Chuckery Primary School

Written Calculation Policy

2022-2023

(Reviwed September 2022)

What does reasoning 'look like' in Maths?

Reasoning v Explaining

When the children are reasoning they do not need to have the right answer – in fact the wrong answer is equally acceptable but they need to be able to justify why they have written/said/thought what they have written/said/thought eg 'I think that 713 might be in the 11 times table because the digits add up to 11'. (Their justification for this might be that they know that when the digits of any number add up to 9, or a multiple of 9, then they know that that number is in the 9 times table eg 612 or 972)

It is important that reasoning is not confused with explaining. Children do need to be provided with opportunities to explain what they have done but reasoning is essential if children are going to be able to develop depth of understanding and be able to make links and justify these links based on this mathematical understanding. The language of explanation would involve using **I do/I did** but the language of reasoning would involve using **I think/I noticed/when I tried.**

When the children reason they need to apply logical thinking to a situation so that they can come up with an appropriate problem solving strategy that they can then develop to work towards, but not necessarily come up with, a solution.

So, reasoning would be needed when:

- first encountering a new challenge
- logical thinking is required
- a range of starting points is possible
- there are different strategies to solve a problem
- there is missing information
- selecting a problem-solving skill
- evaluating a solution in context
- there is more than one solution

This is a breakdown of the steps leading to reasoning:

Step 1: *Describing:* simply tells what they did.
Step 2: *Explaining*: offers some reasons for what they did. These may or may not be correct. The argument may yet not hang together coherently. This is the beginning of being able to start to reason.
Step 3: *Convincing*: confident that their chain of reasoning is right and may use words such as, 'I think' or 'without doubt'. The underlying mathematical argument may or may not be accurate yet is likely to have more coherence and completeness than the explaining stage..
Step 4: *Justifying:* a correct logical argument that has a complete chain of reasoning to it and uses words such as 'because', 'therefore', 'and so', 'that leads to' ...
Step 5: *Proving:* a watertight argument that is mathematically sound, often based on generalisations and underlying structure. This is also called deductive reasoning and it is at this point that children are working at Greater Depth

Here are some possible sentence starters when communicating reasoning;

I think this because ...
If this is true then ...
I know that the next one is ... because ...
This can't work because ...
When I tried ________
I noticed that ... The pattern looks like ...
All the numbers begin with ...
Because _______ then I think _______
This won't work because ...

Year 1

Pupils memorise and reason with number bonds to 10 and 20 in several forms.

+ = signs and missing numbers

Children need to understand the concept of equality and its meaning of 'the same as' before using the '=' sign. Calculations should be written either side of the equals sign so that the sign is not just interpreted as 'the answer'.

2 = 1+ 1

2 + 3 = 4 + 1

Missing numbers need to be placed in all possible places.

3 + 4 = □   □ = 3 + 4

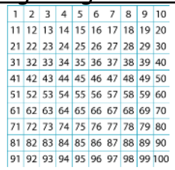
3 + □ = 7   7 = □ + 4

Counting and Combining sets of Objects

Combining two sets of objects (aggregation) which will progress onto adding on to a set (augmentation)

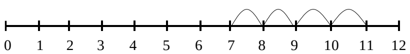
Understanding of counting on with a numbertrack and using numicon.

Understanding of counting using a hundred square.



Understanding of counting on with a number line (supported by models and images).

7+4



Year 2

Practise addition to 20 and become increasing fluent in deriving facts.

Missing number problems e.g 14 + 5 = 10 + □   32 + □ + □ = 100   35 = 1 + □ + 5

It is valuable to use a range of representations (also see Y1). Continue to use number lines to develop understanding of:

Counting on in tens and ones

23 + 12 = 23 + 10 + 2

= 33 + 2

= 35

Partitioning and bridging through 10.

The steps in addition often bridge through a multiple of 10 e.g. Children should be able to partition the 7 to relate adding the 2 and then the 5.

8 + 7 = 15

Adding 9 or 11 by adding 10 and adjusting by 1

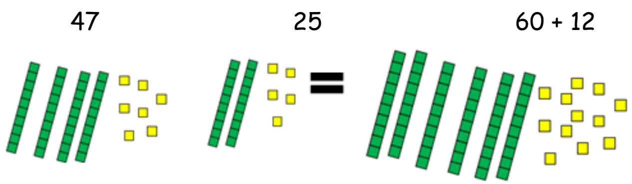
e.g. Add 9 by adding 10 and adjusting by 1

35 + 9 = 44

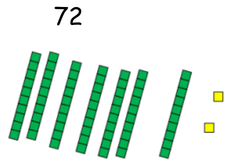
Towards a Written Method

Partitioning in different ways and recombine

47+25



Leading to exchanging:



Leading to Expanded Method:

40 + 7
+ 20 + 5
60 + 12 = 72

Year 3

Practise solving varied addition questions with two digit numbers – the answers could exceed 100.

Missing number problems using a range of equations as in Year 1 and 2 but with appropriate, larger numbers.

Partition into tens and ones

Partition both numbers and recombine.

Count on by partitioning the second number only e.g.

247 + 125 = 247 + 100 + 20+ 5

= 347 + 20 + 5

= 367 + 5

= 372

Children need to be secure adding multiples of 100 and 10 to any three-digit number including those that are not multiples of 10.

Towards a Written Method (with equipment)

Introduce expanded column addition modelled with place value counters or Dienes.

200 + 40 + 7
100 + 20 + 5
300 + 60 +12 = 372

Some children may begin to use a formal columnar algorithm, initially introduced alongside the expanded method. The formal method should be seen as a more streamlined version of the expanded method, not a new method.

247
+125
372
10

Year 4

Pupils continue to practise mental methods with increasingly large numbers using models and images to help them.

Written methods (progressing to 4-digits)

Expanded column addition modelled with place value counters, progressing to calculations with 4-digit numbers.

```
 200 + 40 + 7
 100 + 20 + 5
 300 + 60 +12 = 372
```

Compact written method

Extend to numbers with at least four digits.

789 + 642 becomes

```
      7  8  9
  +   6  4  2
  -----------
  1   4  3  1
  -----------
      1  1
```

Answer: 1431

```
  2634
 +4517
 -----
  7151
 -----
  1  1
```

Children should be able to make the choice of reverting to expanded methods if experiencing any difficulty.

Extend to up to two places of decimals (same number of decimals places) and adding several numbers (with different numbers of digits).

Year 5

Children practise mental calculations with increasingly large numbers to help fluency (12,462 +2300 = 14,762) using models and images to help them.

Written methods (progressing to more than 4-digits)

As year 4, progressing when understanding of the expanded method is secure, children will move on to the formal columnar method for whole numbers and decimal numbers as an efficient written algorithm.

Year 6

Undertake mental calculations with increasingly large numbers and more complex calculations using models and images to help them.

Written methods

As year 5, progressing to larger numbers, aiming for both conceptual understanding and procedural fluency with columnar method to be secured.

Continue calculating with decimals, including those with different numbers of decimal places

Problem Solving

Teachers should ensure that pupils have the opportunity to apply their knowledge in a variety of contexts and problems (exploring cross curricular links) to deepen their understanding.

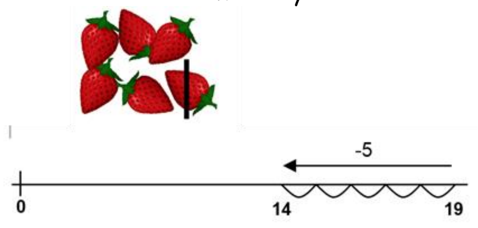
Year 1

Pupils memorise and reason with number bonds in several forms (16 - 7 = 9 7 = 16 – 9)

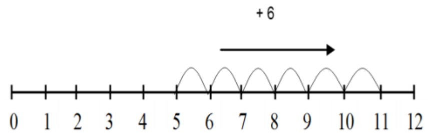
Missing number problems e.g. 7 = □ - 9; 20 - □ = 9; 15 – 9 = □; □ - □ = 11; 16 – 0 = □

Use concrete objects and pictorial representations. If appropriate, progress from using number lines with every number shown to number lines with significant numbers shown.

Understand subtraction as take-away:



Understand subtraction as finding the difference:



Understand how to use a hundred square to takeaway and find the difference.

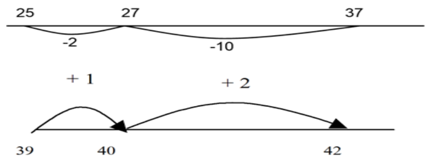
1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Year 2

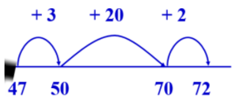
Practise subtraction to 20 becoming increasingly fluent in deriving facts (such as; 10 - 7 = 3 7 = 10 - 3 to calculate 100 – 70 = 30 70 = 100 - 30)

Missing number problems e.g. 52 – 8 = □; □ – 20 = 25; 22 = □ – 21; 6 + □ + 3 = 11

It is valuable to use a range of representations (also see Y1). Continue to use number lines to model take-away and difference. E.g.

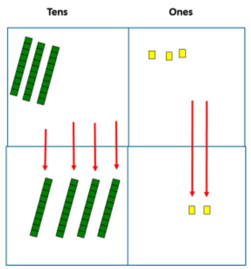


The link between the two may be supported by an image like this, with 47 being taken away from 72, leaving the difference, which is 25.



Towards written methods

Recording addition and subtraction in expanded columns can support understanding of the quantity aspect of place value and prepare for efficient written methods with larger numbers. The numbers may be represented with Dienes apparatus. E.g. 75 – 42




```
  70  5
- 40  2
  30  3
```

Year 3

Practise solving varied subtraction questions – calculations with two digit numbers where the answers exceed 100.

Missing number problems e.g. □ = 43 – 27; 145 – □ = 138; 274 – 30 = □; 245 – □ = 195; 532 – 200 = □; 364 – 153 = □

Written methods (progressing to 3-digits)

Introduce expanded column subtraction with no decomposition, modelled with place value counters or dienes.

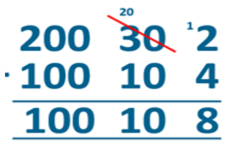
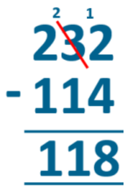
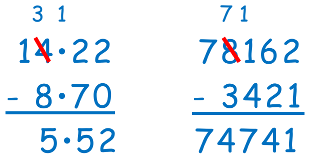
```
  90  8
- 30  5
  60  3
```

For some children this will lead to exchanging, modelled using place value counters or Dienes.

```
  60
  ~~70~~  ¹2
- 40   7
  20   5
```

A number line and expanded column method may be compared next to each other.

Some children may begin to use a formal columnar algorithm, initially introduced alongside the expanded method. The formal method should be seen as a more streamlined version of the expanded method, not a new method.

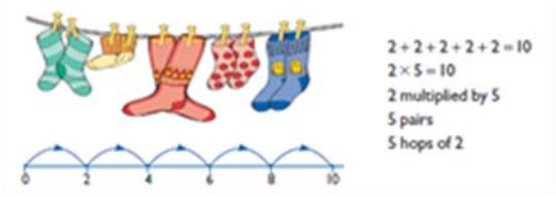
Year 4	Year 5	Year 6
Pupils continue to practise mental methods with increasingly large numbers using models and images to help them.	Children practise mental calculations with increasingly large numbers to aid fluency (12,462 -2300 = 10,162) using models and images to help them.	Undertake mental calculations with increasingly large numbers and more complex calculations using models and images to help them.
Missing number/digit problems: 456 + □ = 710; 1□7 + 6□ = 200; 60 + 99 + □ = 340; 200 – 90 – 80 = □; 225 - □ = 150; □ – 25 = 67; 3450 – 1000 = □; □ - 2000 = 900 **<u>Written methods (progressing to 4-digits)</u>** Expanded column subtraction with decomposition, modelled with place value counters or dienes, progressing to calculations with 4-digit numbers.  If understanding of the expanded method is secure, children will move on to the formal method of decomposition, which again can be initially modelled with place value counters or dienes. 	Missing number/digit problems: 6.45 = 6 + 0.4 + □; 119 - □ = 86; 1 000 000 - □ = 999 000; 600 000 + □ + 1000 = 671 000; 12 462 – 2 300 = □ **<u>Written methods (progressing to more than 4-digits)</u>** When understanding of the expanded method is secure, children will move on to the formal method of decomposition, which can be initially modelled with place value counters or dienes.  Progress to calculating with decimals, including those with different numbers of decimal places.	Missing number/digit problems: □ and # each stand for a different number. # = 34. # + # = □ + □ + #. What is the value of □? What if # = 28? What if # = 21 10 000 000 = 9 000 100 + □ 7 – 2 x 3 = □; (7 – 2) x 3 = □; (□ - 2) x 3 = 15 **<u>Written methods</u>** As year 5, progressing to larger numbers, aiming for both conceptual understanding and procedural fluency with decomposition to be secured.  Continue calculating with decimals, including those with different numbers of decimal places.

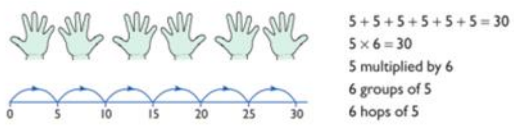
Year 1

Through grouping and sharing small quantities, pupils begin to understand doubling numbers and quantities. The children can count in twos, fives and tens.

Understand multiplication is related to doubling and combining groups of the same size (repeated addition)

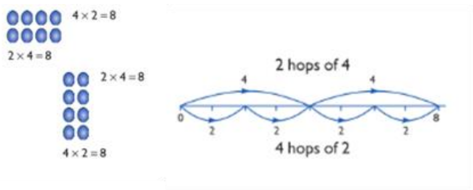
Washing line, and other practical resources for counting. Concrete objects. Numicon; bundles of straws, bead strings





Problem solving with concrete objects (including money and measures.) Use practical equipment to develop the vocabulary relating to 'times' –

Pick up five, 4 times. Use arrays to understand multiplication can be done in any order (commutative)



Year 2

Children practise and become fluent in the 2, 5 and 10 multiplication tables. They connect the 10 multiplication table to place value.

Expressing multiplication as a number sentence using x

Using understanding of the inverse and practical resources to solve missing number problems.

7 x 2 = □   □ = 2 x 7

7 x □ = 14   14 = □ x 7

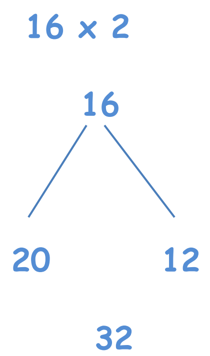
□ x 2 = 14   14 = 2 x □

□⊗ = 14   14 = □⊗

Develop understanding of multiplication using array and number lines (see Year 1). Include multiplications not in the 2, 5 or 10 times tables. Begin to develop understanding of multiplication as scaling (3 times bigger/taller).

Towards written methods

Use jottings to develop an understanding of doubling two digit numbers.



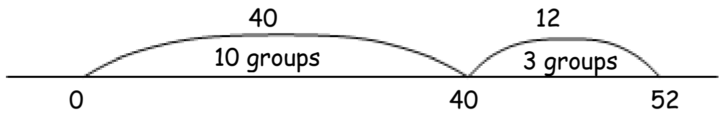
Year 3

Practise their recall of multiplication tables and, through doubling, they connect the 2, 4 and 8 multiplication tables.

Doubling 2 digit numbers using partitioning – using jottings from Year 2.

Demonstrating multiplication on a number line.

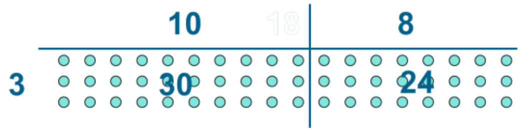
Jumping in larger groups of amounts



13 x 4 = 10 groups 4 = 3 groups of 4

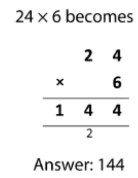
Written methods (progressing to 2 digit x 1 digit)

Developing written methods using understanding of visual images.



Develop onto the grid method

Progressing to short multiplication:

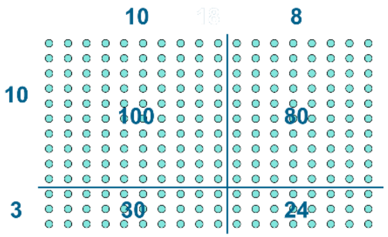


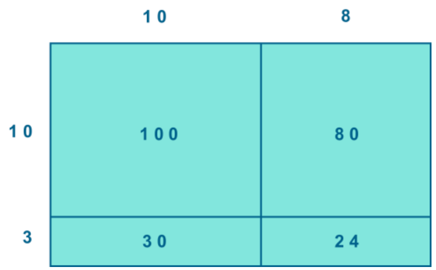
Year 4

Recall all multiplication facts up to 12 x 12. Counting in multiples of 6, 7, 9, 25 and 1000, and steps of 1/100. Solving practical problems where children need to scale up. Relate to known number facts. (e.g. how tall would a 25cm sunflower be if it grew 6 times taller.)

Written methods (progressing to 3 digits x 2 digits)

Children to embed and deepen their understanding of the grid method to multiply up 2 digits x 2digits. Ensure this is still linked back to their understanding of arrays and place value counters.





Short multiplication (TU X U HTU X U)

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

Year 5

Identify multiples and factors and factor pairs of numbers. Know and use prime numbers and prime factors. Recognise squared and cubed numbers (using the correct notation).

Written methods (progressing to 4 digits x 2 digits)

Continue to refine short multiplication methods. Long multiplication using place value counters. Children to explore how the grid method supports an understanding of long multiplication (for 2 digits x 2 digits)

2741 × 6 becomes

```
    2 7 4 1
×         6
  1 6 4 4 6
    4 2
```

Answer: 16 446

Long multiplication:

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

Year 6

Undertake mental multiplications with increasingly large numbers and decimals. Continue to use all multiplication facts to support developing fluency.

Written methods

Continue to refine and deepen understanding of written methods including fluency for using long multiplication.

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

Long multiplication:

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

Year 1

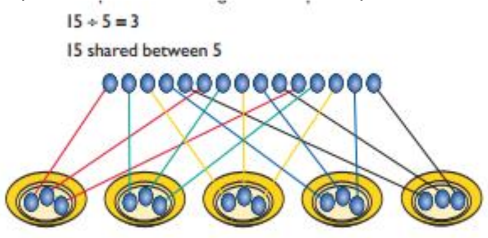
Through sharing small quantities, children begin to understand division and finding simple fractions of amounts and quantities.

Children must have secure counting skills- being able to confidently count in 2s, 5s and 10s. Children should be given opportunities to reason about what they notice in number patterns.

Group AND share small quantities- understanding the difference between the two concepts.

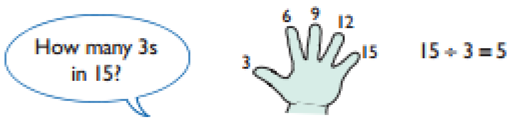
Sharing

Develops importance of one-to-one correspondence.



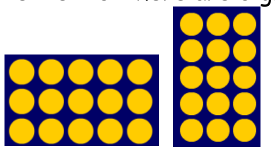
Grouping

Children should apply their counting skills to develop some understanding of grouping.



Use of arrays as a pictorial representation for division. 15 ÷ 3 = 5 There are 5 groups of 3.

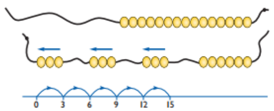
15 ÷ 5 = 3 There are 3 groups of 5.



Grouping using a number line

Group from zero in jumps of the divisor to find our 'how many groups of 3 are there in 15?'

15 divided by 3



Year 2

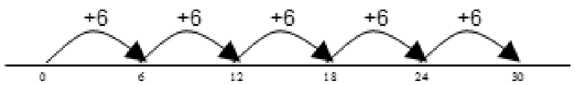
Children practise and become fluent in their recall of the 2, 5 and 10 division facts.

Continue work on arrays. Support children to understand how multiplication and division are inverse. Look at an array – what do you see?

Grouping

How many 6's are in 30?

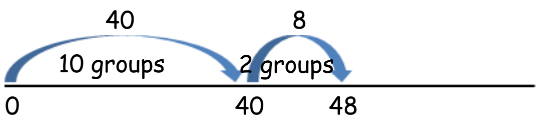
30 ÷ 6 can be modelled as:



Becoming more efficient using a number line.

Children need to be able to partition the dividend in different ways.

48 ÷ 4 = 12



Year 3

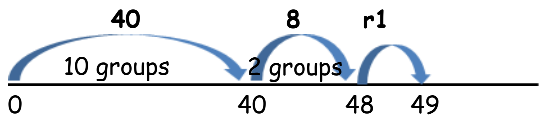
Children practise and become fluent in the recall of the 2, 4 and 8 division facts.

Becoming more efficient using a number line

Children need to be able to partition the dividend (the amount to be divided) in different ways.

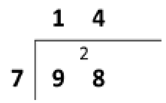
Answers with remainders:

49 ÷ 4 = 12 r1



Progressing to the formal written method of short division:

98 ÷ 7 becomes



Answer: 14

Year 4	Year 5	Year 6
Children MUST know all the division facts up to 12 x 12	Undertake mental multiplications with increasingly hard numbers and decimals.	Undertake mental multiplications with increasingly hard numbers and decimals.

Year 4 and Year 5

÷ = signs and missing numbers

Continue using a range of equations as in Year 3 but with appropriate numbers.

Sharing, Grouping and using a number line

Children will continue to explore division as sharing and grouping, and to represent calculations on a number line until they have a secure understanding. Children should progress in their use of written division calculations:

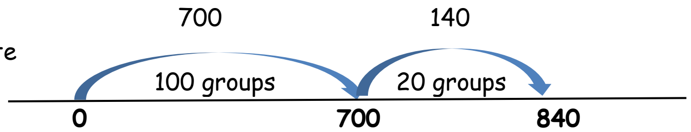
- using tables facts with which they are fluent
- experiencing a logical progression in the numbers they use, for example:

1. Dividend just over 10x the divisor, e.g. 84 ÷ 7
2. Dividend just over 10x the divisor when the divisor is a teen number, e.g. 173 ÷ 15 (learning sensible strategies for calculations such as 102 ÷ 17)
3. Dividend over 100x the divisor, e.g. 840 ÷ 7
4. Dividend over 20x the divisor, e.g. 168 ÷ 7

All of the above stages should include calculations with remainders as well as without.

Remainders should be interpreted according to the context. (i.e. rounded up or down to relate to the answer to the problem)

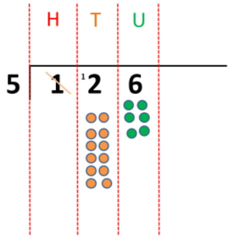
840 divided by 7 = 120



Formal Written Methods (Year 4)

Formal short division should only be introduced once children have a good understanding of division, its links with multiplication and the idea of 'chunking up' to find a target number (see use of number lines above)

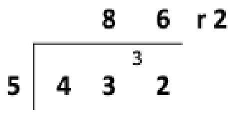
Short division to be modelled for understanding using place value counters as shown below. Calculations with 2 and 3-digit dividends.



Formal Written Methods (Year 5)

Continued as shown in Year 4, leading to the efficient use of a formal method. E.g. 432 divided by 5 ;

432 ÷ 5 becomes



Answer: 86 remainder 2

Year 6

÷ = signs and missing numbers

Continue using a range of equations but with appropriate numbers

Sharing and Grouping and using a number line

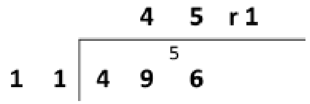
Children will continue to explore division as sharing and grouping, and to represent calculations on a number line as appropriate.

Remainders should be expressed as decimals and fractions.

Formal written methods

Short division:

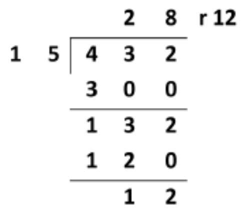
496 ÷ 11 becomes



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

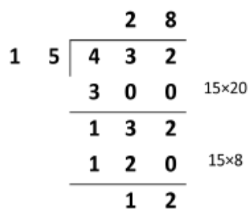
Long division: 432 divided by 15

432 ÷ 15 becomes



Answer: 28 remainder 12

432 ÷ 15 becomes



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

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

Signed		**Signed**	
Print:	**Mr. James Pearce**	**Print:**	**Mrs. Nicola Rudge**
Date:	**5th September 2022**	**Date:**	**5th September 2022**
	Headteacher		**Chair of Governors**

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