

Calculation Policy  
for  
Alnwick Partnership of schools

2014-15



Progression **towards** a standard written method of calculation

**Introduction**

This calculation policy has been written in line with the programmes of study taken from the revised National Curriculum for Mathematics (2014). It provides guidance on appropriate calculation methods and progression from Y3 to Y6. The content is set out in yearly blocks under the following headings: addition, subtraction, multiplication and division. Statements taken directly from the programmes of study are listed in bold at the beginning of each section. It was written by a number of teachers from Alnwick Partnership of schools to aid transition from Y4 in First Schools to Y5 in Middle Schools.

**Aims Of The Policy**

- To ensure consistency and progression in our approach to calculation
- To ensure that children develop an efficient, reliable, formal written method of calculation for all operations
- To ensure that children can use these methods accurately and independently with confidence and understanding.

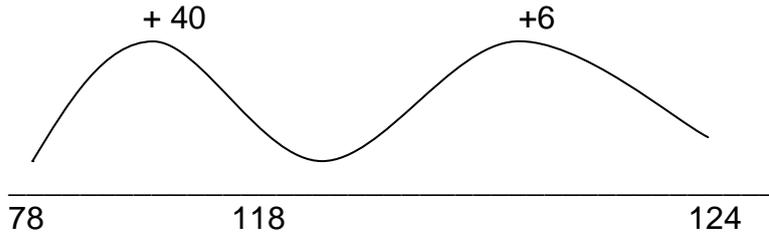
# Addition

## By the end of Year 3

**Add numbers with up to three digits, using the effective formal written method of columnar addition**

The use of the empty number line with calculations that bridge 100:

$$78 + 46 = 124$$



Use a 200 grid to support counting on in tens and bridging 100 and with addition of a three-digit and a two-digit number:

Further develop the partitioning method with calculations that bridge 100:

$$85 + 37 = 80 + 5 + 30 + 7$$

$$80 + 30 = 110$$

$$5 + 7 = 12$$

$$110 + 12 = 122$$

$$85 + 37 = 122$$

The partitioning method can also be used with three-digit numbers. Introduce the expanded written method with the calculation presented both horizontally and vertically (in columns).

$$63 + 32 = 95$$

$$60 + 3 + 30 + 2$$

$$90 + 5 = 95$$

Initially use calculations where it has not been necessary to bridge across the tens or hundreds:

Then...

$$63$$

$$32$$

$$\begin{array}{r} 63 \\ 32 \\ \hline 5(3+2) \\ 90(60+30) \\ \hline 95 \end{array}$$

This will lead into the formal written method...

$$63$$

$$32$$

$$\begin{array}{r} 63 \\ 32 \\ \hline 95 \end{array}$$

NB Informal/mental methods would be more appropriate for numbers of this size, but use two-digit numbers when introducing the columnar method. Then introduce calculations where it is necessary to bridge, returning to an expanded method initially:

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$$\begin{aligned}68 + 24 &= 92 \\60 + 8 + 20 + 4 & \\80 + 12 &= 92\end{aligned}$$

'Partition the numbers into tens and ones/units. Add the tens together and then add the ones/units together. Recombine to give the answer.'  
Add the least significant digits (units) together first and then the tens in preparation for the formal written method.

If children are ready, introduce the formal written method, where it is necessary to 'carry' ten from the units to the tens column:

$$\begin{array}{r}68 \\+ 24 \\ \hline92 \\ \hline1\end{array}$$

The digit that has been 'carried' should be recorded under the line in the correct column.

When children are confident, extend with examples where it is necessary to bridge across the tens and the hundreds:

$$\begin{aligned}76 + 47 &= 123 \\70 + 6 & \\+ 40 + 7 & \\ \hline110 + 13 &= 123\end{aligned}$$

Then...

$$\begin{array}{r}76 \\+ 47 \\ \hline13 \text{ (7 + 6)} \\110 \text{ (70 + 40)} \\ \hline123\end{array}$$

Add the least significant digits (units) together first and then the tens in preparation for the formal written method. 'Partition the numbers into tens and ones/units. Add the tens together and then add the ones /units together. Recombine to give the answer.' Add the least significant digits (units) together first and then the tens in preparation for the formal written method.

Use the language of place value to ensure understanding: 'Eight add four equals 12. Write two in the units column and 'carry' one (10) across into the tens column. 60 add 20 and the ten that we 'carried' equals 90. Write 9 (90) in the tens column. 92 is the answer.

If children are ready introduce the formal written method, where it is necessary to 'carry' across the columns and bridge 100:

$$\begin{aligned}76 + 47 &= 123 \\47 & \\76 & \\ \hline123 & \\ \hline1 \quad 1 &\end{aligned}$$

Use the language of place value to ensure understanding:  
'Seven add six equals 13. Write three in the units column and 'carry' one (10) across into the tens column. 40 add 70 and the ten that we 'carried' equals 120. Write 2 (20) in the tens column and 'carry' one (100) across into the hundreds column (100). The digits that have been 'carried' should be recorded under the line in the correct column.

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If children are confident, further develop with the addition of a three-digit number and a two-digit number:

$$\begin{array}{r} 178 + 43 = 221 \\ 178 \\ + 43 \\ \hline 221 \\ \hline 11 \end{array}$$

### **By the end of Year 4**

#### **Add numbers with up to 4 digits using the formal written method of columnar addition where appropriate**

Further develop the formal written method of addition, with three-digit numbers. Revisit the expanded method first, if necessary:

$$\begin{array}{r} 176 + 147 = 323 \\ 176 \\ 147 \\ \hline 13 \text{ (7 + 6)} \\ 110 \text{ (70 + 40)} \\ 200 \text{ (100 + 100)} \\ \hline 323 \end{array}$$

This will lead into the formal written method...

$$\begin{array}{r} 176 + 147 = 323 \\ 147 \\ 176 \\ \hline 323 \\ \hline 11 \end{array}$$

Use the language of place value to ensure understanding:

'Seven add six equals 13. Write three in the units column and 'carry' one across into the tens column (10). 40 add 70 and the ten that we carried equals 120. Write 2 in the tens column (20) and 'carry' 1 across into the hundreds column (100). 100 add 100 and the 100 that has been carried equals 300. Write 3 in the hundreds column (300).

If children are confident, introduce the addition of a four-digit number and a three digit number:

$$\begin{array}{r} 1845 + 526 = 2371 \\ 1845 \\ + 526 \\ \hline 2371 \\ \hline 11 \end{array}$$

Continue to develop with addition of two four-digit numbers and with decimals up to two decimal places (in the context of money or measures).

### **By the end of Year 5**

#### **Add whole numbers with more than 4 digits, including using formal**

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### **written method (columnar addition)**

Continue to teach the use of empty number lines with larger numbers (and decimals), as appropriate. Continue to develop the formal written method for addition with larger numbers (and decimal numbers) and with the addition of three or more numbers

$$21848 + 1523 = 23371$$

$$\begin{array}{r} 21848 \\ + 1523 \\ \hline 23371 \\ 1 \quad 1 \end{array}$$

Continue to use the language of place value to ensure understanding. Ensure that the digits that have been 'carried' are recorded under the line in the correct column.

Use the formal written method for the addition of decimal numbers:

$$£154.75 + £233.82 = £388.57$$

$$\begin{array}{r} 154.75 \\ + 233.82 \\ \hline 388.57 \\ 1 \end{array}$$

Continue to use the language of place value to ensure understanding

Ensure that the decimal points line up. Teach children to place the decimal point first. Continue to practise and apply the formal written method throughout Y5.

### **By the end of Year 6**

No objectives have been included in the programmes of study explicitly related to written methods for addition in Y6. However, there is an expectation that children will continue to practise and use the formal written method for larger numbers and decimals and use these methods when solving problems, when appropriate (see previous year's guidance for methods). The aim is that by the end of Y6, children use mental methods (with jottings) where appropriate, but for calculations that they cannot do in their heads, they use an efficient formal written method accurately and with confidence.

## Subtraction

### By the end of Year 3

Subtract numbers with up to three digits, using formal written method of columnar subtraction. Further develop the use of the empty number line with calculations that bridge 100:

Use a 200 grid to support counting back in tens and bridging 100. Then use more efficient jumps.

Extend with larger numbers by counting back...  
 $216 - 27 = 189$

Introduce the expanded written method with the calculation presented both horizontally and vertically (in columns). Use two-digit numbers when introducing this method, initially:

$$\begin{array}{r} 78 - 23 = 55 \\ 70 + 8 \\ -20 + 3 \\ \hline 50 + 5 = 55 \end{array}$$

Partition numbers into tens and ones/units.  
Subtract the ones, and then subtract the tens.  
Recombine to give the answer.  
In this example decomposition (exchange) is not required.

### **If needed**

$$\begin{array}{r} 754 = \\ - 86 \\ \hline \end{array}$$

$$\text{Step 1} \quad \begin{array}{r} 700 \rightarrow 50 \rightarrow 4 \\ - \quad \quad \quad 80 \rightarrow 6 \\ \hline \end{array}$$

$$\text{Step 2} \quad \begin{array}{r} 700 \rightarrow 40 \rightarrow 14 \\ - \quad \quad \quad 80 \rightarrow 6 \\ \hline \end{array} \quad (\text{adjust from } T \text{ to } U)$$

$$\text{Step 3} \quad \begin{array}{r} 600 \rightarrow 140 \rightarrow 14 \\ - \quad \quad \quad 80 \rightarrow 6 \\ \hline 600 \rightarrow 60 \rightarrow 8 = 668 \end{array} \quad (\text{adjust from } H \text{ to } T)$$

This would be recorded by the children as

$$\begin{array}{r} \overset{600}{\cancel{700}} \rightarrow \overset{140}{\cancel{50}} \rightarrow 14 \\ - \quad \quad \quad \cancel{80} \rightarrow 6 \\ \hline 600 \rightarrow 60 \rightarrow 8 = 668 \end{array}$$

### By the end of Year 4

When children are ready, this leads on to the compact method of decomposition:

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$$\begin{array}{r} 614\ 1 \\ \cancel{7}54 \\ - \quad 86 \\ \hline 668 \end{array}$$

Children should:

- be able to subtract numbers with different numbers of digits;
- using this method, children should also begin to find the difference between two three-digit sums of money, with or without 'adjustment' from the pence to the pounds;
- know that decimal points should line up under each other.

For example:

$$\begin{array}{r} \pounds 8.95 \\ - \pounds 4.38 \\ \hline \end{array} = \begin{array}{r} 8 \rightarrow 0.9 \rightarrow 0.05 \\ - 4 \rightarrow 0.3 \rightarrow 0.08 \\ \hline \end{array} \quad \text{leading to}$$

$$= \begin{array}{r} 8 \rightarrow 0.8 \rightarrow 0.15 \\ \quad 4 \rightarrow 0.3 \rightarrow 0.08 \\ \hline 4 \rightarrow 0.5 \rightarrow 0.07 \end{array} \quad \begin{array}{l} \text{(adjust from T to U)} \\ 8.85 \\ - 4.38 \\ \hline = \pounds 4.57 \end{array}$$

	2	<del>7</del>	5	4
-	1	5	6	2
	1	1	9	2

### By the end of Y5

**NB** If children have not reached the stage of compact method of decomposition then they will continue at this point with the expanded method.

$\begin{array}{r} 614\ 1 \\ \cancel{17}54 \\ - \quad 286 \\ \hline 1468 \end{array}$	$\begin{array}{r} 2\ 13\ 1 \\ \cancel{3}.42 \\ - \quad 1.76 \\ \hline 1.66 \end{array}$
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Children should:

- be able to subtract numbers with different numbers of digits;
- begin to find the difference between two decimal fractions with up to three digits and the same number of decimal places;
- know that decimal points should line up under each other.

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### By the end of Y6

$$\begin{array}{r} 5 \ 13 \ 1 \\ 16467 \\ - \ 2684 \\ \hline 13783 \end{array}$$

Children should:

- be able to subtract numbers with different numbers of digits;
- be able to subtract two or more decimal fractions with up to three digits and either one or two decimal places;
- know that decimal points should line up under each other.

If the numbers involved in the calculation are close together or near to multiples of 10, 100 etc, children should be encouraged to recognise that it is more efficient to find the difference by counting up.

e.g.  $3002 - 1997 = 1005$

**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:**

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

**Children should be encouraged to consider if a mental calculation would be appropriate before using written methods.**

## **Multiplication**

### Using multiplication facts

Tables should be taught every day from Y2 onwards, either as part of the mental oral starter or other times as appropriate within the day.

#### Year 2

2 times table

5 times table

10 times table

#### Year 3

2 times table

3 times table

4 times table

5 times table

6 times table

10 times table

#### Year 4

Derive and recall all multiplication facts up to 10 x 10 including learning the 7, 8 and 9 times table

#### Years 5 and 6

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Derive and recall quickly all multiplication facts up to  $10 \times 10$ .

### **Prior to Year 2**

Children work with concrete apparatus/pictures to solve 1 step multiplication problems by sorting objects into 'groups of', lots of', 'sets of' etc. with sorting hoops/trays/plates/etc. with the support of the teacher. They become increasingly aware of the symbols associated with multiplication ( $\times$ ,  $=$ ), and how they are used to record their findings in simple horizontal sums or number sentences, e.g.  $2 \times 10 = 20$ ; 3 tables with 4 children sitting at each totals 12 children altogether.

### **By the end of Year 2**

Majority of children:

- (are able to partition 2 or 3 digit numbers into TU/HTU)
- are visually aware of, but not necessarily able to use, the First Formal Written Method for multiplication when multiplying numbers by 2 or 5, reinforcing a secure understanding of place value, when setting figures out: e.g.  $151 \times 2 = 302$

<b>X</b>	<b>2</b>
<b>100</b>	<b>200</b>
<b>50</b>	<b>100</b>
<b>1</b>	<b>2</b>
	<b><u>302</u></b>

- have a growing understanding of doubling as another way of expressing  $\times 2$  (and the opposite operation of halving)
- are working, supported by other methods as applicable, to find correct answers to problems involving  $\times 2$ ,  $\times 5$ ,  $\times 10$ .

### **By the end of Year 3**

Majority of children are:

- using a vertical grid method (shortened grid method) to solve multiplication problems where 2 digit numbers, or larger, by a one digit number (the first Formal Written Method) e.g.  $235 \times 3 = 705$

<b>X</b>	<b>3</b>
<b>200</b>	<b>600</b>
<b>30</b>	<b>90</b>
<b>5</b>	<b>15</b>
	<b><u>705</u></b>
	<b>4</b>

- working, supported by other methods as applicable, to find correct answers to problems involving multiplication.

### **By the end of Year 4**

Majority of children:

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- using a vertical grid method (shortened grid method) to solve multiplication problems where 2 digit numbers, or larger, by a one digit number (the first Formal Written Method) e.g.  $35 \times 31 =$

X	30	1	
30	90	30	105
5	15	5	35
	105	35	240

- are secure in using long multiplication to multiply numbers by a 1 digit number

$$\begin{array}{r} 26 \\ \times 7 \\ \hline 42 \\ 140 \\ \hline 182 \end{array}$$

- have an understanding of how to compute using short multiplication

$$\begin{array}{r} 26 \\ \times 7 \\ \hline 182 \end{array}$$

4 (strike through once included in total)

- are progressing from multiplying by a 1 digit number to by a 2 digit number
- are working, supported by other methods as applicable, to find correct answers to problems involving multiplication

### By the end of Year 5

Majority of children:

- are secure in using short multiplication for multiplying 2/3/larger
- 2 digit and digit by a 1 digit number;
- have a growing understanding of how to use long multiplication for multiplying 2 digit numbers (& larger) by a 2digit number;
- are working, supported by other methods as applicable, to find correct answers to problems involving multiplication.

### By the end of Year 6

Majority of children are secure in all of the above.

They use their mental recall of multiplication and addition facts to help them solve calculations quickly and accurately. They can explain orally how to use formal written methods. Teachers to ensure children are aware of the formal written methods that must be used in SATs

## **Division**

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### By the end of Year 3

**STEP 1: Children continue to work out unknown division facts by grouping on a number line from zero.** They are also now taught the concept of **remainders**, as in the example. This should be introduced practically and with arrays, as well as being translated to a number line. Children should work towards calculating some basic division facts with remainders mentally for the 2s, 3s, 4s, 5s, 8s and 10s, ready for 'carrying' remainders across within the short division method. They should be encouraged to see the link between multiplication as repeated addition, and therefore division as a repeated subtraction.

**STEP 2:** Once children are secure with division as grouping and demonstrate this using number lines, arrays etc., **short division** for larger 2-digit numbers should be introduced, initially with carefully selected examples requiring no calculating of remainders at all. Start by introducing the layout of short division by comparing it to an array.

**Remind children of correct place value, that 96 is equal to 90 and 6, but in short division, pose:**

- How many 3's in 9? = 3, and record it above the **9 tens**.
- How many 3's in 6? = 2, and record it above the **6 units**.

A handwritten short division problem on a blue grid. The divisor 3 is written to the left of the dividend 96. A horizontal line is drawn above the 96. The quotient 32 is written above the line, with the 3 above the 9 and the 2 above the 6.

**STEP 3:** Once children demonstrate a full understanding of remainders, and also the short division method taught, they can be taught how to use the method when remainders occur within the calculation (e.g. 96r4), and be taught to 'carry' the remainder onto the next digit. **If needed, children should use the number line to work out individual division facts that occur which they are not yet able to recall mentally**

A handwritten short division problem. The divisor 4 is written to the left of the dividend 732. A horizontal line is drawn above the 732. The quotient 18 is written above the line, with the 1 above the 7 and the 8 above the 3. A red squiggly line is drawn under the 732.

### By the end of Year 4

**Divide up to 3-digit numbers by a single digit (without remainders initially)**

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$$\begin{array}{r} 18 \\ 4 \overline{) 72} \end{array}$$

**STEP 1:** Pupils must be secure with the process of short division for dividing 2-digit numbers by a single digit (**those that do not result in a final remainder** — see steps in Y3), but must understand how to calculate remainders, using this to 'carry' remainders within the calculation process (see example)

$$\begin{array}{r} 218 \\ 4 \overline{) 872} \end{array}$$

**STEP 2:** Pupils move onto dividing numbers with up to **3-digits** by a single digit, however problems and calculations provided should **not result in a final answer with remainder** at this stage. Children who exceed this expectation may progress to Y5 level.

$$\begin{array}{r} 037 \\ 5 \overline{) 185} \end{array}$$

When the answer for the **first column** is zero ( $1 \div 5$ , as in example), children could initially write a zero above to acknowledge its place, and must always 'carry' the number (1) over to the next digit as a remainder

### By the end of Year 5

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

$$\begin{array}{r} 0663 \text{ r } 5 \\ 8 \overline{) 5309} \end{array}$$

**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.

### By the end of Year 6

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

$$\begin{array}{r} 0812.125 \\ 8 \overline{) 6497.000} \end{array}$$

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**Short division with remainders:** 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). Keep dividing to an appropriate degree of accuracy for the problem being solved

Children will continue to use written methods to solve short division  $TU \div U$  and  $HTU \div U$ .

### **Long division $HTU \div TU$**

$$972 \div 36 = 27$$

$$\begin{array}{r} 36 \quad 972 \\ - \underline{720} \quad (20 \times 36) \\ \quad 252 \\ - \underline{252} \quad (7 \times 36) \\ \quad \quad 0 \end{array}$$

Answer = 27

Any remainders should be shown as fractions, i.e. if the children were dividing 32 by 10, the answer should be shown as  $3 \frac{2}{10}$  which could then be written as  $3 \frac{1}{5}$  in its lowest terms.

Extend to decimals with up to two decimal places. Children should know that decimal points line up under each other.

$$87.5 \div 7 = 12.5$$

$$\begin{array}{r} 7 \quad 87.5 \\ - \underline{70.0} \quad (10 \times 7) \\ \quad 17.5 \\ - \underline{14.0} \quad (2 \times 7) \\ \quad \quad 3.5 \\ - \underline{3.5} \quad (0.5 \times 7) \\ \quad \quad \quad 0 \end{array}$$

Answer = 12.5

Long division up to 4D numbers by 2 D numbers

$$\begin{array}{r} \quad \underline{433r2} \\ 15 \mid 6497 \\ - \underline{150} \quad (10 \times 15) \\ \quad 6347 \\ - \underline{300} \quad (20 \times 15) \end{array} \quad * \text{ add up the multiples of 15 (433),}$$

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6047		* write in the remainder (r2)
<u>-3000</u>	(200x15)	or as a fraction
3047		
<u>-3000</u>	(200x15)	
47		
- 45	( 3x15)	
2		