

Park Hill Junior School

Routes through Formal Written Calculations


January 2015

This is the policy for written calculations at Park Hill Junior School. It covers how **formal written methods** for arithmetic are modelled and recorded in Years 3, 4, 5 and 6.

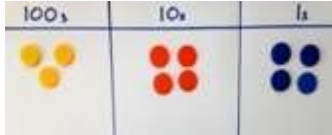
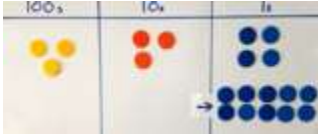
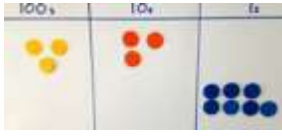
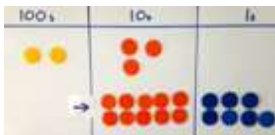


There is a separate policy for mental calculations (and informal recording) that covers both Thorns Infant School and Park Hill Junior School.

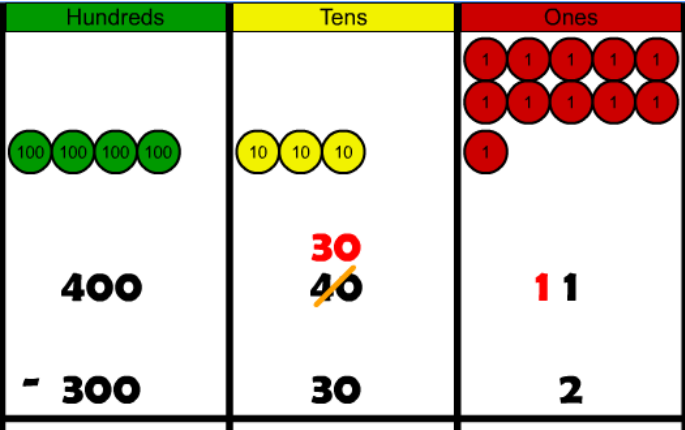
The policy is based on the following ideas:

- Children should develop a clear conceptual understanding of arithmetic processes.
- Children should develop a secure understanding of efficient written algorithms for arithmetic.
- Addition and subtraction should be introduced together, with explicit links between them.
- The role of place value in arithmetic processes should be modelled and made clear.

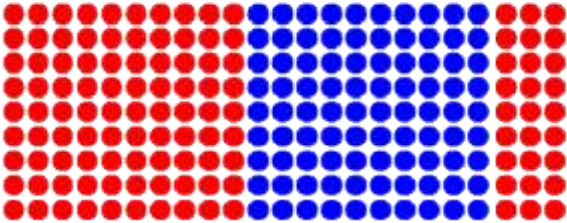
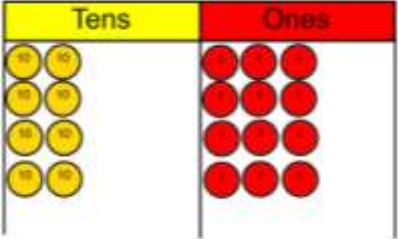
Addition	Visual Representations	Written Recording
<p>Year 3</p> <ul style="list-style-type: none"> add and subtract numbers with up to three digits, using formal written methods of columnar addition and subtraction estimate the answer to a calculation and use inverse operations to check answers 	<p>Place Value Equipment on base grids- Hundreds, Tens and Units</p> <p>Place Value Counters on base grids – Hundreds, Tens and Units</p>  <p>Place Value Cards – Hundreds, Tens and Units</p> <p>400 + 70 + 9</p> <p>400 + 70 + 6</p>	<p>Build on partitioning to develop expanded column addition with two 3-digit numbers e.g. $466 + 358$</p> $\begin{array}{r} 400 & 60 & 6 \\ + & 300 & 50 & 8 \\ \hline 700 & 110 & 14 & = 824 \end{array}$ <p>Use expanded column addition with exchange where digits in a column add to more than the column value e.g. $466 + 358$</p> $\begin{array}{r} 400 & 60 & 6 \\ 300 & 50 & 8 \\ + & 100 & 10 \\ \hline 800 & 20 & 4 \end{array}$ <p>Compact column addition with two or more 3-digit numbers or towers of 2-digit numbers e.g. $347 + 286 + 495$</p> $\begin{array}{r} 347 \\ 286 \\ + 495 \\ \hline 1128 \end{array}$ <p>Compact column addition with 3- and 4-digit numbers</p>

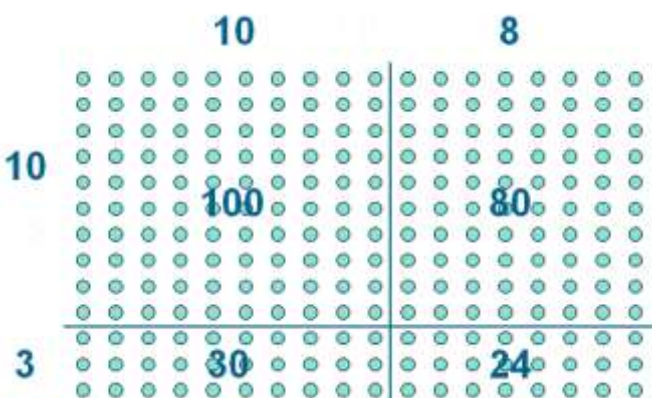
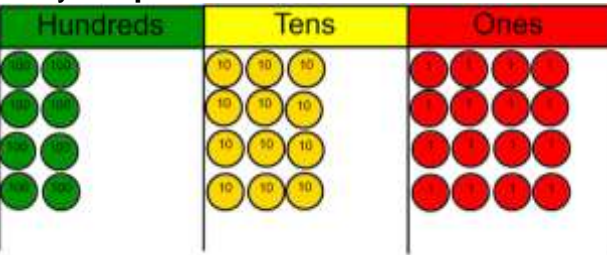
Addition	Visual Representations	Written Recording
Year 4 <ul style="list-style-type: none"> ▪ add and subtract numbers with up to 4 digits using the formal written methods of columnar addition and subtraction where appropriate ▪ estimate and use inverse operations to check answers to a calculation 	Place Value Counters on Grids – Thousands, Hundreds, Tens and Units Place Value Cards - Thousands, Hundreds, Tens and Units Money – Notes and Coins	Build on expanded column addition to develop compact column addition with larger numbers e.g. $1466 + 4868$ $ \begin{array}{r} 1000 \quad 400 \quad 60 \quad 6 \\ 4000 \quad 800 \quad 60 \quad 8 \\ + 1000 \quad 100 \quad 10 \\ \hline 6000 \quad 300 \quad 30 \quad 4 \end{array} $ Compact column addition with larger numbers e.g. $5347 + 2286 + 1495$ $ \begin{array}{r} 5347 \\ 2286 \\ + 1495 \\ \hline 9128 \end{array} $ Use expanded and compact column addition to add amounts of money


Subtraction	Visual Representations	Written Recording
<p>Year 3</p> <ul style="list-style-type: none"> add and subtract numbers with up to three digits, using formal written methods of columnar addition and subtraction estimate the answer to a calculation and use inverse operations to check answers 	<p>Bead Strings and Number Lines</p> <p>Place Value Equipment – Hundreds, Tens and Units Place value counters <i>'Where's the one hundred and eighty and seven?'</i></p>  <p><i>Exchange to create three hundred and thirty and fourteen</i></p>  <p><i>Now take away the 'seven'</i></p>  <p><i>Exchange to create two hundred, thirteen tens and seven</i></p>  <p><i>Now take away the 'eighty'</i></p>  <p><i>Now take away the 'one hundred'</i></p> 	<p>Expanded column subtraction with 2- and 3-digit numbers e.g. $148 - 35$</p> $ \begin{array}{r} 100 \ 40 \ 8 \\ - \quad 30 \ 5 \\ \hline 100 \ 10 \ 3 \end{array} $

Subtraction	Visual Representations	Written Recording
<p>Year 4</p> <ul style="list-style-type: none"> add and subtract numbers with up to 4 digits using the formal written methods of columnar addition and subtraction where appropriate estimate and use inverse operations to check answers to a calculation 	<p>Place Value Counters on Grids – Thousands, Hundreds, Tens and Units</p>  <p>Place Value Cards - Thousands, Hundreds, Tens and Units</p>	<p>Expanded column subtraction with 3- and 4-digit numbers e.g. $726 - 358$</p> $\begin{array}{r} 600 & 110 & 16 \\ \cancel{700} & \cancel{20} & \cancel{8} \\ - 300 & 50 & 8 \\ \hline 300 & 60 & 8 \end{array}$ <p>Begin to develop compact column subtraction e.g. $726 - 358$</p> $\begin{array}{r} 6 & 11 & 16 \\ \cancel{7} & \cancel{2} & \cancel{8} \\ - 3 & 5 & 8 \\ \hline 3 & 6 & 8 \end{array}$
<p>Year 5</p> <ul style="list-style-type: none"> add and subtract whole numbers with more than 4 digits, including using formal written methods (columnar addition and subtraction) use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy 	<p>Place Value Counters on Grids – including Tenths and Hundredths</p> <p>Place Value Cards – including Tenths and Hundredths</p> <p>Money – Notes and Coins</p>	<p>Compact column subtraction for numbers with up to 5 digits e.g. $16324 - 8516$</p> $\begin{array}{r} 0 & 15 & 13 & 1 & 14 \\ \cancel{1} & \cancel{6} & \cancel{3} & \cancel{2} & \cancel{4} \\ - 8 & 5 & 1 & 6 & \\ \hline 7 & 8 & 0 & 8 & \end{array}$

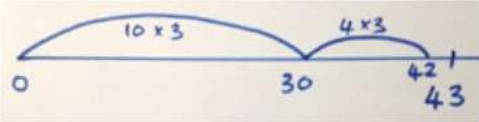

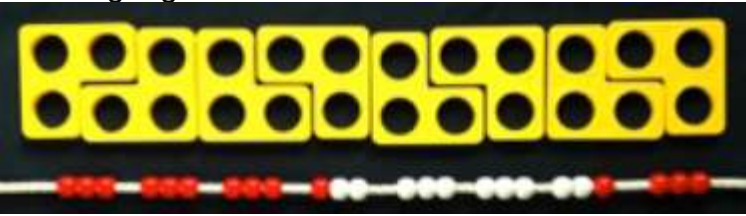
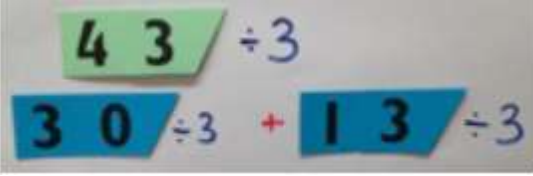
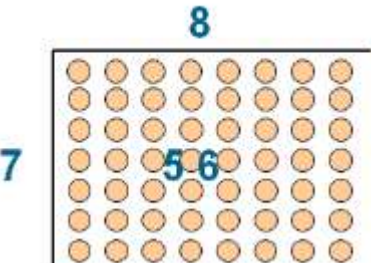
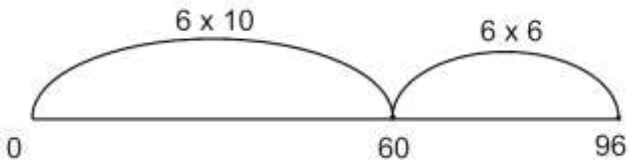
Subtraction	Visual Representations	Written Recording
<p>Year 6</p> <ul style="list-style-type: none">▪ solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why▪ solve problems involving addition, subtraction, multiplication and division▪ use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy.		<p>Compact column subtraction for large numbers e.g. $34\,685 - 16\,458$</p> $\begin{array}{r} 2\ 14\ \ \ \ 7\ 15 \\ \cancel{3}\ \cancel{4}\ 6\ \cancel{8}\ \cancel{5} \\ - 1\ 6\ 4\ 5\ 8 \\ \hline 1\ 8\ 2\ 2\ 7 \end{array}$

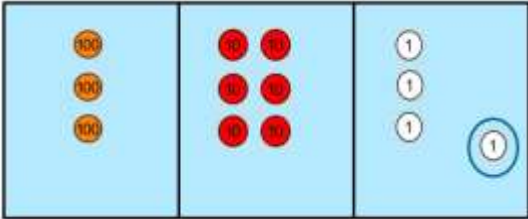
Multiplication	Visual Representations	Written Recording								
<p>Year 3</p> <ul style="list-style-type: none"> write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods 	<p>Arrays of counters</p> <p style="text-align: center;">$23 \times 9 = ?$</p>  <p>Place Value Equipment in arrays</p> <p>Place Value Counters in arrays</p> 	<p>Build on partitioning to develop grid multiplication</p> <p>e.g. 23×4</p> <table border="1" data-bbox="1377 263 1612 383"> <tr> <td style="text-align: center;">×</td> <td style="text-align: center; color: green;">20</td> <td style="text-align: center; color: orange;">3</td> <td></td> </tr> <tr> <td style="text-align: center;">4</td> <td style="text-align: center;">80</td> <td style="text-align: center;">12</td> <td style="text-align: center;">= 92</td> </tr> </table>	×	20	3		4	80	12	= 92
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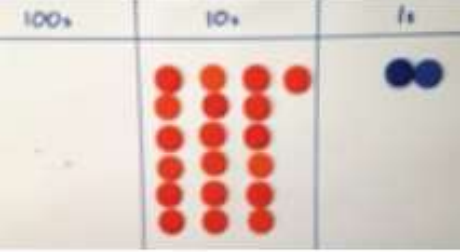
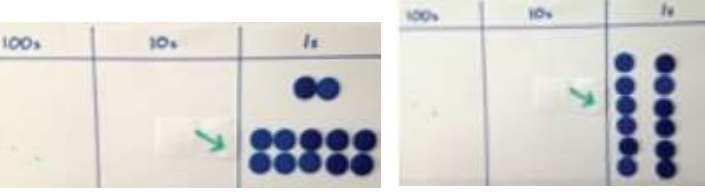
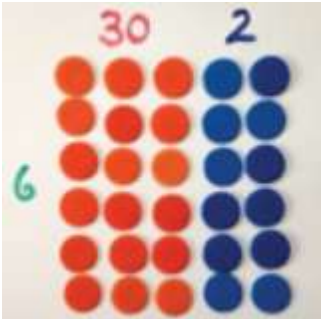
Multiplication	Visual Representations	Written Recording																										
<p>Year 4</p> <ul style="list-style-type: none"> multiply two-digit and three-digit numbers by a one-digit number using formal written layout 	<p>Arrays of counters 18x13 by partitioning</p>  <p>$100 + 80 + 30 + 24 = 224$</p> <p>Arrays of place value counters</p> 	<p>Use grid multiplication to multiply 3-digit numbers by 1-digit numbers e.g. 253×6</p> <table border="1" data-bbox="1377 263 1836 375"> <tr> <td>×</td> <td>200</td> <td>50</td> <td>3</td> <td></td> </tr> <tr> <td>6</td> <td>1200</td> <td>300</td> <td>18</td> <td>= 1518</td> </tr> </table> <p>Use a vertical written algorithm (ladder) to multiply 3-digit numbers by 1-digit numbers e.g. 253×6</p> $ \begin{array}{r} 253 \\ \times 6 \\ \hline 1200 \leftarrow 6 \times 200 \\ 300 \leftarrow 6 \times 50 \\ + 18 \leftarrow 6 \times 3 \\ \hline 1518 \end{array} $ <p>Use grid multiplication to multiply 2-digit numbers by 2-digit numbers e.g. 16×48</p> <table border="1" data-bbox="1377 949 1814 1189"> <tr> <td>×</td> <td>10</td> <td>6</td> <td></td> </tr> <tr> <td>40</td> <td>400</td> <td>240</td> <td>= 640</td> </tr> <tr> <td>8</td> <td>80</td> <td>48</td> <td>= 128</td> </tr> <tr> <td></td> <td></td> <td></td> <td><u>768</u></td> </tr> </table>	×	200	50	3		6	1200	300	18	= 1518	×	10	6		40	400	240	= 640	8	80	48	= 128				<u>768</u>
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Multiplication	Visual Representations	Written Recording																				
<p>Year 5</p> <ul style="list-style-type: none"> multiply numbers up to 4 digits by a one- or two-digit number using a formal written method, including long multiplication for two-digit numbers 	<p>Arrays of place value counters</p>  <p>Grid Method linked to formal written method</p> <table border="1" data-bbox="542 512 1144 754"> <tr> <td>x</td> <td>200</td> <td>40</td> <td>3</td> </tr> <tr> <td>30</td> <td>6000</td> <td>1200</td> <td>90</td> </tr> <tr> <td>6</td> <td>1200</td> <td>240</td> <td>18</td> </tr> </table>	x	200	40	3	30	6000	1200	90	6	1200	240	18	<p>Short multiplication of 2-, 3- and 4-digit numbers by 1-digit numbers e.g. 435×8</p> $\begin{array}{r} 435 \\ \times 8 \\ \hline 24 \\ \hline 3480 \end{array}$ <p>Long multiplication of 2-, 3- and 4-digit numbers by 'teen' numbers e.g. 48×16</p> $\begin{array}{r} 48 \\ \times 16 \\ \hline 480 \\ 288 \\ \hline 768 \end{array}$ <p>Grid multiplication of numbers with up to 2 decimal places by 1-digit numbers e.g. 1.34×6</p> <table border="1" data-bbox="1357 871 1749 991"> <tr> <td>x</td> <td>1</td> <td>0.3</td> <td>0.04</td> </tr> <tr> <td>6</td> <td>6</td> <td>1.8</td> <td>0.24</td> </tr> </table> <p>= 8.04</p>	x	1	0.3	0.04	6	6	1.8	0.24
x	200	40	3																			
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Multiplication	Visual Representations	Written Recording										
<p>Year 6</p> <ul style="list-style-type: none"> multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication 		<p>Short multiplication of 2-, 3- and 4-digit numbers by 1-digit numbers e.g. 3743×6</p> $\begin{array}{r} 3743 \\ \times \quad 6 \\ \hline 22458 \end{array}$ <p>Long multiplication of 2-, 3- and 4-digit numbers by 2-digit numbers e.g. 456×38</p> $\begin{array}{r} 456 \\ \times 38 \\ \hline 13680 \\ 3648 \\ \hline 17328 \end{array}$ <p>Short multiplication of decimal numbers using $\times 100$ and $\div 100$ e.g. 13.72×6 as $(1372 \times 6) \div 100 = 82.32$ Short multiplication of money e.g. $\pounds 13.72 \times 6$</p> $\begin{array}{r} \pounds 13.72 \\ \times \quad 6 \\ \hline \pounds 82.32 \end{array}$ <p>Grid multiplication of numbers with up to 2 decimal places by 1-digit numbers e.g. 6.76×4</p> <table border="1" data-bbox="1377 1189 1713 1292"> <tr> <td>\times</td> <td>6</td> <td>0.7</td> <td>0.06</td> <td></td> </tr> <tr> <td>4</td> <td>24</td> <td>2.8</td> <td>0.24</td> <td>$= 27.04$</td> </tr> </table>	\times	6	0.7	0.06		4	24	2.8	0.24	$= 27.04$
\times	6	0.7	0.06									
4	24	2.8	0.24	$= 27.04$								

Division	Visual Representations	Written Recording
<p>Year 3</p> <ul style="list-style-type: none"> write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods 	<p>Bead strings & number lines Use counting on in steps to represent division as grouping.</p>   <p>Use language of division linked to tables</p>  <p>Place Value Cards Use partitioning and splitting equally to represent division as sharing.</p>  <p>Counters Begin to use arrays of counters to represent division e.g. $56 \div 7$</p> 	<p>Division by counting on in groups Division of two-digit numbers should be recorded with informal written representations of the visual representations used. e.g. $96 \div 6$</p>  <p>Division by sharing Tens and units split into equal groups (without exchange) e.g. $48 \div 4$</p> $ \begin{array}{r l} 10 & 2 \\ 4 & \overline{) 40} \\ \hline & 8 \end{array} $

Division	Visual Representations	Written Recording
Year 4 • [No curriculum objectives given]	Represent using partitioning and arrays: e.g. $364 \div 3$ 	Division by sharing Tens and units split into equal groups (with exchange) e.g. $64 \div 4$ $ \begin{array}{r l} 10 & 6 \\ 4 \overline{) 40} & 24 \end{array} $ Short division of 2- and 3- digit numbers by 1-digit numbers using times table facts. $ \begin{array}{r} 27 \\ 3 \overline{) 81} \end{array} $

Division	Visual Representations	Written Recording
<p>Year 5</p> <ul style="list-style-type: none"> divide numbers up to 4 digits by a one-digit number using the formal written method of short division and interpret remainders appropriately for the context 	<p>$192 \div 6$ using place value counters to support written method</p> <p>Exchange 100 for ten 10s</p>  <p>19 tens into groups of 6</p>  <p>3 groups so that is 30×6, exchange remaining 10 for ten 1s</p>  <p>So $192 \div 6 = 32$</p> 	<p>Short division of 3- and 4-digit numbers by 1-digit numbers e.g. $139 \div 3$</p> <p style="text-align: center;">4 6 r 1</p> <p style="text-align: center;">3 $\overline{) 139}$</p> <p>Give remainders as whole numbers or as fractions</p>

Division	Visual Representations	Written Recording
<p>Year 6</p> <ul style="list-style-type: none"> divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division, and interpret remainders as whole number remainders, fractions, or by rounding, as appropriate for the context divide numbers up to 4 digits by a two-digit number using the formal written method of short division where appropriate, interpreting remainders according to the context 		<p>Short division of 3- and 4-digit numbers by 1-digit numbers e.g. $139 \div 3$</p> $\begin{array}{r} 46 \text{ r } 1 \\ 3 \overline{) 139} \end{array}$ <p>Long division of 3- and 4-digit numbers by 2-digit numbers e.g. $4176 \div 13$</p> $\begin{array}{r} 300 + 20 + 1, \text{ r } 3 \\ 13 \overline{) 4176} \\ \underline{-3900} \\ 276 \\ \underline{-260} \\ 16 \\ \underline{-13} \\ 3 \end{array} \quad 4176 \div 13 = 321 \text{ r } 3$ <p>Give remainders as whole numbers, fractions or decimals Use place value to divide 1- and 2-place decimals by numbers ≤ 12 e.g. $3.65 \div 5$ as $(365 \div 5) \div 100 = 0.73$</p>