingly large numbers .
- ➤ Use rounding and estimation to check answers to calculations and determine, in a range of contexts, levels of accuracy.
- ➤ Solve addition and subtraction multi-step problems in context, deciding which operations and methods to use and why.
- ➤ Read, write, order and compare numbers to at least 1 million and determine the value of each digit.
- ➤ Count forwards or backwards in steps of powers of 10 for any given number up to 1 million.
- ➤ Interpret negative numbers in context, counting forwards and backwards with positive and negative in-tegers through 0.
- ➤ Round any number up to 1 million to the nearest 10, 100, 1000, 10 000 and 100 000.

Use compact or expanded column subtraction to subtract numbers with up to 5 digits.

Use complementary addition for subtractions where the larger number is a multiple or near multiple of 1000.

Use complementary addition for subtractions of decimals with up to two places incl. amounts of money

Begin to subtract related fractions using equivalences. (E.g. $\frac{1}{2} - \frac{1}{6} = \frac{2}{6}$)

Choose the most efficient method in any given situation

Subtract with at least 4-digit numbers: including money, measure and decimals.
Children use the column compact method, with exchanging.

$$
\begin{array}{r}
{}^2\cancel{3}\;{}^{10}\cancel{1}\;{}^{}0\;{}^4\cancel{5}\;{}^{}6 \\
-\quad 2\;1\;2\;8 \\
\hline
2\,8,9\,2\,8
\end{array}
$$

Only move to this method when children are secure with number facts and place value. Children who are not secure will need to remain on the partitioned method.

Subtract with larger integers

$$
\begin{array}{r}
{}^6\cancel{7}\;{}^{10}\cancel{1}\;{}^{}6\;{}^8\cancel{9}\cdot{}^1 0 \\
-\quad\;\; 3\;7\;2\cdot 5 \\
\hline
6\,7\,9\,6\cdot 5
\end{array}
$$

Add a zero in empty decimal places to aid the understanding of what to subtract in that column.

Create lots of opportunities for subtracting and finding differences with money and measures.

Subtract with decimal values, including mixtures of integers and decimals, aligning the decimal point down to the answer.

Approximate,
Calculate,
Check it mate!

Year 6

Key vocabulary: equal to, take, take away, less, minus, subtract, leaves, distance between, how many more, how many fewer / less than, most, least, count back , how many left, how much less is_? difference, count on, strategy, partition, tens, units exchange, decrease, hundreds, value, digit, inverse, tenths, hundredths, decimal point, decimal

Key skills for subtraction at Y6:

➢ Solve addition and subtraction multi-step problems in context, deciding which operations and methods to use and why.
➢ Read, write, order and compare numbers up to 10 million and determine the value of each digit
➢ Round any whole number to a required degree of accuracy
➢ Use negative numbers in context, and calculate intervals across zero.
➢ Children need to utilise and consider a range of mental subtraction strategies, jottings and written methods before choosing how to calculate.

Use column subtraction to subtract numbers with up to 6 digits.
Use complementary addition for subtractions where the larger number is a multiple or near multiple of 1000 or 10,000.
Use complementary addition for subtractions of decimal numbers with up to three places including money.
Subtract mixed numbers and fractions with different denominators

Pupils should be able to apply their knowledge of a range of mental strategies, mental recall skills, and informal and formal written methods when selecting **the most appropriate method** to work out subtraction problems.

• Subtracting with increasingly large and more complex numbers and decimal values.

Continue to use the compact method of subtraction for more complex integers.

Empty decimal place can be filled with a zero.

Using the compact column method to subtract money and measures, including decimals with different numbers of decimal places.

✖ Multiplication ✖

Children should not be made to go onto the next stage if:
>   **1) they are not ready.**
>   **2) they are not confident.**

- ✓ **Children should be taught through real life experiences and word problems.**
- ✓ **Children should be encouraged to consider if a mental calculation would be appropriate before using written methods.**
- ✓ **Children should be encouraged to approximate their answers before calculating.**
- ✓ **Children should be encouraged to check their answers after calculation using an appropriate strategy.**

Year 5 ✖

Key vocabulary groups of, lots of, times, array, altogether, multiply, count, multiplied by, repeated ad-dition, column, row, commutative, sets of, equal groups, _times as big as, once, twice, three times..., parti-tion, grid method, total, multiple, product, inverse, **square, factor, integer, decimal, short/long multi-plication, _carry'**

Key skills for multiplication at Y5:

- ➢ Know by heart all the multiplication facts up to 12 x 12.
- ➢ Multiply whole numbers and one-and two-place decimals by 10, 100, 1000, 10,000
- ➢ Use knowledge of factors and multiples in multiplication. (E.g. 43 x 6 is double 43 x 3, and 28 x 50 is ½ of 28 x 100 = 1400)
- ➢ Use knowledge of place value and rounding in mental multiplication. (E.g. 67 x 199 as 67 x 200 – 67)
- ➢ Use doubling and halving as a strategy in mental multiplication. (E.g. 58 x 5 = half of 58 x 10, and 34 x 4 is 34 doubled twice)
- ➢ Partition 2-digit numbers, including decimals, to multiply by a single-digit number mentally. (E.g. 6 x 27 as 6 x 20 (120) plus 6 x 7 (42) making 162 or 6.3 x 7 as 6 x 7 plus 0.3 x 7)
- ➢ Double amounts of money by partitioning. (E.g. £37.45 doubled = £37 doubled (£74) plus 45p doubled (90p) £74.90)

Written

- ➢ Use short multiplication to multiply a 1-digit number by a number with up to 4 digits
- ➢ Use long multiplication to multiply 3-digit and 4-digit number by a number between 11 and 20
- ➢ Choose the most efficient method in any given situation
- ➢ Find simple percentages of amounts 9e.g. 10%, 5%, 20%, 155 and 50%)
- ➢ Begin to multiply fractions and mixed numbers by whole numbers ≤ 10, e.g. $4 \times \frac{2}{3} = \frac{8}{3} = 2\frac{2}{3}$.

➢ **Multiply up to 4-digits by 1 or 2 digits.**

Introducing column multiplication
  ➢ Introduce by comparing a grid method calculation to a short multiplication meth-od, to see how the steps are related, but notice how there are less steps involved in the column method (see video).
  ➢ Children need to be taught to approximate first, e.g. for **72 x 38, they will use rounding: 72 x 38** is approximately 70 x 40 = **2800**, and use the approximation to check the reasonableness of their answer against

Short multiplication for multiplying by a single digit

×	300	20	7
4	1200	80	28

→

$$\begin{array}{r} 327 \\ \times\quad 4 \\ \hline 1308 \\ {\scriptstyle 1\ 2} \end{array}$$

Pupils could be asked to work out a given calculation using the grid method, and then compare it to the column method. What are the similarities and differences? Unpick the steps and show how they are reduced.

➢ **Introduce long multiplication for multiplying by 2 digits**

	10	8
10	100	80
3	30	24

.

		1	8	
×		1	3	
		2	4	
		3	0	
		8	0	
	1	0	0	
1				
	2	3	4	

3×8 on the 1st row 3×10 on the second row. 1×8 om the third. 10×10 on the last.

Remember to leave a row for carrying above the line. It tends to be forgotten when put below.

Use column addition to find the total.

➤ Moving towards more complex numbers:

(1234 x 6)

(1234 x 10)

Year 6

Key vocabulary: groups of, lots of, times, array, altogether, multiply, count, multiplied by, repeated ad-dition, array, column, row, commutative, sets of, equal groups, times as big as, once, twice, three times... partition, grid method, total, multiple, product, inverse, square, factor, integer, decimal, short / long mul-tiplication, „carry", **tenths, hundredths, decimal**
Key skills for multiplication at Y6:

➤ Know by heart all the multiplication facts up to 12 x 12.
➤ Multiply whole numbers and decimals with up to three places by 10, 100 or 1000, e.g. 234 x 1000 = 234,000 and 0.23 x 1000 = 230)
➤ Identify common factors, common multiples and prime numbers and use factors in mental multiplication. (E.g. 326 x 6 is 652 x 3 which is 1956)
➤ Use place value and number facts in mental multiplication. (E.g. 40,000 x 6 = 24,000 and 0.03 x 6 = 0.18)
➤ Use doubling and halving as mental multiplication strategies, including to multiply by 2, 4, 8, 5, 20, 50 and 25 (E.g. 28 x 25 is ¼ of 28 x 100 = 700)
➤ Use rounding in mental multiplication. (34 x 19 as (20 x 34) – 34)
➤ Multiply one and two-place decimals by numbers up to and including 10 using place value and partitioning. (E.g. 3.6 x 4 is 12 + 2.4 or 2.53 x 3 is 6 + 1.5 + 0.09)
➤ Double decimal numbers with up to 2 places using partitioning
e.g. 36·73 doubled is double 36 (72) plus double 0·73 (1·46)
Written

➤ Use short multiplication to multiply a 1-digit number by a number with up to 4 digits
➤ Use long multiplication to multiply a 2-digit by a number with up to 4 digits
➤ Use short multiplication to multiply a 1-digit number by a number with one or two decimal places, including amounts of money.
➤ Multiply fractions and mixed numbers by whole numbers.
➤ Multiply fractions by proper fractions.
➤ Use percentages for comparison and calculate simple percentages.

Children will be able to:

➢ Use rounding and place value to make approximations before calculating and use these to check answers against.

➢ Use **short multiplication** (see Y5) to multiply numbers with **more than 4-digits by a single digit**; to multiply money and measures, and to **multiply decimals with up to 2d.p. by a single digit.**

➢ Use **long multiplication** (see Y5) to multiply numbers with **at least 4 digits by a 2-digit number.**

➢ **Short and long multiplication as in Y5, and multiply decimals with up to 2d.p by a single digit.**

This works well for multiplying money **(£p)** and other measures.

Make sure the decimal points are lined up in the question and the answer.

Remind children that the single digit belongs on the ones column.

By the end of year 6, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.
Children should not be made to go onto the next stage if:

3) **they are not ready.**
4) **they are not confident.**

Children should always be encouraged to approximate their answers before calculating.
Children should always be encouraged to consider if a mental calculation would be appropriate before using written methods.

÷ Division ÷

Children should not be made to go onto the next stage if:

1) they are not ready.
2) they are not confident.

- ✓ **Children should be taught through real life experiences and word problems.**
- ✓ **Children should be encouraged to consider if a mental calculation would be appropriate before using written methods.**
- ✓ **Children should be encouraged to approximate their answers before calculating.**
- ✓ **Children should be encouraged to check their answers after calculation using an appropriate strategy.**

Year 5 ÷

Key Vocabulary: share, share equally, one each, two each…, group, equal groups of, lots of, array, divide, divided by, divided into, division, grouping, number line, left, left over, inverse, short division, 'carry', remainder, multiple, divisible by, factor, inverse, **quotient, prime number, prime factors, composite number (non-prime)**
Key number skills needed for division at Y5:

- ➤ Recall multiplication and division facts for all numbers up to 12 x 12 (as in Y4).
- ➤ Multiply and divide numbers mentally, drawing upon known facts.
- ➤ Identify multiples and factors, including finding all factor pairs of a number, and common factors of two number.
- ➤ Solve problems involving multiplication and division where larger numbers are decomposed into their factors.
- ➤ Multiply and divide whole numbers and those involving decimals by 10, 100 and 1000 and 10,000 to give whole number answers or answers to to 1,2 or 3 decimal places.
- ➤ Use the vocabulary of prime numbers, prime factors and composite (non-prime) numbers.
- ➤ Work out whether a number up to 100 is prime, and recall prime numbers to 19.
- ➤ Use multiplication and division as inverses.
- ➤ Halve amounts of money by partitioning. (E.g. Half of £75.40 = half of £75 (37.50) plus half of 40p (20p) which is £37.70)
- ➤ Divide larger numbers mentally by subtracting the 10th or 100th multiple as appropriate. (E.g. 96 ÷ 6 is 10 + 6, as 10 × 6 = 60 and 6 × 6 = 36; 312 ÷ 3 is 100 + 4 as 100 x 3 = 300 and 4 x 3 = 12)
- ➤ Reduce fractions to their simplest form.

- ➤ Interpret non-integer answers to division by expressing results in different ways according to the context, including with remainders, as fractions, as decimals or by

rounding (e.g. 98 ÷ 4 = 24 r 2 = 241/2 = 24.5 ≈ 25).

Written

- ➢ Use short division to divide a number with up to 4 digits by a number ≤12.
- ➢ Give remainders as whole numbers, fractions or appropriate context.
- ➢ Find non-unit fractions of large amounts.
- ➢ Turn improper fractions into mixed numbers and vice versa.
- ➢ Choose the most efficient method in any given situation

Divide up to 4 digits by a single digit, including those with remainders.

Children should continue to use the vertical method of chunking (see Y4).

Those who are not secure should use previous methods (Y4).

.**Short division with remainders:** Now that pupils are introduced to examples that give rise to remainder answers, division needs to have a real life problem solving context, where **pupils consider the meaning of the remainder and how to express it,** ie. as a fraction, a decimal, or as a rounded number or value , depending upon the context of the problem.

The answer to 5309 ÷ 8 could be expressed as 663 and five eighths, 663 r 5, as a decimal, or rounded as appropriate to the problem involved.

See Y6 for how to continue the short division to give a decimal answer for children who are confident.

Include money and measure contexts.

If children are confident and accurate:

- ➢ Introduce **long division** for pupils who are ready to divide any number by a 2-digit number (e.g. 2678 ÷ 19). This is a Year 6 expectation.

Year 6
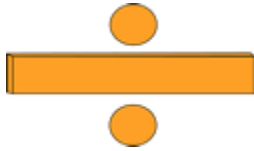
Key Vocabulary: As previously, & common factor
Key number skills needed for division at Y6:

➤ Know by heart all the division facts up to 144 ÷ 12.
➤ Divide whole numbers by powers of 10 to give whole number answers or answers with up to three decimal places.
➤ Identify common factors, common multiples and prime numbers and use factors in mental division. (E.g. 438 ÷ 6 is 219 ÷ 3 which is 73)
➤ Use tests for divisibility to aid mental calculation.
➤ Use doubling and halving as mental division strategies, e.g. to divide by 2, 4, 8, 5, 20 and 25. (E.g. 628 ÷ 8 is halved three times: 314, 157, 78.5)
➤ Divide one and two place decimals by numbers up to and including 10 using place value. (E.g. 2.4 ÷ 6 = 0.4 or 0.65 ÷ 5 = 0.13, £6.33 ÷ 3 = £2.11)
➤ Halve decimal numbers with up to 2 places using partitioning
  e.g. Half of 36·86 is half of 36 (18) plus half of 0·86 (0·43)
➤ Know and use equivalence between simple fractions, decimals and percentages, including in different contexts.
➤ Recognise a given ratio and reduce a given ratio to its lowest terms.

Written

➤ Use short division to divide a number with up to 4 digits by a 1-digit or a 2-digit number
➤ Use long division to divide 3-digit and 4-digit numbers by 'friendly' 2-digit numbers.
➤ Give remainders as whole numbers or as fractions, decimals or the appropriate context
➤ Divide a one-place or a two-place decimal number by a number ≤ 12 using multiples of the divisors.
➤ Divide proper fractions by whole numbers.

Divide at least 4 digits by both single-digit and 2-digit numbers (including decimal numbers and quantities)

Only move to this method when they are secure.

Short division, for dividing by a single digit: e.g. 6497 ÷ 8

Short division with remainders: (see Y5) Pupils should continue to use this method, but with numbers to at least 4 digits, and understand how to express remainders as fractions, decimals, whole number remainders, or rounded numbers. Real life problem solving contexts need to be the starting point, where pupils have to consider the most appropriate way to express the remainder.

Calculating a decimal remainder: In this example, rather than expressing the remainder as **r 1**, a decimal point is added after the units because there is still a remainder, and the one remainder is carried onto zeros after the decimal point (to show there was no decimal value in the original number).

Introduce long division by chunking **for dividing by 2 digits.**

```
        27
36 ) 972
    - 720      20x
      252
    - 252      7x
        0

Answer :    27
```

Find out „How many 36s are in 972? by subtracting „chunks" of 36, until zero is reached (or until there is a remainder).
⬚ Teach pupils to write a „**useful list'** first at the side that will help them decide what chunks to use, e.g.:

Must be aligned in place value for subtracting.

Where **remainders** occur, pupils should express them as fractions, decimals or use rounding, depending upon the problem.

Useful' list:
1x = 36
10x = 360
100x = 3600

➢ Introduce the method in a simple way by limiting the choice of chunks to „Can we use 10 lots? Can use 100 lots? As children become confident with the process, encourage more efficient chunks to get to the answer more quickly (e.g. 20x, 5x), and expand on their „useful" lists.

By the end of year 6, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.