St Peter's RC Primary School

Calculation Policy

Background to the policy

This policy contains the key pencil and paper procedures that will be taught within our school. It has been written to ensure consistency and progression throughout the school and reflects a whole school agreement.

Although the focus of the policy is on pencil and paper procedures, it is important to recognise that the ability to estimate and calculate mentally is an essential life skill. Mental methods of calculation will be taught systematically from Primary 1 onwards and pupils will be given regular opportunities to develop the necessary skills.

However, mental calculation is not at the exclusion of written recording and should be seen as complementary to and not as separate from it. Sharing written methods with the teacher encourages children to think about the mental strategies that underpin them and to develop new ideas. Therefore, written recording

- helps children to clarify their thinking
- supports and extends the development of more fluent and sophisticated mental strategies.

For written recording, children use plain paper in P1 and start to use paper with large squares in P2. They are encouraged to set out sums neatly with appropriate space between them.

During their time at St Peter's, children will be encouraged to see mathematics as both a written and spoken language. Teachers will support and guide children through the following important stages:

- developing the use of pictures and a mixture of words and symbols to represent numerical activities;
- using standard symbols and conventions;
- use of jottings to aid a mental strategy;
- use of pencil and paper procedures;
- use of a calculator.

Aims:

Children should be able to choose an efficient method - mental, written or calculator - appropriate to the given task. By the end of P7, the majority of children will have been taught, and be secure with, a compact standard method for each operation.

General Progression:

- Establish mental methods, based on a good understanding of place value
- Use of informal jottings to aid mental calculations
- Develop use of empty number line to help mental imagery and aid recording
- Use partitioning and recombining to aid informal methods
- Introduce expanded written methods
- Develop expanded methods into compact standard written form

Before carrying out a calculation, children will be encouraged to consider:

- Can I do it in my head (using rounding, adjustment)?
- The size of an approximate answer (estimation)
- Could I use jottings to keep track of the calculation?
- Do I need to use an expanded or compact written method?

Written methods for **addition** of whole numbers

To add successfully, children need to be able to:

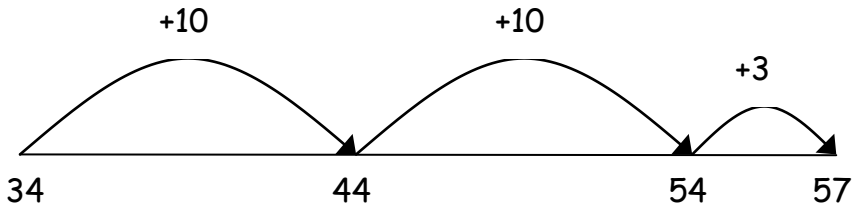
- recall all addition pairs to 9 + 9 and complements in 10;
- add mentally a series of one-digit numbers, such as 5 + 8 + 4;
- add multiples of 10 (such as 60 + 70) or of 100 (such as 600 + 700) using the related addition fact, 6 + 7, and their knowledge of place value;
- partition two-digit and three-digit numbers into multiples of 100, 10 and 1 in different ways.

Stage 1 – The empty number line

The empty number line helps to record the steps on the way to calculating the total.

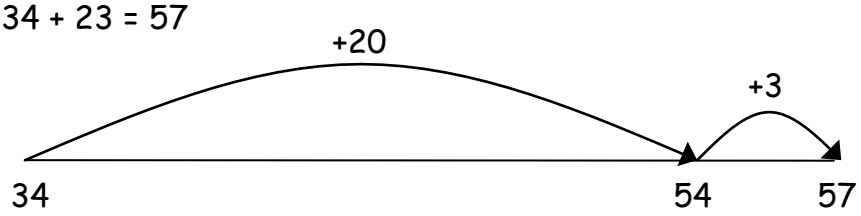
First counting on in tens and then units.

34 + 23 = 57



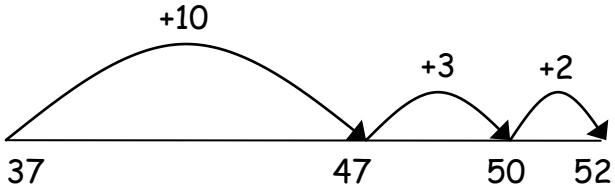
Followed by adding the tens in one jump and the units in one jump.

34 + 23 = 57



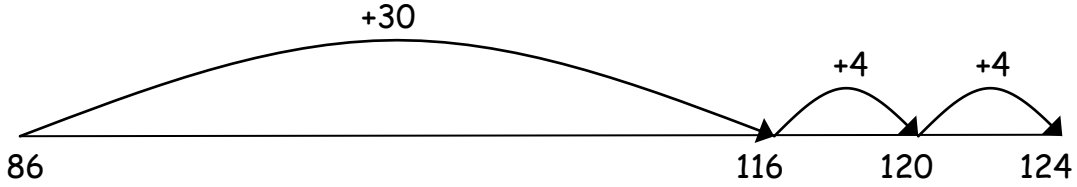
Bridging through ten can help children become more efficient.

37 + 15 = 52



Children will continue to use empty number lines with increasingly large numbers.

38 + 86 = 124 *Start with the bigger one of the two numbers to be added:*



Stage 2 - Partitioning

Children will begin to use informal pencil and paper methods (jottings) to support, record and explain partial mental methods building on existing mental strategies.

The next stage is to record mental methods using partitioning. Add the units and then the tens to form partial sums and then add these partial sums.

47 + 76 =

40 + 7
+ 70 + 6
110 + 13 = 123

Stage 3: Expanded method in columns

Move on to a layout showing the addition of the tens to the tens and the units to the units separately. To find the partial sums, either the tens or the units can be added first. The total of the partial sums can be found by adding them in any order. As children gain confidence, ask them to adopt the strategy of always adding the units digits first.

Adding the **units** first:

47
+ 76
13
110
123

The addition of the tens in the calculation 47 + 76 is described in the words 'forty plus seventy equals one hundred and ten', stressing the link to the related fact 'four plus seven equals eleven'.

We call these ***'chimney sums'***

The expanded method leads children to the more compact method so that they understand its structure and efficiency. The amount of time that should be spent teaching and practising the expanded method will depend on how secure the children are in their recall of number facts and in their understanding of place value.

Stage 4: Column method

In this method, recording is reduced further. Carry digits are recorded below the line, using the words 'carry ten' or 'carry one hundred', not 'carry one'.

625	783	367
+ 48	+ 42	+ 85
673	825	452
1	1	1 1

Column addition remains efficient when used with larger whole numbers and decimals. Once learned, the method is quick and reliable.

By the end of P7, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.

Children should not go onto the next stage if:

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

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

Written methods for **subtraction** of whole numbers

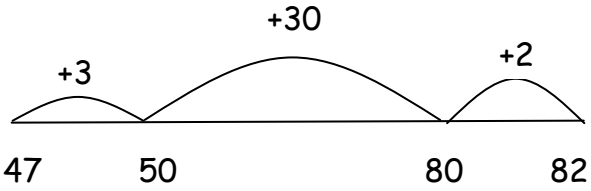
To subtract successfully, children need to be able to:

- recall all addition and subtraction facts to 20;
- subtract multiples of 10 (such as 160 – 70) using the related subtraction fact,16 – 7, and their knowledge of place value;
- partition two-digit and three-digit numbers into multiples of one hundred, ten and one in different ways (e.g. partition 74 into 70 + 4 or 60 + 14).

Stage 1 – The Counting Up Method – or counting back

The mental method of counting up from the smaller to the larger number can be recorded using a number line. The number of steps can be reduced by combining steps.
Keeping the numbers in the correct order on the number line, children can start at the bigger number and count back.

82 - 47



The jump from 82 to 80 is 2.
The jump from 80 to 50 is 30.
The jump from 50 to 47 is 3.

Children will continue to use empty number lines with increasingly large numbers.

The method can also be used with decimal numbers.

2 + 30 + 3 = 35
So 82 – 47 = 35

Stage 2 – Expanded Method (Partitioning)

Partitioning the numbers into tens and units and writing one under the other mirrors the column method, where units are placed under units and tens under tens.
This does not link directly to mental methods of counting back or up but parallels the partitioning method for addition. It also relies on secure mental skills.

This process should be demonstrated using arrow cards to show the partitioning and base 10 materials to show the decomposition of the number.

Initially, the children will be taught using examples that do not need the children to exchange.

$$\begin{array}{rrcl} 89 & = & 80 + 9 & \\ -\ 57 & & \underline{50 + 7} & \\ & & 30 + 2 & = 32 \end{array}$$

Exchange would be recorded in this way:

$$\begin{array}{rrcl} & {\scriptstyle 60} & & \\ & \cancel{7}0 + {}^{1}1 & & \\ -\ & \underline{40 + 6} & & \\ & 20 + 5 & = & 25 \end{array}$$

$$\begin{array}{rrcl} & {\scriptstyle 600} \quad {\scriptstyle 140} & & \\ & \cancel{7}\cancel{0}0 + \cancel{5}0 + {}^{1}4 & & \\ -\ & \underline{\qquad\quad 80 + 6} & & \\ & 600 + 60 + 8 & = & 668 \end{array}$$

Children should know that units line up under units, tens under tens, and so on.

Stage 3 – Compact Method (Decomposition)

$$\begin{array}{r} {\scriptstyle 6\ 14\ 1} \\ 7\not{3}\not{5}4 \\ -\ 86 \\ \hline 668 \end{array}$$

The expanded method leads children to the more compact method so that they understand its structure and efficiency. The amount of time that should be spent teaching and practising the expanded method will depend on how secure the children are in their recall of number facts and with partitioning.

It has been decided that we will use the term '**exchange**.'
In the example, we cannot take 6 away from 4 and so we **exchange** 5 tens for 4 tens and 10 units. Similarly we cannot take 8 away from 5 and so we exchange 7 hundreds for 6 hundreds and 10 tens.

By the end of P7, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.

Children should not go onto the next stage if:

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

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

Written methods for **multiplication** of whole numbers

To multiply successfully, children need to be able to:

- recall all multiplication facts to 10 × 10;
- partition number into multiples of one hundred, ten and one;
- work out products such as 70 × 5, 70 × 50, 700 × 5 or 700 × 50 using the related fact 7 × 5 and their knowledge of place value;
- add two or more single-digit numbers mentally;
- add multiples of 10 (such as 60 + 70) or of 100 (such as 600 + 700) using the related addition fact, 6 + 7, and their knowledge of place value;
- add combinations of whole numbers using the column method (see above).

Stage 1 – Mental Multiplication using partitioning

Mental methods for multiplying TU × U can be based on the distributive law of multiplication over addition. This allows the tens and ones to be multiplied separately to form partial products. These are then added to find the total product.

43 x 6 = 40 x 6 = 240
3 x 6 = 18
258

Stage 2 – The Grid Method

As a staging post, an expanded method which uses a grid can be used. This is based on the distributive law and links directly to the mental method. It is an alternative way of recording the same steps.

43 x 6 =

X	6
40	240
3	18

258

It is better to place the number with the most digits in the left-hand column of the grid so that it is easier to add the partial products.

The grid method may be the main method used by some children throughout primary school.

Stage 3 – Short Multiplication

The recording is reduced further, with carry digits recorded below the line.

$$\begin{array}{r} 43 \\ \times\ 6 \\ \hline 258 \\ {\scriptstyle 1} \end{array}$$

If, after practice, children cannot use the compact method without making errors, they should return to the expanded format of stage 2.

Stage 4 – Two-digit by two-digit products

Start with the grid method. The partial products in each row are added, and then the two sums at the end of each row added to find the total product.

56 x 27 =

x	20	7	
50	1000	350	1350
6	120	42	162
			1512

Reduce the recording, showing the links to the grid method above.

$$\begin{array}{r} 56 \\ \times\ 27 \\ \hline 350 \\ 42 \\ 1000 \\ 120 \\ \hline 1512 \end{array}$$

50 x 7 = 350
6 x 7 = 42
50 x 20 = 1000
6 x 20 = 120

Leading to

$$\begin{array}{r} 56 \\ \times\ 27 \\ \hline 392 \\ 1120 \\ \hline 1512 \end{array}$$

56 x 7
56 x 20

The aim is for most children to use this long multiplication method for TU × TU by the end of P6.

Children who are already secure with multiplication for TU × U and TU × TU should have little difficulty in using the same method for HTU × TU.

By the end of P7, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.

Children should not go onto the next stage if:

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

Children should be encouraged to approximate their answers before calculating.

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

Written methods for **division** of whole numbers

To divide successfully in their heads, children need to be able to:

- understand and use the vocabulary of division – for example in 18 ÷ 3 = 6, the 18 is the dividend, the 3 is the divisor and the 6 is the quotient;
- partition two-digit and three-digit numbers into multiples of 100, 10 and 1 in different ways;
- recall multiplication and division facts to 10 × 10, recognise multiples of one-digit numbers and divide multiples of 10 or 100 by a single-digit number using their knowledge of division facts and place value;
- know how to find a remainder working mentally – for example, find the remainder when 48 is divided by 5;
- understand and use multiplication and division as inverse operations.

Note: *It is important that children's mental methods of calculation are practised and secured alongside their learning and use of an efficient written method for division.*

To carry out written methods of division successfully, children also need to be able to:

- understand division as repeated subtraction;
- estimate how many times one number divides into another – for example, how many sixes there are in 47, or how many 23s there are in 92;
- multiply a two-digit number by a single-digit number mentally;
- subtract numbers using the column method.

Stage 1 – Short division of TU ÷ U

'Short' division of TU ÷ U can be introduced as a more compact recording of the mental method of partitioning.

81 ÷ 3 =

$$\begin{array}{r} 27 \\ 3\overline{)81^{2}1} \end{array}$$

Short division of a two-digit number can be introduced to children who are confident with multiplication and division facts and with subtracting multiples of 10 mentally, and whose understanding of partitioning and place value is sound.

For most children this will be at the end of P5 or the beginning of P6.

Stage 2 – Expanded Method for HTU ÷ U

This method, often referred to as 'chunking', is based on subtracting multiples of the divisor, or 'chunks'.

$$
\begin{array}{rll}
6\overline{)196} & & \\
-\ 60 & 6\times10 & \\
136 & & \\
-\ 60 & 6\times10 & \\
76 & & \\
-\ 60 & 6\times10 & \\
16 & & \\
-\ 12 & 6\times\ 2 & \\
4 & 32 & \\
\text{Answer:} & 32\text{ R }4 &
\end{array}
$$

This method, often referred to as 'chunking', is based on subtracting multiples of the divisor, or 'chunks'. Initially children subtract several chunks, but, with practice, they should look for the biggest multiples of the divisor that they can find to subtract.

However, children need to recognise that chunking is inefficient if too many subtractions have to be carried out. Encourage them to reduce the number of steps and move them on quickly to finding the largest possible multiples.

Stage 3 - Long division

The next step is to tackle HTU ÷ TU, which, for most children, will be in P7.

$$
\begin{array}{rll}
24\overline{)\ 560} & & \\
-\ 480 & 24\times20 & \\
80 & & \\
\ \ 72 & 24\times3 & \\
8 & & \\
\text{Answer: } 23\text{ R }8 & &
\end{array}
$$

The layout on the left, which links to chunking, is in essence the 'long division' method. Recording the build-up to the quotient on the left of the calculation keeps the links with 'chunking' and reduces the errors that tend to occur with the positioning of the first digit of the quotient.

By the end of P7, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.

Children should not go onto the next stage if:

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

Children should be encouraged to approximate their answers before calculating.

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

Year	Level for 'On track' at the end of the year	Addition	Subtraction	Multiplication	Division
P1	Early secure	Add single digits e.g. 5 + 3	Subtract single digits e.g. 9 - 4		
P2	First developing	7 + 3 + 8 + 2	25 – 12	6 x 5p (in context and using materials)	12 ÷ 4 (sharing materials)
P3	First consolidating	24 + 19 24 + 67 + 45	30 – 15 63 - 28	6 x 3 (in context) 12 x 5 (in context)	18 ÷ 5 (sharing materials)
P4	First secure	369 + 251	120 – 51	4 x 20	£1.48 ÷ 2
P5	Second developing	130 + 215 + 106	£5.00 – 82p	600 × 4	56 ÷ 4
P6	Second consolidating	1202 + 45 + 367	438 – 296	549 × 6	847 ÷ 7
P7	Second secure	10.8 + 6.5	13.6 – 2.8	417 x 20	*621 ÷ 7*
	Third developing	52.85 + 143.6	15.05 – 14.84	143 × 37	848 ÷ 16