Progression in Methods of Calculation

INTRODUCTION

The National Curriculum emphasises the importance of all pupils' mastery of the content taught each year and discourages the acceleration of pupils into content from subsequent years.

In line with the new curriculum objectives, we will be teaching our children to:

- Become fluent in the fundamentals of mathematics, with increasingly complex problems over time so pupils develop conceptual understanding.
- Reason mathematically by following a line of enquiry, focusing on explanations and justifications of how they know an answer.
- Solve problems by applying mathematics to a variety of problems.

WHAT IS 'SINGAPORE' MATHS?

Singapore maths is just maths! It is a style of maths teaching that is proven to develop a deeper conceptual understanding of mathematical concepts, giving children opportunities to use and apply their knowledge. It is child led, with a focus on questioning and discussion where children explore and investigate key mathematical concepts through problem solving.

CONCRETE – PICTORIAL – ABSTRACT (CPA APPROACH)

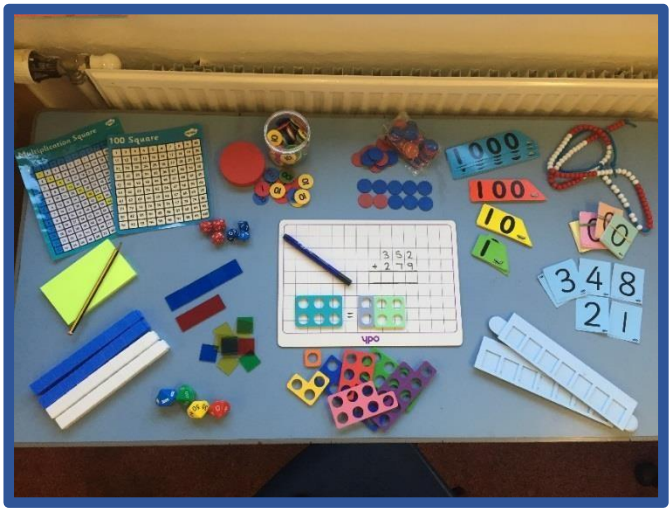
We follow a Concrete, Pictorial, Abstract approach throughout the school. Children will begin learning through the use of concrete materials (Base Ten, counters, multilink, tens frames) before progressing onto a pictorial representation of the resources. Children will move onto the abstract approach only when they are secure in their understanding.

CONCRETE RESOURCES

Children will have the opportunity to access a range of concrete manipulatives in every lesson to help secure their understanding.

There are a range of resources such as:

- Number fans
- Numicon
- Place Value cards
- Counters
- Square Tiles
- Digit cards
- Place Value Counters
- A range of dice
- Place Value sliders
- Unifix cubes
- Bead strings
- Base Ten
- Place Value Mats
- Hundred Squares
- Multiplication Grids
- Fraction Walls
- Tens Frames
- Everyday counting tools e.g. dinosaurs, fish etc.



MATHEMATICAL LANGUAGE

To ensure consistency across the whole school, it is important we are all using the correct mathematical terminology.

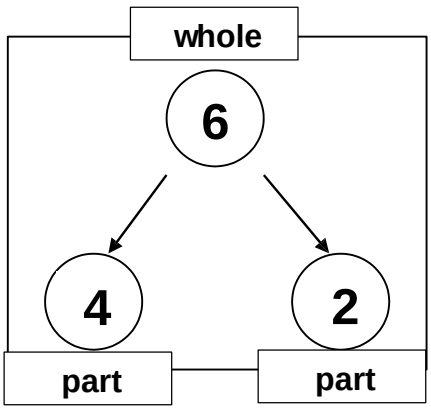
Use of correct mathematical terminology is critical to teaching mathematical vocabulary. Placing math terms on a math word wall and using them daily makes ongoing review easy and fun.

The best way to learn a language - any language- is to be fully immersed in it. And so it should be in the math classroom because math is a language. Every math classroom should be rich with language, and the use of the correct terms must not just be encouraged. It must be expected.

In order for children to learn to speak maths, teachers must model the language regularly and correctly.

NUMBER BONDS

Children must have a secure understanding of number bonds as this will help them when approaching addition and subtraction problems.



This way children learn the various parts that make the whole.

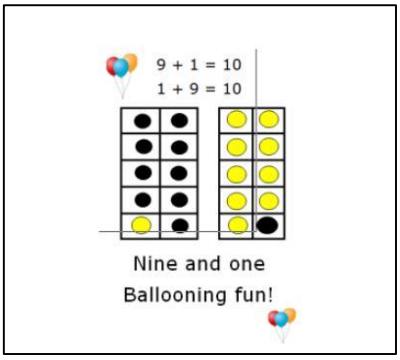
They recognise that these are interchangeable yet give the same whole.

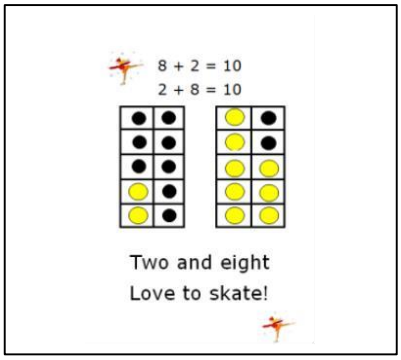
This then prepares them for the acquisition of addition/subtraction facts which in turn leads to formal algorithm and mental strategies.

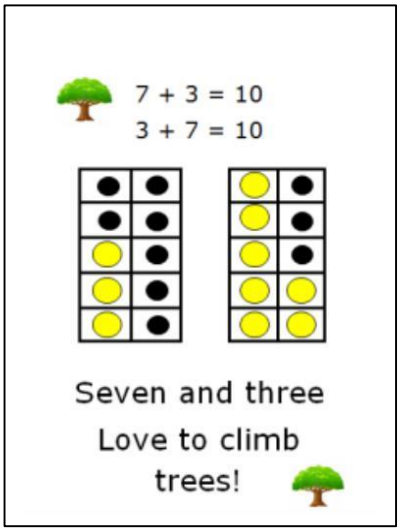
They will need to explore number patterns and relationships using concrete resources such as those contained in the classroom toolkits.

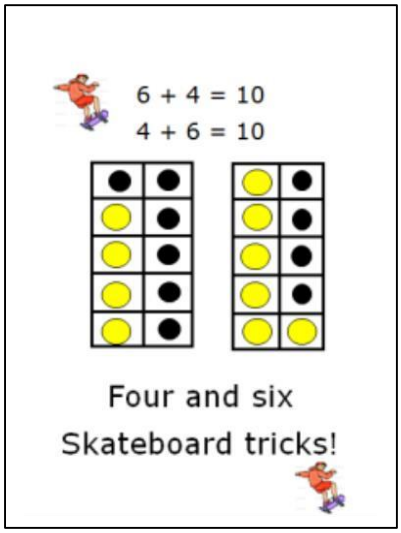
Once children have explored making different totals they begin to forge relationships between bonds to 10. They use a number of concrete tools to support this process.

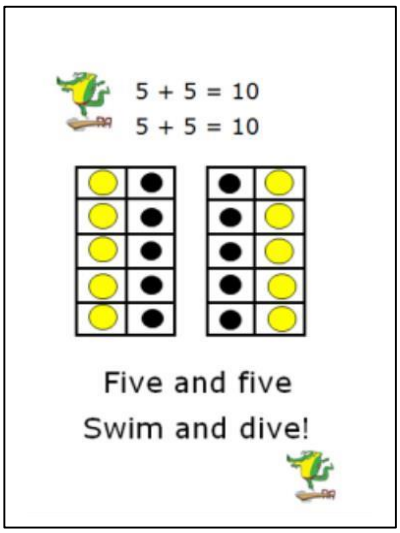
Ten Frames/Egg boxes feature heavily and represent the base 10. Children explore and learn the number of different ways to make 10 using the egg box, base 10 frame.
In EYFS, children learn and explore the different ways of making ten through the use of ten frames and rhymes.











BAR MODEL

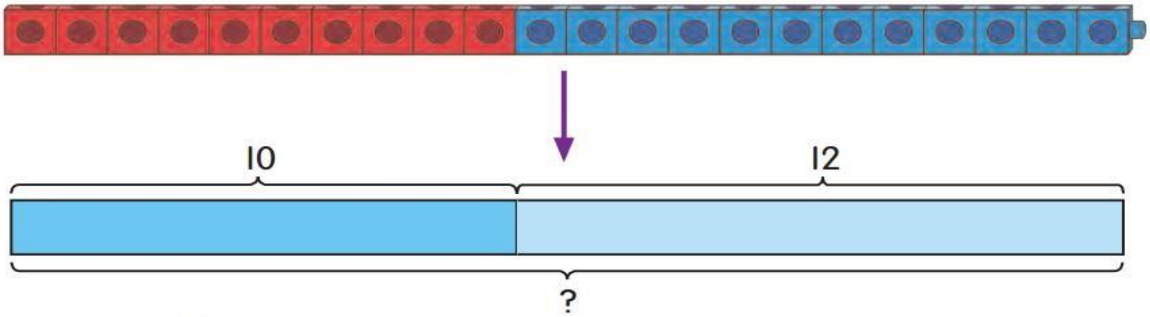
The bar model is a step by step method that helps children to understand and extract the information within a calculation or word problem. By drawing a bar model, children translate a calculation or word problem into a picture. The approach helps children process the information given in the problem, visualise the structure, make connections and solve the problem.

In Year 1 children have been prepared for the introduction of the bar model by using concrete apparatus; for example, using interlocking cubes to compare the number of objects in two groups.

In Year 2 children explore addition and subtraction initially with concrete apparatus before moving on to using a pictorial representation – the bar model.

Adding sets of objects

1 Omar bakes 10 biscuits.
Ruby bakes 12 biscuits.
How many biscuits do they bake altogether?

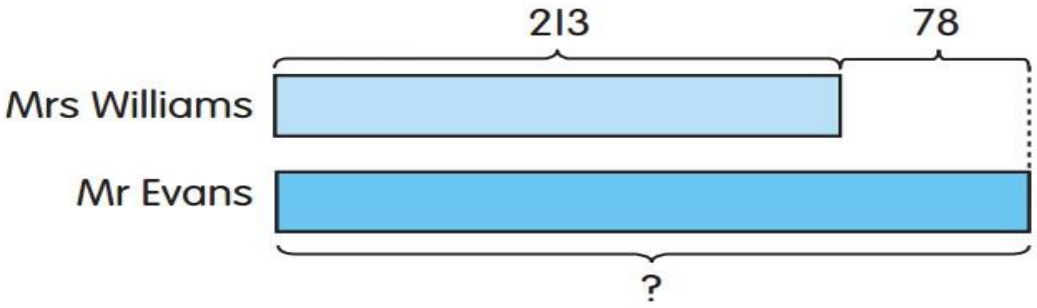


10 + 12 = 22

They bake 22 biscuits altogether.

Comparing two sets

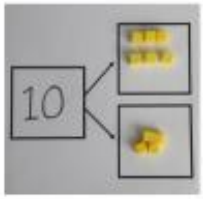
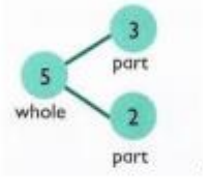
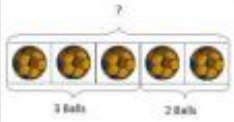
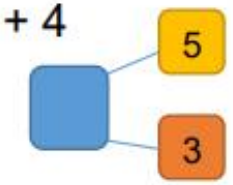
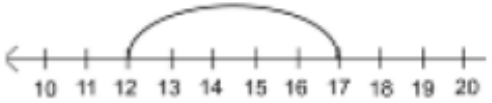
1 Mrs Williams has 213 chickens on her farm.
Mr Evans has 78 more chickens on his farm.
How many chickens does Mr Evans have on his farm?

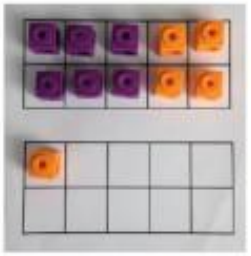
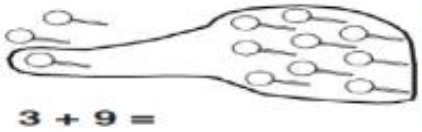


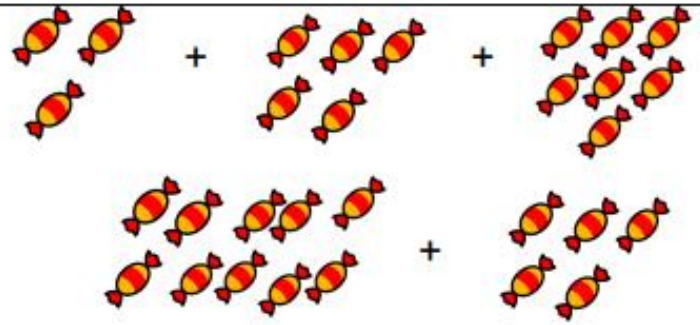
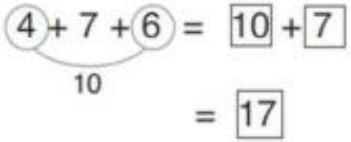
213 + 78 = 291

Mr Evans has 291 chickens on his farm.

ADDITION

Objective and Strategies	Concrete	Pictorial	Abstract
Combining two parts to make a whole: part-whole model(number bond diagram/ partitioning diagram)	  Use cubes to add two numbers together as a group or in a bar. 	   Use pictures to add two numbers together as a group or in a bar. 	4 + 3 = 7 10= 6 + 4  Use the part-part whole diagram as shown above to move into the abstract.
Starting at the bigger number and counting on	 Start with the larger number on the bead string and then count on to the smaller number 1 by 1 to find the answer.	12 + 5 = 17  Start at the larger number on the number line and count on in ones or in one jump to find the answer.	5 + 12 = 17 Place the larger number in your head and count on the smaller number to find your answer.

<table>
<tr>
<td>Regrouping to make 10.</td>
<td> 
6 + 5 = 11
 
Start with the bigger number and use the smaller number to make 10.</td>
<td> 
3 + 9 =
Use pictures or a number line. Regroup or partition the smaller number to make 10.
9 + 5 = 14
1 4
+1 +4
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20</td>
<td>7 + 4= 11

If I am at seven, how many more do I need to make 10. How many more do I add on now?</td>
</tr>
<tr>
<td>Adding three single digits</td>
<td>4 + 7 + 6= 17
Put 4 and 6 together to make 10. Add on 7.
 
Following on from making 10, make 10 with 2 of the digits (if possible) then add on the third digit.</td>
<td> 
Add together three groups of objects. Draw a picture to recombine the groups to make 10.</td>
<td> 
4 + 7 + 6 = 10 + 7
10
= 17
Combine the two numbers that make 10 and then add on the remainder.</td>
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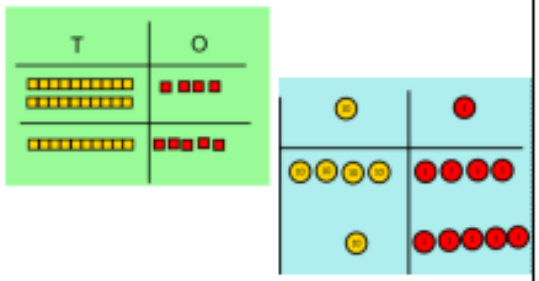
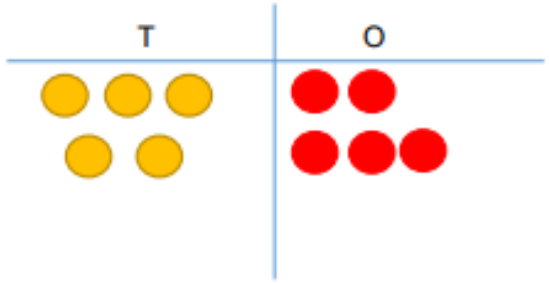
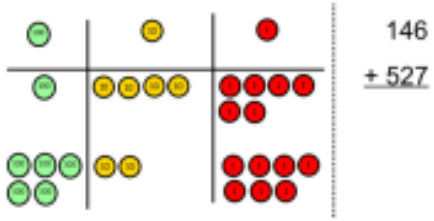
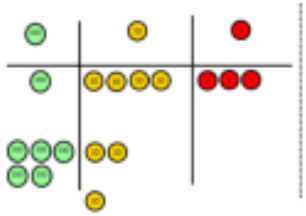
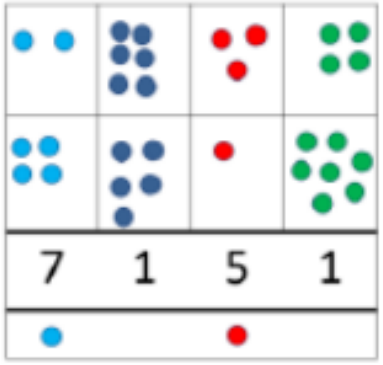
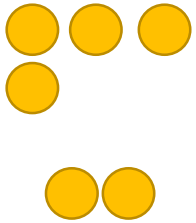
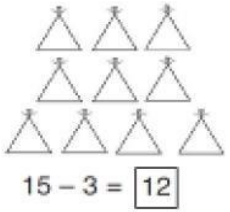
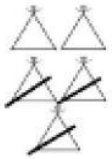
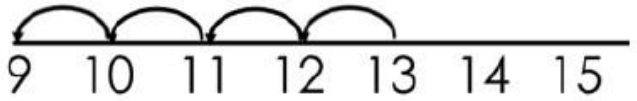
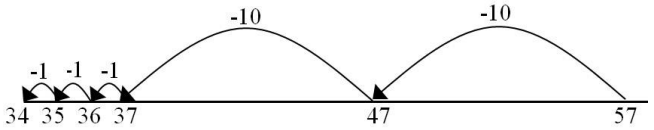
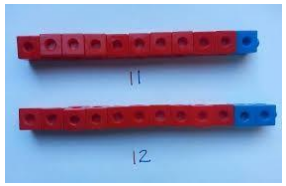
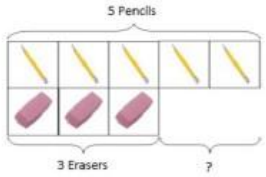
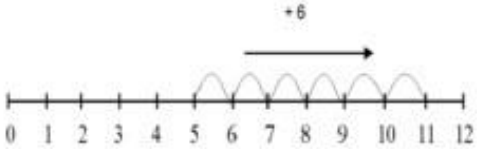
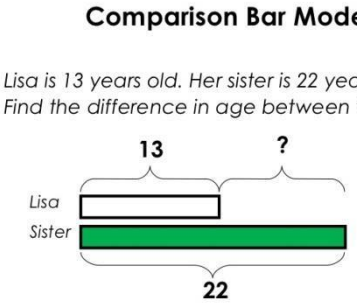
Column method- no regrouping	24 + 15= Add together the ones first then add the tens. Use the Base 10 blocks first before moving onto place value counters.  	After practically using the base 10 blocks and place value counters, children can draw the counters to help them to solve additions.  	Calculations 21 + 42 = 21 + 42
Column method- regrouping	Make both numbers on a place value grid.  146 + 527 Add up the ones and exchange 10 ones for one 10.  146 + 527 Add up the rest of the columns, exchanging the 10 counters from one column for the next place value column until every column has been added.	Children can draw a pictoral representation of the columns and place value counters to further support their learning and understanding.  	Start by partitioning the numbers before moving on to clearly show the exchange below the addition. 20 + 5 40 + 8 60 + 13 = 73 536 + 85 621 1 1 As the children move on, introduce decimals with the same number of decimal places and different. Money can be 

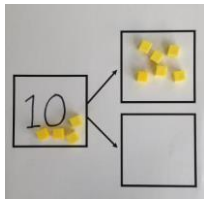
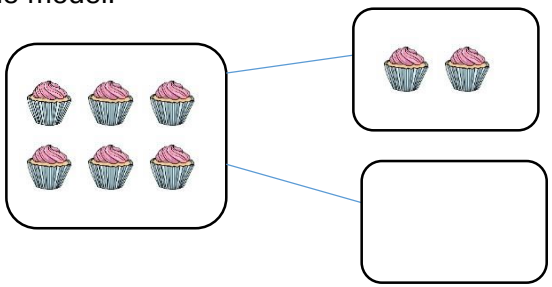
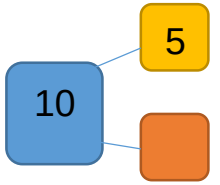
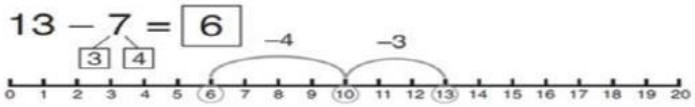
	This can also be done with Base 10 to help children clearly see that 10 ones equal 1 ten and 10 tens equal 100. As children move on to decimals, money and decimal place value counters can be used to support learning.		used here.

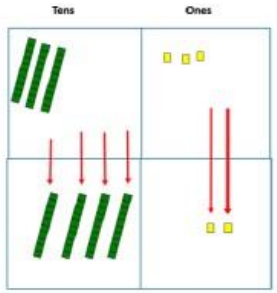
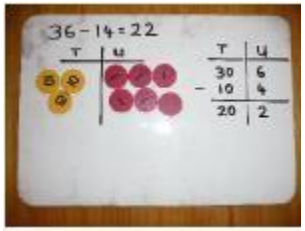
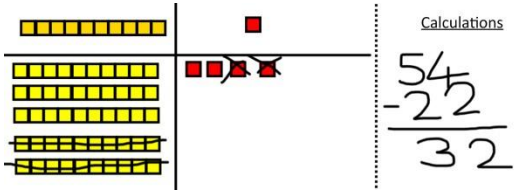
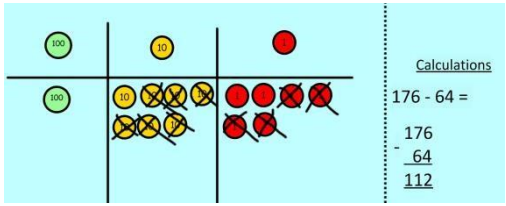
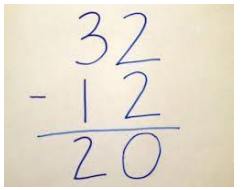
SUBTRACTION

Objective and Strategies	Concrete	Pictorial	Abstract
Taking away ones	Use physical objects, counters, cubes etc to show how objects can be taken away.  6 – 2 = 4	Cross out drawn objects to show what has been taken away.   15 – 3 = 12 	18 – 3 = 15 8 – 2 = 6

Counting back	Make the larger number in your subtraction. Move the beads along your bead string as you count backwards in ones.  13 – 4 Use counters and move them away from the group as you take them away counting backwards as you go. 	Count back on a number line or number track  Start at the bigger number and count back the smaller number showing the jumps on the number line.  This can progress all the way to counting back using two 2-digit numbers.	Put 13 in your head, count back 4. What number are you at?

Find the difference	Compare amounts and objects to find the difference.  Use cubes to build towers or make bars to find the difference  Use basic bar models with items to find the difference	 Count on to find the difference. Draw bars to find the difference between 2 numbers. 	Hannah has 23 sandwiches, Helen has 15 sandwiches. Find the difference between the number of sandwiches.

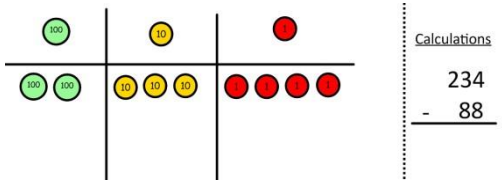
Part Part Whole Model	 Link to addition- use the part whole model to help explain the inverse between addition and subtraction. If 10 is the whole and 6 is one of the parts. What is the other part? 10 - 6 =	Use a pictorial representation of objects to show the part part whole model. 	 Move to using numbers within the part whole model.
Make 10	14 – 9 =  Make 14 on the ten frame. Take away the four first to make 10 and then takeaway one more so you have taken away 5. You are left with the answer of 9.	 Start at 13. Take away 3 to reach 10. Then take away the remaining 4 so you have taken away 7 altogether. You have reached your answer.	16 – 8= How many do we take off to reach the next 10? How many do we have left to take off?

Column method without regrouping	 Use Base 10 to make the bigger number then take the smaller number away. Show how you partition numbers to subtract. Again, make the larger number first. 	 Draw the Base 10 or place value counters alongside the written calculation to help to show working. 	47 - 24 = 23 40 + 7 - 20 + 4 20 + 3 This will lead to a clear written column subtraction. 

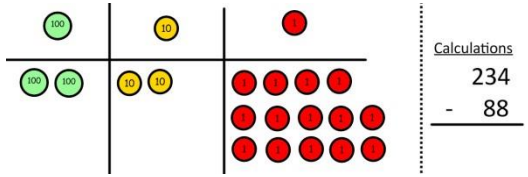
Column method with regrouping

Use Base 10 to start with before moving on to place value counters. Start with one exchange before moving onto subtractions with 2 exchanges.

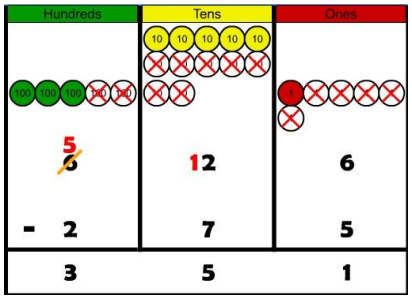
Make the larger number with the place value counters



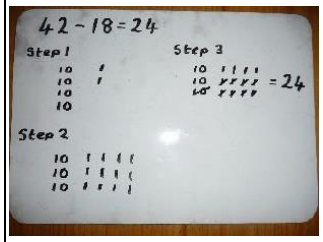
Start with the ones, can I take away 8 from 4 easily? I need to exchange one of my tens for ten ones.



Now I can subtract my ones.

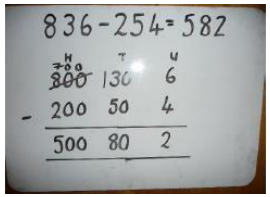


Draw the counters onto a place value grid and show what you have taken away by crossing the counters out as well as clearly showing the exchanges you make.

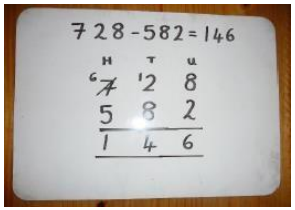


When confident, children can find their own way to record the exchange/regrouping.

Just writing the numbers as shown here shows that the child understands the method and knows when to exchange/regroup.



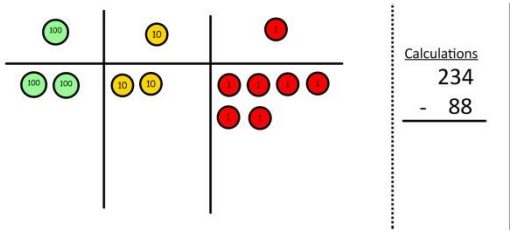
Children can start their formal written method by partitioning the number into clear place value columns.



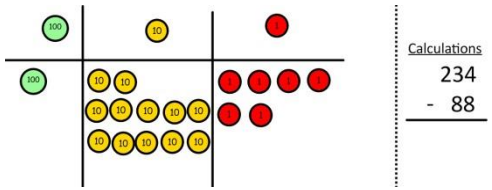
Moving forward the children use a more compact method.

This will lead to an understanding of subtracting any number including decimals.

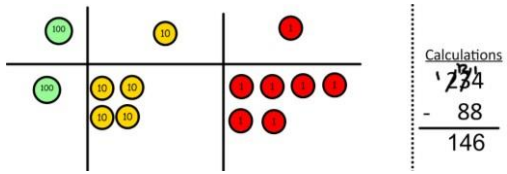
$$\begin{array}{r} {\scriptstyle 5\ \ 12\ \ \ \ 1} \\ 2\ \not{6}\ \not{3}\ .\ \mathbf{0} \\ -\quad 2\ 6\ .\ 5 \\ \hline 2\ 3\ 6\ .\ 5 \end{array}$$



Now look at the tens, can I take away 8 tens easily? I need to exchange one hundred for ten tens.

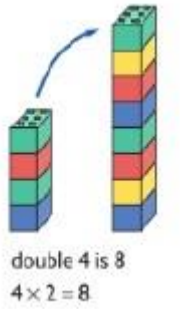
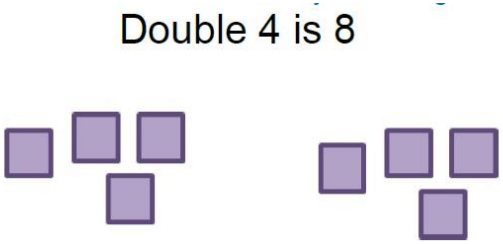
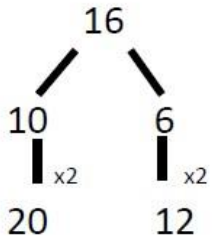


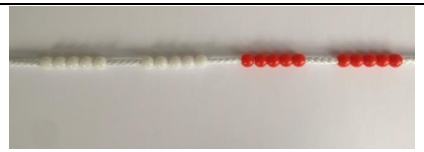
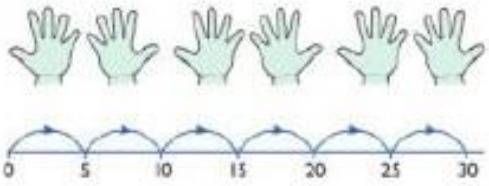
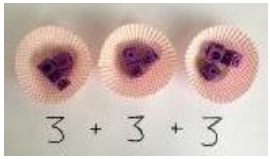
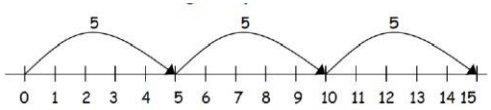
Now I can take away eight tens and complete my subtraction

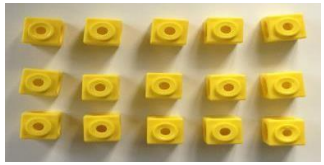
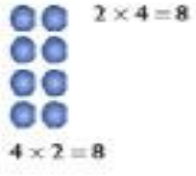
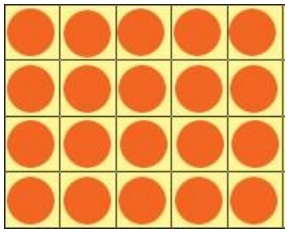


Show children how the concrete method links to the written method alongside your working. Cross out the numbers when exchanging and show where we write our new amount.

MULTIPLICATION

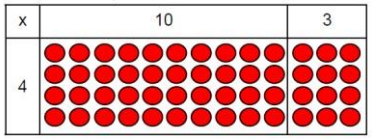
Objective and Strategies	Concrete	Pictorial	Abstract
Doubling	 Use practical activities to show how to double a number.	Draw pictures to show how to double a number. 	 Partition a number and then double each part before recombining it back together.

Counting in multiples	  Count in multiples supported by concrete objects in equal groups.	 Use a number line or pictures to continue support in counting in multiples.	Count in multiples of a number aloud. Write sequences with multiples of numbers. 2, 4, 6, 8, 10 5, 10, 15, 20, 25, 30
Repeated addition	   Use different objects to add equal groups.	There are 3 plates. Each plate has 2 star biscuits on. How many biscuits are there?  2 add 2 add 2 equals 6  5 + 5 + 5 = 15	Write addition sentences to describe objects and pictures.  2 + 2 + 2 + 2 + 2 = 10

Arrays- showing commutative multiplication	Create arrays using counters/ cubes to show multiplication sentences.  	Draw arrays in different rotations to find **commutative** multiplication sentences.    Link arrays to area of rectangles.	Use an array to write multiplication sentences and reinforce repeated addition.  5 + 5 + 5 = 15 3 + 3 + 3 + 3 + 3 = 15 5 x 3 = 15 3 x 5 = 15

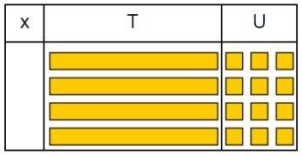
Grid Method

Show the link with arrays to first introduce the grid method.



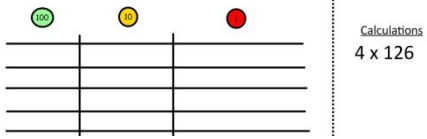
4 rows of 10 4 rows of 3

Move on to using Base 10 to move towards a more compact method.

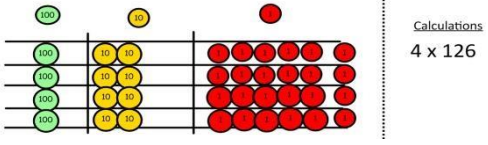


4 rows of 13

Move on to place value counters to show how we are finding groups of a number. We are multiplying by 4 so we need 4 rows.

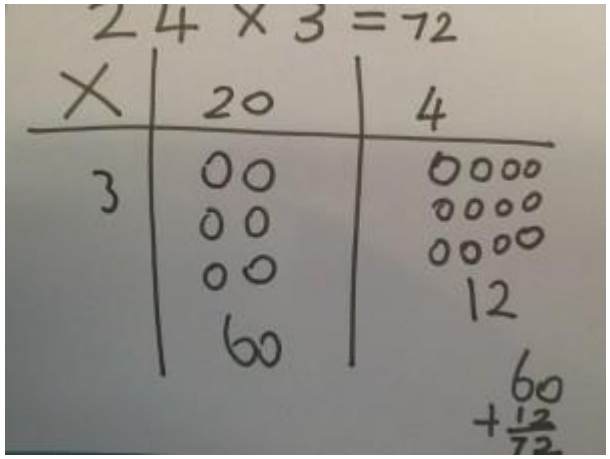


Fill each row with 126.



Children can represent the work they have done with place value counters in a way that they understand.

They can draw the counters, using colours to show different amounts or just use circles in the different columns to show their thinking as shown below.



Start with multiplying by one digit numbers and showing the clear addition alongside the grid.

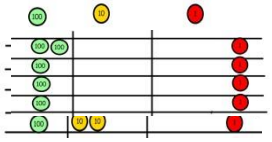
×	30	5
7	210	35

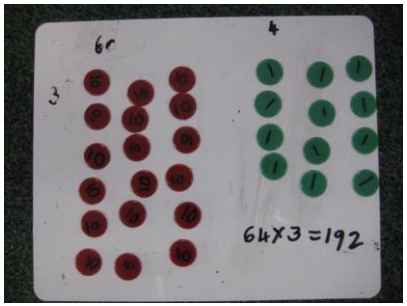
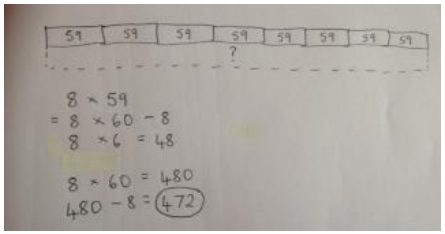
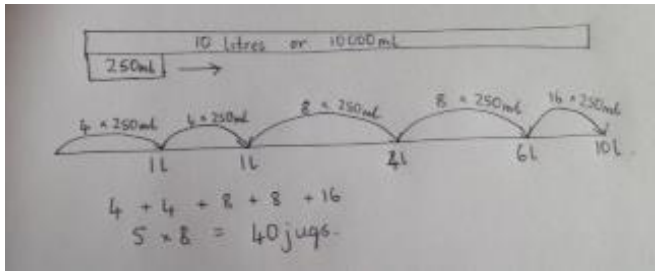
210 + 35 = 245

Moving forward, multiply by a 2-digit number showing the different rows within the grid method.

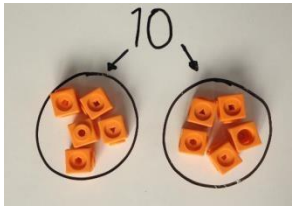
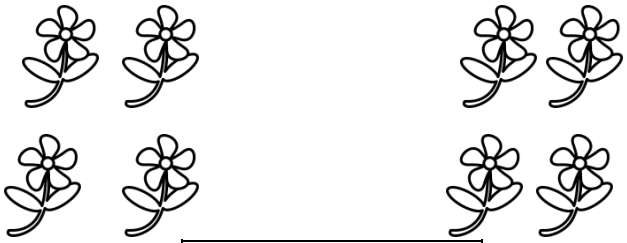
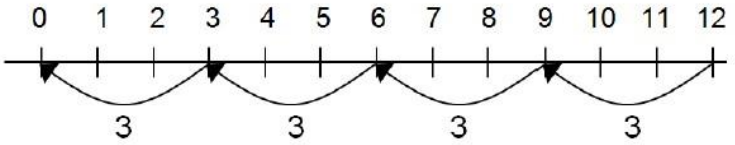
	10	8
10	100	80
3	30	24

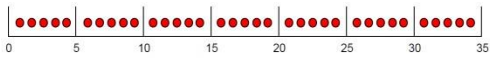
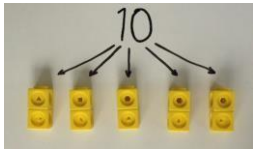
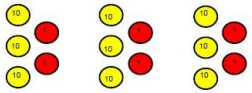
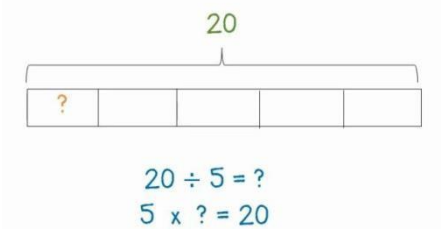
X	1000	300	40	2
10	10000	3000	400	20
8	8000	2400	320	16

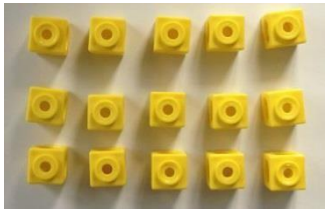
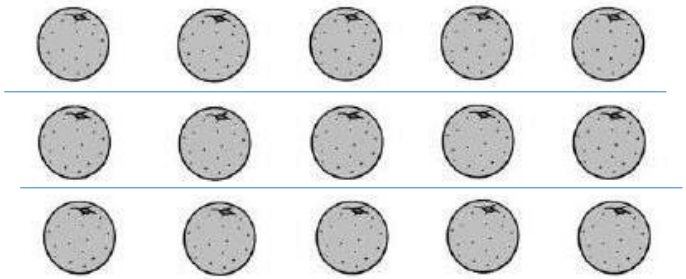
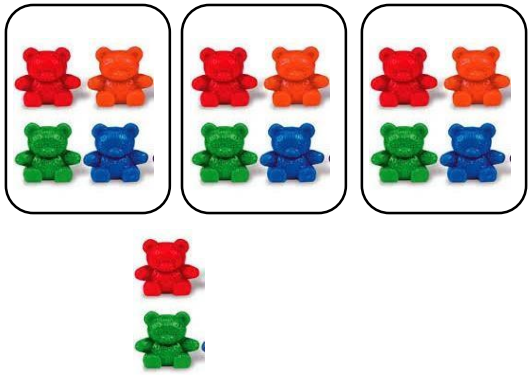
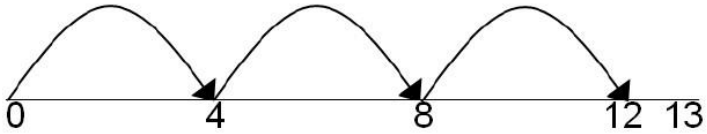
	Add up each column, starting with the ones making any exchanges needed.  Then you have your answer.		

Column multiplication	Children can continue to be supported by place value counters at the stage of multiplication.  It is important at this stage that they always multiply the ones first and note down their answer followed by the tens which they note below.	Bar modelling and number lines can support learners when solving problems with multiplication alongside the formal written methods.   	Start with long multiplication, reminding the children about lining up their numbers clearly in columns. If it helps, children can write out what they are solving next to their answer. 32 x 24 8 (4 x 2) 120 (4 x 30) 40 (20 x 2) 600 (20 x 30) 768 This moves to the more compact method. 2 3 1 1342 x 18 13420 10736 24156 1

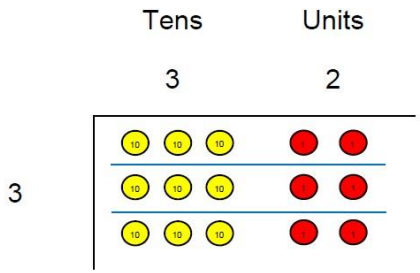
DIVISION

Objective and Strategies	Concrete	Pictorial	Abstract
Sharing objects into groups	 I have 10 cubes; can you share them equally in 2 groups? 	Children use pictures or shapes to share quantities.  8 ÷ 2 = 4	Share 9 buns between three people. 9 ÷ 3 = 3
Division as grouping	Divide quantities into equal groups. Use cubes, counters, objects or place value counters to aid understanding.	Use a number line to show jumps in groups. The number of jumps equals the number of groups. 	28 ÷ 7 = 4 Divide 28 into 7 groups. How many are in each group?

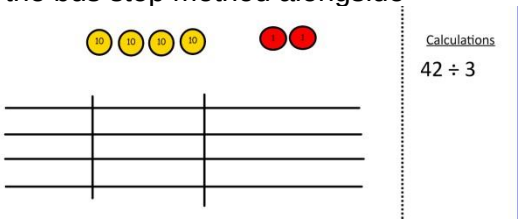
	   96 ÷ 3 = 32 		
			

Division within arrays	 Link division to multiplication by creating an array and thinking about the number sentences that can be created. Eg 15 ÷ 3 = 5 5 x 3 = 15 15 ÷ 5 = 3 3 x 5 = 15	 Draw an array and use lines to split the array into groups to make multiplication and division sentences.	Find the inverse of multiplication and division sentences by creating four linking number sentences. 7 x 4 = 28 4 x 7 = 28 28 ÷ 7 = 4 28 ÷ 4 = 7
Division with a remainder	14 ÷ 3 = Divide objects between groups and see how much is left over 	Jump forward in equal jumps on a number line then see how many more you need to jump to find a remainder.  Draw dots and group them to divide an amount and clearly show a remainder. 	Complete written divisions and show the remainder using r. 

Short division



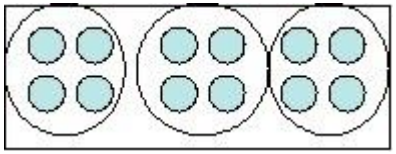
Use place value counters to divide using the bus stop method alongside



42 ÷ 3=

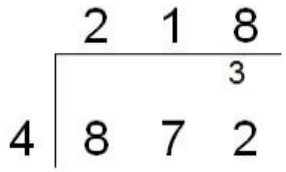
Start with the biggest place value, we are sharing 40 into three groups. We

Students can continue to use drawn diagrams with dots or circles to help them divide numbers into equal groups.

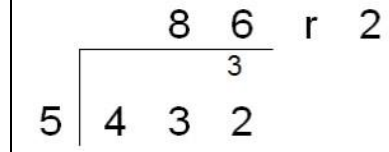


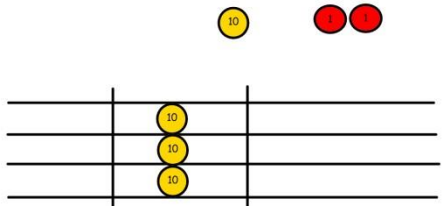
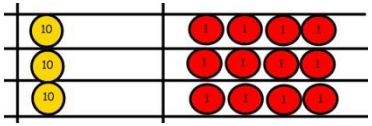
Encourage them to move towards counting in multiples to divide more efficiently.

Begin with divisions that divide equally with no remainder.



Move onto divisions with a remainder.



	can put 1 ten in each group and we have 1 ten left over.  We exchange this ten for ten ones and then share the ones equally among the groups.  We look how much in 1 group so the answer is 14.		Finally move into decimal places to divide the total accurately. 14.6 16 21 35 | 511.0

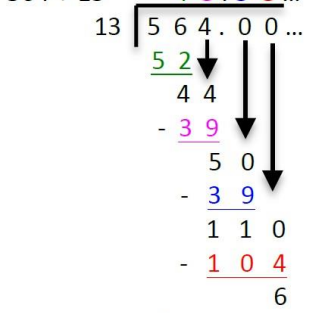
Long division

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

Write out the first ten multiples of the number you are dividing by:

1	13
2	26
3	39
4	52
5	65
6	78
7	91
8	104
9	117
10	130

564 ÷ 13



= 43 r 5 = $43\frac{5}{13}$ = 43.4 (to 1dp)