Guilden Morden Church of England Primary Academy

Mathematics Calculation Policy

A guide to how we teach addition, subtraction, multiplication and division

Aim

This booklet explains the different calculation methods taught at Guilden Morden Church of England Primary School. In each section of this booklet the calculation methods are presented in the order in which they are introduced. It is our expectation that by the end of primary school, each child will be familiar with a range of calculation strategies which they can confidently choose and apply efficiently and accurately.

There is a strong focus on developing the children's mathematical *understanding* through the use of practical resources and pictorial representations. You will also find the common written procedures are developed over time, so as to ensure that the children can not only understand the methods they are using but they can apply them when solving problems and challenges.

Contents

Written in partnership with:

Addition

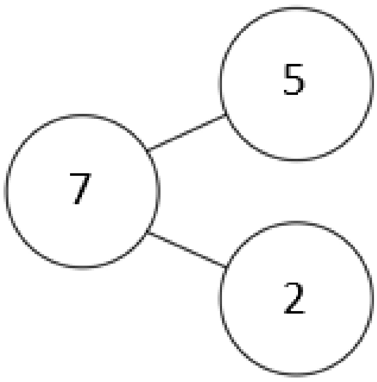
Maths At Home: Addition

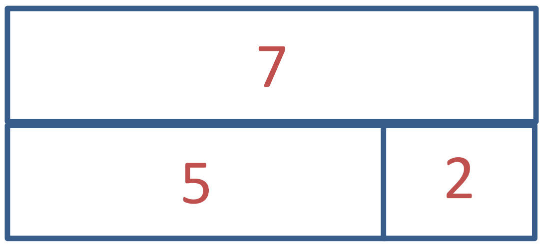
- Counting with objects at home, such as toys and books
- Counting in twos with pairs of socks, shoes or gloves
- Adding common coins to make different totals
- Adding items to shopping baskets, including counting fruit and vegetables
- Adding measurements of length, volume and mass of objects
- Weighing and measuring for practical applications, such as cooking, planning parties and building construction models

Stage 1 (Reception and Year 1)

<u>Combining two parts to make a whole, with a part-whole model</u>

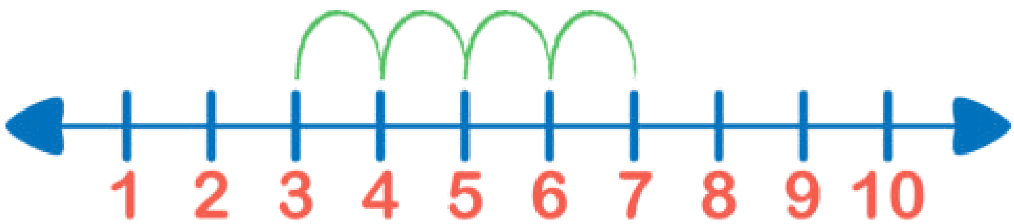
For example, 7 can be made with 5 and 2.



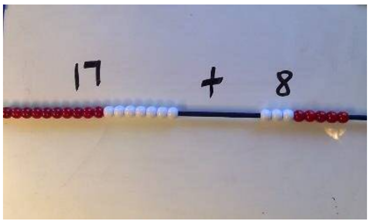


<u>Counting forwards and backwards on a number line</u>

For example 3 + 4 = 7

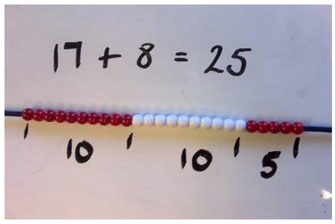


<u>Adding on to the larger number, when adding two numbers, using a number line or bead string</u>

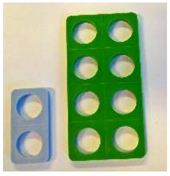


In this example we are adding 17 + 8, starting with 17.

Children understand that the two numbers combine to make the sum, 25, which can also be represented with bead strings or on a number line.



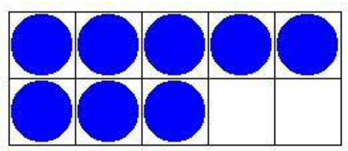
<u>Regrouping to make 10 and 20, using ‘Numicon’ and ‘Ten Frames’</u>



Plastic tiles can be used to show how numbers can be added together to make 10.

For example, 2 + 8 = 10.

Children use these tiles to make one-digit and two-number bonds up to and including 20.



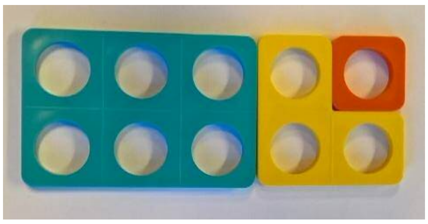
Similarly, a ‘ten frame’ can be used to develop an understanding of numbers of 10 and 20.

For example, 8 + ? = 10

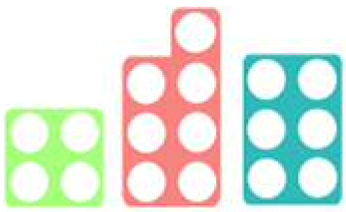
Stage 2 (Year 1 and Year 2)

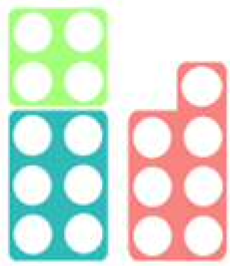
<u>Adding three single digits, with Numicon plastic tiles.</u>

Exploring adding tiles in different ways to make number bonds, for example: 6 + 3 + 1 = 10



Then adding tiles to make larger totals, changing the number order to make calcuations easier. For example 4 + 7 + 6 is the same as 6 + 4 + 7 = 17.

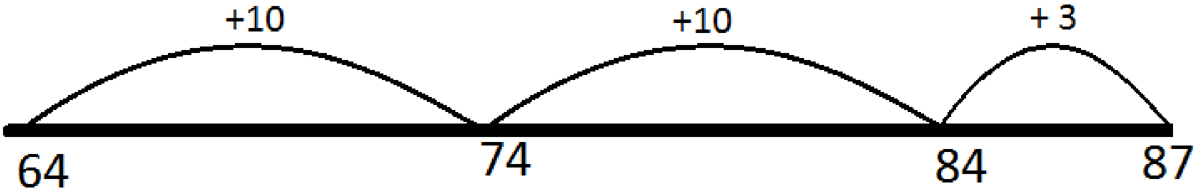




Adding two-digits, using number lines.

In this example, 23 is partitioned into 10 + 10 + 3 and added one part at a time on a number line. Children can be supported in this activity with the use of Base 10.

64 + 23 = 87

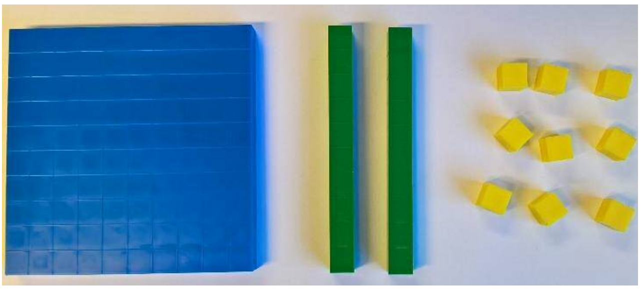


Children will then be taught to record this more efficiently, by drawing one jump to represent adding all of the tens at once. For example adding 23 by adding 20 then 3 in two jumps.

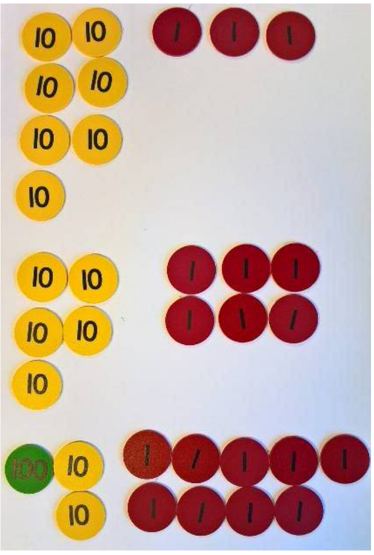
Partitioning method for addition with Base 10, then Place Value Counters

Children can partition two-digit numbers using Base 10, for example here is 73 and 59.

These can then be combined to make a new total, 129. This is made by exchanging ten '10 rods' for one '100 tile'.

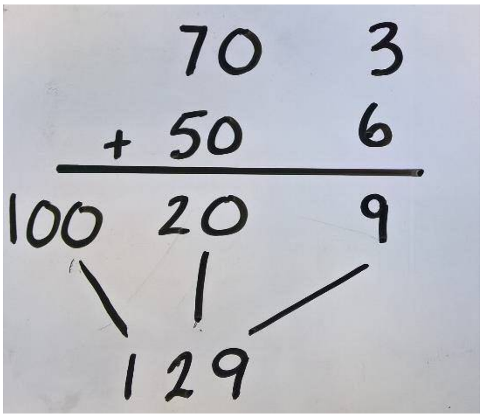


When children are familiar with Base 10 equipment and can demonstrate an understanding of the value of ones, tens and hundreds, children can then move on to using 'Place Value Counters'.



In this example, 73 + 56 = 129, the counters are used to show the addition through partitioning.

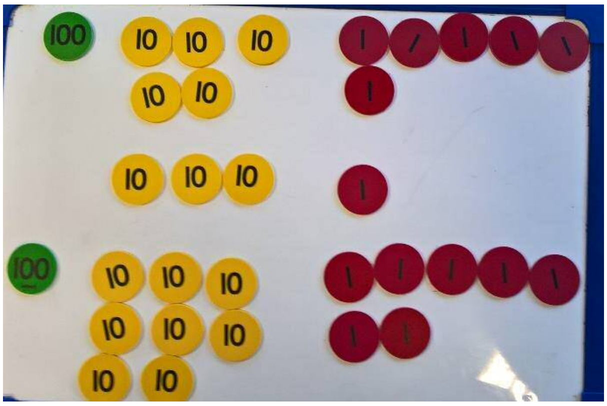
This can be written as:

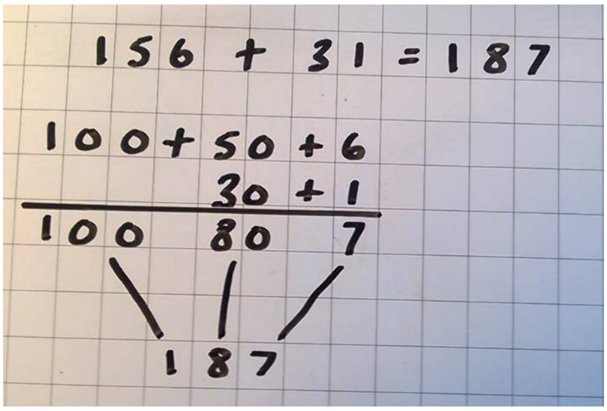


Stage 3 (Year 2 and Year 3)

<u>Expanded Column method with 2-digit and 3-digit numbers – no regrouping, with place value counters</u>

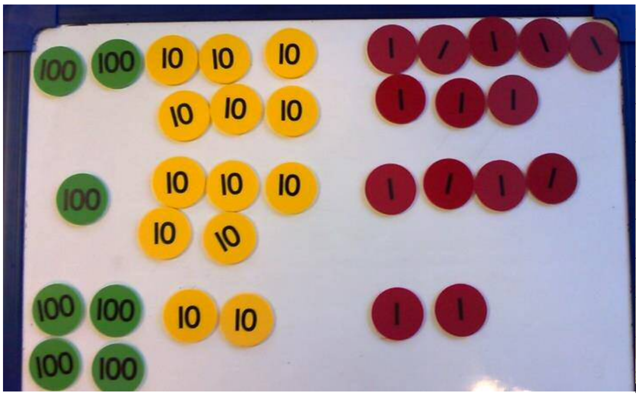
Example: 156 + 31 = 181

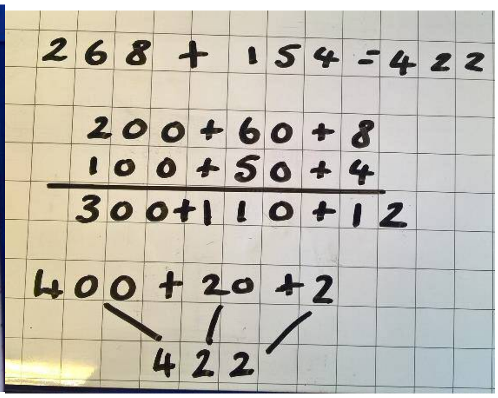




<u>Expanded Column method with regrouping</u>

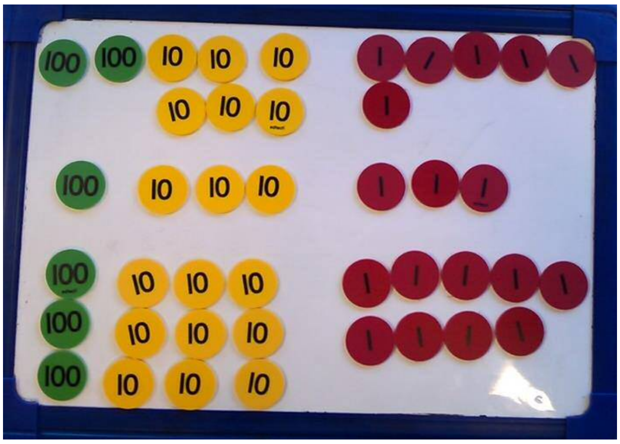
Example: 268 + 154 = 422

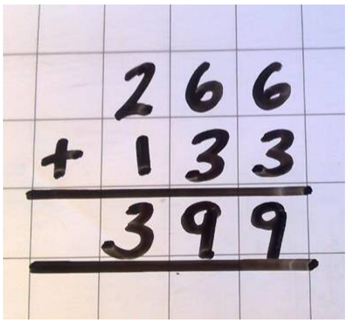




<u>Column addition with no regrouping</u>

Example: 266 + 133 = 399



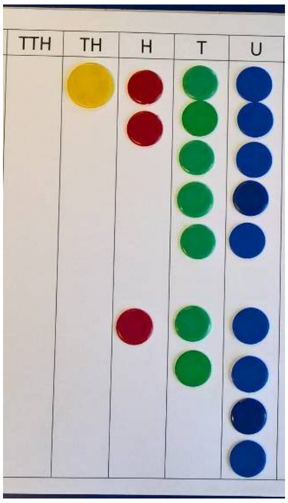


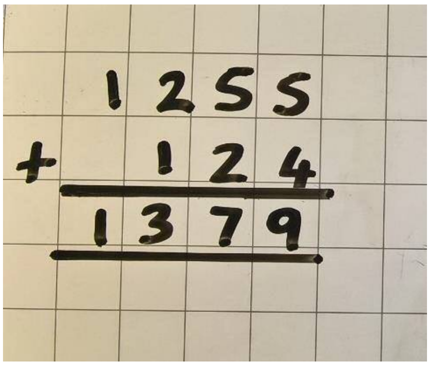
With experience, children may choose not to use place value counters to support their calculations.

Stage 4 (Year 4 and Year 5)

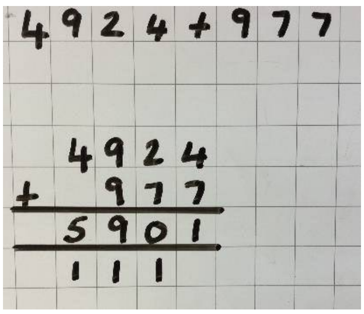
<u>Column method with regrouping (with up to 4 digits)</u>

For example: 1255 + 124 = 1379



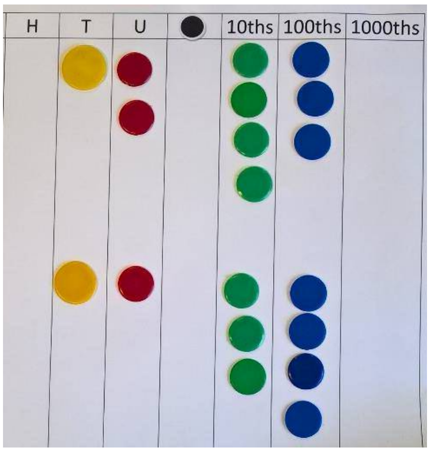


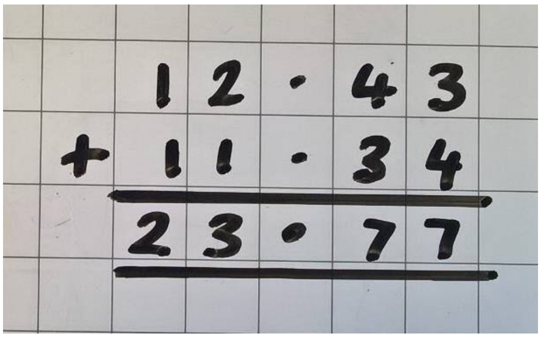
Including addition with regrouping, for example: 4924 + 977 = 5901



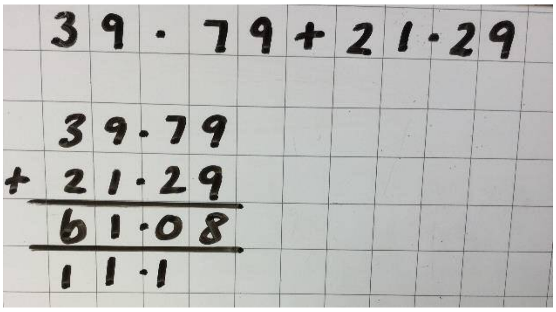
Column method with regrouping for calculating with decimal numbers

For example: 12.43 + 11.34 = 23.77





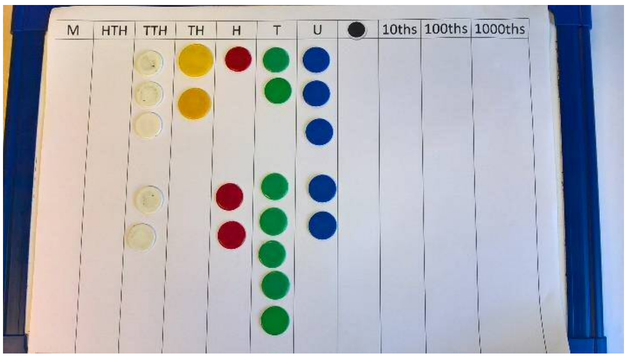
Including addition with regrouping, for example: 39.79 + 21.29 = 61.08

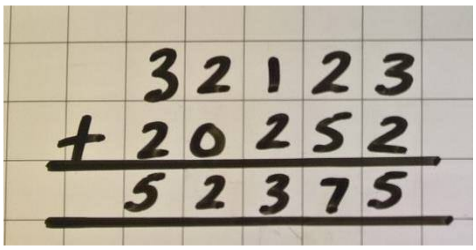


Stage 5 (Year 5 and Year 6)

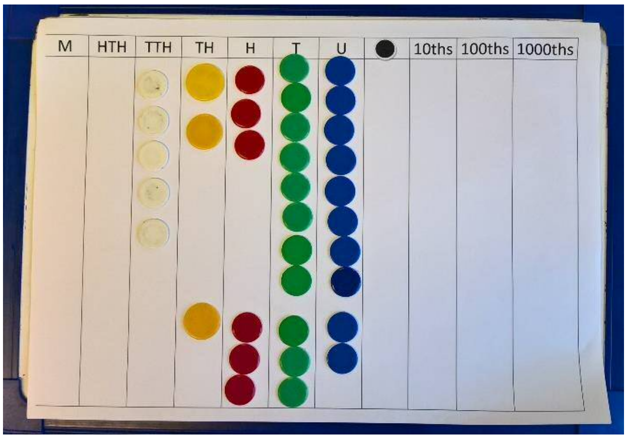
Column method with more than 4 digits

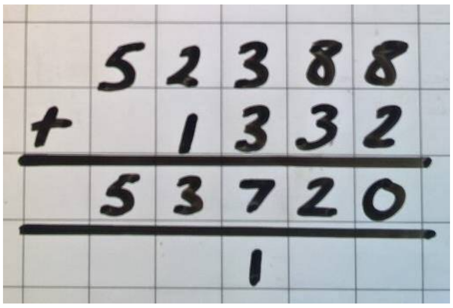
Counters can be used to support calculation with larger number. For example: 32,123 + 20,252 = 52,375





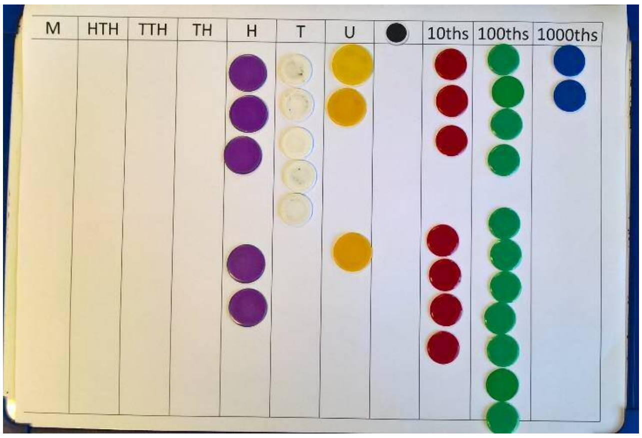
Including with regrouping, for example: 52,388 + 1,332 = 53,720

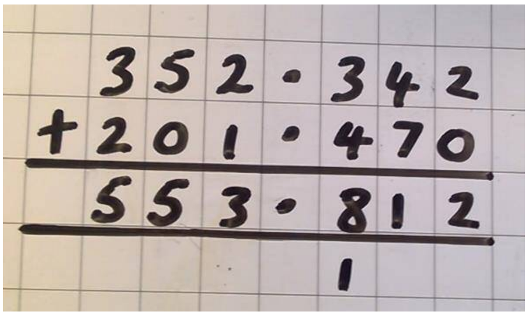




<u>Column method (with decimals- including different amounts of decimal places)</u>

Children are taught to recognise when one number has fewer digits, then add a **0** as a place holder, for example: 352.342 + 201.47 (0 is added as a place holder, see below) = 553.812





Exemplification from the National Curriculum

Addition and subtraction

789 + 642 becomes	874 – 523 becomes	932 – 457 becomes	932 – 457 becomes
		8 12 1	1 1
7 8 9	8 7 4	$\cancel{9}$ $\cancel{3}$ 2	9 3 2
+ 6 4 2	– 5 2 3	– 4 5 7	– $\cancel{4}$ $\cancel{5}$ 7
			5 6
1 4 3 1	**3 5 1**	**4 7 5**	**4 7 5**
1 1			
Answer: 1431	Answer: 351	Answer: 475	Answer: 475

Subtraction

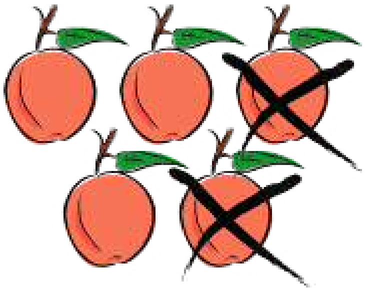
Maths At Home: Subtracting

- Counting backwards when taking away or using objects at home
- Finding the difference between two amounts
- Calculating the change when shopping
- Finding the difference between two measurements, such as heights on a height chart
- Subtracting amounts for practical applications such as cooking or when playing board games

Stage 1 (Reception and Year 1)

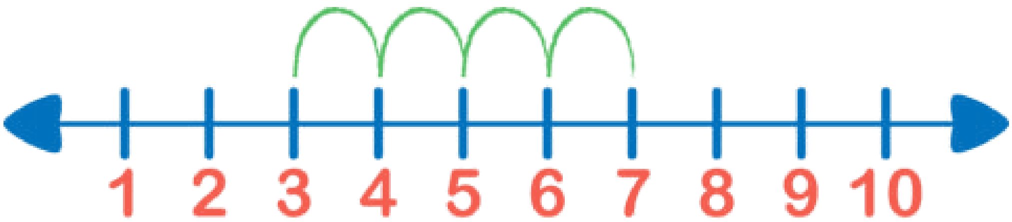
Taking away (with objects)

For example: 5 – 3 = 2



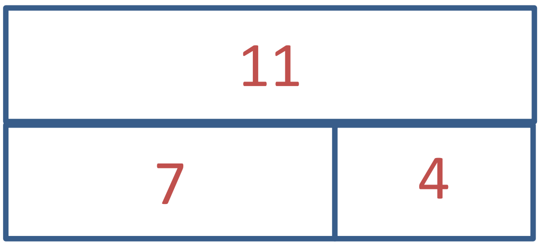
Counting back (number lines)

For example: 7 – 4 = 3

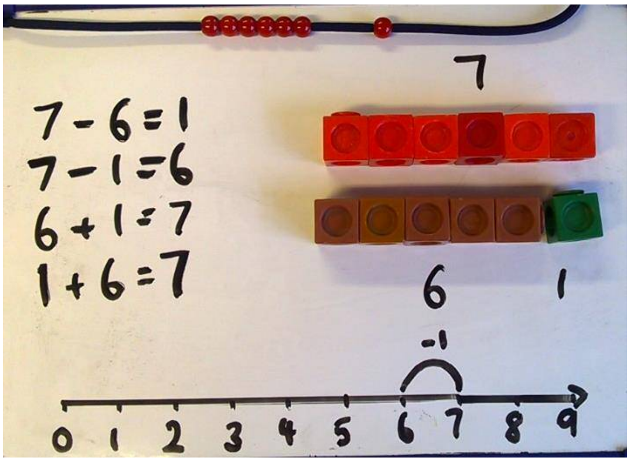


Part whole model (object to bar models)

For example: 11 - 4 = 7

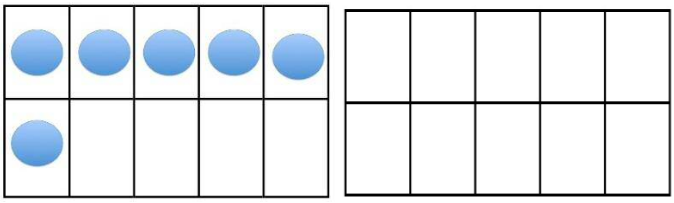


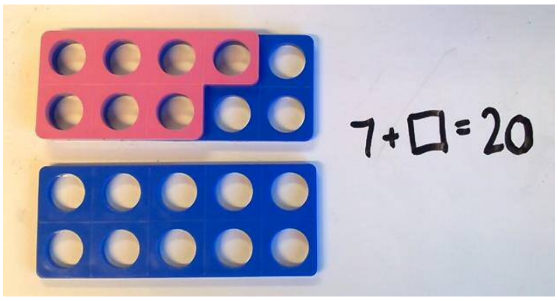
Using multiple representations for subtraction



Addition and subtraction facts for numbers to 20 (with Ten Frames and Numicon)

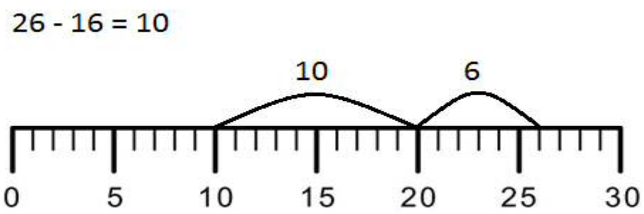
For example: 7 + ☐ = 20





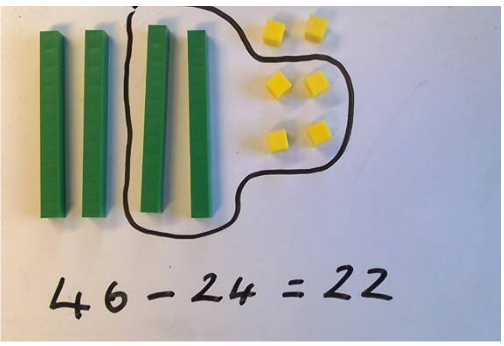
Stage 2 (Year 2)

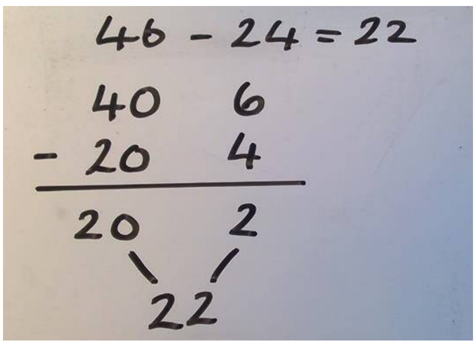
Counting back (with partially numbered number tracks or number lines if needed)



Find the difference between 2-digit numbers (with Base 10 and expanded subtraction)

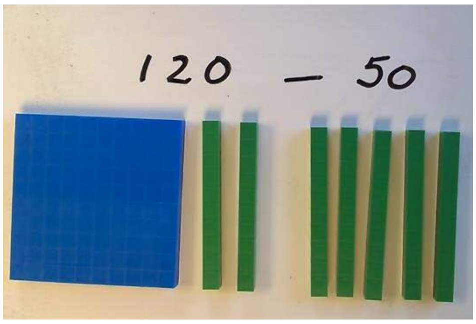
For example: 46 – 24 – 22

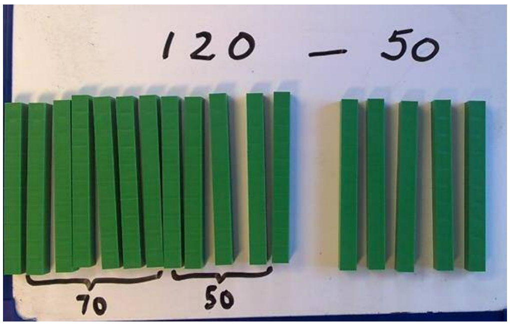




Finding the difference between three-digit multiples of 10 (using Base 10 and/or Place Value Counters)

For example: 120 – 50 exchanging one ‘100 tile’ for ten ’10 rods’



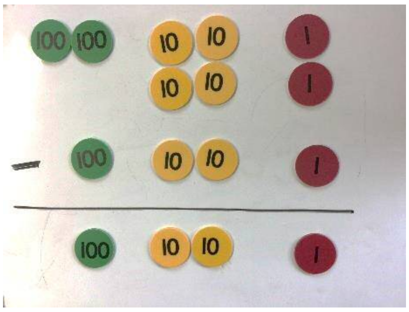


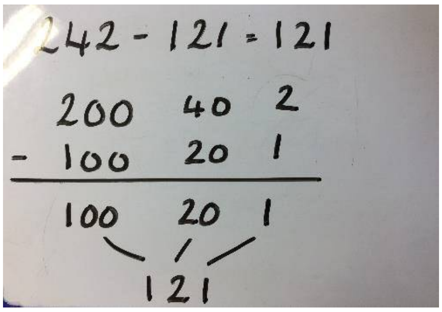
Making complements to 100 (with Base 10 or Place Value Counters)

Stage 3 (Year 2 and Year 3)

Expanded column method: no regrouping (Base 10 – Place Value Counters)

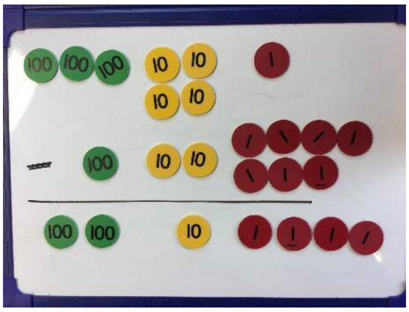
For example: 242 - 121 = 121

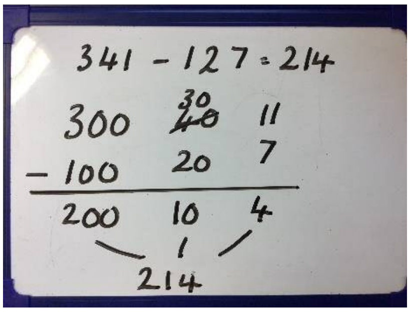




Expanded column method: with regrouping (up to 3 digits – Place Value Counters)

For example: 341 - 127 = 214

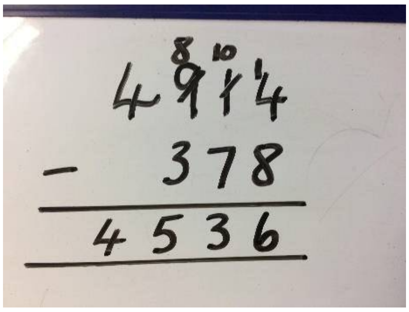




Stage 4 (Year 3 and Year 4)

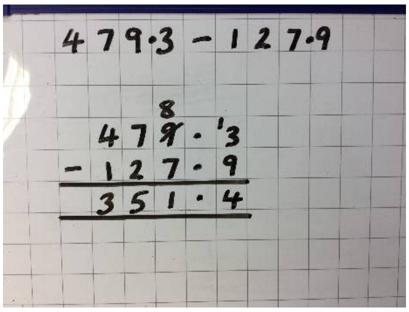
Column method with regrouping (up to 4 digits)

For example: 4914 – 378 = 4536



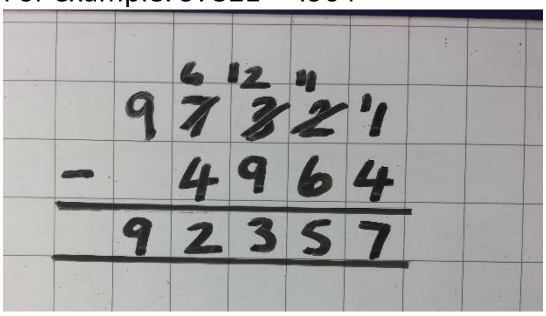
Column method with regrouping (decimals- with the same amount of decimal places)

For example: 479.3 – 127.9 = 351.4

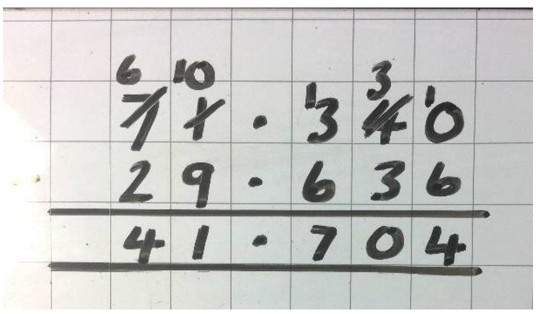


Stage 5 (Year 5 and Year 6)

Column method with regrouping (with more than 4 digits)
For example: 97321 – 4964 =



Column method with regrouping (decimals, with different amounts of decimal places)
For example: 71.34 – 29.636



Exemplification from the National Curriculum

Addition and subtraction

789 + 642 becomes

$$\begin{array}{ccccc} & & 7 & 8 & 9 \\ + & & 6 & 4 & 2 \\ \hline & 1 & 4 & 3 & 1 \\ \hline & & {\scriptstyle 1} & {\scriptstyle 1} & \end{array}$$

Answer: 1431

874 – 523 becomes

$$\begin{array}{cccc} & 8 & 7 & 4 \\ - & 5 & 2 & 3 \\ \hline & 3 & 5 & 1 \\ \hline \end{array}$$

Answer: 351

932 – 457 becomes

$$\begin{array}{cccc} & {\scriptstyle 8} & {\scriptstyle 12} & {\scriptstyle 1} \\ & \cancel{9} & \cancel{3} & 2 \\ - & 4 & 5 & 7 \\ \hline & 4 & 7 & 5 \\ \hline \end{array}$$

Answer: 475

932 – 457 becomes

$$\begin{array}{cccc} & & {\scriptstyle 1} & {\scriptstyle 1} \\ & 9 & 3 & 2 \\ - & \cancel{4} & \cancel{5} & 7 \\ & {\scriptstyle 5} & {\scriptstyle 6} & \\ \hline & 4 & 7 & 5 \\ \hline \end{array}$$

Answer: 475

Multiplication

Maths At Home: Multiplication

- Counting in groups, such as counting in 2s with shoes, or counting in 5s with gloves
- Scaling up recipes when cooking or baking for lots of people
- Multiplying for solving real life problems or when playing games, building construction or creating things.

Stage 1 (Year 1)

<u>Doubling with real life objects such as shoes, socks or gloves</u>

For example, 'double 5 is 10' because 5 + 5 is 10

<u>Counting in multiples (2's, 5's, 10's with coins for example)</u>

Counting with 10p coins, for example 10p x 9 = "10, 20, 30, 40, 50, 60, 70, 80, 90"

<u>Multiplying sets of objects</u>

In this picture we have 3 blocks in each set (factor).

There are 5 sets (factor).

5 sets of 3 blocks is 15 blocks (total = product)

The factors are 3 and 5 and the product is 15

3 x 5 = 15

In this picture we have 5 blocks in each set (factor).

There are 3 sets (factor).

5 multiplied by 3 = 15 (product)

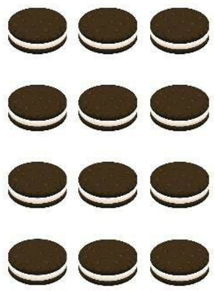
The factors are 5 and 3 and the product is 15

5 x 3 = 15

In this way children understand that two different multiplication questions, where the factors are the same (3 and 5), can create the same product (15). This is called 'commutativity' – a term taught in Year 2.

Arrays with blocks, counters and real life objects

Children begin to organise their multiplication calculations more efficiently using arrays:



In this picture the cookies are organised into 4 rows of 3.

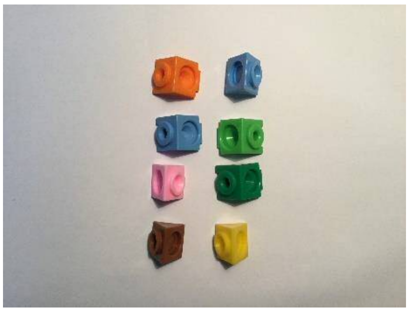
There are 3 cookies in each row (or set = factor).

There are 4 rows in total (number of sets = factor).

There are 12 cookies altogether (the total = product).

We can write this as 3 cookies x 4 = 12 cookies

We can then replace cookies with counters to calculate the answer to other questions, for example:



2 x 4 = 8

5 x 2 = 10

5 x 4 = 20

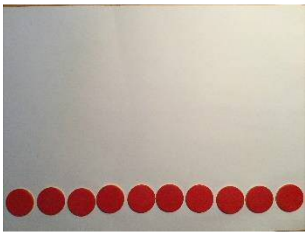
Stage 2 (Years 1 and 2)

Doubling 2-digit numbers (Numicon or Base 10)

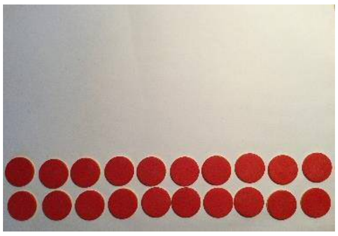
Children understand that doubling is the same as multiplying by 2, or adding the same number to itself. They can rehearse this with Numicon tiles or Base 10 rods.

Counting in multiples (2's, 5's, 10's and 3's)

Children recap their work on arrays in Stage 1 and talk about what happens to the array when more 10s are added. This helps children to see that when we multiply the number 10, we add 10 each time.

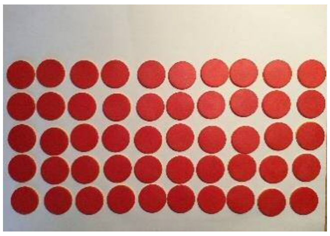


10 x 1



10 x 2

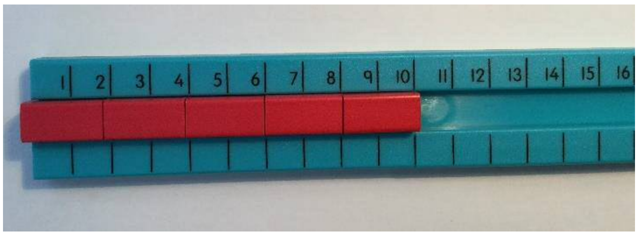
…

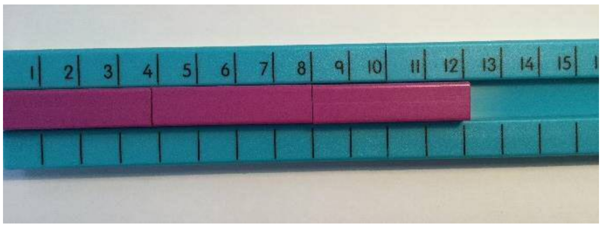


10 x 5

Repeated addition (with Cusinaire rods and number lines)

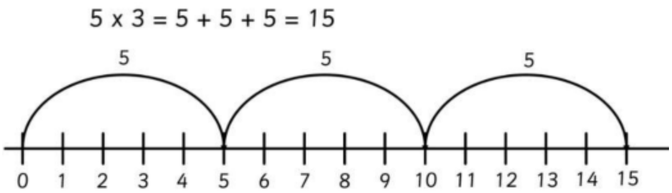
Children can explore multiplication with other resources, including Cuisenaire Rods, which can represent the value of a number.



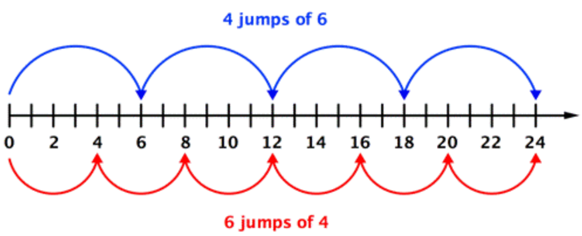


Each red rod is 2cm long, so one rod represents the number 2. The image on the right shows 2 x 5 = 10.

Each purple rod is 4cm long, so one rod represents the number 4. The image on the left shows 4 x 3 = 12.



The number line can help children to see the effect of multiplying the number 5 is the same as adding 5 each time. So 5 x 3 is the same as 5 + 5 + 5 = 15.

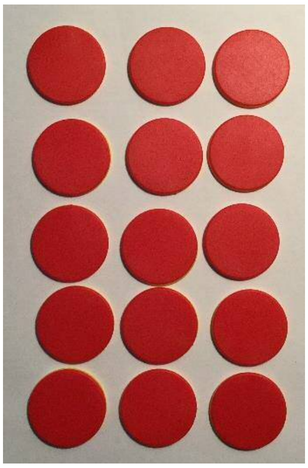


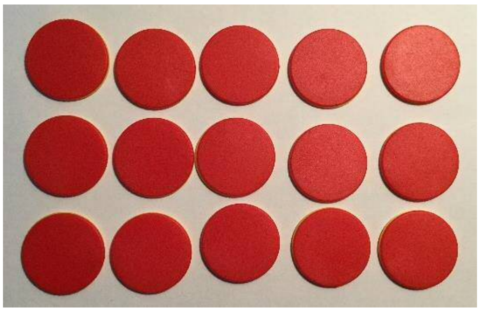
Children can represent the concept of commutativity using a number line.

In this example 6 x 4 (blue) = 4 x 6 (red) and it is also true that 6 + 6 + 6 + 6 = 4 + 4 + 4 + 4 + 4 + 4

<u>Arrays for showing commutative multiplication (arrays can be made with cubes or counters)</u>

Commutativity can also be shown with arrays, for example:





5 x 3 = 15

3 x 5 = 15

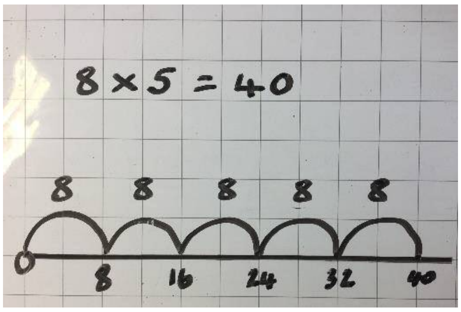
By the end of Year 2, children can choose to use either arrays or the repeated addition method to calculate the answer to multiplication questions.

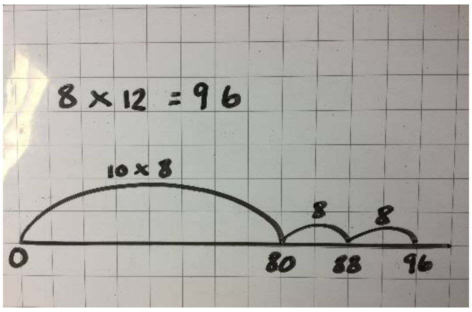
Stage 3 (Year 3 and Year 4)

In year 3 children learn their multiplication tables and division facts for the 3x, 4x, 6x and 8x tables. In year 4 children learn their multiplication tables and division facts for the 7x, 9x, 11x and 12x tables.

Repeated addition (using a number line)

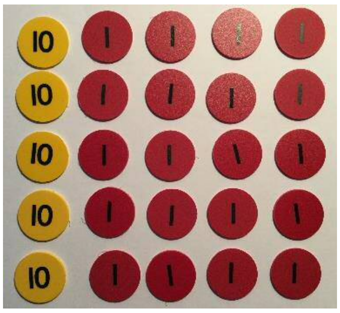
Progressing from multiplying by one digit (for example: 8 x 5 = 40) to multiplying by two digits (e.g. 8 x 12)

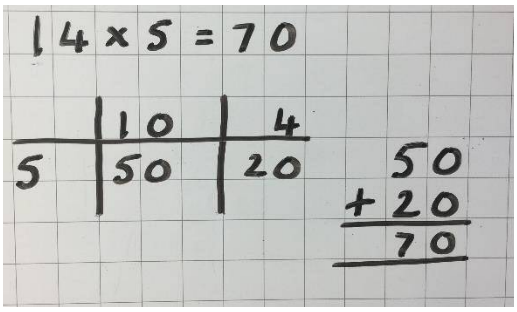




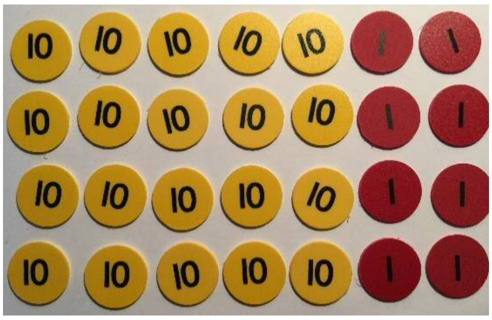
Arrays and grid method for partitioning to multiply (place value counters)

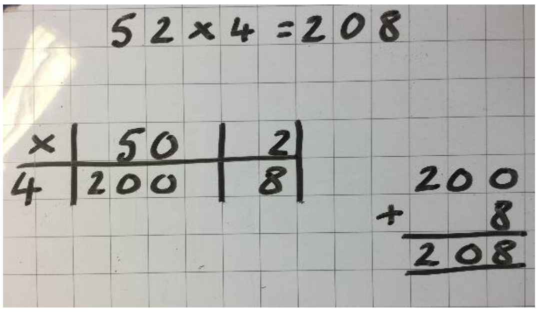
Multiplying a two-digit number by one digit, for example: 14 x 5 = (10 x 5) + (4 x 5) = 70



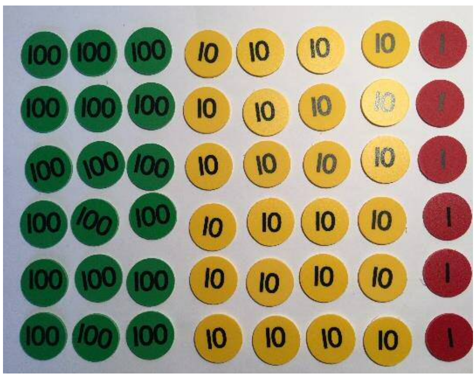


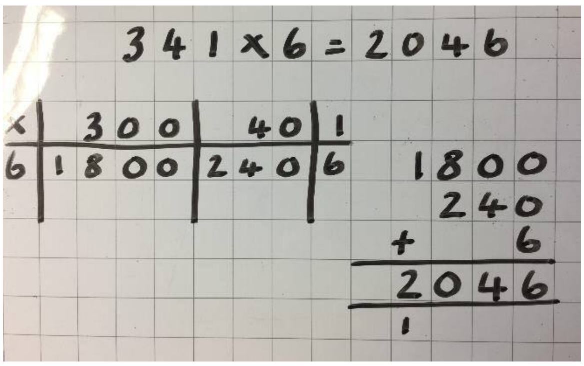
Multiplying a larger two-digit number by one digit, for example: 52 x 4 = (50 x 4) + (2 x 4) = 208





Progressing to multiplying a three-digit number by a one-digit number, for example: 341 x 6 = 2046



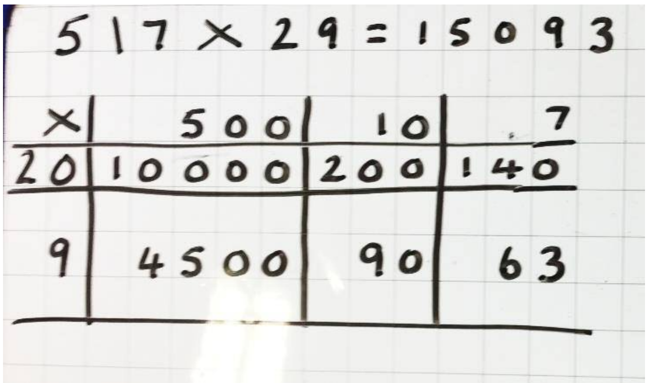


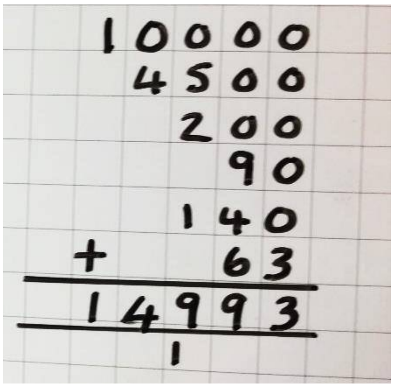
Stage 4 (Year 4, Year 5 and Year 6)

Children continue to learn their times tables and division facts for all multiplication tables to 12 x 12.

<u>Grid method for multiplying larger numbers</u>

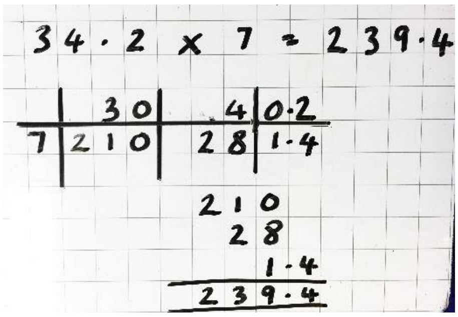
Multiplying a three-digit number by a two-digit number, for example: 517 x 29 = 14993



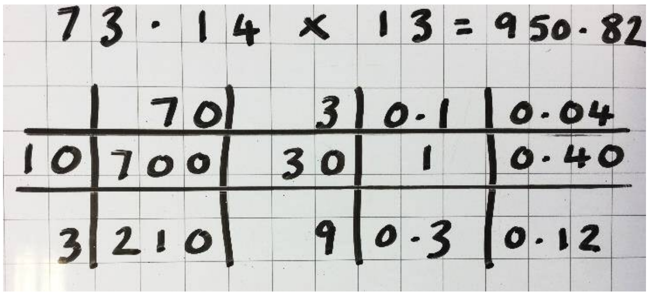


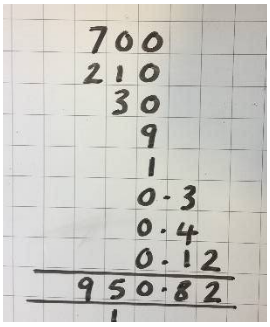
<u>Grid method for multiplying decimal numbers (with up to 2 d.p.)</u>

For example: 34.2 x 7 = 239.4



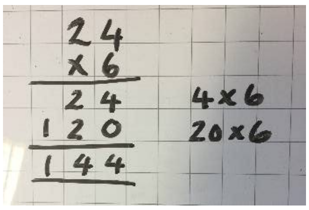
For example: 73.14 x 13 =



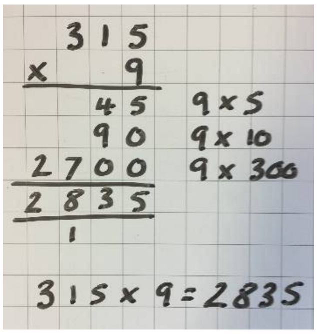


<u>Expanded column multiplication (2 and 3 digit multiplied by 1 digit)</u>

For example: 24 x 6 = 144



For example 315 x 9 = 2835



<u>Column multiplication (up to 4 digit numbers multiplied by 1 or 2 digits)</u>

Exemplification from the National Curriculum

Short multiplication

24 × 6 becomes

		2	**4**
×			**6**
	1	**4**	**4**
		2	

Answer: 144

342 × 7 becomes

		3	**4**	**2**
×				**7**
	2	**3**	**9**	**4**
		2	1	

Answer: 2394

2741 × 6 becomes

		2	**7**	**4**	**1**
×					**6**
	1	**6**	**4**	**4**	**6**
		4	2		

Answer: 16 446

Long multiplication: exemplification from the National Curriculum

Long multiplication

24 × 16 becomes

		2	
		2	**4**
×	**1**	**6**	
2	**4**	**0**	
1	**4**	**4**	
3	**8**	**4**	

Answer: 384

124 × 26 becomes

		1	2	
		1	**2**	**4**
×			**2**	**6**
	2	**4**	**8**	**0**
		7	**4**	**4**
	3	**2**	**2**	**4**
	1	1		

Answer: 3224

124 × 26 becomes

		1	2	
		1	**2**	**4**
×			**2**	**6**
		7	**4**	**4**
	2	**4**	**8**	**0**
	3	**2**	**2**	**4**
	1	1		

Answer: 3224

Division

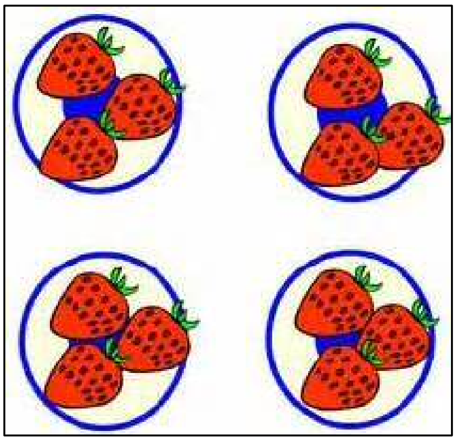
Maths At Home: Division

- Sharing equally with food, games, toys, books etc.
- Scaling down recipes when cooking or baking to make smaller quantities
- Dividing for solving real life problems or when playing games

Stage 1 (Reception and Year 1)

<u>Sharing objects into groups (with real life objects and cubes)</u>





Stage 2 (Year 1 and Year 2)

<u>Division with 2-digit numbers arrays (counters to make arrays, place value counters)</u>

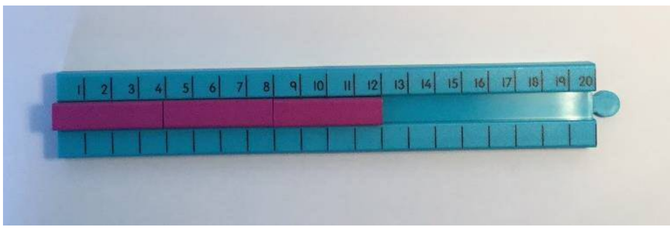
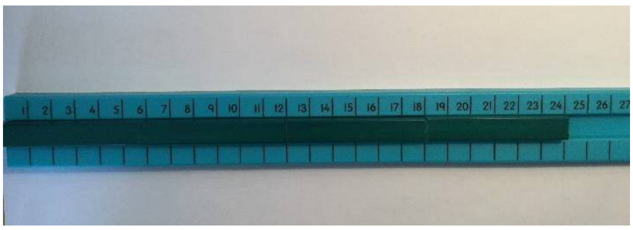

In these questions, the children have divided 24 between different numbers of people.

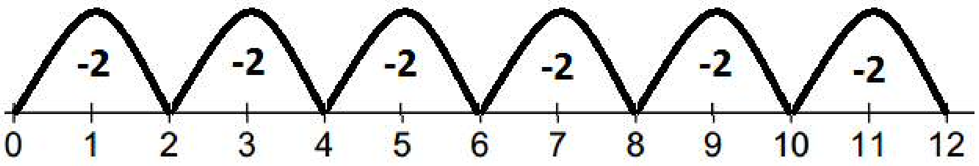
When dividing 24 ÷ 6 each child gets more cubes than when dividing 24 ÷ 8.

For this activity cubes have been used but it is useful for children to experience sharing with familiar real life objects, such as toys, books or games.

For example: 24 ÷ 6 = 4 and 24 ÷ 8 = 3

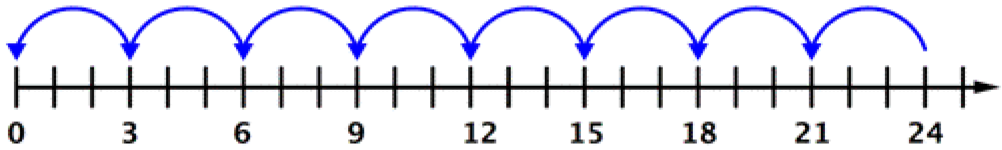
<u>Division as grouping and repeated subtraction (similar to multiplication)</u>



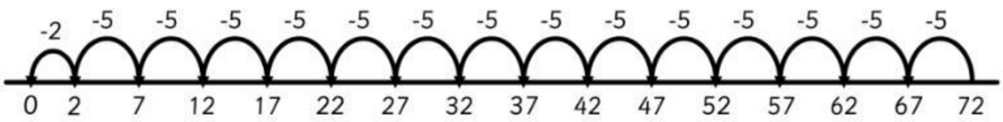
For example:

12 ÷ 2 = 6



24 ÷ 3 = 8

72 ÷ 5

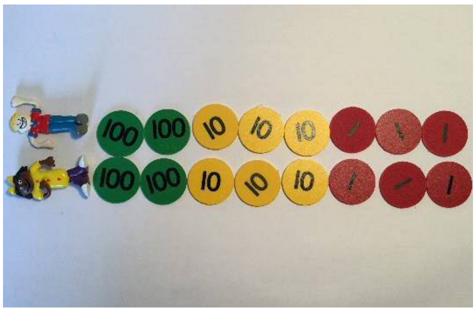


72 ÷ 5 = 14 r 2

Stage 3 (Year 3 and Year 4)

In Key Stage 2, children are taught to derive division facts from known multiplication facts. For example, if you know that 4 x 5 = 20, then you also know that 20 ÷ 4 = 5 and 20 ÷ 5 = 4.

Division within arrays (place value counters are used to create an array)



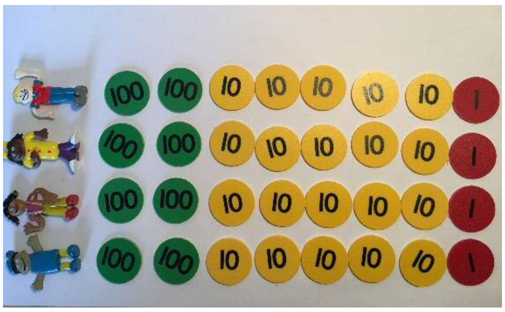
In this example, 466 divided by 2, the counters can be easily divided into 2 equal rows without any regrouping or exchanging.

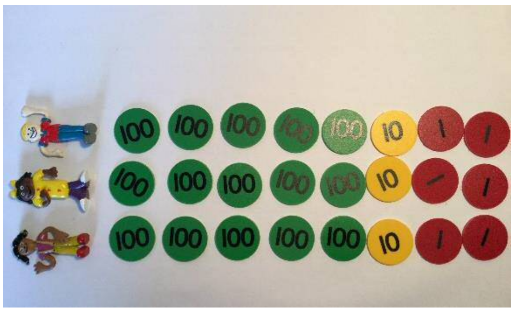
466 ÷ 2 = 233

Each ‘person’ gets 233

In these examples, 1008 ÷ 4 = 251 and 1536 ÷ 3, children will start with a ‘1000 counter’ and exchange it for ten ’10 counters’ to make the sharing easier.

If there are any ‘100s’ left over, these are exchanged for ‘10s’ and so on until the answer is reached. If any counters are left over at the end these are the *remainders*.





Division with a remainder

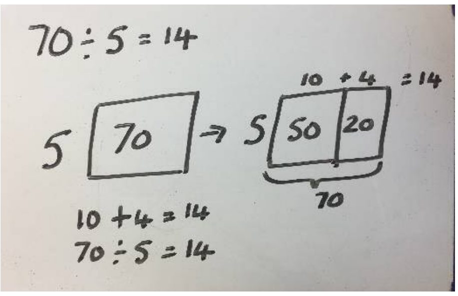
For example: 693 ÷ 3

In this example, there are two counters left over so the answer is 231 r2

Stage 4 (Year 3, Year 4 and Year 5)

Division within 'open arrays' (pictorial arrays)

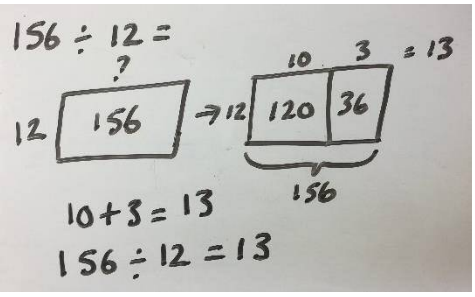
In the following examples, children can find the answer by using known multiplication facts.

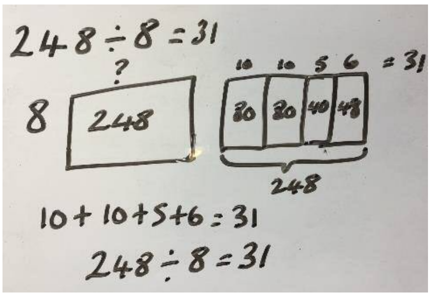


In this example, 70 ÷ 5, 70 has been partitioned into two other numbers 50 + 20 because both 50 and 20 are multiples of 5.

70 ÷ 5 = (50 ÷ 5) + (20 ÷ 5)

70 ÷ 5 = 10 + 4

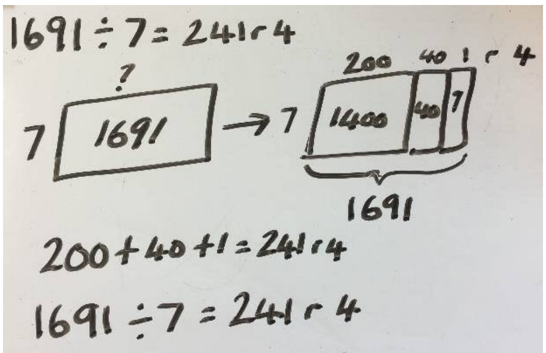




156 ÷ 12 = 13

248 ÷ 8 = 31

Division with a remainder



In this example, 1691 ÷ 7, the answer has been found by partitioning 1691 into smaller numbers 1400 + 280 + 7 + 4.

1400 ÷ 7 = 200; 280 ÷ 7 = 40; 7 ÷ 7 = 1
However 4 is not divisible by 7 so the remainder is 4.

1691 ÷ 7 = 240 remainder 4

Expanded division method (also referred to as 'chunking')

$172 \div 8 = 21r4$

$$\begin{array}{rl} 172 & \\ \underline{-\ 80} & (\underline{10} \times 8) \\ 92 & \\ \underline{-\ 80} & (\underline{10} \times 8) \\ 12 & \\ \underline{-\ 8} & (\underline{1} \times 8) \\ 4 & \quad r4 \end{array}$$

This method is similar to the 'open array' method, because multiplication facts are used for dividing.

In this example, 172 8, multiples of 8 are subtracted from 172. If, after subtracting multiples of 8, there is an amount left over then that is the remainder.

The number of 8's that are subtracted are recorded in brackets and then added together to find the answer.

Stage 5 (Year 4, Year 5 and Year 6)

Short division (up to 4 digits by a 1 digit number interpret remainders appropriately for the context)

National Curriculum exemplification

Short division

98 ÷ 7 becomes

$$\begin{array}{r|l} & 1\ \ 4 \\ \hline 7 & 9\ {}^{2}8 \end{array}$$

Answer: 14

432 ÷ 5 becomes

$$\begin{array}{r|l} & 8\ \ 6\ \ r2 \\ \hline 5 & 4\ \ 3\ {}^{3}2 \end{array}$$

Answer: 86 remainder 2

496 ÷ 11 becomes

$$\begin{array}{r|l} & 4\ \ 5\ \ r1 \\ \hline 1\ 1 & 4\ \ 9\ {}^{5}6 \end{array}$$

Answer: $45\frac{1}{11}$

Long division (interpret remainders as whole numbers, fractions or round)

National Curriculum exemplification

Long division

432 ÷ 15 becomes

$$\begin{array}{r|rrrl} & & 2 & 8 & r\,12 \\ \hline 1\ 5 & 4 & 3 & 2 & \\ & 3 & 0 & 0 & \\ \hline & 1 & 3 & 2 & \\ & 1 & 2 & 0 & \\ \hline & & 1 & 2 & \end{array}$$

Answer: 28 remainder 12

432 ÷ 15 becomes

$$\begin{array}{r|rrrl} & & 2 & 8 & \\ \hline 1\ 5 & 4 & 3 & 2 & \\ & 3 & 0 & 0 & 15\times20 \\ \hline & 1 & 3 & 2 & \\ & 1 & 2 & 0 & 15\times8 \\ \hline & & 1 & 2 & \end{array}$$

$\frac{12}{15} = \frac{4}{5}$

Answer: $28\frac{4}{5}$

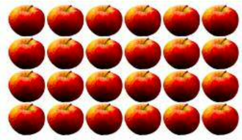
432 ÷ 15 becomes

$$\begin{array}{r|rrrr} & & 2 & 8 & \cdot\,8 \\ \hline 1\ 5 & 4 & 3 & 2 & \cdot\,0 \\ & 3 & 0 & \downarrow & \downarrow \\ \hline & 1 & 3 & 2 & \\ & 1 & 2 & 0 & \\ \hline & & 1 & 2 & 0 \\ & & 1 & 2 & 0 \\ \hline & & & & 0 \end{array}$$

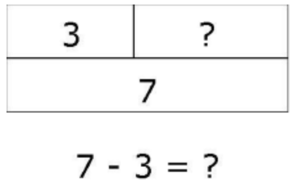
Answer: 28·8

Glossary

Array – a set of objects or numbers arranged into rows and columns



Bar Model – a pictorial representation showing the relationship between more than two numbers



Bridging – calculating with numbers whose sum total is greater than the next multiple of 10, 100 or 1000, for example 91 + 12 is greater than 100, so the calculation could be made simpler, i.e. 91 + 9 + 3 = 100 + 3

Calculate – to work out a new total or amount

Decimal fraction – a fraction written as a decimal, e.g. ¼ = 0.25

Decimal point – a point (similar to a full stop) between a whole number and a decimal fraction

Decomposition – a method of subtraction

Digit – a symbol used to show a number. For example 8 is a one-digit number, 88 is a two-digit number.

Difference – the difference between two numbers is calculated by subtraction

Estimate – to make an approximation based on a rough calculation or rounding

Exchanging – used in subtraction for changing one unit, e.g tens, into another unit, e.g. ten ones

Factor – a whole number that divides exactly into another number, for example 8 is a factor of 16

Grid Method – a calculation method for multiplication involving partitioning

×	30	5
20	600	100
6	180	30

600 + 100 = 700
180 + 30 = 210

700 + 210 = 910

Integer – a whole number, including positive numbers, negative numbers and zero; but not including decimals or fractions

Least significant digit – the digit in a number with the lowest value or significance, for example in the number 758 the least significant digit is 8 because it's value is only 8 ones, but the 5 is worth 50 and the 7 is worth 700

Number line – a line marked with numbers, showing the increasing or decreasing value of numbers, usually used to support calculations

Partitioning – breaking numbers into parts, often tens and ones, usually to support calculation

Pictorial – an image or picture used to represent something

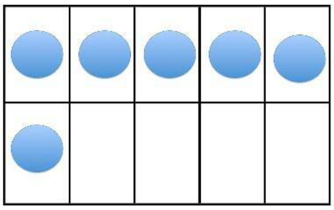
Product – the result when two numbers are multiplied

Remainder – the amount left over after dividing a number

Rounding – to change a number to another number which is easier to calculate with or handle

Sum – the total or whole amount, often the result of adding

Ten Frames – a pictorial representation of 10 counters arranged in 2 rows and 5 columns



For more vocabulary you could use an online maths dictionary such as: www.amathsdictionaryforkids.com/dictionary.html