Charlton Manor Primary School

Calculation Policy

Agreed: April 2023
Review: July 2024

Introduction

At Charlton Manor, we believe in kinaesthetic and practical learning opportunities that give children the ability to use and apply their skills and knowledge in a variety of contexts. We believe in equipping them with the skills, knowledge and understanding of mathematics to enable them to be successful in their adult lives.

Aims

Aims of the (new) National Curriculum for Mathematics:

- Fluency in the fundamentals (number facts, algorithms, procedures) through varied and frequent practice with increasingly complex problems so they can recall and apply knowledge rapidly and accurately.
- To develop conceptual understanding (deep learning, mastery).
- Reason mathematically – follow a line of enquiry, conjecture relationships/generalisations, develop an argument, justify or prove using mathematical language.
- Apply maths to solving a variety of increasingly sophisticated problems, breaking them into simpler steps, persevering to seek solutions, making connections across domains and in other subjects.

This policy aims to secure a template for consistent delivery across our school in terms of calculation methodology and use of key vocabulary for both mental and written calculations which allows for progression, higher levels of achievement and is part of a whole school agreement. Calculation is organised in a sequence and teachers use accurate assessments, high expectations and quality teaching to ensure progression regardless of a child's start point or any special educational needs.

The Early Years Curriculum ensures mathematics is interactive, real life and encompasses adult led and child led activities. Cross-curricular links are made where possible using whole school topics.

Mental Methods

Oral and mental work in mathematics is essential. It is important that early practical, oral and mental work must lay firm foundations by providing children with a good understanding of how the four operations build on efficient counting strategies and a secure knowledge of place value and number facts. Later work must ensure that children recognise how the operations relate to one another and how the rules and laws of arithmetic are to be used and applied. Ongoing oral and mental work provides practice and consolidation of these ideas. It must give children the opportunity to apply their learning to particular cases, exemplifying how the rules and laws work and so also to more general cases where children make decisions and choices for themselves.

The ability to calculate mentally forms the basis of all methods of calculation and has to be maintained and refined. A good knowledge of numbers is the product of structured practice and repetition. It requires an understanding of number patterns and relationships developed through directed enquiry, use of models and images and the application of acquired number knowledge and skills. Secure mental calculation requires the ability to recall key number facts instantly- for example, number bonds to 10, multiplication and division facts up to 10x10.

The mental methods for teaching mathematics are taught systematically from Foundation onwards and pupils will be given regular opportunities to develop the necessary skills. However mental calculation is not at the exclusion of written recording and should be seen as complementary to and not as separate from it.

Children should be confident when moving from concrete maths to mental strategies to written methods, with the ability to move between these depending on the requirements of the task at hand.

Written Methods

In every written method there is an element of mental processing. Sharing written methods with the teacher encourages children to think about the mental strategies that underpin them and to develop new ideas. Therefore written recording both helps children to clarify their thinking and supports and extends the development of more fluent and sophisticated mental strategies.
During their time at Charlton Manor children will be encouraged to see mathematics as both a written and spoken language.

Our aim is that by the end of Key Stage 2, our children should be able to use an efficient written method for each operation with confidence and understanding. We promote methods that are efficient and work for any calculations, including those that work for whole numbers or decimals. They are compact and consequently help children to keep track of their recorded steps. Being able to use these written methods gives children an efficient set of tools they can use when they are unable to carry out a calculation in their heads or do not have access to a calculator.

When met with a mathematical challenge, we encourage children to think:

- "Can I do this in my head?"
- "Do I know the approximate size of the answer?"
- "What strategy do I need to use to solve this problem?"
- "If I can't do it wholly in my head, what notes or jottings do I need to write down to help me calculate the answer mentally?"
- "Will the formal written method I know be helpful?"

Models and images

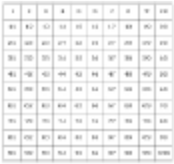
Children at Charlton Manor are given the opportunity to explore mathematical concepts using the following resources, models and images:

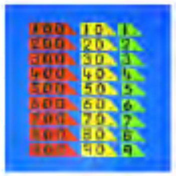
 Numicon

 Counters

 Multilink or unifix cubes

 Bead strings

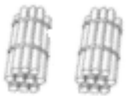
 hundred square

 place value arrow cards

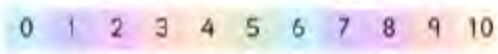
 money

 fingers

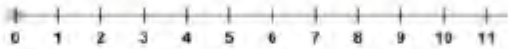
 socks

 straws

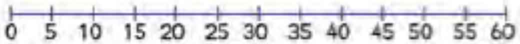
- Number tracks



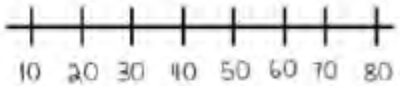
- Number line with all numbers labelled



- Number line with 5's and 10's labelled

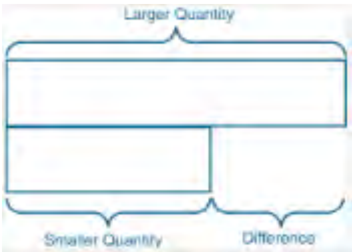


- Number line with 10's labelled



- Number lines, marked but unlabelled

- Empty number line



bar models

Written methods for addition

Key vocabulary:

Add, more, count on, plus, sum, total, altogether, how many, equals, is equal to, partition, multiple of 10, number line, 100 square, bar, column, addition, place value, hundreds, tens, ones, commutative, carry, expanded, decimal, hundredths, tenths.

Children must become secure in the recall and application of addition facts (and corresponding subtraction facts) through frequent practice. This can be achieved through mental maths tests, warms up and games, during guided maths, targeted intervention groups (if required) and in homework challenges.

To aid addition, children need to be able to:

- Recall addition pairs to 9+9 and bonds to 10.
- Add mentally a series of one digit numbers such as 5 + 8 + 4.
- Add multiples of 10 (e.g. 60 + 70) using their bonds to 10 and knowledge of place value to support.
- Partition ten and three digit numbers into multiples of 100, 10 and 1 in different ways (e.g. partition 74 into 70 + 4 or 60 + 14).

Mental methods of calculation should be practiced and secured alongside their learning and use of an efficient written method for addition.

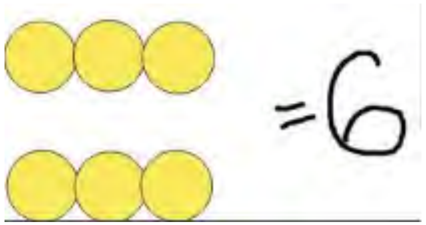
Phase 1

Develop secure 1:1 correspondence and understanding of addition.

- Count accurately 0-10 then to 20.
- Recognise and write numerals 0-10.
- Use number tracks and number lines with missing numbers. What number comes before? After? What numbers are between 7 and 10?

0	1	2	3	4	5	6	7	8	9	10

- Count and add real objects.

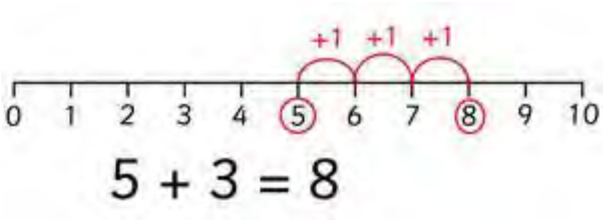


Introduce the idea that addition can be done in any order (it is commutative).

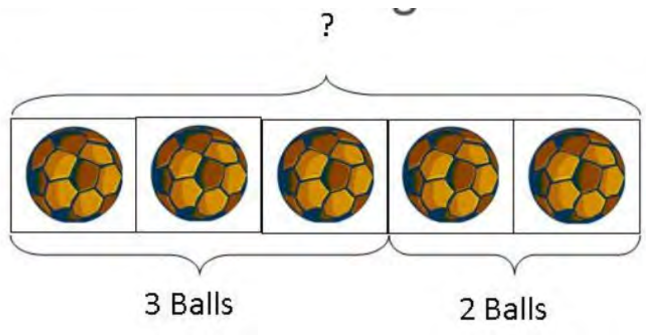
Phase 2

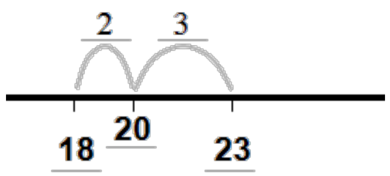
Number lines, hundred squares and bars.

- Number lines help children move from using concrete objects.
- Bridging through 10- children split a number to add to the nearest multiple of 10 and then count on.
- Use a bar to show the problem.
- The hundred square supports understanding when adding 10 to any number; the ones stay the same and then tens go up. Eventually this will be done mentally.



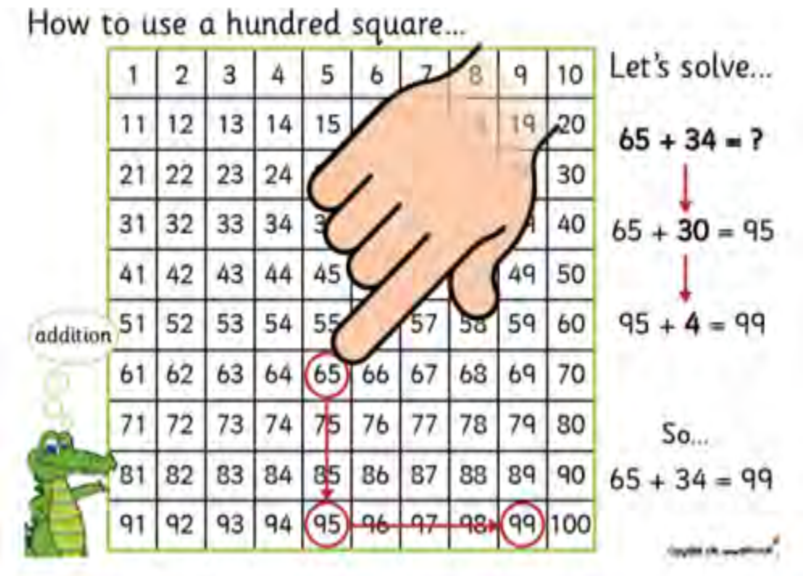
Counting on





bridging through 10 (use a numbered number line)

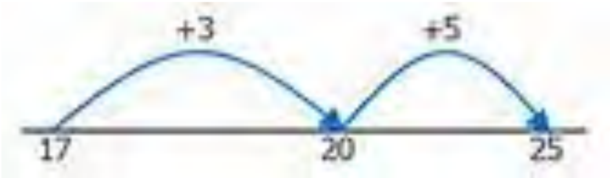
adding in multiples of 10



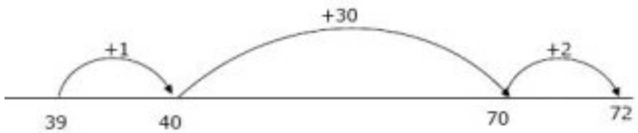
Phase 3

Empty number lines.

- Mental methods that lead to column addition generally involve partitioning (adding the tens and ones separately). Children need to be able to partition numbers in many ways to help them make multiples of 10.
- The empty number line helps record the steps on the way to calculating the total.



17 + 8 = 25

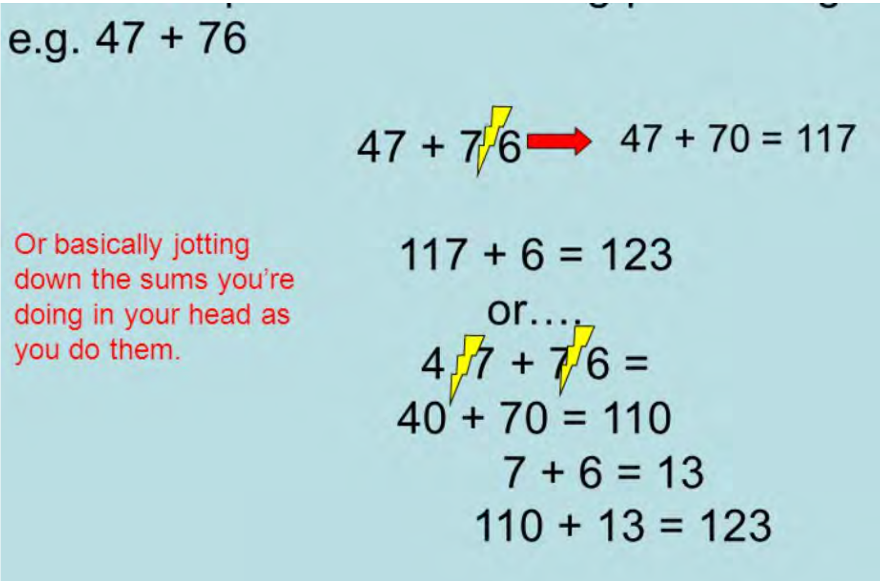


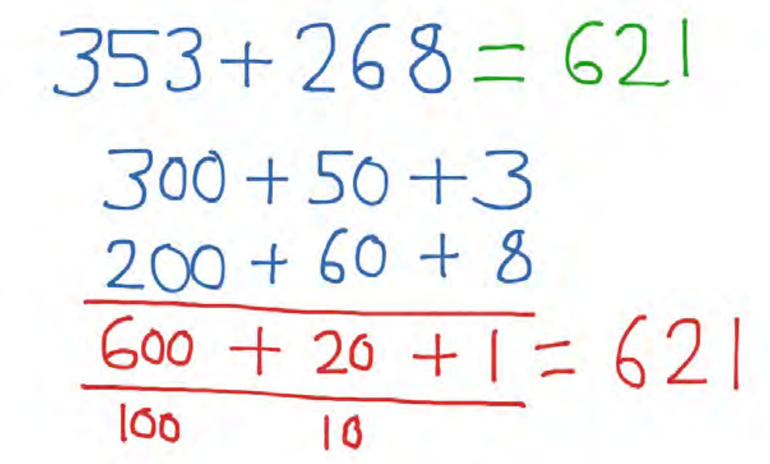
39 + 33 = 72

Phase 4

Partitioning

- Recording mental methods using partitioning. Add the tens and then the ones to form partial sums and then add thee partial sums.
- Partitioning both numbers mirrors the column method.
- Partitioned numbers are then written under one another
-

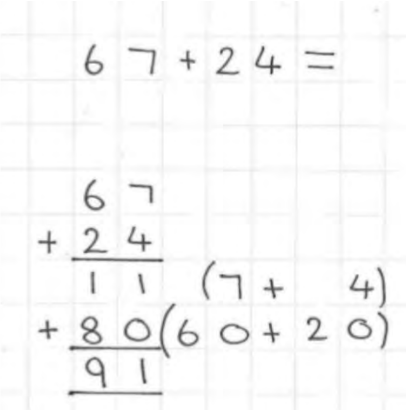




Phase 5

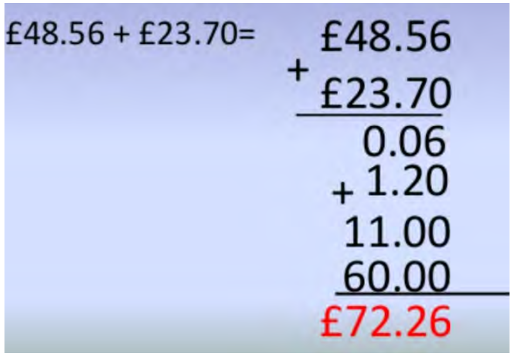
Expanded method in columns

- Layout as columns and showing the addition of tens and tens, ones and ones. This creates partial sums. Finally add these together.
- Use words to describe what you are doing (talk through the calculations).
- This helps children to understand place value and the structure of column addition.




```
 247
+125
  12
  60
 300
 372
```

Extend to decimals

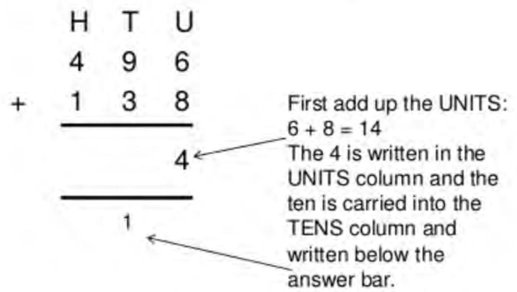


Phase 6

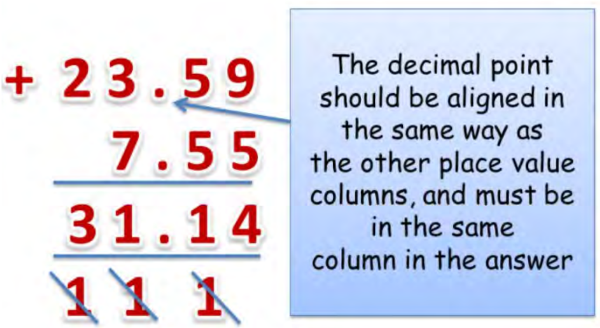
Column method

- Recording is reduced further.
- Carrying digits are recorded under the line saying “carry ten” or “carry one hundred”, NOT “carry one”.

Column addition is particularly efficient when used with larger whole numbers and decimals. Once learned, the method is quick and reliable. For example; 496 + 138



Extend to include decimals



Written methods for subtraction

Key vocabulary:

Subtract, take away, minus, find the difference, more than, less than, count back, how many are left, remain/remaining, equals, is equal to, partition, multiple of 10, number line, 100 square, bar, column, subtraction, place value, hundreds, tens, ones, carry, expanded, decimal, hundredths, tenths, borrow, adjust.

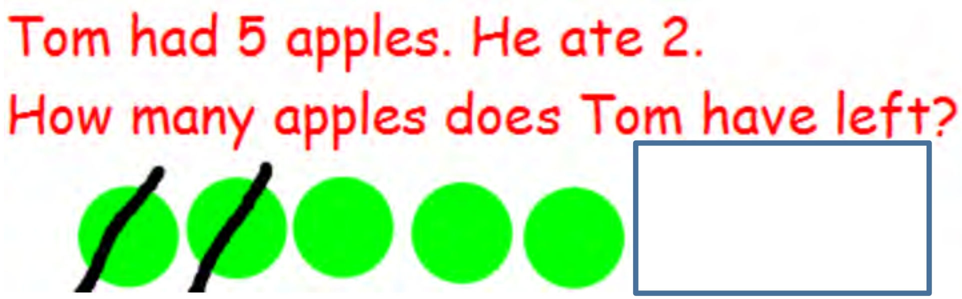
To be able to successfully subtract, children need to be able to:

- Recall all addition and subtraction facts to 20.
- Subtract multiples of 10 (such as 160-70) using the related subtraction fact 16-7 and their knowledge of place value.
- Partition two and three digit numbers into multiples of one hundred, ten and one in different ways (e.g. partition 74 into 70+4 or 60+14).
- Children must practice and secure their mental methods of calculation alongside learning efficient written methods.

Phase 1

Secure 1:1 correspondence and understanding of subtraction.

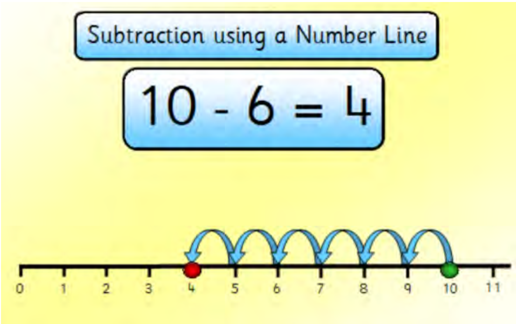
- Counting forwards and backwards 10 10 then 20.
- Recognise and write numerals 1-10.
- Use number lines and number tracks with missing numbers. What comes before, after? What numbers are between 4 and 8?..
- Count and subtract real objects and pictures.

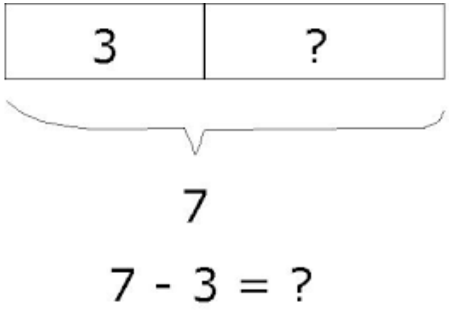


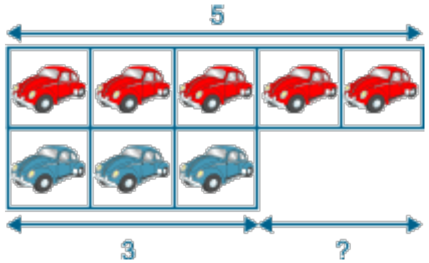
Phase 2

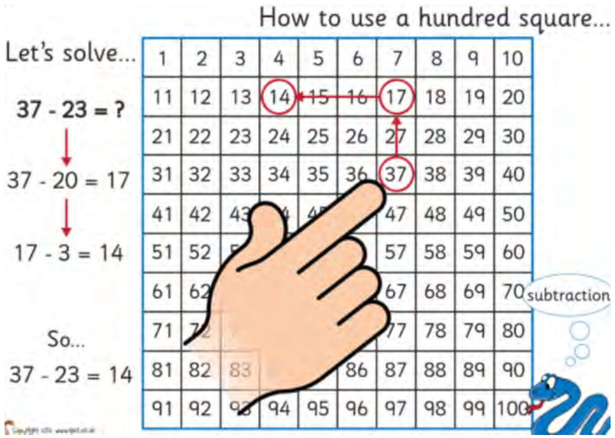
Number lines, 100 squares and bars.

- Begin by counting back to find one less/subtract 1.
- Count back to subtract on a number line.
- Show the subtraction problem using a bar.
- Use a 100 square to subtract from any number.
- Use a 100 square to subtract multiples of 10 from any number.
- Link to place value (which digits change and which don't).





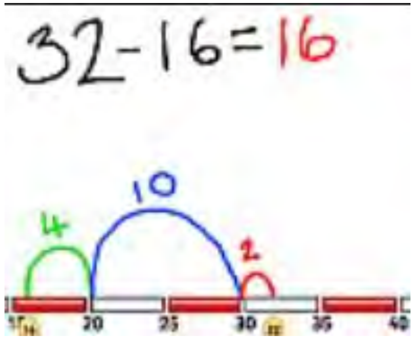


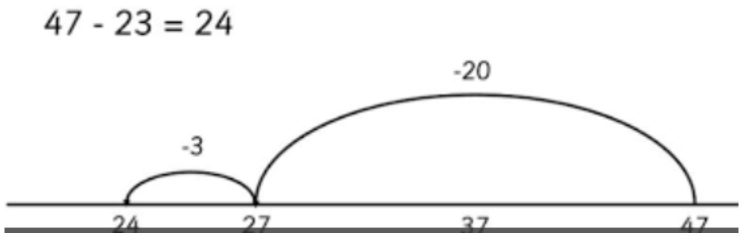


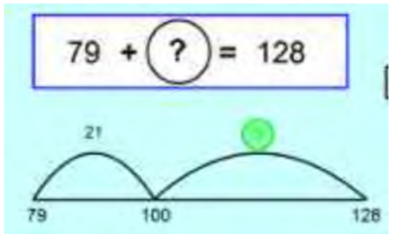
Phase 3

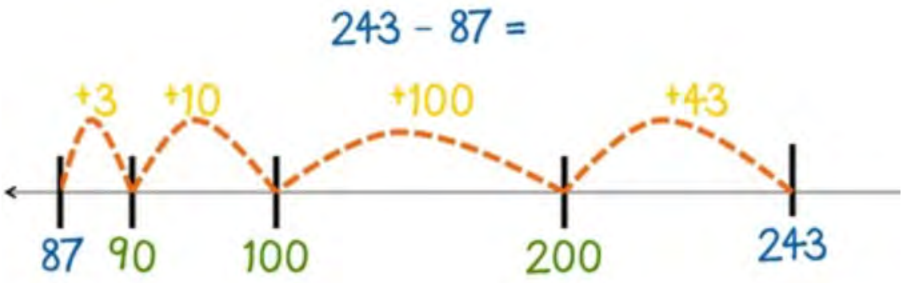
Blank number lines

- The blank number line helps record mental calculations. Children can draw them themselves.
- Children can show counting back to subtract including bridging through 10.
- Children can also count on from the smaller to the bigger number/ finding the difference. Children must practice this method to support subtraction as finding the difference. Emphasize using correct vocabulary.
- Continue to use the bar as a visual support/explanation of what we are solving.





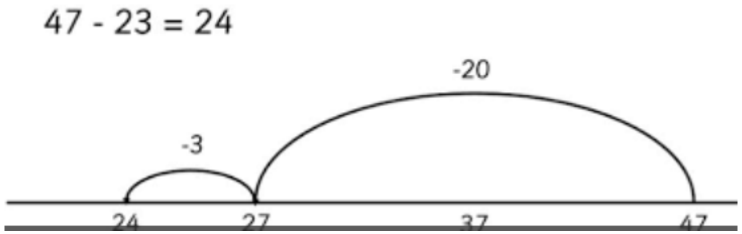




Phase 4

Partitioning

- Records mental calculations.
- E.g. 47-23. Children partition 23 into 20 and 3 then subtract each from 47 in turn. Some children may need to partition the 47 into 40 and 7 or 30 and 17 to carry out the subtraction.



47 – 23 = 47 – 20 – 3

= 27 – 3

= 24

Phase 5

Expanded layout leading to column method

- Does not link to counting back methods of subtraction, but does parallel partitioning methods for addition.
- Expanded method depends on the security of children in recalling number facts and partitioning.

The first stage of the expanded method is to partition the numbers. For example, in the calculation: 798-452, 798 is partitioned as 700 + 90 + 8 and 452 is partitioned as 400 + 50 + 2. The hundreds are then placed under the hundreds, the tens under the tens and the ones under the ones:

$$
\begin{array}{rrrrrrr}
 & 700 & & 90 & & 8 & \\
- & 400 & & 50 & & 2 & \\
\hline
 & 300 & + & 40 & + & 6 & = 346 \\
\hline
\end{array}
$$

Sometimes, the tens and ones to be subtracted are bigger than the tens and ones to be subtracted from. In these cases, we must make adjustments and “borrow” amounts, being sure to take account of place value. In Charlton Manor, we like to use the terms taking or exchanging. Children must be secure in place value to do this. Use correct vocabulary to support this (e.g. exchange/take a ten, one hundred…).

645-378

		130	
	500	~~30~~	15
	~~600~~	~~40~~	~~5~~
−	300	70	8
	200	60	7

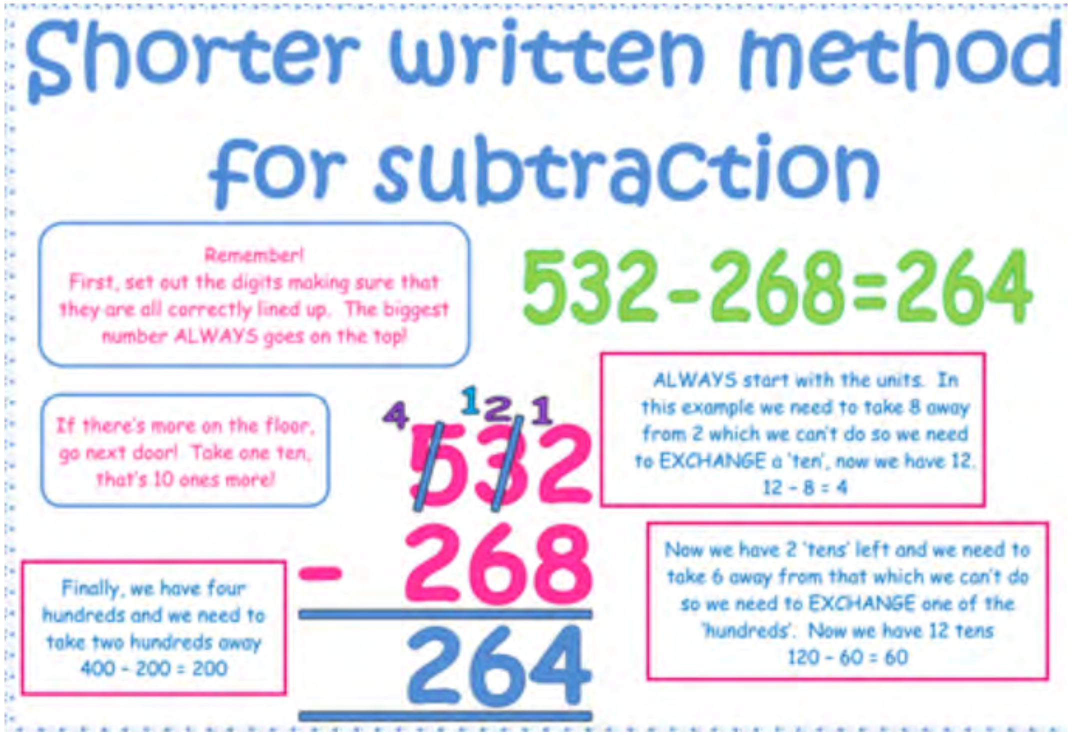
= 267

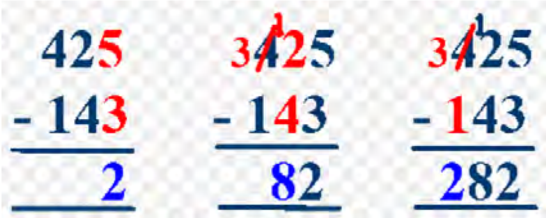
Begin by adjusting the units by taking a ten, then the tens by taking one hundred.

Phase 6

Column method

Use correct vocabulary to talk through what you are doing. Do not move onto this method until children are secure in place value and using the expanded method.





Written methods for multiplication of whole numbers

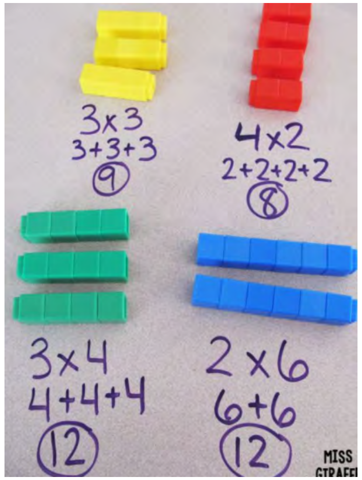
Key vocabulary:

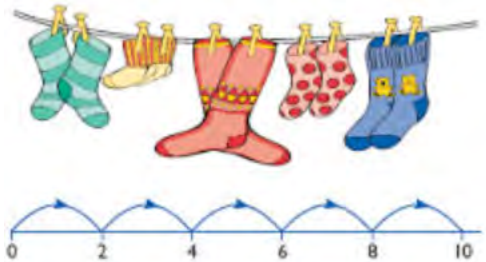
Multiply, times, lots of, groups of, multiples, multiplication, array, columns, rows, partition, product, grid method, carry, thousands, hundreds, tens, ones, estimate.

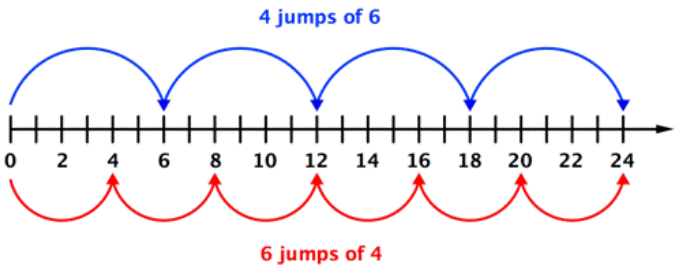
Children must become secure in the recall of multiplication facts (and corresponding subtraction facts) through frequent practice. This can be achieved through mental maths tests, warms up and games, during guided maths, targeted intervention groups (if required) and in homework challenges. Each year group has certain times tables to learn as set out in the 2014 NC.

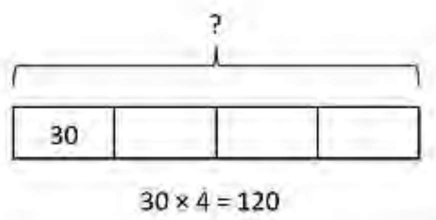
Phase 1

- Begin by children putting real objects into groups or sets and counting them.
- Move to solving multiplication through repeated addition. Use objects, number lines and the bar to support.
- Move to using arrays to solve multiplication.
- Support children to identify patterns within multiplications (e.g. numbers in the 2x table end in 0, 2, 4, 6, 8)









Introduce multiplication as commutative (can be done in any order) e.g. 4 x 3 is the same as 3 x 4.

Phase 2

Mental multiplication using partitioning.

- This method is an informal means to record mental calculations.
- Children learn that multiplication is done before addition.
- Multiply the tens and units separately then add the products to find the total. We usually start with the tens first.

$$14 \times 3 = (10 + 4) \times 3$$
$$= (10 \times 3) + (4 \times 3) = 30 + 12 = 42$$

$$43 \times 6 = (40 + 3) \times 6$$
$$= (40 \times 6) + (3 \times 6) = 240 + 18 = 258$$

These methods use distributive law. Children should know how to break numbers down to use known multiplication facts to find unknown facts.

E.g. 7×3 is the same as $(5 + 2) \times 3$ or $(5 \times 3) + (2 \times 3)= 15 + 6 – 21$

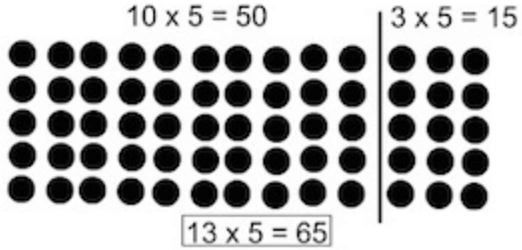
Phase 3

Grid method

- Also based on distributive law, this is an expanded method linking to mental strategies.
- This is a method of recording mental strategies.
- It is based on arrays and the link should be made clear (moving from concrete to mental).

13 x 5 = 65

x	10	3	
5	50	15	= 65



An expanded method which uses a grid can be used. It is an alternative way of recording the same steps e.g. 38 x 7 =

×	7
30	210
8	56
	266

Phase 4

Expanded short multiplication leading to compact short multiplication

- Represent the method in columns but show the working. Draw attention to the link to the grid method.
- Children to describe what they are doing using the actual values e.g. "thirty multiplied by seven", not "three times seven".
- Most children should be able to use this method for T O x O.

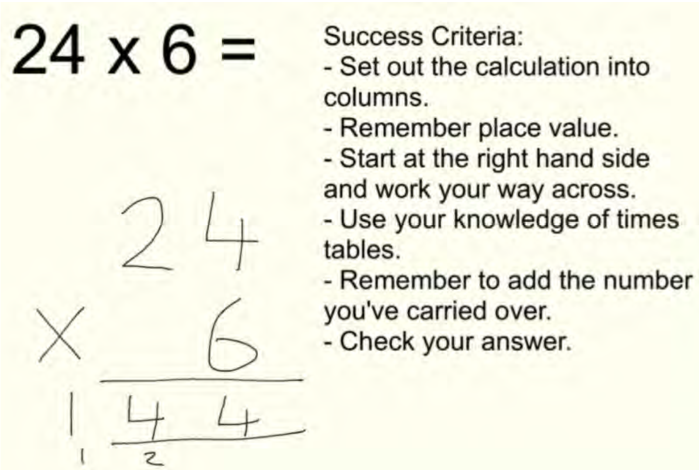
Multiply the ones first.	Then multiply the tens and place the result underneath. Remember, the 3 in 34 is signifying 30.	Then add.
$\begin{array}{r} 34 \\ \times\ 5 \\ \hline 20 \end{array}$	$\begin{array}{r} 34 \\ \times\ 5 \\ \hline 20 \\ 150 \end{array}$	$\begin{array}{r} 34 \\ \times\ 5 \\ \hline 20 \\ +\ 150 \\ \hline 170 \end{array}$
$5 \times 4 = 20$	$5 \times 30 = 150$	

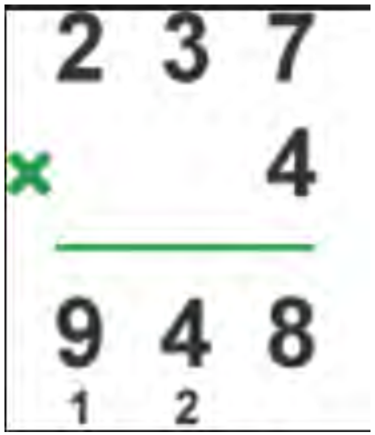
$$\begin{array}{rl} 30 + 8 & \\ \underline{\times \quad 7} & \\ 56 & (8 \times 7 = 56) \\ \underline{210} & (30 \times 7 = 210) \\ \underline{266} & \end{array} \longrightarrow \begin{array}{r} 38 \\ \times\ \underline{7} \\ 56 \\ \underline{210} \\ \underline{266} \end{array}$$

Phase 5

Compact short multiplication

- In compact short multiplication, the carry digits are recorded below the line.
- T O x O
- If children cannot use this method without making errors, they should return to the expanded short multiplication method.





Children need secure recall of multiplication facts (times tables) and place value to be able to ue this method.

Phase 6

Two digits by two digits working towards long multiplication.

- Get the children to make an estimate first. If when they work out the answer and it's way off their estimate, they know they need to check their workings.
- Start with the grid method putting the partial products at the end of each row and then adding to find the total product.
- Reduce the recording into a column layout.
- Reduce further and carry the digits under the line.

X	70	2	
30	2100	60 =	2160
8	560	16 =	576 +
			2736

$$\begin{array}{rl} 32 & \\ \times\ 24 & \\ \hline 8 & (4 \times 2) \\ 120 & (4 \times 30) \\ 40 & (20 \times 2) \\ 600 & (20 \times 30) \\ \hline 768 & \end{array}$$

Further reduction carrying the digits under the line. (not seen here)

$$\begin{array}{r} 28 \\ \times 36 \\ \hline \end{array} \quad \begin{array}{r} {}^{4}28 \\ \times 36 \\ \hline 8 \end{array} \quad \begin{array}{r} {}^{4}28 \\ \times 36 \\ \hline 168 \end{array} \quad \begin{array}{r} {}^{4}28 \\ \times 36 \\ \hline 168 \\ 0 \end{array} \quad \begin{array}{r} {}^{2}_{4}28 \\ \times 36 \\ \hline 168 \\ 40 \end{array} \quad \begin{array}{r} {}^{2}_{4}28 \\ \times 36 \\ \hline 168 \\ 840 \end{array} \quad \begin{array}{r} {}^{2}_{4}28 \\ \times 36 \\ \hline {}^{1}168 \\ +840 \\ \hline 1008 \end{array}$$

Extend to three digits by two digits (H T O x TO) using the same methods only when secure using TO x TO.

Multiplication of decimals

Children must be secure in all other methods and in place value before moving onto this.

1) Ignore the decimal points and multiply as usual...

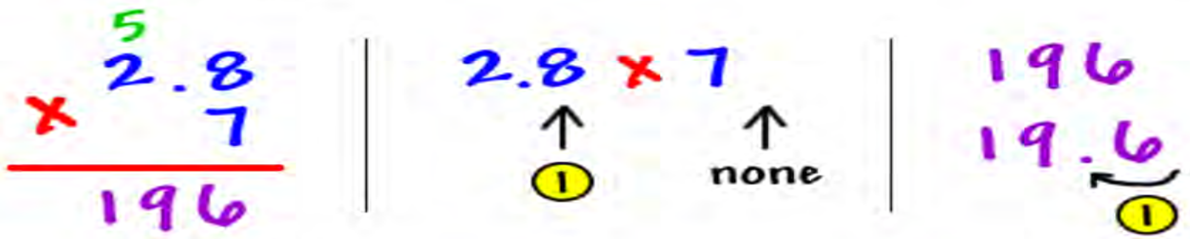
2) Count how many total digits are on the right side of the decimal points in the guys you are multiplying...

3) Place the decimal point in your answer so there are this many digits to the right.

Let's just do one!

$$2.8 \times 7$$

Multiply... Count the spots behind the decimals... Put the decimal point in your answer:



So, $2.8 \times 7 = 19.6$

Does our answer make sense? Do a little rounding and think about it... 2.8 is a little less than 3... 3 x 7 = 21... So, our answer should be a little less than 21. Yep, our answer looks good!

And remember, you can always grab a calculator to check your answers on these!

Be very careful to talk about changing place value and NOT MOVING THE DECIMAL POINT!!!

$$3.1 \times 5.9$$

Before we get into it, what should our answer be close to? Do some rounding... 3 x 6 = 18... So, our answer should be around 18!

Here we go!

Multiply... Count the spots behind the decimals... Put the decimal point in your answer:

$$\begin{array}{r} 3.1 \\ \times\ 5.9 \\ \hline 279 \\ +155 \\ \hline 1829 \end{array}$$

$$3.1 \times 5.9$$

1 2

1829

18.29

2 1

$$\text{So, } 3.1 \times 5.9 = 18.29$$

A 0 as place holder to make it clear that 155 is actually 1550 will help with place value in this example.

Written methods for division of whole numbers

Key vocabulary:

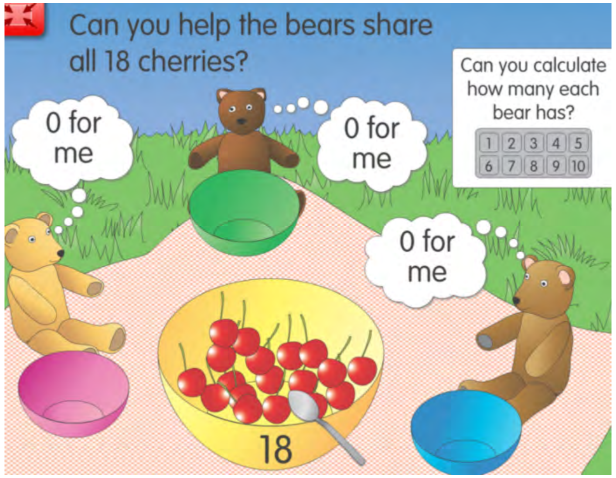
Divide, share, equal groups, equally, divided by, divisible by, divide into, group, estimate, dividend, divisor, quotient.

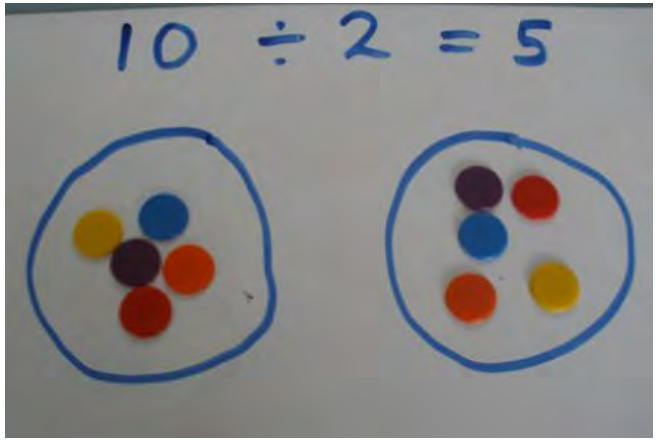
Children must be able to understand and use the correct vocabulary related to division (e.g. in $18 \div 3 = 6$, 18 is the dividend, 3 is the divisor, and 6 is the quotient).

Children must also be able to: partition two and three digit numbers, recall multiplication and related division facts (seeing them as inverse operations), understand place value and mentally find a remainder.

Phase 1

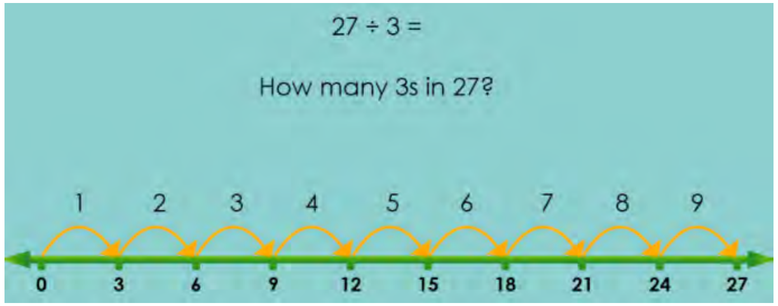
- Children should divide practically by sharing into equal groups. Correct use of vocabulary from the outset will support the idea of equal groups (when we share check it's fair).
- Children find half of number to 10 then 20 practically then mentally (sharing into two equal groups using one for you, one for me).

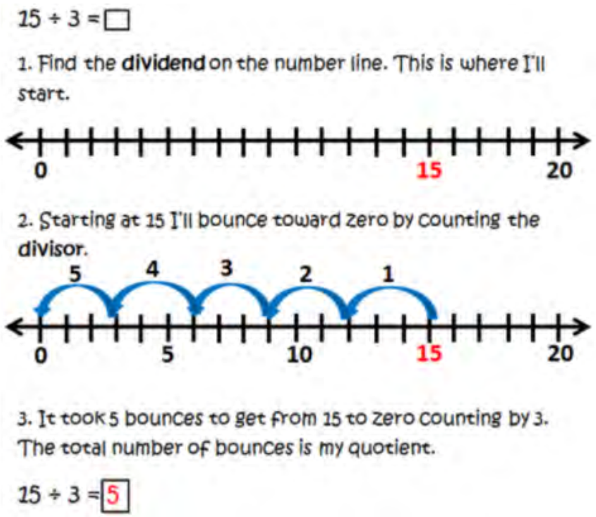




Phase 2

- Divide using a number line using repeated addition and subtraction with no remainders then later with remainders.
- Use the bar as a visual representation of division problems.



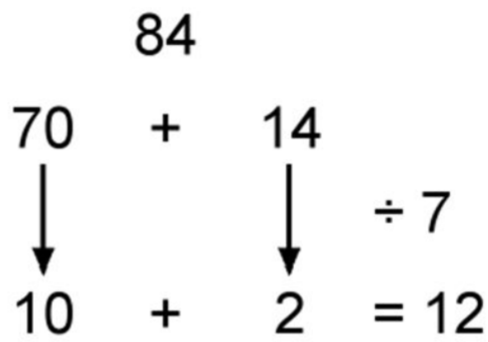


10 ÷ 2 = 5 using the bar model

Phase 3

Mental division using partitioning.

- Using distributive law (as in multiplication), division is done before addition.
- Mental methods of division should be well practiced and given emphasis to ensure security before moving on to written methods.
- Children should be able to find a remainder.



In this example, using knowledge of multiples, the 84 is partitioned into 70 (the highest multiple of 7 that is also a multiple of 10 and less than 84) plus 14. As the mental method is recorded, ask: ‘How many sevens in seventy?’ and: ‘How many sevens in fourteen?’

$64 \div 4 = (40 + 24) \div 4 = (40 \div 4) + (24 \div 4) = 10 + 6 = 16$

$87 \div 3 = (60 + 27) \div 3 = (60 \div 3) + (27 \div 3) = 20 + 9 = 29$

Remainders after division can be recorded similarly.

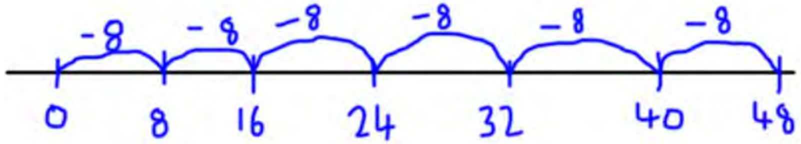
$96 \div 7 = (70 + 26) \div 7 = (70 \div 7) + (26 \div 7) = 10 + 3\text{ R }5 = 13\text{ R }5$

Phase 4

Chunking using a number line leading to expanded method for T O/H T O ÷ O (expanded bus stop).

- The number line method is based on subtracting multiples of the divisor (chunks) from the dividend (the number to be divided by). This is our preferred method of chunking.
- Just as division is the inverse to multiplication, repeated addition on the number line can be used as well as repeated subtraction. Use what you know!
- For TO ÷ O there is a link to the mental method.
- Talk through each step e.g. "how many 9s in 90" or "what is 90 divided by 9"?
- Children can move onto HTO ÷ O once secure in TO ÷ O quite quickly as the method is the same.
- Children will eventually realise this is an inefficient method if there are many subtractions to be carried out and can move to subtracting the largest possible multiple using their multiplication and corresponding division facts.

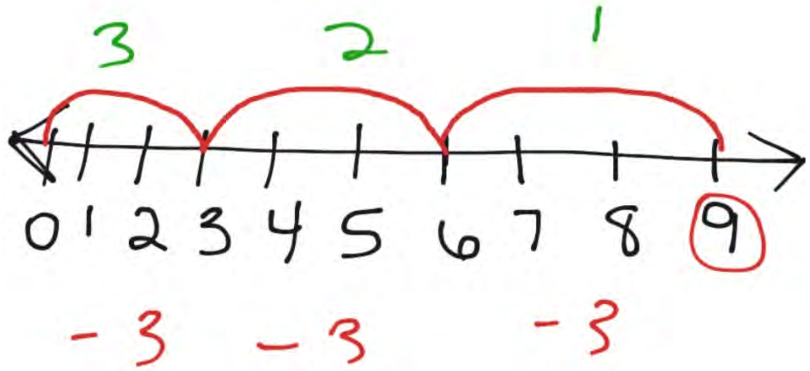
48 ÷ 8



6 lots of 8 subtracted.

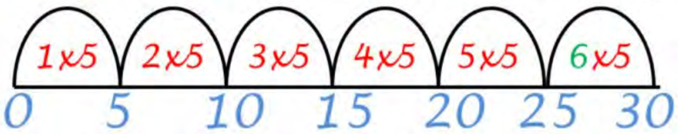
So $48 \div 8 = 6$

$9 \div \underline{3} = 3$

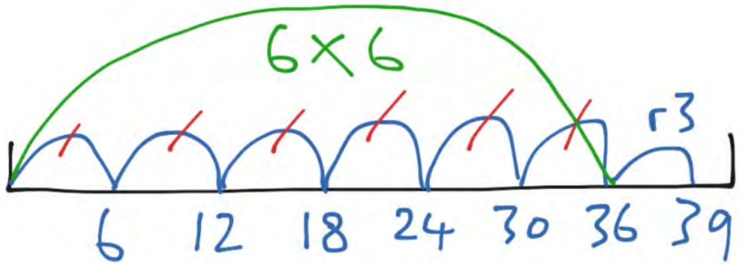


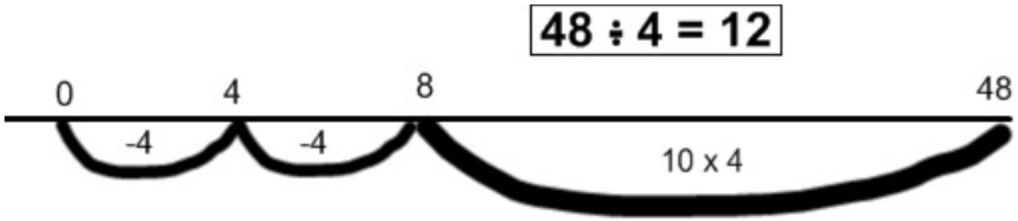
$30 \div 5 = 6$

Jump in lots of the divisor number (5)



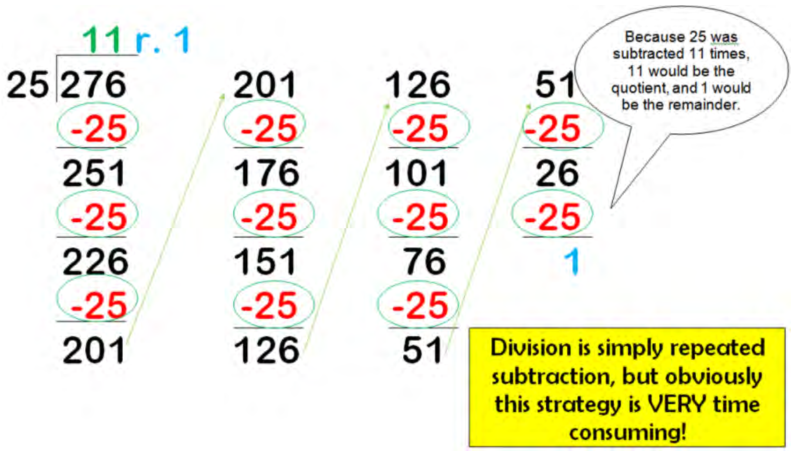
$39 \div 6 = 6\ r3$



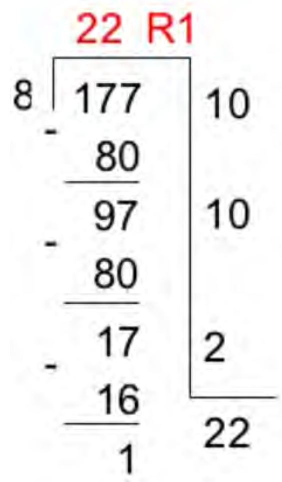


using a multiple to make less steps.

Expanded notation method



simplify using multiples of 10



Using an estimate to simplify chunking

$$\begin{array}{rl} 6\overline{)196} & \\ -\underline{60} & 6\times10 \\ 136 & \\ -\underline{60} & 6\times10 \\ 76 & \\ -\underline{60} & 6\times10 \\ 16 & \\ -\underline{12} & 6\times\underline{2} \\ 4 & 32 \\ \text{Answer:} & 32\,R\,4 \end{array}$$

$$\begin{array}{rl} 6\overline{)196} & \\ -\underline{180} & 6\times30 \\ 16 & \\ -\underline{12} & 6\times\underline{2} \\ 4 & 32 \\ \text{Answer:} & 32\,R\,4 \end{array}$$

We can multiply 6 by 10, 20, 30, 40 until we "trap" the target number. 6 x 30 = 180 6 x 40 = 240, so the quotient (answer) will be between 30 and 40.

Chunking is an important step that allows children to divide larger numbers and links to long division.

Phase 5

Compact (short) division

357 ÷ 6 =

$$\begin{array}{r} 59\ R\,3 \\ 6\overline{)357} \\ \underline{30} \\ \underline{57} \\ 3 \end{array}$$

357 ÷ 6 = 59 r 3

357 ÷ 6 =

$$\begin{array}{r} 59\ r3 \\ 6\overline{)35^{5}7} \end{array}$$

357 ÷ 6 = 59 r3

When children are secure using chunking, they can compact this into short division. Remainders can begin to be interpreted as decimals.

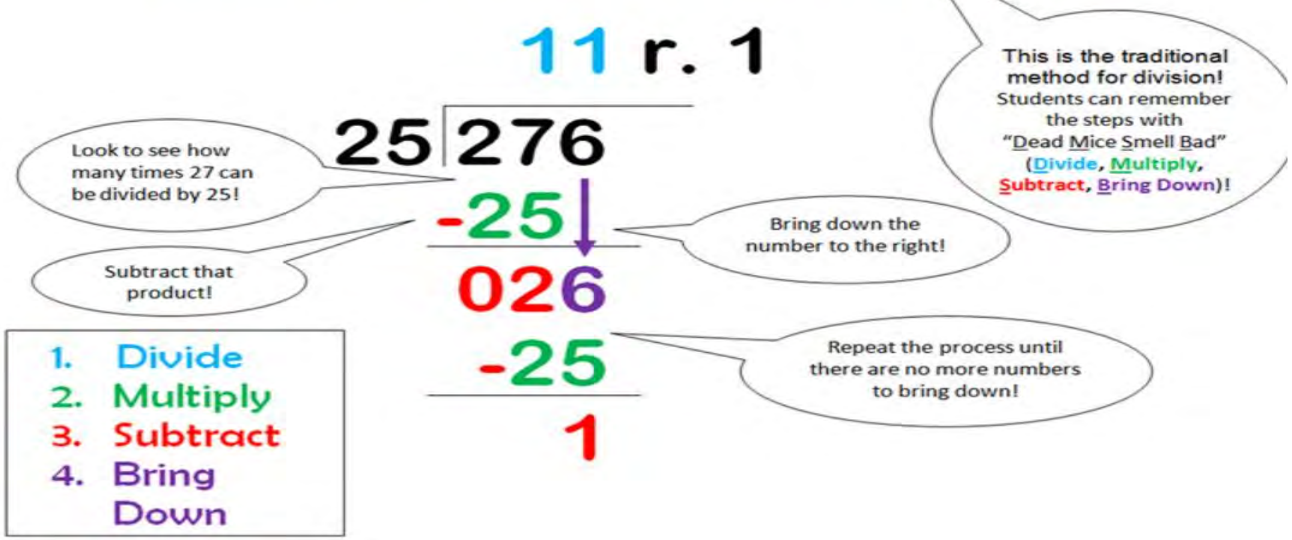
Phase 6

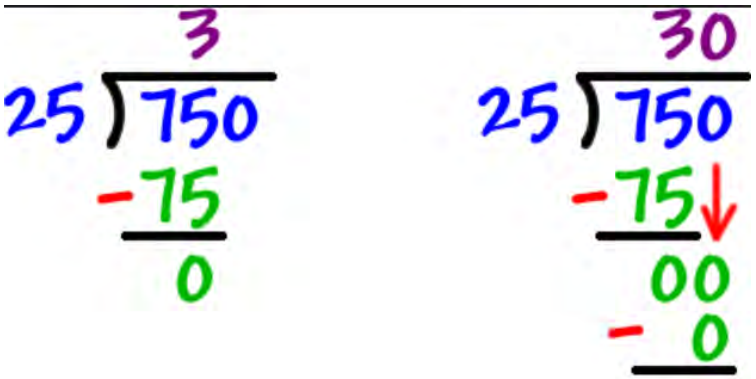
Long division

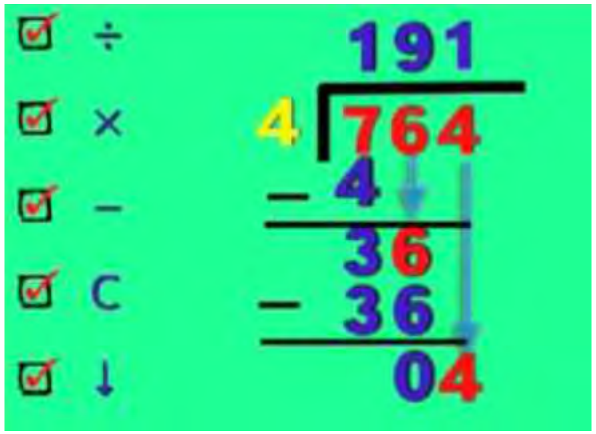
HTO ÷ TO

Children must be secure in place value and remember 0 as a place holder.

LONG DIVISION

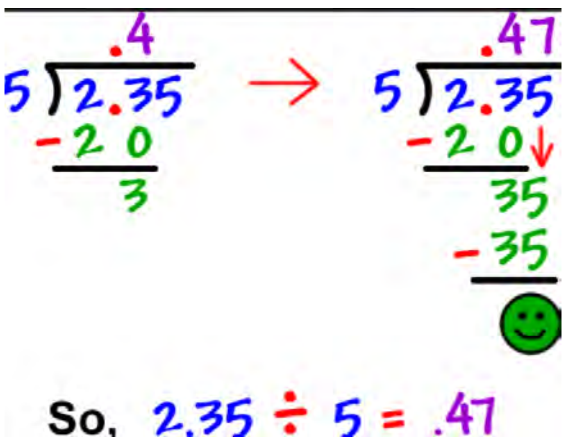


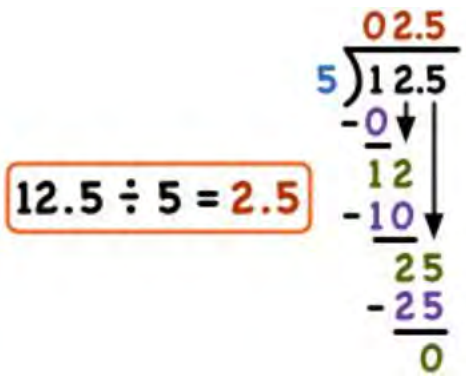


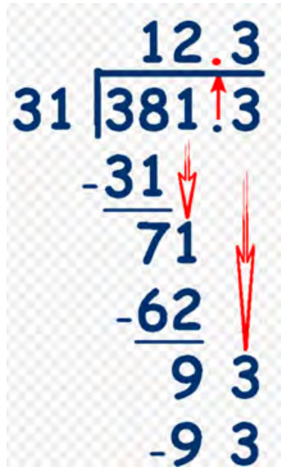


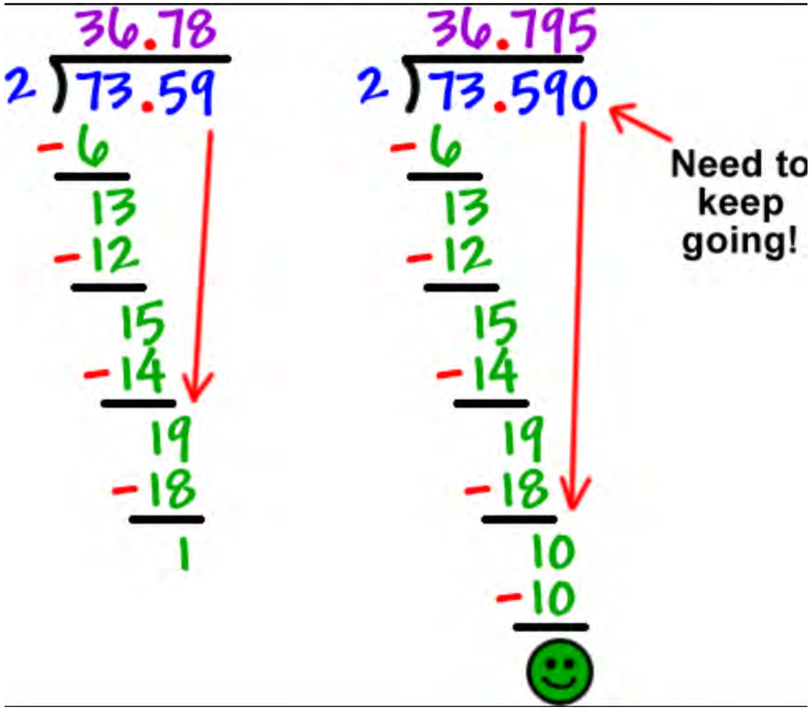
Long division with decimals

Children need to be solid in long division method and place value.



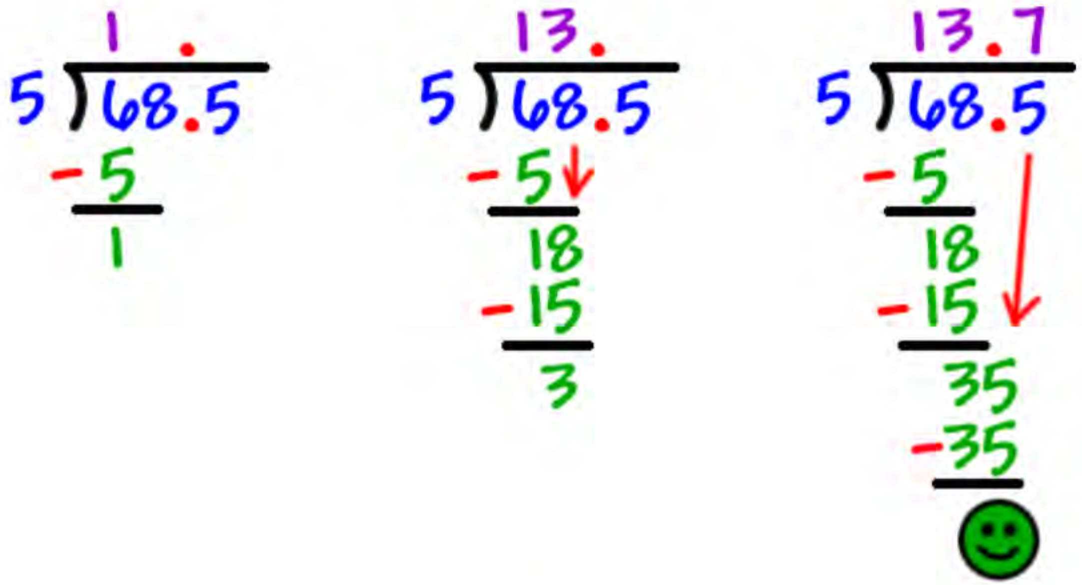





36.78
2) 73.59
-6
13
-12
15
-14
19
-18
1
36.795
2) 73.590
-6
13
-12
15
-14
19
-18
10
-10
Need to keep going!

convert decimals by **changing place value** DO NOT SAY MOVING THE DECIMAL POINT!!!

6.85 ÷ 0.5 would become 68.5 ÷ 5



So, 6.85 ÷ .5 = 13.7

>> Remember, you can check this by multiplying

13.7 x .5

and the use a calculator to check.