

Whitchurch CE Junior School



Initiative, Care, Cooperation, Respect, Responsibility, Effort and Enjoyment

Calculation Policy 2018

(Last updated: 2018)

Introduction to Mathematics (National Curriculum 2014)

Purpose of study:

Mathematics is a creative and highly inter-connected 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.

Aims:

The national curriculum for mathematics aims to ensure 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.
- **reason mathematically** by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language
- can **solve problems** by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions.

Curriculum Expectations (National Curriculum 2014)

Year 3	Year 4
<ul style="list-style-type: none">• Compare & order numbers up to 1000.• Read & write all numbers to 1000 in digits and words.• Find 10 or 100 more/less than a given number.• Count from 0 in multiples of 4, 8, 50 and 100.• Recall & use multiplication & division facts for 3, 4, 8 tables.• Recognise place value of any 3-digit number.• Add and subtract: 3-digit numbers and ones, 3-digit numbers and tens, 3-digit numbers and hundreds• Add and subtract: Numbers with up to 3-digits using written columnar method.• Estimate and use inverse to check.• Multiply: 2-digit by 1-digit• Count up/down in tenths.• Compare and order fractions with same denominator.• Add and subtract fractions with same denominator.• Tell time using 12 and 24 hour clocks; and using Roman numerals.• Tell time to nearest minute.	<ul style="list-style-type: none">• Count backwards through zero to include negative numbers.• Compare and order numbers beyond 1,000.• Compare and order numbers with up to 2 decimal places.• Read Roman numerals to 100.• Find 1,000 more/less than a given number.• Count in multiples of 6, 7, 9, 25 and 1000.• Recall and use multiplication and division facts all tables to 12x12.• Recognise place value of any 4-digit number.• Round any number to the nearest 10, 100 or 1,000.• Round decimals with 1 decimal point to nearest whole number.• Add and subtract numbers with up to 4-digits using written columnar method.• Multiply: 2-digit by 1-digit - 3-digit by 1-digit• Count up/down in hundredths.• Recognise and write equivalent fractions• Add and subtract fractions with same denominator.• Read, write and convert time between analogue and digital 12 and 24 hour clocks.

Curriculum Expectations (National Curriculum 2014)

Year 5	Year 6
<ul style="list-style-type: none">• Count forwards and backward with positive and negative numbers through zero.• Count forwards/backwards in steps of powers of 10 for any given number up to 1,000,000.• Compare and order numbers up to 1,000,000.• Compare and order numbers with 3 decimal places.• Read Roman numerals to 1,000.• Identify all multiples and factors, including finding all factor pairs.• Use known tables to derive other number facts.• Recall prime numbers up to 19.• Recognise and use square numbers and cube numbers.• Recognise place value of any number up to 1,000,000.• Round any number up to 1,000,000 to the nearest 10, 100, 1000, 10,000 or 100,000.• Round decimals with 2 decimal places to nearest whole number and 1 decimal place.• Add and subtract numbers with more than 4-digits using formal written method.• Use rounding to check answers.• Multiply 4-digits by 1-digit/ 2-digit• Divide up to 4-digits by 1-digit• Multiply & divide whole numbers & decimals by 10, 100 and 1,000• Recognise and use thousandths.• Recognise mixed numbers and improper fractions and convert from one to another.• Multiply proper fractions and mixed numbers by whole numbers.• Identify and write equivalent fractions.• Solve time problems using timetables and converting between different units of time.	<ul style="list-style-type: none">• Use negative numbers in context and calculate intervals across zero.• Compare and order numbers up to 10,000,000.• Identify common factors, common multiples and prime numbers.• Round any whole number to a required degree of accuracy.• Identify the value of each digit to 3 decimal places.• Use knowledge of order of operations to carry out calculations involving four operations.• Multiply 4-digit by 2-digit• Divide 4-digit by 2-digit• Add and subtract fractions with different denominators and mixed numbers.• Multiply simple pairs of proper fractions, writing the answer in the simplest form.• Divide proper fractions by whole numbers.• Calculate percentage of whole number.

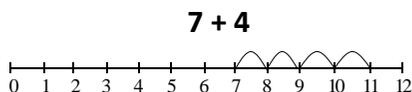
Addition

(N.B. Children do not have to follow every step and should progress to the final written methods as soon as they are ready to.)



Number line

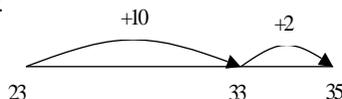
Understanding of counting on with a number line:
(supported by models and images where necessary).



Continue to use number lines to develop understanding of:

Counting on in tens and ones

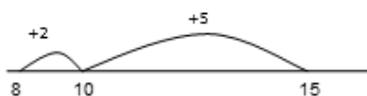
$$\begin{aligned} 23 + 12 &= 23 + 10 + 2 \\ &= 33 + 2 \\ &= 35 \end{aligned}$$



Partitioning and bridging through 10.

The steps in addition often bridge through a multiple of 10 e.g. Children should be able to partition the 7 to relate adding the 2 and then the 5.

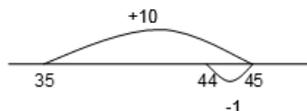
8 + 7 = 15



Adding 9 or 11 by adding 10 and adjusting by 1

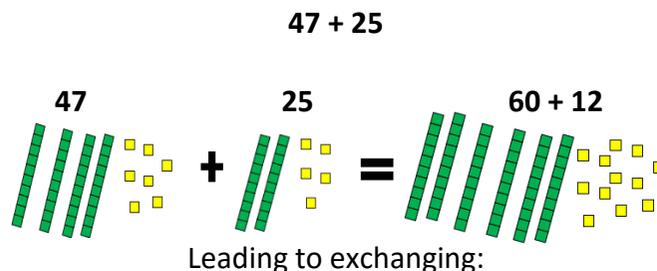
e.g. Add 9 by adding 10 and adjusting by 1

35 + 9 = 44

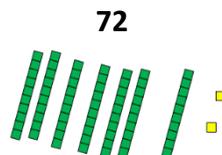


Partition

Partition in different ways and recombine:



Leading to exchanging:



Expanded written method:

$$\begin{aligned} 40 + 20 + 7 + 5 &= \\ 60 + 12 &= 72 \end{aligned}$$

$$\begin{aligned} &40 + 7 \\ &+ 20 + 5 \\ &60 + 12 = 72 \end{aligned}$$

Partition both numbers and recombine:

$$\begin{aligned} 247 + 125 &= 200 + 40 + 7 \\ &100 + 20 + 5 \\ &300 + 60 + 12 = 372 \end{aligned}$$

Partition the second number only:

$$\begin{aligned} 247 + 125 &= 247 + 100 + 20 + 5 \\ &= 347 + 20 + 5 \\ &= 367 + 5 \\ &= 37 \end{aligned}$$

Column method

Introducing a formal columnar method:

Using the column method without crossing the tens:

$$\begin{array}{r} 124 \\ + 235 \\ \hline 359 \end{array}$$

Crossing the tens:

789 + 642 becomes

$$\begin{array}{r} 789 \\ + 642 \\ \hline 1431 \\ \hline 11 \end{array}$$

Children must be taught to carry over.

Answer: 1431

Extend to numbers with at least four digits:

$$\begin{array}{r} 2634 \\ + 4517 \\ \hline 7151 \\ \hline 11 \end{array}$$

Extend to numbers with the same number of decimal places and apply to adding several numbers with different numbers of digits:

$$\begin{array}{r} 36.4 \\ + 23.5 \\ \hline 59.9 \end{array}$$

Children must be taught to use place holders to make the number of digits the same.

$$\begin{array}{r} 167.5 \\ + 052.4 \\ \hline 219.9 \\ \hline 1 \end{array}$$

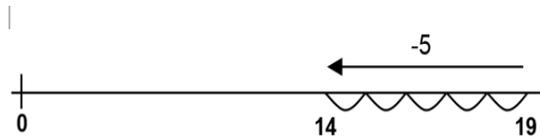
Subtraction

(N.B. Children do not have to follow every step and should progress to the final written methods as soon as they are ready to.)

Number line

Understand subtraction as take-away:

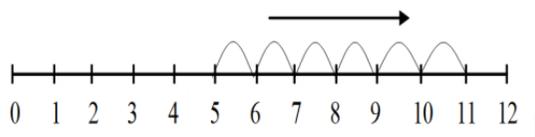
$$19 - 5$$



Understand subtraction as finding the difference:

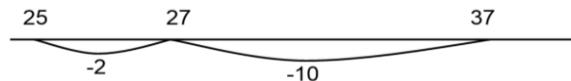
$$11 - 6$$

+6

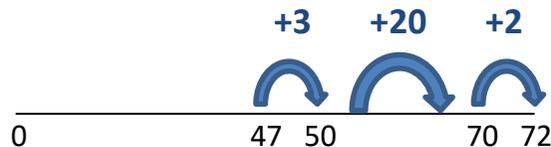


Extend to two-digit numbers:

$$37 - 12$$



The link between the two may be supported by an image like this, with 47 being taken away from 72, leaving the difference, which is 25.



Partition

Moving towards formal written methods:

Recording addition and subtraction in expanded columns can support understanding of the quantity aspect of place value and prepare for efficient written methods with larger numbers.

Partition (expanded column method **without** decomposition):

$$\begin{array}{r} 70 \ 5 \\ -40 \ 2 \\ \hline 30 \ 3 \end{array}$$

Partition (expanded column subtraction **with** decomposition):

$$\begin{array}{r} \overset{60}{\cancel{70}} \ 2 \\ -40 \ 7 \\ \hline 20 \ 5 \end{array}$$

$$\begin{array}{r} \overset{20}{\cancel{200}} \ \overset{1}{\cancel{30}} \ 2 \\ -100 \ 10 \ 4 \\ \hline 100 \ 10 \ 8 \end{array}$$

Column

Introducing a formal columnar method:

Without decomposition:

$$\begin{array}{r} 874 - 523 \text{ becomes} \\ \begin{array}{r} 8 \ 7 \ 4 \\ -5 \ 2 \ 3 \\ \hline 3 \ 5 \ 1 \end{array} \\ \text{Answer: } 351 \end{array}$$

With decomposition:

932 - 457 becomes

$$\begin{array}{r} \overset{8}{\cancel{9}} \ \overset{12}{\cancel{3}} \ 2 \\ -4 \ 5 \ 7 \\ \hline 4 \ 7 \ 5 \end{array}$$

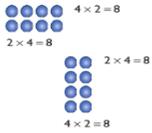
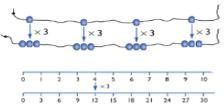
Answer: 475

When the subtraction cannot be done, e.g. 2 - 7, the child must **exchange** from the next column.

Progress to calculating with decimals, including those with different numbers of decimal places.

Multiplication (N.B. Children do not have to follow every step and should progress to the final written methods as soon as they are ready to.)



Arrays / Number line	Partition	Short multiplication	Long multiplication
<p><u>Use arrays to understand multiplication can be done in any order (commutative):</u></p>  <p><u>Use a number line to represent multiplication by repeated addition:</u> $5 + 5 + 5 + 5 + 5 = 30$ $5 \times 6 = 30$ 5 multiplied by 6 5 groups of 6</p>  <p><u>Use understanding of the inverse to solve missing number problems:</u></p> <p> $7 \times 2 = \square$ $\square = 2 \times 7$ $7 \times \square = 14$ $14 = \square \times 7$ $\square \times 2 = 14$ $14 = 2 \times \square$ $\square \times \bigcirc = 14$ $14 = \square \times \bigcirc$ </p> <p><u>Begin to develop understanding of multiplication as scaling (3 times bigger/taller):</u></p>  <p><u>Demonstrating multiplication on a number line – jumping in larger groups of amounts</u> $13 \times 4 = 10 \text{ groups of } 4 + 3 \text{ groups of } 4$</p>	<p><u>Doubling two digit numbers using partitioning:</u></p> <p>Double 24 $20 \times 2 = 40$ $4 \times 2 = 8$ <hr/> $= 48$</p> <p><u>Use the partitioning method to multiply one digit by two digit numbers:</u></p> <p>6 x 17 $6 \times 10 = 60$ $6 \times 7 = 42$ <hr/> $= 102$</p> <p><u>Use the partitioning method to multiply two digit by two digit numbers:</u></p> <p>23 x 14 23 x 14 $20 \times 10 = 200$ $23 \times 10 = 230$ $20 \times 4 = 80$ $23 \times 4 = 92$ $3 \times 10 = 30$ $= 322$ $3 \times 4 = 12$ <hr/> $= 322$</p> <p><u>Introduce short multiplication with expansion:</u></p> <p>24 x 6 $\begin{array}{r} 24 \\ \times 6 \\ \hline 24 \end{array}$ (4 x 6) $\begin{array}{r} 120 \\ \hline 144 \end{array}$ (20 x 6) 144</p>	<p><u>Short multiplication: one digit x two digits</u></p> <p>24 x 6 becomes</p> $\begin{array}{r} 24 \\ \times 6 \\ \hline 144 \end{array}$ <p>Answer: 144</p> <p><u>Short multiplication: one digit x three digits</u></p> <p>342 x 7 becomes</p> $\begin{array}{r} 342 \\ \times 7 \\ \hline 2394 \end{array}$ <p>Answer: 2394</p> <p><u>Short multiplication: one digit x four digits</u></p> <p>2741 x 6 becomes</p> $\begin{array}{r} 2741 \\ \times 6 \\ \hline 16446 \end{array}$ <p>Answer: 16 446</p>	<p><u>Long multiplication: two digit x two digits</u></p> <p>24 x 16 becomes</p> $\begin{array}{r} 24 \\ \times 16 \\ \hline 240 \\ 144 \\ \hline 384 \end{array}$ <p>Answer: 384</p> <p><u>Long multiplication: two digit x three digits</u></p> <p>124 x 26 becomes</p> $\begin{array}{r} 124 \\ \times 26 \\ \hline 2480 \\ 744 \\ \hline 3224 \end{array}$ <p>Answer: 3224</p> <p><u>Reversing the order:</u></p> <p>124 x 26 becomes</p> $\begin{array}{r} 124 \\ \times 26 \\ \hline 744 \\ 2480 \\ \hline 3224 \end{array}$ <p>Answer: 3224</p>

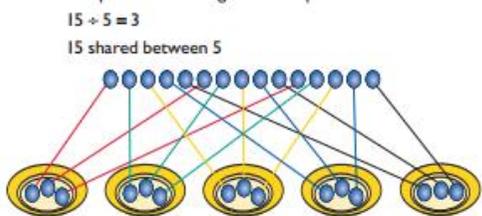
Division (N.B. Children do not have to follow every step and should progress to the final written methods as soon as they are ready to.)



Visual representation and number line

Group AND share small quantities- understanding the difference between the two concepts.

Sharing



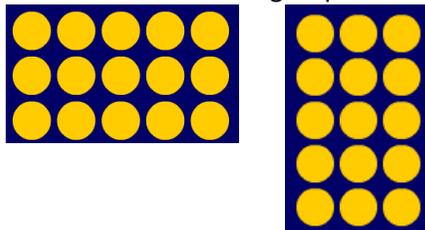
Grouping

Children should apply their counting skills to develop some understanding of grouping.

Use of arrays as a pictorial representation for division. $15 \div 3 = 5$

There are 5 groups of 3.

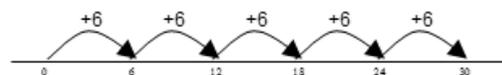
$15 \div 5 = 3$ There are 3 groups of 5.



Grouping using a number line:

How many 6's are in 30?

$30 \div 6$ can be modelled as:

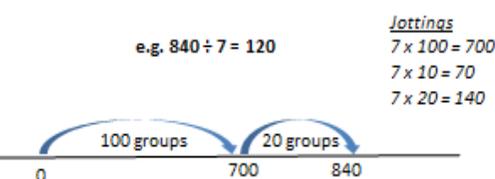


Sharing, grouping and using a number line:

Children will continue to explore division as sharing and grouping, and to represent calculations on a number line until they have a secure understanding. Children should progress in their use of written division calculations:

- Using tables facts with which they are fluent
- Experiencing a logical progression in the numbers they use, for example:
 - Dividend just over 10 x the divisor, e.g. $84 \div 7$
 - Dividend just over 10 x the divisor when the divisor is a teen number, e.g. $173 \div 15$ (learning sensible strategies for calculations such as $102 \div 17$)
 - Dividend over 100 x the divisor, e.g. $840 \div 7$
 - Dividend over 20 x the divisor, e.g. $168 \div 7$

All of the above stages should include calculations with remainders as well as without. Remainders should be interpreted according to the context, (i.e. rounded up or down to relate to the answer to the problem).



Short division

Short division without remainders:

$$98 \div 7 \text{ becomes}$$

$$\begin{array}{r} 14 \\ 7 \overline{) 98} \\ \underline{7} \\ 28 \\ \underline{28} \\ 0 \end{array}$$

Answer: 14

Expressing the remainder as a whole number:

$$432 \div 5 \text{ becomes}$$

$$\begin{array}{r} 86 \text{ r } 2 \\ 5 \overline{) 432} \\ \underline{40} \\ 32 \\ \underline{30} \\ 2 \end{array}$$

Answer: 86 remainder 2

Expressing the remainder as a fraction:

$$496 \div 11 \text{ becomes}$$

$$\begin{array}{r} 45 \text{ r } 1 \\ 11 \overline{) 496} \\ \underline{44} \\ 56 \\ \underline{55} \\ 1 \end{array}$$

Answer: $45 \frac{1}{11}$

Long division

Long division with a remainder:

$$432 \div 15 \text{ becomes}$$

$$\begin{array}{r} 28 \text{ r } 12 \\ 15 \overline{) 432} \\ \underline{30} \\ 132 \\ \underline{120} \\ 12 \end{array}$$

Answer: 28 remainder 12

Expressing the remainder as a fraction:

$$432 \div 15 \text{ becomes}$$

$$\begin{array}{r} 28 \\ 15 \overline{) 432} \\ \underline{30} \\ 132 \\ \underline{120} \\ 12 \end{array}$$

$\frac{12}{15} = \frac{4}{5}$

Answer: $28 \frac{4}{5}$

Expressing the remainder as a decimal:

$$432 \div 15 \text{ becomes}$$

$$\begin{array}{r} 28.8 \\ 15 \overline{) 432.0} \\ \underline{30} \\ 132 \\ \underline{120} \\ 120 \\ \underline{120} \\ 0 \end{array}$$

Answer: 28.8

National Curriculum Formal Written Methods Exemplars

Addition and subtraction

789 + 642 becomes

$$\begin{array}{r} 789 \\ + 642 \\ \hline 1431 \\ \hline 11 \end{array}$$

Answer: 1431

874 - 523 becomes

$$\begin{array}{r} 874 \\ - 523 \\ \hline 351 \end{array}$$

Answer: 351

932 - 457 becomes

$$\begin{array}{r} 8 \quad 12 \quad 1 \\ 932 \\ - 457 \\ \hline 475 \end{array}$$

Answer: 475

932 - 457 becomes

$$\begin{array}{r} 1 \quad 1 \\ 932 \\ - 457 \\ \hline 475 \\ \hline 5 \quad 6 \end{array}$$

Answer: 475

Short multiplication

24 × 6 becomes

$$\begin{array}{r} 24 \\ \times 6 \\ \hline 144 \\ \hline 2 \end{array}$$

Answer: 144

342 × 7 becomes

$$\begin{array}{r} 342 \\ \times 7 \\ \hline 2394 \\ \hline 2 \quad 1 \end{array}$$

Answer: 2394

2741 × 6 becomes

$$\begin{array}{r} 2741 \\ \times 6 \\ \hline 16446 \\ \hline 4 \quad 2 \end{array}$$

Answer: 16 446

Long multiplication

24 × 16 becomes

$$\begin{array}{r} 2 \\ 24 \\ \times 16 \\ \hline 240 \\ 144 \\ \hline 384 \end{array}$$

Answer: 384

124 × 26 becomes

$$\begin{array}{r} 1 \quad 2 \\ 124 \\ \times 26 \\ \hline 2480 \\ 744 \\ \hline 3224 \\ \hline 1 \quad 1 \end{array}$$

Answer: 3224

124 × 26 becomes

$$\begin{array}{r} 1 \quad 2 \\ 124 \\ \times 26 \\ \hline 744 \\ 2480 \\ \hline 3224 \\ \hline 1 \quad 1 \end{array}$$

Answer: 3224

Short division

98 ÷ 7 becomes

$$\begin{array}{r} 14 \\ 7 \overline{) 98} \\ \underline{7} \\ 28 \\ \underline{28} \\ 0 \end{array}$$

Answer: 14

432 ÷ 5 becomes

$$\begin{array}{r} 86 \text{ r } 2 \\ 5 \overline{) 432} \\ \underline{40} \\ 32 \\ \underline{30} \\ 2 \end{array}$$

Answer: 86 remainder 2

496 ÷ 11 becomes

$$\begin{array}{r} 45 \text{ r } 1 \\ 11 \overline{) 496} \\ \underline{44} \\ 56 \\ \underline{55} \\ 1 \end{array}$$

Answer: $45 \frac{1}{11}$

Long division

432 ÷ 15 becomes

$$\begin{array}{r} 28 \text{ r } 12 \\ 15 \overline{) 432} \\ \underline{30} \\ 132 \\ \underline{150} \\ 12 \end{array}$$

Answer: 28 remainder 12

432 ÷ 15 becomes

$$\begin{array}{r} 28 \\ 15 \overline{) 432} \\ \underline{30} \\ 132 \\ \underline{150} \\ 12 \end{array}$$

15×20

15×8

$$\frac{\cancel{12}}{\cancel{15}} = \frac{4}{5}$$

Answer: $28 \frac{4}{5}$

432 ÷ 15 becomes

$$\begin{array}{r} 28.8 \\ 15 \overline{) 432.0} \\ \underline{30} \\ 132 \\ \underline{150} \\ 120 \\ \underline{150} \\ 0 \end{array}$$

Answer: 28.8