

# St Margaret's CEVA Primary School



## Calculation Policy

## Purpose

The purpose of this policy is to ensure that all staff are able to model and teach the mastery approach to maths to a high standard in order for our pupils to achieve to the best of their abilities.

In September 2017 we began transitioning towards a mastery approach to the teaching and learning of mathematics. We understood that this would be a gradual process and take several years to embed. The rationale behind changing our approach to teaching mathematics lay within the research of the theorists Skemp, Bruner and Dienes and the NCTEM maths hubs as well as the 2014 National Curriculum which states:

The expectation is that most pupils will move through the programmes of study at broadly the same pace.

Pupils who grasp concepts rapidly should be challenged through being offered rich and sophisticated problems before any acceleration through new content.

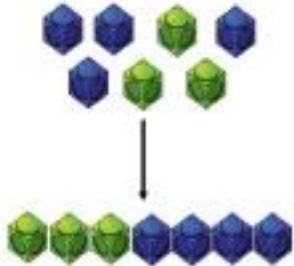
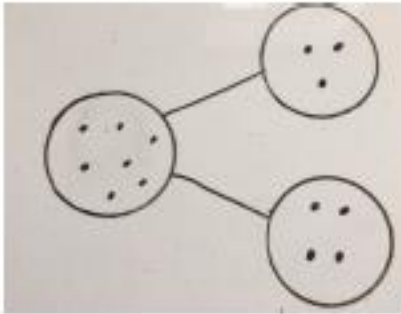
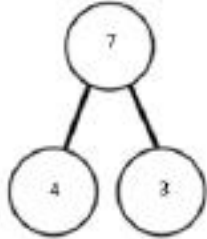
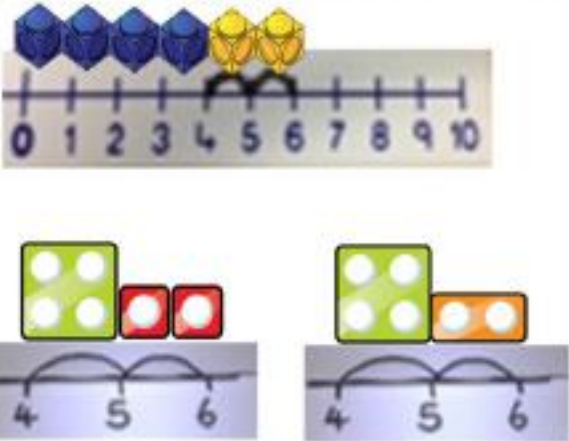
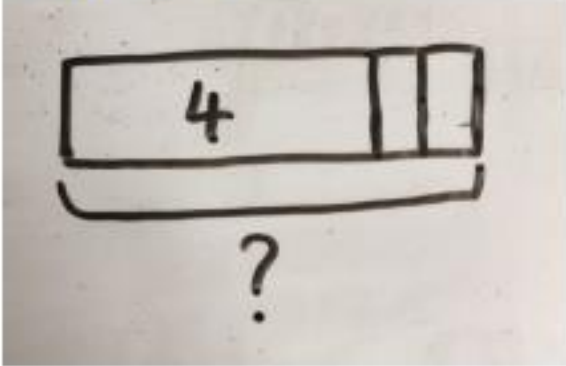

Those who are not sufficiently fluent with earlier material should consolidate their understanding, including additional practice, before moving on.

By representing maths using concrete, pictorial and abstract ways the children hopefully get a better grasp and more in-depth understanding of mathematical processes, as for too long children are expected to understand the abstract concepts over anything else. (The below examples are from the White Rose Calculation policy) Year 5 and 6 are going to be using a combination of the below examples on how to approach problem solving and reasoning using White Rose and SATS based questions.

Children are encouraged to use the manipulatives to represent numbers, problems or calculations in a variety of ways to help develop their understanding and the meaning behind mathematical concepts.

Years 1 and 2 are using White Rose scheme but are focusing on the concrete elements of maths (please see the maths policy for an explanations) years 3, 4 and Year 5 and Year 6 are using 'Target your Maths' and the 'White Rose' scheme to continue CPA practice but using the White Rose booklets so they have a high quality pictorial representations to base their learning on. The below representations are based on the maths mastery approach. A more detailed explanation of these can be found in the maths policy.

# Addition

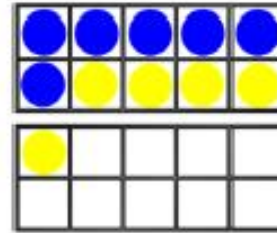
Concrete	Pictorial	Abstract
<p>Combining two parts to make a whole (use other resources too e.g. eggs, shells, teddy bears, cars).</p> 	<p>Children to represent the cubes using dots or crosses. They could put each part on a part whole model too.</p> 	<p><math>4 + 3 = 7</math> Four is a part, 3 is a part 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? <math>4 + 2</math></p> 

Regrouping to make 10; using ten frames and counters/cubes or using Numicon.

6 + 5



Children to draw the ten frame and counters/cubes.



Children to develop an understanding of equality e.g.

$$6 + \square = 11$$

$$6 + 5 = 5 + \square$$

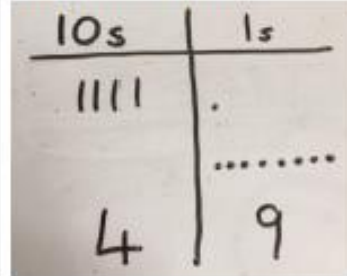
$$6 + 5 = \square + 4$$

TO + O using base 10. Continue to develop understanding of partitioning and place value.

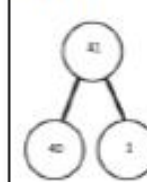
41 + 8



Children to represent the base 10 e.g. lines for tens and dot/crosses for ones.

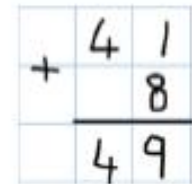


41 + 8



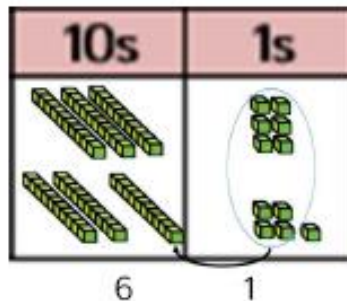
$$1 + 8 = 9$$

$$40 + 9 = 49$$

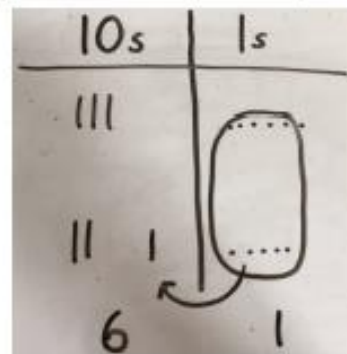


TO + TO using base 10. Continue to develop understanding of partitioning and place value.

36 + 25



Children to represent the base 10 in a place value chart.



Looking for ways to make 10.

$$36 + 25 =$$

$$30 + 20 = 50$$

$$5 + 5 = 10$$

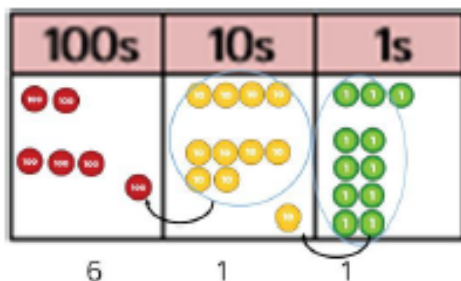
$$50 + 10 + 1 = 61$$

1      5      36

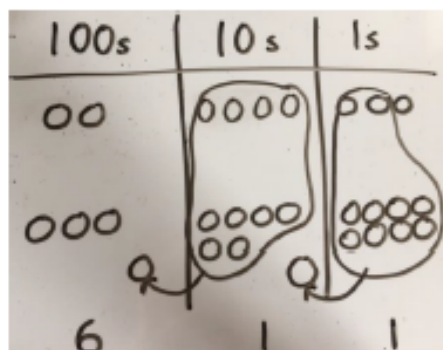
Formal method:

$$\begin{array}{r} +25 \\ 36 \\ \hline 61 \\ \hline 1 \end{array}$$

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.



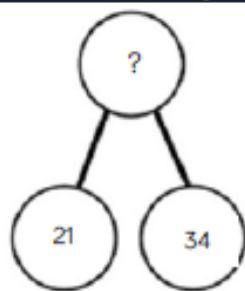
Children to represent the counters in a place value chart, circling when they make an exchange.



243

$$\begin{array}{r} 243 \\ +368 \\ \hline 611 \\ \hline 11 \end{array}$$

## 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

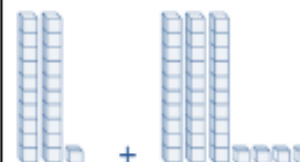
—

$21 + 34 =$



$= 21 + 34$

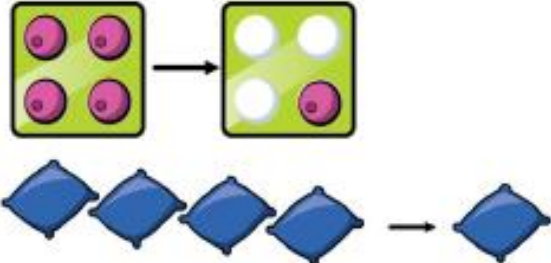
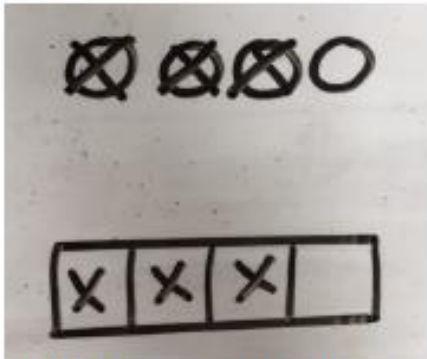

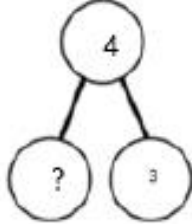

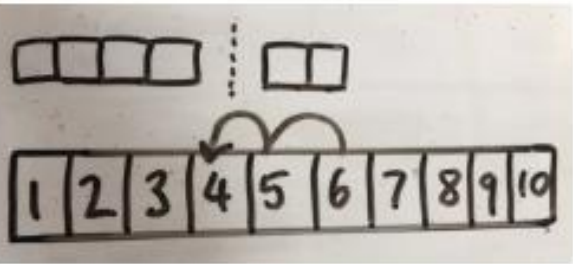
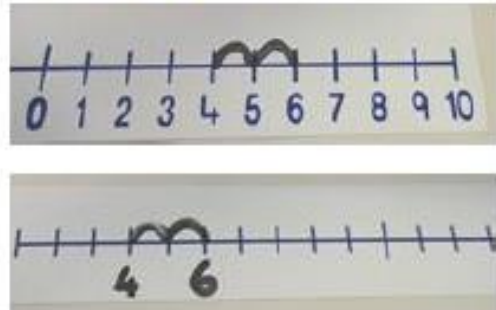
Calculate the sum of twenty-one and thirty-four.



Missing digit problems:

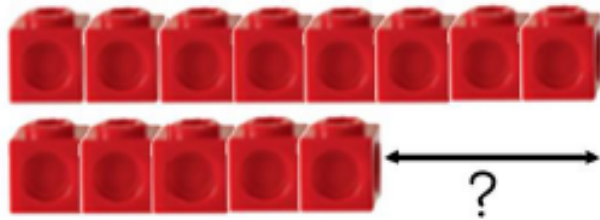
10s	1s
20	1
30	?
?	5

# Subtraction

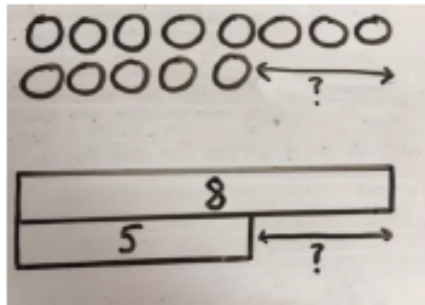
Concrete	Pictorial	Abstract				
<p>Physically taking away and removing objects from a whole (ten frames, Numicon, cubes and other items such as beanbags could be used).</p> <p><math>4 - 3 = 1</math></p> 	<p>Children to draw the concrete resources they are using and cross out the correct amount. The bar model can also be used.</p> 	<p><math>4 - 3 =</math></p> <p> <math>= 4 - 3</math></p> <table border="1" data-bbox="1653 454 1971 534"> <tr> <td colspan="2">4</td> </tr> <tr> <td>3</td> <td>?</td> </tr> </table> 	4		3	?
4						
3	?					
<p>Counting back (using number lines or number tracks) children start with 6 and count back 2.</p> <p><math>6 - 2 = 4</math></p> 	<p>Children to represent what they see pictorially e.g.</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> 				

**Finding the difference** (using cubes, Numicon or Cuisenaire rods, other objects can also be used).

Calculate the difference between 8 and 5.



Children to draw the cubes/other concrete objects which they have used or use the bar model to illustrate what they need to calculate.



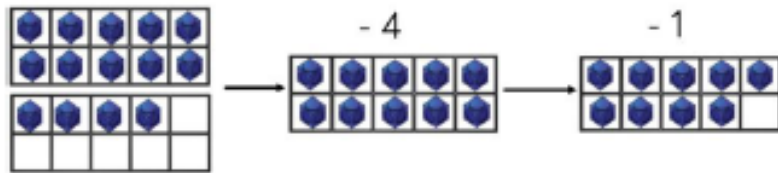
Find the difference between 8 and 5.

8 - 5, the difference is

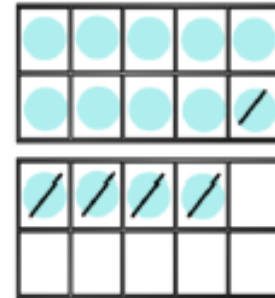
Children to explore why  $9 - 6 = 8 - 5 = 7 - 4$  have the same difference.

**Making 10 using ten frames.**

$14 - 5$



Children to present the ten frame pictorially and discuss what they did to make 10.



Children to show how they can make 10 by partitioning the subtrahend.

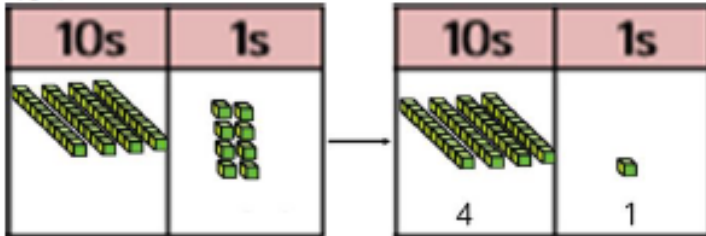
$$14 - 5 = 9$$

$$14 - 4 = 10$$

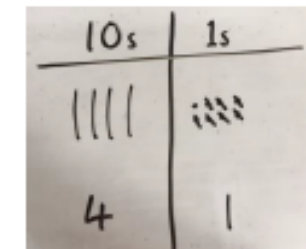
$$10 - 1 = 9$$

**Column method using base 10.**

$48 - 7$



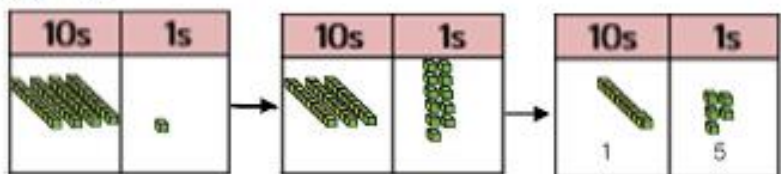
Children to represent the base 10 pictorially.



Column method or children could count back 7.

	4	8
-		7
	4	1

Column method using base 10 and having to exchange.  
41 - 26



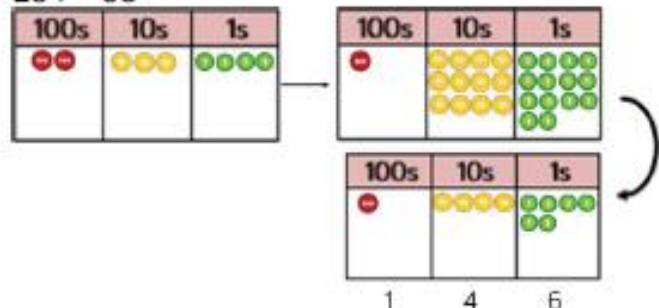
Represent the base 10 pictorially, remembering to show the exchange.



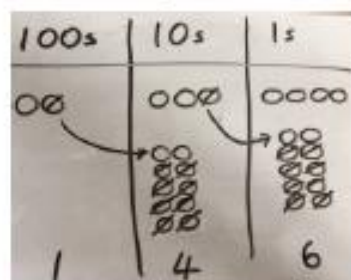
Formal column method. Children must understand that when they have exchanged the 10 they still have 41 because  $41 = 30 + 11$ .

$$\begin{array}{r} \overset{3}{\cancel{4}} \overset{1}{1} \\ - 26 \\ \hline 15 \end{array}$$

Column method using place value counters.  
234 - 88



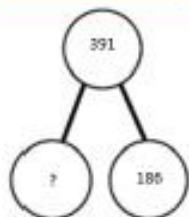
Represent the place value counters pictorially; remembering to show what has been exchanged.



Formal column method. Children must understand what has happened when they have crossed out digits.

$$\begin{array}{r} \overset{2}{2} \overset{1}{\cancel{3}} \overset{4}{4} \\ - 88 \\ \hline 6 \end{array}$$

## Conceptual variation; different ways to ask children to solve 391 - 186



Raj spent £391, Timmy spent £186.  
How much more did Raj spend?

Calculate the difference between 391 and 186.

391	
186	?

$$\square = 391 - 186$$

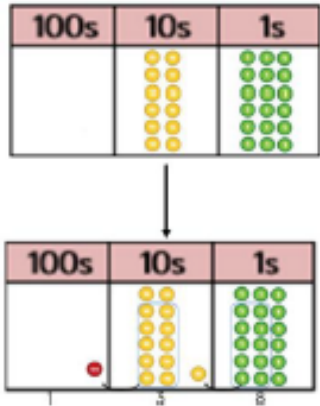
$$\begin{array}{r} 391 \\ - 186 \\ \hline \end{array}$$

What is 186 less than 391?

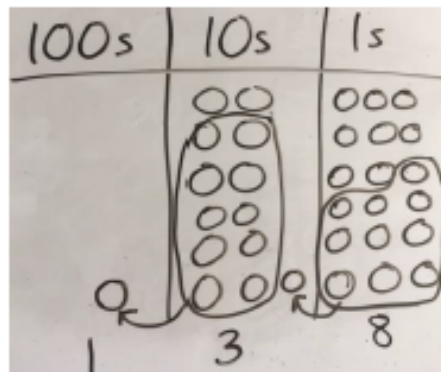
Missing digit calculations

$$\begin{array}{r} 39\square \\ - \square\square 6 \\ \hline \square 0 5 \end{array}$$

Formal column method with place value counters.  
 $6 \times 23$



Children to represent the counters/base 10, pictorially  
 e.g. the image below.



Formal written method

$$\begin{array}{r}
 6 \times 23 = \\
 23 \\
 \times 6 \\
 \hline
 138 \\
 \hline
 1 \quad 1
 \end{array}$$

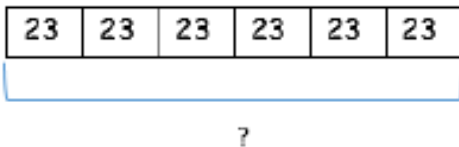
When children start to multiply  $3d \times 3d$  and  $4d \times 2d$  etc., they should be confident with the abstract:

To get 744 children have solved  $6 \times 124$ .  
 To get 2480 they have solved  $20 \times 124$ .

$$\begin{array}{r}
 1 \quad 2 \quad 4 \\
 \times \quad 2 \quad 6 \\
 \hline
 7 \quad 4 \quad 4 \\
 2 \quad 4 \quad 8 \quad 0 \\
 \hline
 3 \quad 2 \quad 2 \quad 4 \\
 1 \quad 1
 \end{array}$$

Answer: 3224

## Conceptual variation; different ways to ask children to solve $6 \times 23$



Mai had to swim 23 lengths, 6 times a week.  
 How many lengths did she swim in one week?

With the counters, prove that  $6 \times 23 = 138$

Find the product of 6 and 23

$$6 \times 23 =$$

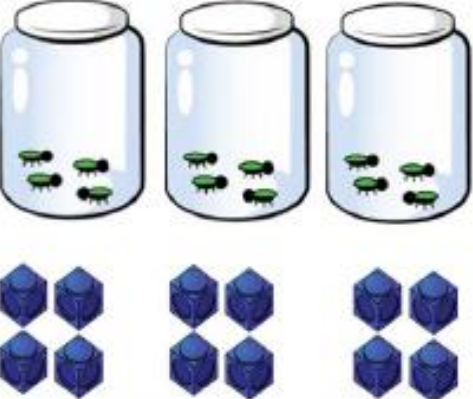
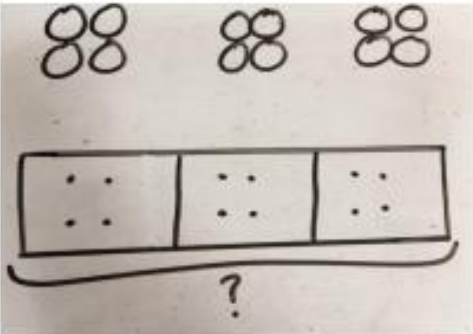

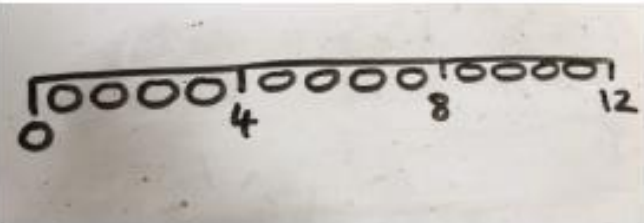
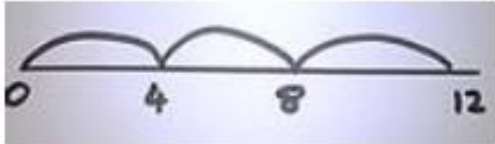
$$\begin{array}{r}
 \square = 6 \times 23 \\
 6 \quad 23 \\
 \times 23 \quad \times 6 \\
 \hline \quad \hline
 \end{array}$$

What is the calculation?  
 What is the product?



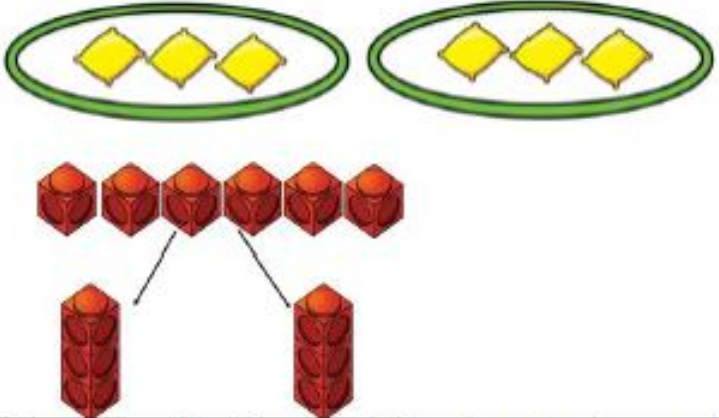
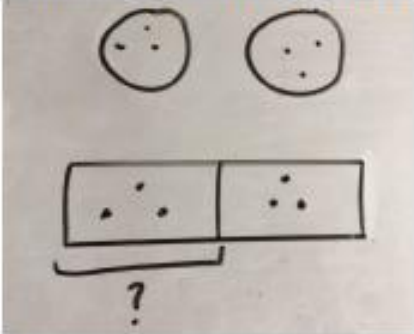
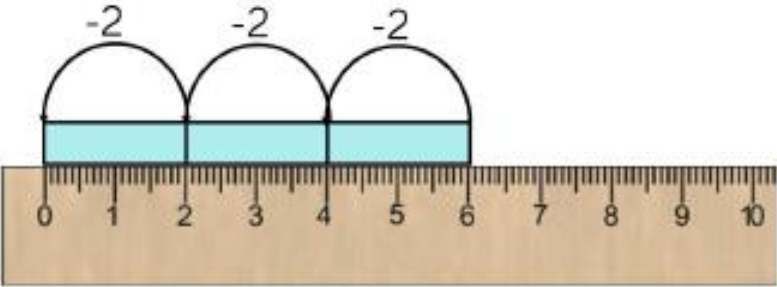
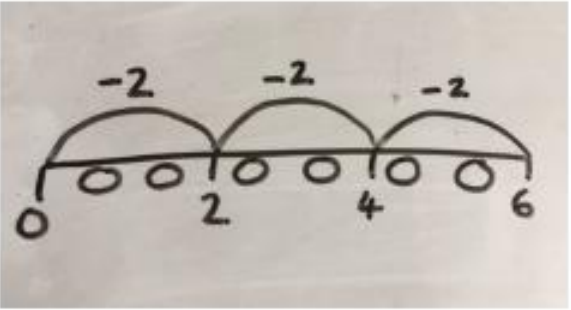
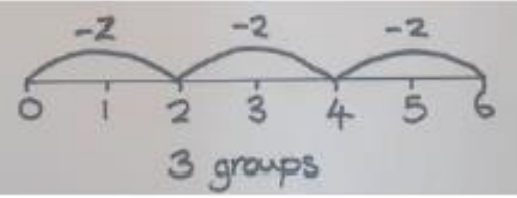
# Multiplication

Key Language: Double, times, multiplied by, the product of, groups of, lots of and equal groups.

Concrete	Pictorial	Abstract
<p>Repeated grouping/repeated addition  <math>3 \times 4</math>  <math>4 + 4 + 4</math>            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><math>3 \times 4 = 12</math>  <math>4 + 4 + 4 = 12</math></p>
<p>Number lines to show repeated groups-  <math>3 \times 4</math></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><math>3 \times 4 = 12</math></p> 

# Division

Key Language: Share, group, divide, divided by, half.

Concrete	Pictorial	Abstract		
<p>Sharing using a range of objects. <math>6 \div 2</math></p> 	<p>Represent the sharing pictorially.</p> 	<p><math>6 \div 2 = 3</math></p> <table border="1" data-bbox="1572 354 2042 427"> <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. <math>6 \div 2</math></p>  <p>3 groups of 2</p>	<p>Children to represent repeated subtraction pictorially.</p> 	<p>Abstract number line to represent the equal groups that have been subtracted.</p>  <p>3 groups</p>		

2d + 1d with remainders using lollipop sticks. Cuisenaire rods, above a ruler can also be used.

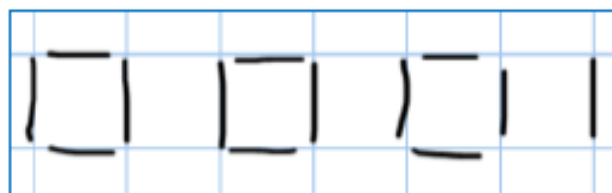
$$13 \div 4$$

Use of lollipop sticks to form wholes- squares are made because we are dividing by 4.



There are 3 whole squares, with 1 left over.

Children to represent the lollipop sticks pictorially.

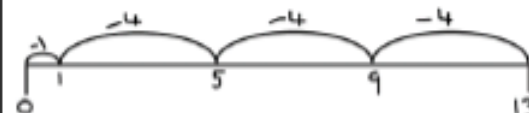


There are 3 whole squares, with 1 left over.

$$13 \div 4 = 3 \text{ remainder } 1$$

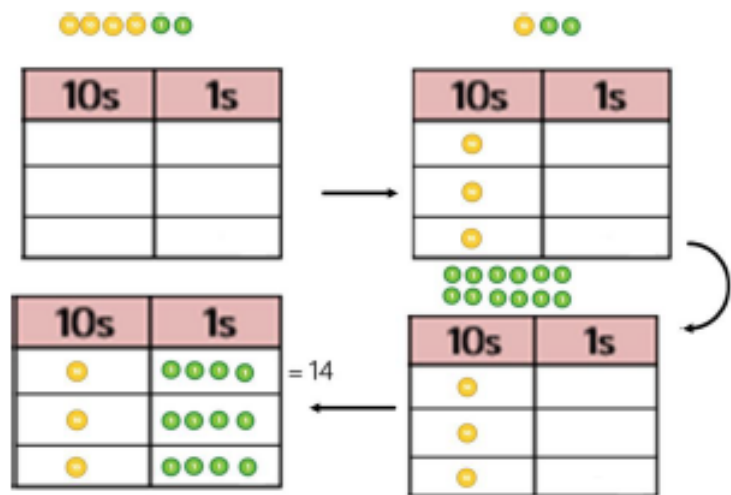
Children should be encouraged to use their times table facts; they could also represent repeated addition on a number line.

'3 groups of 4, with 1 left over'

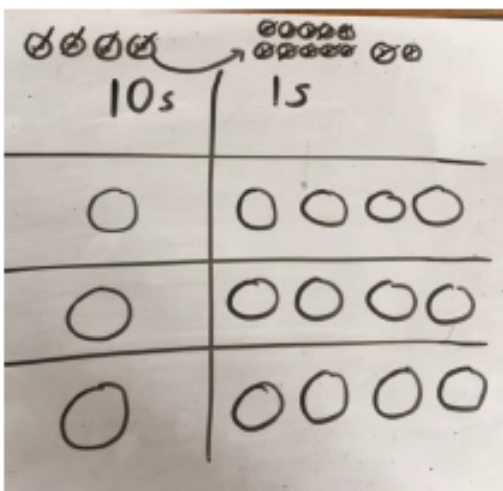


Sharing using place value counters.

$$42 \div 3 = 14$$



Children to represent the place value counters pictorially.



Children to be able to make sense of the place value counters and write calculations to show the process.

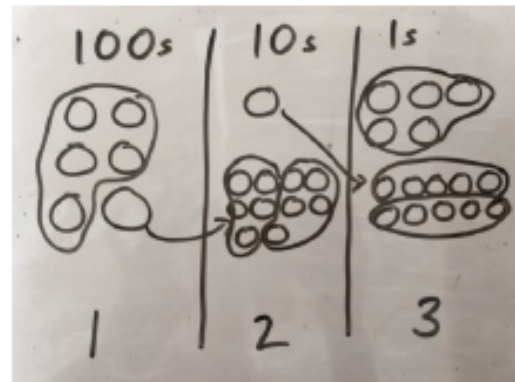
$$\begin{aligned} 42 \div 3 \\ 42 &= 30 + 12 \\ 30 \div 3 &= 10 \\ 12 \div 3 &= 4 \\ 10 + 4 &= 14 \end{aligned}$$

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.

$$\begin{array}{r}
 123 \\
 5 \overline{) 615} \\
 \underline{5} \phantom{0} \\
 11 \phantom{0} \\
 \underline{10} \phantom{0} \\
 15 \\
 \underline{15} \\
 0
 \end{array}$$

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

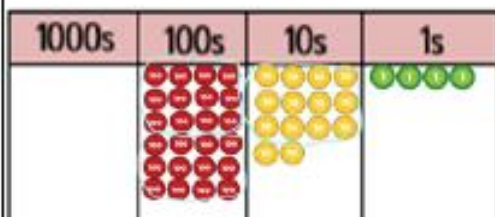
1000s	100s	10s	1s

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

1000s	100s	10s	1s

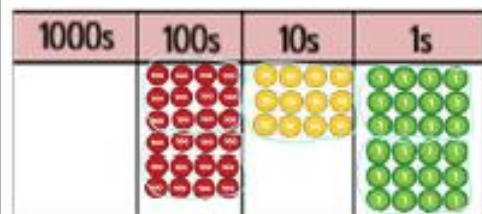
We can group 24 hundreds into groups of 12 which leaves with 1 hundred.

$$\begin{array}{r}
 02 \\
 12 \overline{) 2544} \\
 \underline{24} \phantom{0} \\
 1 \phantom{0}
 \end{array}$$



After exchanging the hundred, we have 14 tens. We can group 12 tens into a group of 12, which leaves 2 tens.

$$\begin{array}{r} 021 \\ 12 \overline{)2544} \\ \underline{24} \\ 14 \\ \underline{12} \\ 2 \end{array}$$

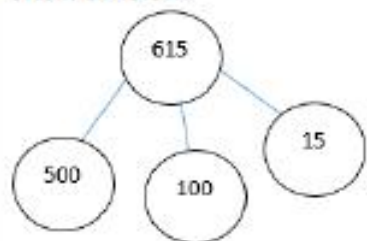


After exchanging the 2 tens, we have 24 ones. We can group 24 ones into 2 group of 12, which leaves no remainder.

$$\begin{array}{r} 0212 \\ 12 \overline{)2544} \\ \underline{24} \\ 14 \\ \underline{12} \\ 24 \\ \underline{24} \\ 0 \end{array}$$

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

Using the part whole model below, how can you divide 615 by 5 without using short division?



I have £615 and share it equally between 5 bank accounts. How much will be in each account?

615 pupils need to be put into 5 groups. How many will be in each group?

$$5 \overline{)615}$$

$$615 \div 5 =$$

$$\square = 615 \div 5$$

What is the calculation?  
What is the answer?

