Park Way Maths Calculation Policy

April 2018

INTRODUCTION

The 2014 National Curriculum provides a structured and systematic approach to the teaching of calculation. The aim is for mental calculations and written procedures to be performed efficiently, fluently, accurately with understanding. Procedures and understanding are to be developed in tandem. End of key stage expectations are explicit in the programme of study.

At Park Way Primary School, we have a consistent approach to the teaching of written calculation methods in order to ensure continuity and progression across the school.

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

Age related expectations:

This calculation policy is organised according to age appropriate 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,** being moved onto the next level as soon as they are ready, or working at a lower stage until they are secure enough to move on.

The Primary National Strategy provides a structured and systematic approach to teaching number. There is a considerable emphasis on teaching mental calculation strategies in KS1.

Addition and Subtraction

In Year 1 children should be *'using concrete objects and pictorial representations, and missing number problems such as 7 = ? - 9.*
In Year 2 in problem solving, children should be *'applying their increasing knowledge of mental and written methods'.* They should *'add and subtract numbers using concrete objects, pictorial representations, and mentally.'*

Multiplication and Division

In Year 1 children should *'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'.*
In Year 2 children should *'solve problems involving multiplication and division, using materials, arrays, repeated addition, mental methods, and multiplication and division facts, including problems in contexts'.*

When teaching addition, subtraction, multiplication and division, informal written recording should take place regularly and is an important part of learning and understanding. **More formal written methods** should follow **only** when the child is able to use a wide range of mental calculation strategies.

Providing a context for calculation:

It is important that any type of 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.

It is also important for children to be confident to use **manipulatives**, **mental** and **written** strategies to explain their thinking**.** This must be a priority within calculation lessons**.** Written methods need to be viewed as tools to enable children to solve problems and record their thinking in an organised way.

REASONS FOR USING WRITTEN METHODS

- To aid mental calculation by writing down some of the numbers and answers involved
- To make clear a mental procedure for the pupil
- To help communicate methods and solutions
- To provide a record of work to be done
- To aid calculation when the problem is too difficult to be done mentally
- To develop and refine a set of rules for calculation

Aims:
Children should be able to use an efficient way, either through **manipulatives, mental** or **written** methods, appropriate to the given task, with understanding. By the end of year 6, children will have been taught a compact standard method for each operation in which they will feel secure in.

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 manipulatives to help me? If so, which will be best?
- Do I need to use an expanded or compact written method?

Pre requisite skills for written calculations

Addition and subtraction:

- Do they know all the addition and subtraction facts for all numbers to 20?
- Do they understand place value and can they partition and then re-partition numbers?
- Can they add three single digit numbers mentally?
- Can they add and subtract any pair of two digit numbers mentally?
- Can they explain their mental strategies orally and record them using informal jottings?

Multiplication and Division:

- Do they know the 2, 3, 4, 5 and 10 times tables and corresponding division facts?
- Do they know the result of multiplying by 1 and 0?

- Do they understand 0 as a place holder?
- Can they multiply two and three digit numbers by 10 and 100?
- Can they double and halve two digit numbers mentally?
- Can they use multiplication and division facts they know to derive mentally other multiplication and division facts that they do not know?
- Can they explain their mental strategies orally and record them using informal jottings?

These lists are not exhaustive but are a guide for the teacher as they structure the move from informal to formal methods of calculation. It is vitally important that children's mental methods of calculation continued to be practised and secured alongside their learning and use of an efficient written method for each operation.

Park Way Primary School - Whole School Approach

Mental methods will be established. These will be based on a solid understanding of place value in number and will include the following:

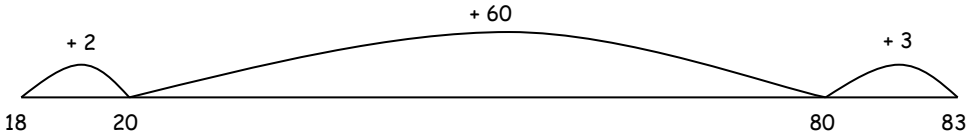
i. Remembering number facts and recalling them without hesitation
e.g. pairs of numbers which make 10
Doubles & halves to 20

ii. Using known facts to calculate unknown facts
e.g. 6 + 6 = 12 therefore 6 + 7 = 13
24 + 10 = 34 therefore 24 + 9 = 33

iii. Understanding and using relationships between addition & subtraction to find answers and check results
e.g. 14 + 6 = 20 therefore 20 – 6 = 14

iv. Having a repertoire of mental strategies to solve calculations
e.g. doubles / near doubles
bridging 10 / bridging 20

v. Making use of informal jottings such as blank number lines to assist in calculations with larger numbers *e.g.83 – 18 = 65*



vi. Solving one-step word problems (either mentally or with jottings) by identifying which operation to use, drawing upon their knowledge of number bonds and explaining their reasoning

vii. Beginning to present calculations in a horizontal format and explain mental steps using numbers, symbols or words

viii. Learn to estimate/approximate first e.g. 29 + 30 (round up to nearest 10, the answer will be near to 60).

Place value will be taught mentally first from Reception class, progressing to number lines (to 10, 20 or 30 as appropriate) in Years 1 and 2. The empty number line will then be introduced to aid calculations.

Subtraction will be taught by counting on and counting back depending on the numbers.

WHEN ARE CHILDREN READY FOR WRITTEN CALCULATIONS?

To develop efficient written calculation strategies children need:

- Secure mental methods which are developed from early years
- A solid understanding of the number system
- Practical hands on experience including a range of **manipulatives**
- Visual models and images including number lines, arrays and bar modelling.
- Experience of expanded methods to develop understanding and avoid rote learning
- Secure understanding of each stage before moving onto the next.

A pathway to teaching calculation methods:

Expanded methods should be viewed as steps towards a standard method and not as methods in themselves.
Before beginning to record in a more refined written format children must have had significant practical work reinforced with appropriate **manipulatives**, **models** and **images**.
Teachers will guide pupils to refine their written methods of recording by modelling and asking questions such as "What is the same? What is different?"
Learning will be planned to ensure **all** pupils are encouraged to use and apply what they have learnt to problem solving tasks.
As children move along the pathway it is vital that they practice, reinforce, consolidate, use and apply it to mathematical learning and NOT simply move onto the next step.

Point to note:
Teachers should refer to the Programme of Study for key vocabulary for each year group.

Progression of mental calculation strategies

Year	Mental Strategies **Most children should be able to use the following strategies as appropriate for mental calculations:**
Year R	• Say and use the number names in order in familiar contexts. • Recite the number names in order continuing the count forwards or backwards from a given number. • Count reliably up to 10 everyday objects. • Begin to recognise none and zero. • Count reliably in other contexts, e.g. clapping sounds or hopping movements. • Count on in tens • Count on in twos. • Count on in fives. • Estimate a number in the range that can be counted reliably, then check by counting.
Year 1	• Count to and across 100, forward and backwards, beginning with 0 or 1, or from any given number. • Count in multiples of twos, fives and tens. • Given a number, identify one more and one less. • Identify and represent numbers using objects and pictorial representations including the number line, and use the language of; equal to, more than, less than (fewer), most, least. • Reorder numbers in a calculation.

	• Find a small difference by counting up from the smaller to the larger number. • Use known number facts and place value to add or subtract pairs of single digit numbers. • Add 9 to single digit numbers by adding 10 then subtracting 1. • Identify near doubles using doubles already known e.g. 6+6 leading to 6+7. • Use patterns of similar calculations, e.g. 10+6 = 16 so 10+16 = 26.
Year 2	• Count in steps of 2, 3 and 5 from 0, and in tens from any number, forward and backward. • Add three or four small numbers by putting the largest number first and/or find a pair totalling 10. • Recognise the place value of each digit in a two digit number (tens and ones). • Partition into tens and units and recombine. • Identify, represent and estimate numbers using different representations, including the number line. • Compare and order numbers from 0 up to 100. • Use <, > and = signs. • Bridge through 10 or 20. • Bridge through a multiple of 10 and adjust. • Use known number facts and place value to add or subtract pairs of numbers. • Partition into '5 and a bit' when adding 6, 7, 8, & 9, then recombine. • Add or subtract 9, 19, 11, or 21 by rounding and compensation e.g. 12+9 = 12+10-1. • Add or subtract mentally a near multiple of 10 to/from a two-digit number. • Identify near doubles. • Use patterns of similar calculations. • Use the relationship between addition and subtraction. • Say or write a subtraction statement corresponding to a given addition statement. • Use knowledge of number facts and place value to multiply or divide by 2, 3, 4, 5, 10 or 100. • To multiply a number by 10/100, shift its digits 1/2 places to the left. • Use doubles and halves, and recognise that halving is the inverse of doubling. • Say or write a division statement corresponding to a given multiplication statement.

Year	**<u>Mental Calculations</u> Most children should be able to calculate mentally:**
Year R	**In practical activities:** • Find one more or one less than a number from one to ten • Begin to relate addition to combining two groups of objects, extend to three groups. • Begin to relate addition to counting on. • Begin to relate the addition of doubles to counting on. • Find a total by counting on, when one group of objects is hidden. • Separate (partition) a given number of objects into two groups. • Select two groups of objects to make a given total. • Begin to relate subtraction to taking away and counting how many are left. • Remove a smaller number from a larger and find how many are left by counting back from the larger number. • Begin to find how many have been removed from a larger group of objects by counting up from a number. • Work out by counting how many more needed to make a larger number.
Year 1	• Add and subtract a one-digit number to or from a one-digit number without crossing 10, e.g. 4+5, 8-3. • Add and subtract one-digit and two-digit numbers to 20, including zero. • Add and subtract a single-digit number to or from a teen number without crossing 20 or 10, e.g. 13+5, 17-3. • Doubles of all numbers to 10 e.g. 8+8, and double 6. • Solve one step problems that involve + and - using concrete objects and pictorial

	representations, and missing numbers such as 7 = ? - 9 • Solve one step problems involving multiplication or division, by calculating the answer using concrete objects, pictorial representations and arrays, moving onto mental calculations counting in twos, fives and tens. • Recognise, find and name a half as one of two equal parts of an object, shape or quantity. • Recognise, find and name a quarter as one of four equal parts of an object, shape or quantity.
Year 2	• Add and subtract any single-digit to or from any two-digit number without crossing the tens boundary e.g. 62+4, 38-7. • Add and subtract any single-digit to or from a multiple of 10 e.g. 60+5, 80-7. • Add or subtract any teens number to any two-digit number without crossing the tens boundary, e.g. 23+14. 48-13. • Add and subtract any pair of two-digit numbers without crossing a tens boundary or 100, e.g. 33+45, 87-22. • Add and subtract any single-digit to any two-digit number including crossing the tens boundary. e.g. 67+5, 82-7. • Add and subtract a multiple of 10 to or from any two-digit number without crossing 100 e.g. 47+30, 82-50. • Find what must be added to any two-digit multiple of 10 to make 100, e.g. 70+? = 100. • Find what must be added to any multiple of 100 to make 1000, e.g. 300+ ? = 1000. • Find what must be added to or subtracted from any two-digit number to make the next higher or lower multiple of 10, e.g. 64+? = 70, 56-? = 50. • Find what must be added to or subtracted from any three-digit number to make the next higher or lower multiple of 10 e.g. 647+? = 650, 246-? = 240. • Subtract any two-digit number from any two-digit number when the difference is less than 10 e.g. 78-71, 52-48. • Subtract any three-digit number from any three-digit number when the difference is less than 10 e.g. 458-451, 603-597. • Doubles of all numbers to at least 20, e.g. double 14 and corresponding halves e.g. halve 28. • Double any multiple of 5 up to 100, e.g. double 35 and corresponding halves e.g. halve 70. • Double any multiple of 10 up to 1000 e.g. double 450, and corresponding halves, e.g. halve 900. • Multiply single-digit numbers by 10 or 100 e.g. 6x100 • Divide any multiple of 10 by 10 e.g. 60 ÷ by 10, and any multiple of 100 by 100 e.g. 700 ÷ by 100. • Show that addition of two numbers can be done in any order (commutative) and subtraction of one number from another cannot. • Recognise and use the inverse relationship between addition and subtraction and use this to check calculations and missing number problems. • Recall and use multiplication and division facts for the 2, 5 and 10 multiplications tables, including recognising odd and even numbers. Calculate mathematical statements for multiplication and division within the multiplication tables and write them using multiplication (x) and division ($\div$) and equals signs (=). • Show that multiplication of two numbers can be done in any order (commutative) and division cannot. • Solve problems involving x and $\div$, using materials, arrays, repeated addition, mental methods and x and $\div$ facts, including problems in context. • Recognise, find, name and write fractions, 1/3, $\frac{1}{2}$, $\frac{1}{4}$, 2/4 and $\frac{3}{4}$ of a length, shape, set of objects or quantity. • Write simple fractions, eg, $\frac{1}{2}$ of 6 = 3 and recognise the equivalence of 2/4 and $\frac{1}{4}$.

Stages in Addition

Introduced in Year 1/2

- **Use concrete objects/manipulatives.**
- **Use representations.**
- **Use numbered number lines and 100 squares, blank number lines Year 2.**
- **Using informal jottings with larger numbers**

(the empty numberline) 42 + 17

- **Develop informal pencil and paper methods for additions that cannot be done mentally**

47 + 76 = (40 + 70) + (7 + 6)

or

47 + 76 = (47 + 70) + 6

Year 3

- **Introduction to vertical layout, using partitioning**

76 + 47 =

70	+	6	
40	+	7	
110	+	13	= 123

478 + 387 =

400	+	70	+	8
300	+	80	+	7
700	+	150	+	15 = 865

Year 4

- **Vertical layout, expanded working**

76	493
+ 47	+ 368
13	11
110	150

123	700
	861

By the end of Year 4

- **Vertical layout, contracting the working to a compact efficient form:**

76	493
+ 47	+368
123	861
1 1	1 1

Year 5 and 6

- **Extend written methods to column addition of two integers less than 10,000**

Add several numbers with different number of digits

- **Extend column addition to decimal amounts of money, lengths, and weights.**

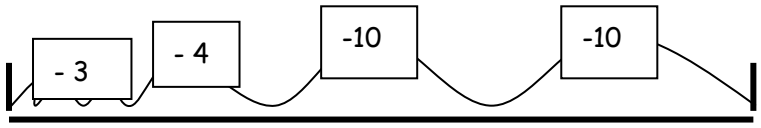
- **Decimals with one or two decimal places**

Stages in Subtraction

Introduced in Year 1/2

- **Using informal jottings with larger numbers**
- **Use representations.**
- **Use numbered number lines and 100 squares, blank number lines Year 2.**
- **Use concrete objects/manipulatives.**

(The empty numberline) 34 - 27



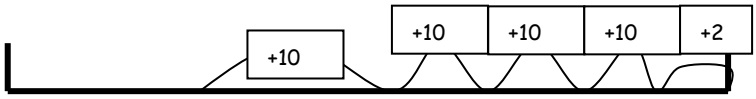
7 8 9 10 14 24 34

- **Develop informal pencil and paper methods for subtractions that cannot be done mentally**

67 – 25 67 – 20 = 47

47 – 5 = 42

Counting on to find a difference



0 **25** 35 45 55 65 **67**

Year 3/4

- **Introduction to vertical layout, no decomposition**

67 – 25 =

60	+ 7	
20	+ 5	
40	+ 2	= 42

563 – 241 =

500	+ 60	+ 3	
200	+ 40	+ 1	
300	+ 20	+ 2	= 322

By the end of Year 4 onwards

- **Vertical layout, contracting the working to a compact efficient form, no decomposition**

563 – 241 =

	5	6	3
-	2	4	1
	3	2	2

- **Vertical layout, one step decomposition**

81 – 57

80	1	→	70	11	
50	7	→	50	7	
			20	4	= 24

- **Vertical layout, two step decomposition**

563 – 278 =

500	60	3	→	400	150	13	
200	70	8	→	200	70	8	
				200	80	5	= 285

- **Vertical layout, contracting the working to a compact efficient form, with decomposition**

563 – 278 =

	$^{4}\cancel{5}$	$^{15}\cancel{6}$	$^{1}3$
-	2	7	8
	2	8	5

Stages in Multiplication

By the end of Year 4 ALL children should know their times tables up to 12 x 12.

Introduced in Year 1/2

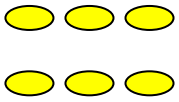
- **Use manipulatives,ie, Diennes, Cuisiennierre Rods**
- **Counting in twos, fives and tens.**
- **Use the bar model method**
- **Understand the operation of multiplication as repeated addition (Y2) or as describing an array**

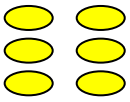
Make arrays practically

Draw on squared paper

Use x and = to record mental calculations

3 lots of / groups of 2
2 lots of / groups of 3
3 + 3 = 6
2 + 2 + 2 = 6
3 x 2 = 6
2 x 3 = 6





Year 3

- **Mental method using partitioning multiplying tens first: 38 x 7**

38 x 7 = (30 x 7) + (8 x 7) = 210 + 56 = 266

Year 4 onwards (as and when children are ready to progress, refer to the New Curriculum for additional guidance)
(NB, The grid layout may only be used as a teacher tool for modelling, the vertical format will be taught as the main method of recording.)

- **Grid layout: 38 x 7**

x	30	8	
7	210	56	= 266

- **Vertical format, expanded working**

```
   38
x   7
  210  (30x7)
   56  (8x7)
  266
```

OR

```
   38
x   7
   56  (8x7)
  210  (30x7)
  266
```

- **Grid and vertical layouts – extend to bigger numbers i.e. 238 x 7**

x	200	30	8	
7	1400	210	56	= 1666

```
   238
x    7
    56   (8x7)
   210   (30x7)
  1400   (200x7)
  1666
```

- **Grid and vertical layouts – extend to bigger numbers i.e. 1453 x 3**

x	1000	400	50	3	
3	3000	1200	150	9	= 4359

```
   1453
x     3
      9    (3x3)
    150    (50x3)
   1200    (400x3)
   3000    (1000x3)
   4359
```

- **Grid layout – extend to bigger numbers i.e. 56 x 27**

56 x 27 = (50 + 6) x (20 + 7)

x	50	6	

20	1000	120	1120
7	350	42	392
			1512

- **Vertical format – extend to TU x TU (long multiplication)**

```
    56
x   27
  1000   (50 x 20)
   120    (6 x 20)
   350    (50 x 7)
    42     (6 x 7)
  1512
```

- **Vertical format, compact working**

```
    56
x   27
  1120   (56 x 20)
   392    (56 x 7)
  1512
   1
```

```
    56
x   27
   392   (56 x 7)
  1120   (56 x 20)
  1512
   1
```

Year 6

- **Revise and extend, incorporating larger numbers, integers and decimals.**

Stages in Division

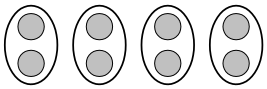
Year 1

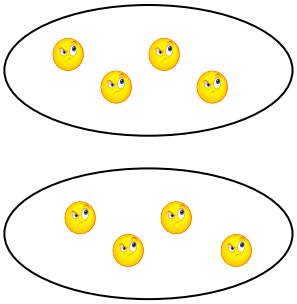
- **Sharing as practical activities.**
- **Introduce the division sign.**

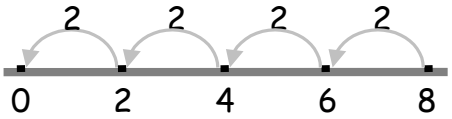
Year 2/3

- **Use of manipulatives.**
- **Use the bar model method.**
- **Number lines, grouping and sharing**

8 ÷ 2 =







Year 4 onwards (as and when children are ready to progress, refer to New Curriculum for additional guidance)

- **Develop and refine written methods for division**
- **Divide a two-digit number by a single-digit, using multiples of the divisor**

  27 ÷ 6 =

  'How many 6's can I take from 27?'

```
  27
- 6
  21
- 6
  15
- 6
   9
- 6
```

27 ÷ 6 = 4 r.3

repeated subtraction

- **Introduction of 'chunking' and contracted methods for division**
  - **TU ÷ U**

72 ÷ 5			72
	5 x 10	= 50	- 50
			22
	5 x 4	= 20	- 20
Answer: 14 r 2	14		2

$$\begin{array}{r} 1\ 2\ \text{r}\ 4 \\ 5\overline{)7^{1}2} \end{array}$$

  - **HTU ÷ U**

256 ÷ 7			256
	7 x 10	= 70	- 70
Approximate answer			186
280 ÷ 7 = 40	7 x 20	= 140	- 140
			46
	7 x 6	= 42	- 42
Answer: 36 r 4	36		4

$$\begin{array}{r} 3\ 6\ \text{r}\ 4 \\ 7\overline{)2^{2}5^{4}6} \end{array}$$

  - **Efficient 'chunking' HTU ÷ U**

196 ÷ 6			196
	6 x 30	= 180	- 180
Approximate answer			16
180 ÷ 6 = 30	6 x 2	= 12	- 12
Answer: 32 r 4	32		4

- **HTU ÷ TU**

560 ÷ 24				560
	24 x	10	= 240	- 240
Approximate answer				320
550 ÷ 25 = 22	24 x	10	= 240	- 240
				80
	24 x	2	= 48	-48
				32
	24 x	1	= 24	-24
Answer: 23 r 8		23		8

$$\begin{array}{r} 23\text{ r }8 \\ 24\overline{)56^{8}0} \end{array}$$

- **Efficient 'chunking' HTU ÷ TU**

560 ÷ 24			560
	24 x	20	- 480
Approximate answer			80
550 ÷ 25 = 22	24 x	3	-72
Answer: 23 r 8		23	8

- **Extend contracted form for larger numbers and decimals with 1, then 2 and 3 decimal places.**

$$\begin{array}{r} 1\,2.5 \\ 7\overline{)\,8^{1}7.^{3}5} \end{array}$$

- **In long division use decimals rather than remainders.**

Summary

- Children should always estimate first
- Always check the answer, preferably using a different method eg. the inverse operation
- Always decide first whether a mental method is appropriate
- Pay attention to language - refer to the actual value of digits
- Children who make persistent mistakes should return to the method that they can use accurately until ready to move on
- Children need to know number and multiplication facts by heart
- Discuss errors and diagnose problem and then work through problem - do not simply re-teach the method
- When revising or extending to harder numbers, refer back to expanded methods. This helps reinforce understanding and reminds children that they have an alternative to fall back on if they are having difficulties.