



Junior School Calculation Policy

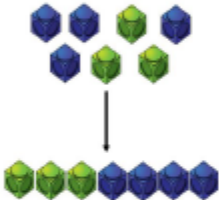
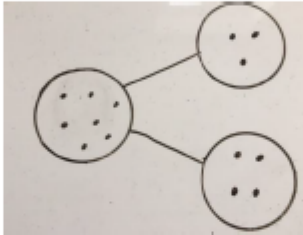
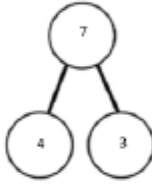


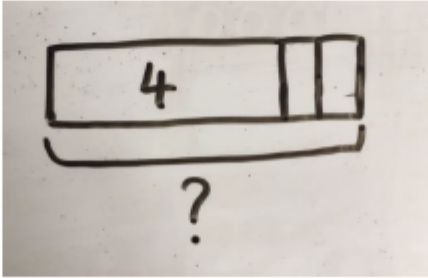

Concrete Pictorial Abstract Approach

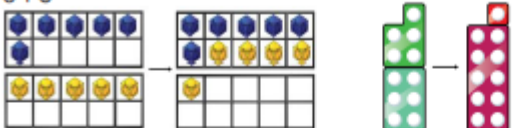
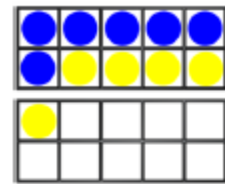
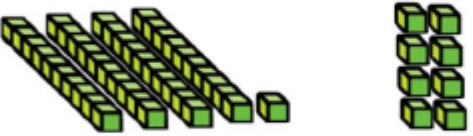
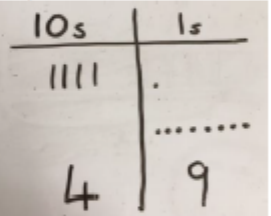
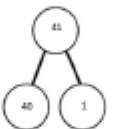
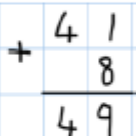
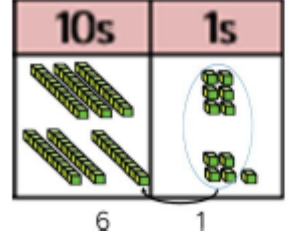
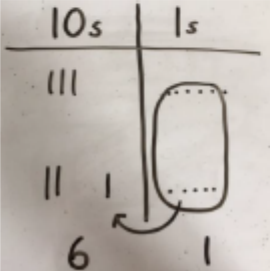
The Concrete Pictorial Abstract (CPA) approach is a system of learning that uses physical and visual aids to build a child's understanding of abstract topics. Pupils are introduced to a new mathematical concept through the use of concrete resources online. When they are comfortable solving problems with physical aids, they are given problems with pictures – usually pictorial representations of the concrete objects they were using. Then, they are asked to solve problems where they only have the abstract i.e. numbers or other symbols. Building these steps across a lesson can help pupils better understand the relationship between numbers and the real world, and therefore helps secure their understanding of the mathematical concept they are learning.

	Year 3	Year 4	Year 5	Year 6
Addition	Column method- regrouping. Using place value counters (up to 3 digits).	Column method- regrouping. (up to 4 digits)	Column method- regrouping. Use of place value counters for adding decimals.	Column method- regrouping. Abstract methods. Place value counters to be used for adding decimal numbers.
Subtraction	Column method with regrouping. (up to 3 digits using place value counters)	Column method with regrouping. (up to 4 digits)	Column method with regrouping. Abstract for whole numbers. Start with place value counters for decimals- with the same amount of decimal places.	Column method with regrouping. Abstract methods. Place value counters for decimals- with different amounts of decimal places
Multiplication	Arrays 2d \times 1d using base 10	Column multiplication- introduced with place value counters. (2 and 3 digit multiplied by 1 digit)	Column multiplication Abstract only but might need a repeat of year 4 first (up to 4 digit numbers multiplied by 1 or 2 digits)	Column multiplication Abstract methods (multi-digit up to 4 digits by a 2 digit number)
Division	Division with a remainder-using lollipop sticks, times tables facts and repeated subtraction. 2d divided by 1d using base 10 or place value counters	Division with a remainder Short division (up to 3 digits by 1 digit- concrete and pictorial)	Short division (up to 4 digits by a 1 digit number including remainders)	Short division Long division with place value counters (up to 4 digits by a 2 digit number) Children should exchange into the tenths and hundredths column too

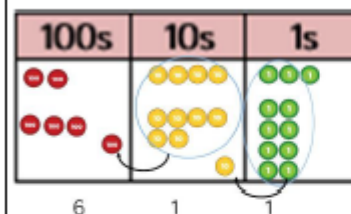
Calculation policy: Addition

Key language: sum, total, parts and wholes, plus, add, altogether, more, 'is equal to' 'is the same as'.

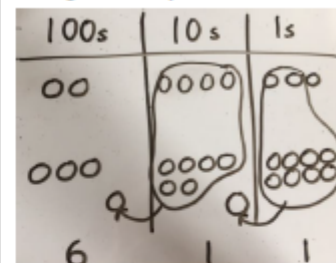
Concrete	Pictorial	Abstract
<p>Combining two parts to make a whole (use other resources too e.g. eggs, shells, teddy bears, cars).</p> 	<p>Children to represent the cubes using dots or crosses. They could put each part on a part whole model too.</p> 	<p>$4 + 3 = 7$ Four is a part, 3 is a part and the whole is seven.</p> 
<p>Counting on using number lines using cubes or Numicon.</p>  	<p>A bar model which encourages the children to count on, rather than count all.</p> 	<p>The abstract number line: What is 2 more than 4? What is the sum of 2 and 4? What is the total of 4 and 2? $4 + 2$</p> 

<p>Regrouping to make 10; using ten frames and counters/cubes or using Numicon.</p> <p>$6 + 5$</p> 	<p>Children to draw the ten frame and counters/cubes.</p> 	<p>Children to develop an understanding of equality e.g.</p> $6 + \square = 11$ $6 + 5 = 5 + \square$ $6 + 5 = \square + 4$
<p>TO + O using base 10. Continue to develop understanding of partitioning and place value.</p> <p>$41 + 8$</p> 	<p>Children to represent the base 10 e.g. lines for tens and dot/crosses for ones.</p> 	<p>$41 + 8$</p>  
<p>TO + TO using base 10. Continue to develop understanding of partitioning and place value.</p> <p>$36 + 25$</p> 	<p>Children to represent the base 10 in a place value chart.</p> 	<p>Looking for ways to make 10.</p> <p>$36 + 25 \approx$</p> <p>1 5</p> <p>Formal method:</p> $\begin{array}{r} 36 \\ +25 \\ \hline 61 \\ 1 \end{array}$ <p> $30 + 20 = 50$ $5 + 5 = 10$ $50 + 10 + 1 = 61$ </p>

Use of place value counters to add HTO + TO, HTO + HTO etc. When there are 10 ones in the 1s column- we exchange for 1 ten, when there are 10 tens in the 10s column- we exchange for 1 hundred.



Children to represent the counters in a place value chart, circling when they make an exchange.



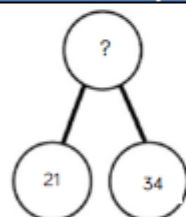
243

+368

611

1 1

Conceptual variation; different ways to ask children to solve $21 + 34$



?	
21	34

Word problems:

In year 3, there are 21 children and in year 4, there are 34 children. How many children in total?

$21 + 34 = 55$. Prove it

21

+34

$21 + 34 =$

= $21 + 34$

Calculate the sum of twenty-one and thirty-four.

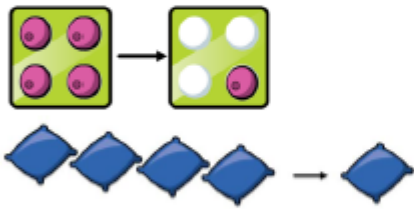
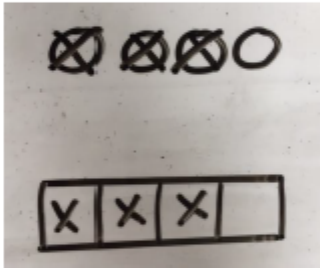
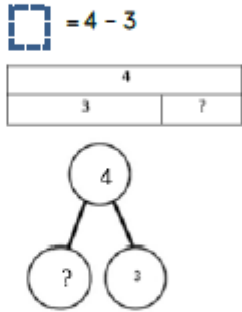
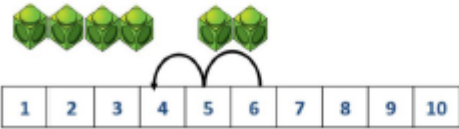
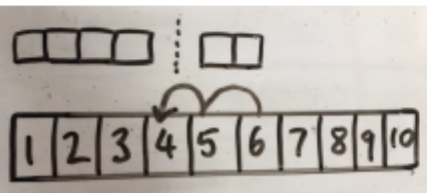



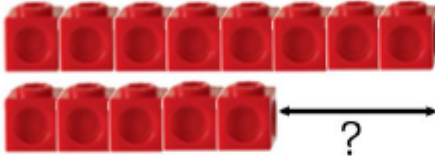
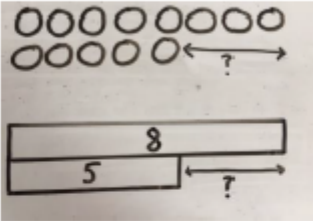
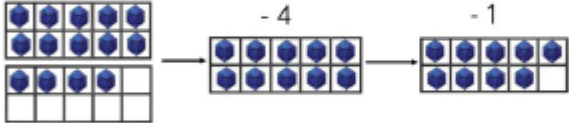

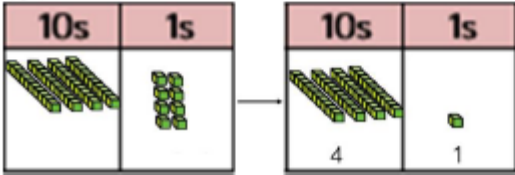
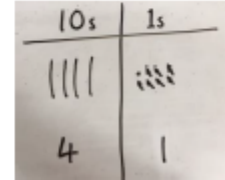
Missing digit problems:

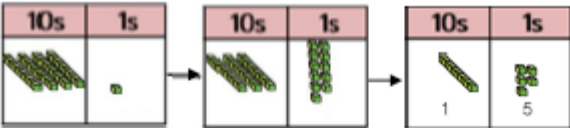
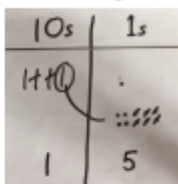
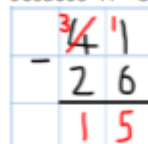
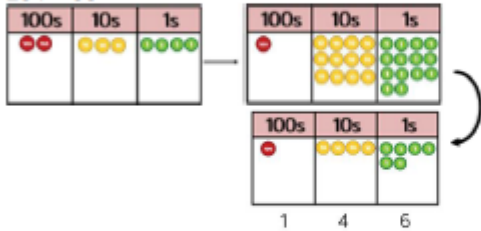
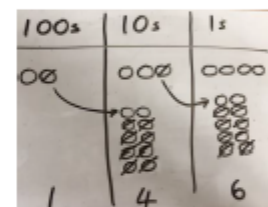
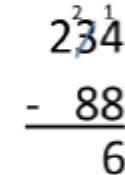
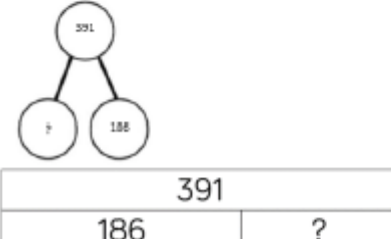
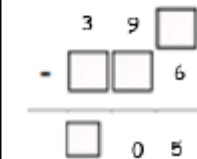
10s	1s
2	1
3	?
?	5

Calculation policy: Subtraction

Key language: take away, less than, the difference, subtract, minus, fewer, decrease.

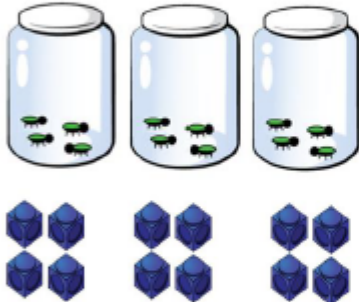
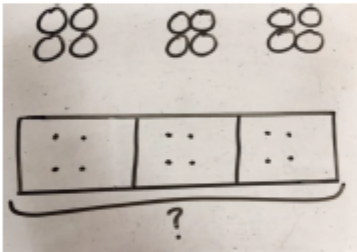
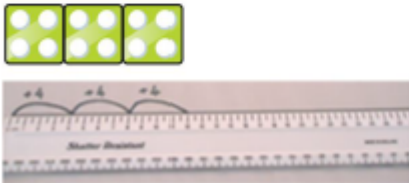
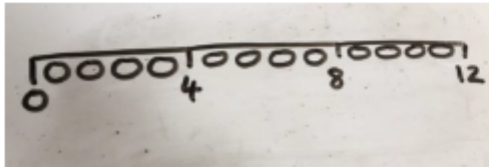
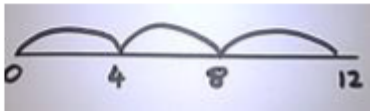
Concrete	Pictorial	Abstract
<p>Physically taking away and removing objects from a whole (ten frames, Numicon, cubes and other items such as beanbags could be used).</p> <p>$4 - 3 = 1$</p>  <p>The diagram shows a ten frame with 4 pink circles. An arrow points to the same ten frame with 3 white circles and 1 pink circle. Below this, four blue diamond shapes are shown, with three of them crossed out and one remaining.</p>	<p>Children to draw the concrete resources they are using and cross out the correct amount. The bar model can also be used.</p>  <p>The diagram shows four hand-drawn circles, the first three of which are crossed out. Below them is a bar model consisting of four boxes, the first three of which are marked with an 'X'.</p>	<p>$4 - 3 =$</p>  <p>The diagram shows a bar model for $4 - 3 =$ with a 4 in the top box, a 3 in the bottom left box, and a question mark in the bottom right box. Below the bar model is a number bond with 4 in the top circle, and question marks and 3 in the bottom circles.</p>
<p>Counting back (using number lines or number tracks) children start with 6 and count back 2.</p> <p>$6 - 2 = 4$</p>  <p>The diagram shows six green cubes. Below them is a number track from 1 to 10. Two curved arrows are drawn above the track, starting at 6 and ending at 4, representing counting back 2.</p>	<p>Children to represent what they see pictorially e.g.</p>  <p>The diagram shows a bar model with two boxes, the first of which is divided into two smaller boxes. Below this is a number track from 1 to 10. Two curved arrows are drawn above the track, starting at 6 and ending at 4, representing counting back 2.</p>	<p>Children to represent the calculation on a number line or number track and show their jumps. Encourage children to use an empty number line</p>  <p>The diagram shows a number line from 0 to 10 with a jump from 6 to 4. Below it is a number track from 1 to 10 with a jump from 6 to 4.</p>


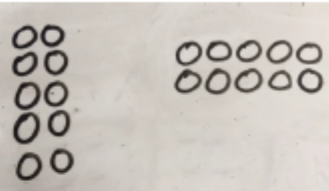
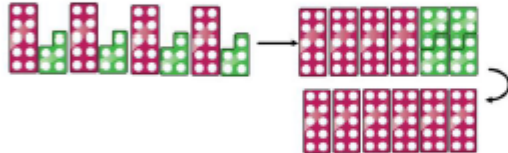
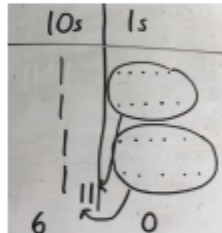
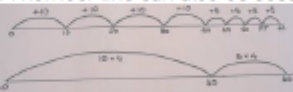




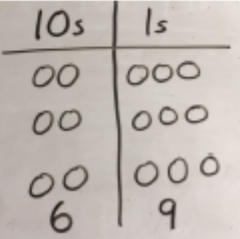


<p>Finding the difference (using cubes, Numicon or Cuisenaire rods, other objects can also be used).</p> <p>Calculate the difference between 8 and 5.</p> 	<p>Children to draw the cubes/other concrete objects which they have used or use the bar model to illustrate what they need to calculate.</p> 	<p>Find the difference between 8 and 5.</p> <p>8 - 5, the difference is <input type="text"/></p> <p>Children to explore why $9 - 6 = 8 - 5 = 7 - 4$ have the same difference.</p>									
<p>Making 10 using ten frames.</p> <p>14 - 5</p> 	<p>Children to present the ten frame pictorially and discuss what they did to make 10.</p> 	<p>Children to show how they can make 10 by partitioning the subtrahend.</p> $14 - 5 = 9$ $\begin{array}{c} 5 \\ / \quad \backslash \\ 4 \quad 1 \end{array}$ <p>14 - 4 = 10 10 - 1 = 9</p>									
<p>Column method using base 10.</p> <p>48 - 7</p> 	<p>Children to represent the base 10 pictorially.</p> 	<p>Column method or children could count back 7.</p> <table border="1" data-bbox="1518 858 1688 1027"> <tr><td></td><td>4</td><td>8</td></tr> <tr><td>-</td><td></td><td>7</td></tr> <tr><td></td><td>4</td><td>1</td></tr> </table>		4	8	-		7		4	1
	4	8									
-		7									
	4	1									

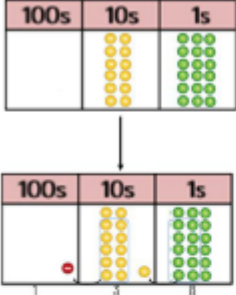
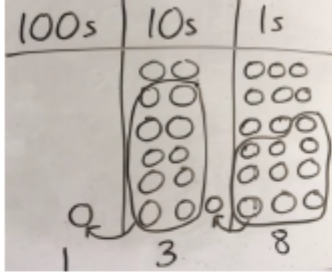

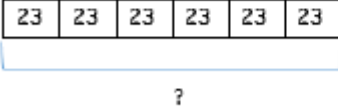
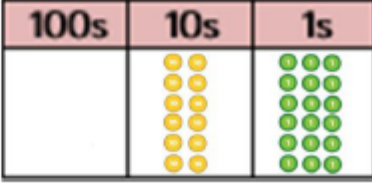
<p>Column method using base 10 and having to exchange. 41 - 26</p> 	<p>Represent the base 10 pictorially, remembering to show the exchange.</p> 	<p>Formal column method. Children must understand that when they have exchanged the 10 they still have 41 because $41 = 30 + 11$.</p> 	
<p>Column method using place value counters. 234 - 88</p> 	<p>Represent the place value counters pictorially, remembering to show what has been exchanged.</p> 	<p>Formal column method. Children must understand what has happened when they have crossed out digits.</p> 	
<h2>Conceptual variation; different ways to ask children to solve 391 - 186</h2>			
	<p>Raj spent £391, Timmy spent £186. How much more did Raj spend?</p> <p>Calculate the difference between 391 and 186.</p>	<p><input type="text"/> = 391 - 186</p> <p>391 -186 ——</p> <p>What is 186 less than 391?</p>	<p>Missing digit calculations</p> 

Calculation policy: Multiplication

Key language: double, times, multiplied by, the product of, groups of, lots of, equal groups.

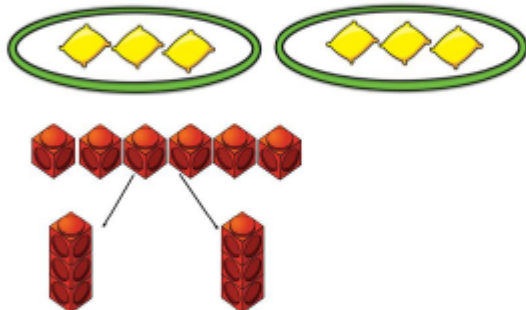
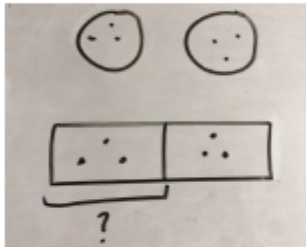
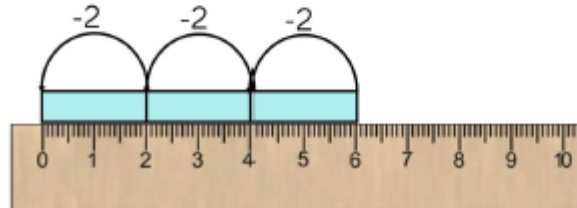
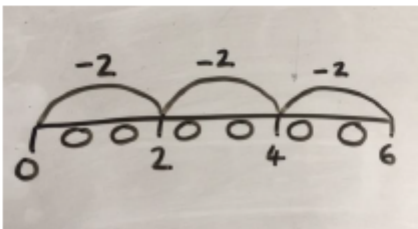
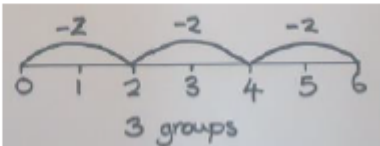
Concrete	Pictorial	Abstract
<p>Repeated grouping/repeated addition 3×4 $4 + 4 + 4$ There are 3 equal groups, with 4 in each group.</p> 	<p>Children to represent the practical resources in a picture and use a bar model.</p> 	<p>$3 \times 4 = 12$ $4 + 4 + 4 = 12$</p>
<p>Number lines to show repeated groups- 3×4</p>  <p>Cuisenaire rods can be used too.</p>	<p>Represent this pictorially alongside a number line e.g.:</p> 	<p>Abstract number line showing three jumps of four.</p> <p>$3 \times 4 = 12$</p> 


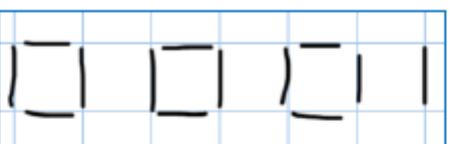

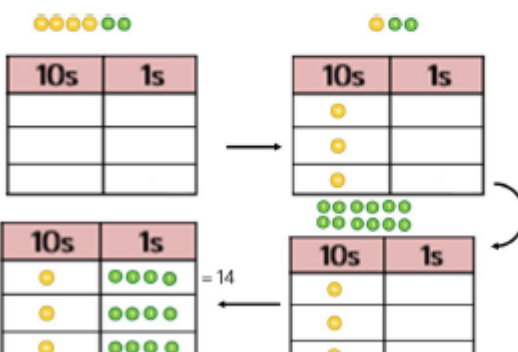
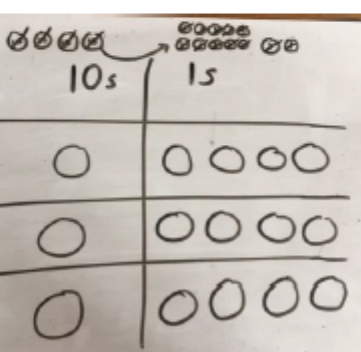
<p>Use arrays to illustrate commutativity counters and other objects can also be used.</p> <p>$2 \times 5 = 5 \times 2$</p>  <p>2 lots of 5 5 lots of 2</p>	<p>Children to represent the arrays pictorially.</p> 	<p>Children to be able to use an array to write a range of calculations e.g.</p> <p>$10 = 2 \times 5$ $5 \times 2 = 10$ $2 + 2 + 2 + 2 + 2 = 10$ $10 = 5 + 5$</p>						
<p>Partition to multiply using Numicon, base 10 or Cuisenaire rods.</p> <p>4×15</p> 	<p>Children to represent the concrete manipulatives pictorially.</p> 	<p>Children to be encouraged to show the steps they have taken.</p> <p>4×15 10 5 $10 \times 4 = 40$ $5 \times 4 = 20$ $40 + 20 = 60$</p> <p>A number line can also be used</p> 						
<p>Formal column method with place value counters (base 10 can also be used.) 3×23</p> <table border="1" data-bbox="338 839 580 1019"><thead><tr><th>10s</th><th>1s</th></tr></thead><tbody><tr><td></td><td></td></tr><tr><td>6</td><td>9</td></tr></tbody></table>	10s	1s			6	9	<p>Children to represent the counters pictorially.</p> 	<p>Children to record what it is they are doing to show understanding.</p> <p>3×23 $3 \times 20 = 60$ 20 3 $3 \times 3 = 9$ 60 + 9 = 69</p> <p>23 $\times 3$ <hr/>69</p>
10s	1s							
								
6	9							

<p>Formal column method with place value counters.</p> <p>6×23</p> 	<p>Children to represent the counters/base 10, pictorially e.g. the image below.</p> 	<p>Formal written method</p> $ \begin{array}{r} 6 \times 23 = \\ 23 \\ \times 6 \\ \hline 138 \\ 11 \end{array} $
<p>When children start to multiply $3d \times 3d$ and $4d \times 2d$ etc., they should be confident with the abstract:</p> <p>To get 744 children have solved 6×124. To get 2480 they have solved 20×124.</p>		 <p>Answer: 3224</p>
<h2>Conceptual variation; different ways to ask children to solve 6×23</h2>		
	<p>Mai had to swim 23 lengths, 6 times a week. How many lengths did she swim in one week?</p> <p>With the counters, prove that $6 \times 23 = 138$</p>	<p>Find the product of 6 and 23</p> <p>$6 \times 23 =$</p> <p>$\square = 6 \times 23$</p> $ \begin{array}{r} 6 \quad 23 \\ \times 23 \quad \times 6 \\ \hline \end{array} $ <p>What is the calculation? What is the product?</p> 

Calculation policy: Division

Key language: share, group, divide, divided by, half.

Concrete	Pictorial	Abstract		
<p>Sharing using a range of objects. $6 \div 2$</p>  <p>The image shows two green ovals, each containing three yellow diamonds. Below them, six red Cuisenaire rods are arranged in a single row. Two lines branch out from the middle of this row to two separate vertical stacks of three red rods each, illustrating the division of six items into two equal groups of three.</p>	<p>Represent the sharing pictorially.</p>  <p>The image shows two circles, each containing three dots. Below them is a rectangle divided into two equal halves, with three dots in each half. A bracket underneath the entire rectangle is labeled with a question mark, indicating the task of representing the division pictorially.</p>	<p>$6 \div 2 = 3$</p> <table border="1" data-bbox="1447 442 1792 497"><tr><td>3</td><td>3</td></tr></table> <p>Children should also be encouraged to use their 2 times tables facts.</p>	3	3
3	3			
<p>Repeated subtraction using Cuisenaire rods above a ruler. $6 \div 2$</p>  <p>The image shows a ruler with markings from 0 to 10. Three light blue Cuisenaire rods, each representing the number 2, are placed end-to-end above the ruler, starting from 0 and ending at 6. Above each rod is a curved line with the number -2 written above it, representing the subtraction of 2 from the total. Below the ruler, the text '3 groups of 2' is written.</p>	<p>Children to represent repeated subtraction pictorially.</p>  <p>The image shows a horizontal line with circles at positions 0, 2, 4, and 6. Three arcs are drawn above the line, each starting from a circle and ending at the next circle to the right. Each arc is labeled with -2 above it, representing the repeated subtraction of 2 from 6.</p>	<p>Abstract number line to represent the equal groups that have been subtracted.</p>  <p>The image shows a number line from 0 to 6 with tick marks at every integer. Three arcs are drawn above the line, each starting from a tick mark and ending at the next tick mark to the right. Each arc is labeled with -2 above it. Below the number line, the text '3 groups' is written.</p>		

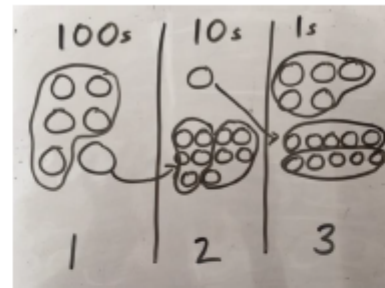
<p>2d + 1d with remainders using lollipop sticks. Cuisenaire rods, above a ruler can also be used.</p> <p>$13 \div 4$</p> <p>Use of lollipop sticks to form wholes- squares are made because we are dividing by 4.</p>  <p>There are 3 whole squares, with 1 left over.</p>	<p>Children to represent the lollipop sticks pictorially.</p>  <p>There are 3 whole squares, with 1 left over.</p>	<p>$13 \div 4 = 3 \text{ remainder } 1$</p> <p>Children should be encouraged to use their times table facts; they could also represent repeated addition on a number line.</p> <p>'3 groups of 4, with 1 left over'</p> 
<p>Sharing using place value counters.</p> <p>$42 \div 3 = 14$</p> 	<p>Children to represent the place value counters pictorially.</p> 	<p>Children to be able to make sense of the place value counters and write calculations to show the process.</p> <p> $42 \div 3$ $42 = 30 + 12$ $30 \div 3 = 10$ $12 \div 3 = 4$ $10 + 4 = 14$ </p>

Short division using place value counters to group.
 $615 \div 5$

100s	10s	1s
1	2	3

1. Make 615 with place value counters.
2. How many groups of 5 hundreds can you make with 6 hundred counters?
3. Exchange 1 hundred for 10 tens.
4. How many groups of 5 tens can you make with 11 ten counters?
5. Exchange 1 ten for 10 ones.
6. How many groups of 5 ones can you make with 15 ones?

Represent the place value counters pictorially.



Children to the calculation using the short division scaffold.

$$\begin{array}{r} 123 \\ 5 \overline{) 615} \end{array}$$

Long division using place value counters
 $2544 \div 12$











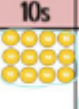


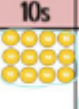


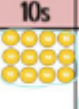

1000s	100s	10s	1s

We can't group 2 thousands into groups of 12 so will exchange them.








1000s	100s	10s	1s

We can group 24 hundreds into groups of 12 which leaves with 1 hundred.

$$\begin{array}{r} 0.2 \\ 12 \overline{) 2544} \\ \underline{24} \\ 1 \end{array}$$

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="padding: 2px;">1000s</th> <th style="padding: 2px;">100s</th> <th style="padding: 2px;">10s</th> <th style="padding: 2px;">1s</th> </tr> <tr> <td style="height: 40px;"></td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> </table>	1000s	100s	10s	1s					<p>After exchanging the hundred, we have 14 tens. We can group 12 tens into a group of 12, which leaves 2 tens.</p>	$ \begin{array}{r} 021 \\ 12 \overline{) 2544} \\ \underline{24} \\ 14 \\ \underline{12} \\ 2 \end{array} $
1000s	100s	10s	1s							
										
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="padding: 2px;">1000s</th> <th style="padding: 2px;">100s</th> <th style="padding: 2px;">10s</th> <th style="padding: 2px;">1s</th> </tr> <tr> <td style="height: 40px;"></td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> </table>	1000s	100s	10s	1s					<p>After exchanging the 2 tens, we have 24 ones. We can group 24 ones into 2 group of 12, which leaves no remainder.</p>	$ \begin{array}{r} 0212 \\ 12 \overline{) 2544} \\ \underline{24} \\ 14 \\ \underline{12} \\ 24 \\ \underline{24} \\ 0 \end{array} $
1000s	100s	10s	1s							
										

Conceptual variation; different ways to ask children to solve $615 \div 5$

<p>Using the part whole model below, how can you divide 615 by 5 without using short division?</p> <div style="text-align: center; margin-top: 10px;">  </div>	<p>I have £615 and share it equally between 5 bank accounts. How much will be in each account?</p> <p>615 pupils need to be put into 5 groups. How many will be in each group?</p>	<div style="text-align: center; margin-bottom: 10px;"> $5 \overline{) 615}$ </div> <p>$615 \div 5 =$</p> <p> $= 615 \div 5$</p>	<p>What is the calculation? What is the answer?</p> <div style="text-align: center; margin-top: 10px;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="padding: 2px;">100s</th> <th style="padding: 2px;">10s</th> <th style="padding: 2px;">1s</th> </tr> <tr> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> <td style="text-align: center;">  </td> </tr> </table> </div>	100s	10s	1s			
100s	10s	1s							
