Calculation Policy

September 2015

St John's Cathedral Catholic Primary School

This calculation policy has been produced to ensure **consistency and progression** in teaching throughout the school in line with the New National Curriculum 2014. It aims to give an overview of the key written calculation strategies that will be taught in each year group. The policy demonstrates the progression in each of the four operations that children will typically follow. Each stage builds upon previous experience and knowledge.

Children will develop calculation skills through a combination of practical, oral and mental activities. Although the focus of this policy is on pencil and paper procedures, it is important to recognise that in every written method there is an element of mental processing. Written calculation strategies will therefore be taught alongside mental calculation strategies and should be seen as complementary to and not as separate from them. Informal written recording will take place regularly and is an important part of learning and understanding. More formal written methods follow only when the child is able to use a wide range of mental calculation strategies.

Although using and applying is now not an explicit strand within the New National Curriculum 2014 all calculations and methods should be taught with the key aims of the curriculum. These are **fluency, reasoning and problem solving** and children should be provided with opportunities to demonstrate this.

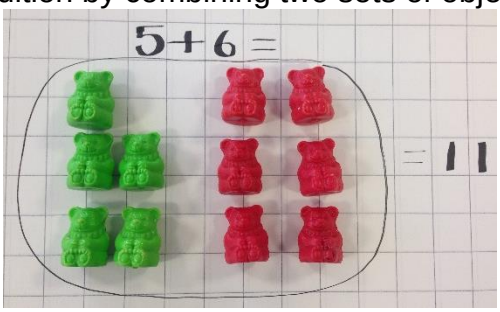
Addition +

Key skills for Year 1 Addition –

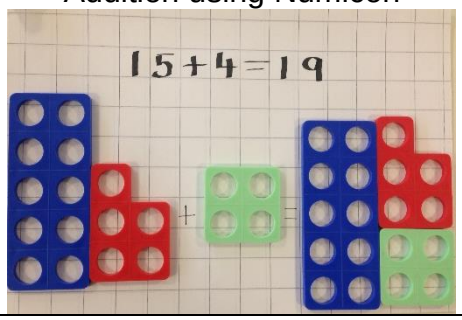
- Read, write and interpret mathematical statements involving addition (+) and equals (=) signs
- Add one-digit and two-digit numbers to 20, including zero
- Represent and use number bonds and related subtraction facts within 20
- Solve one-step problems that involve addition using concrete objects and pictorial representations
- Missing number problems such as 9 = □ + 2

Strategies

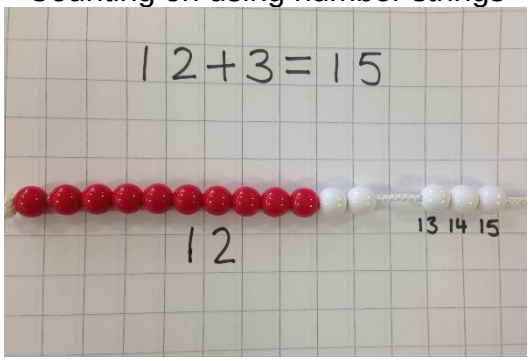
Addition by combining two sets of objects



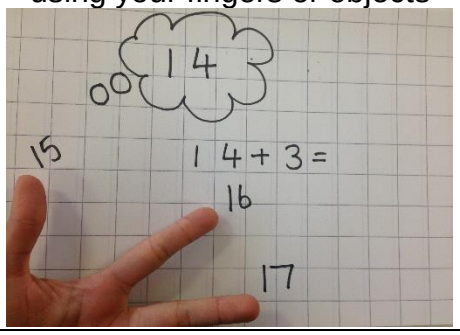
Addition using Numicon



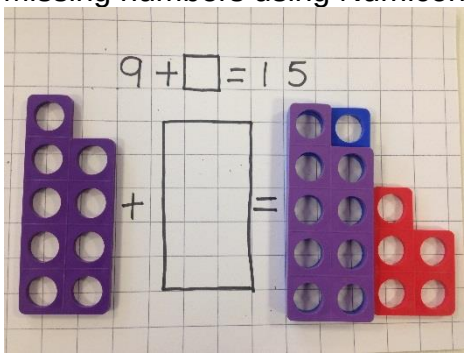
Counting on using number strings



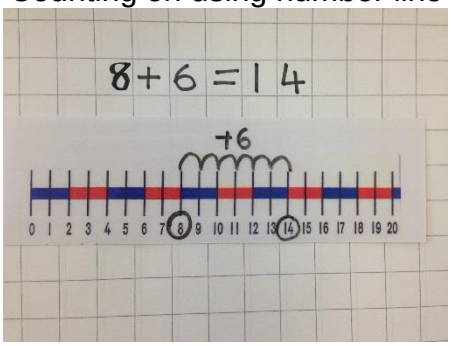
Hold a number in your head and count on using your fingers or objects



Missing numbers using Numicon



Counting on using number line



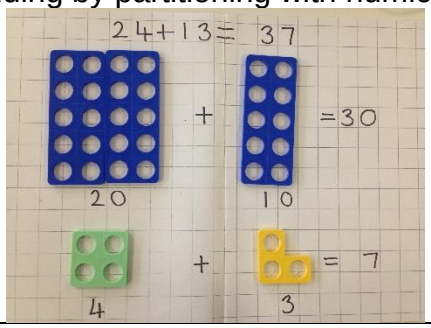
Addition +

Key skills for Year 2 Addition –

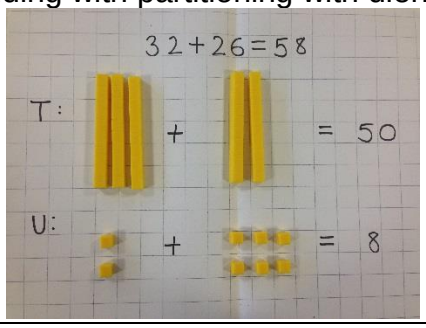
- Solve problems with addition:
  - using concrete objects and pictorial representations, including those involving numbers, quantities and measures
- Recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100
- Add numbers using concrete objects, pictorial representations, and mentally, including:
  - a two-digit number and ones
  - a two-digit number and tens
  - two two-digit numbers
  - adding three one-digit numbers
- Show that addition of two numbers can be done in any order (commutative) and subtraction of one number from another cannot
- Recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems.

Strategies

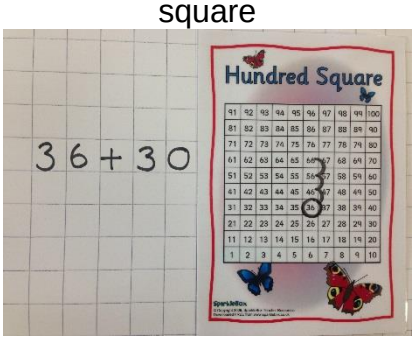
Adding by partitioning with numicon



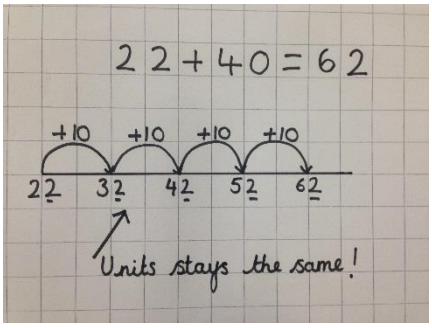
Adding with partitioning with dienes



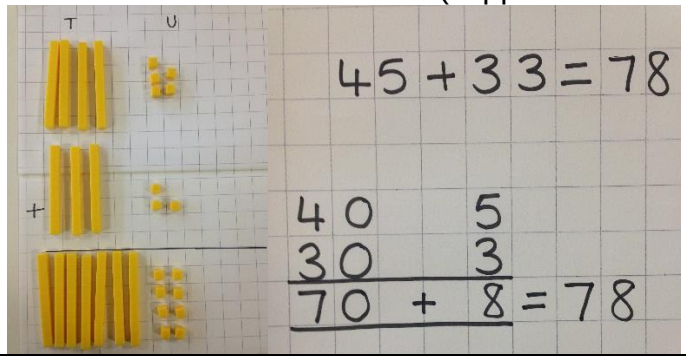
Adding multiples of ten using hundred square



Adding multiples of ten on blank number line



Expanded column addition TO + TO (supported with dienes)



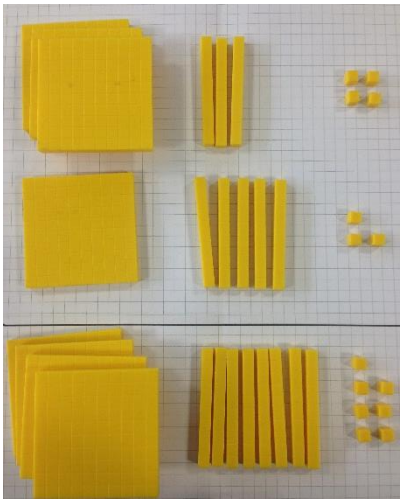
Addition +

Key skills for Year 3 Addition –

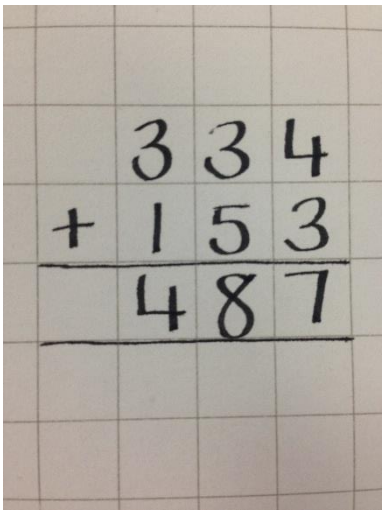
- Add numbers mentally, including:
  - a three-digit number and ones
  - a three-digit number and tens
  - a three-digit number and hundreds
- Add numbers with up to three digits, using formal written methods of columnar addition
- Estimate the answer to a calculation and use inverse operations to check answers
- Solve problems, including missing number problems, using number facts, place value, and more complex addition
- Add fractions with the same denominator within one whole (e.g. $^{5}/_{7} + {}^{1}/_{7} = {}^{6}/_{7}$)

Strategies

Column method with dienes



Formal column method HTO + HTO



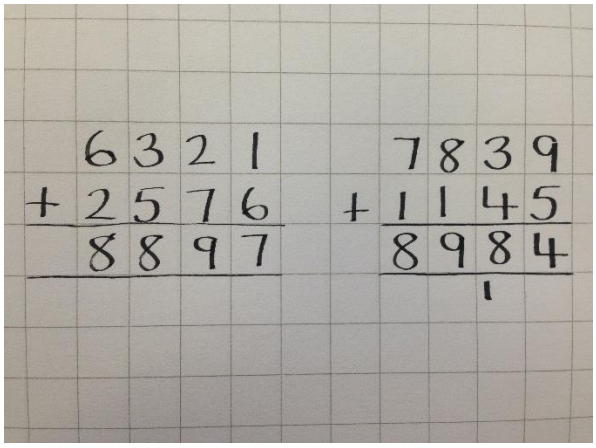
Addition +

Key skills for Year 4 Addition –

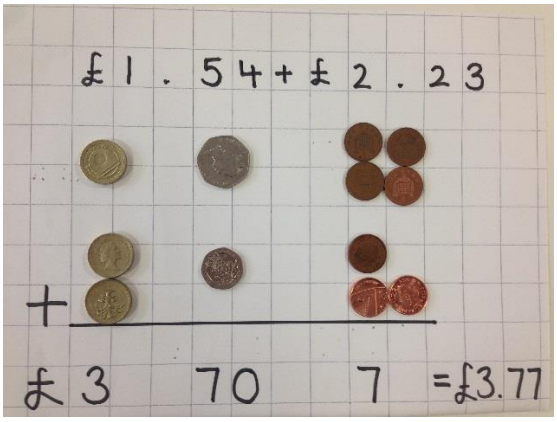
- Add numbers with up to 4 digits using the formal written methods of columnar addition
- Estimate and use inverse operations to check answers to a calculation
- Solve addition two-step problems in contexts, deciding which operations and methods to use and why
- Add fractions with the same denominator (This may exceed the whole)
- Solve simple measure and money problems involving fractions and decimals to two decimal places.

Strategies

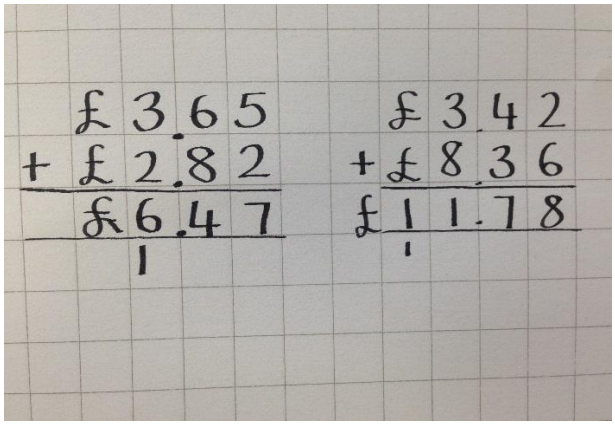
Column Method ThHTO + ThHTO



Column method with coins used for £ and pence



Formal column method with decimals in the context of money



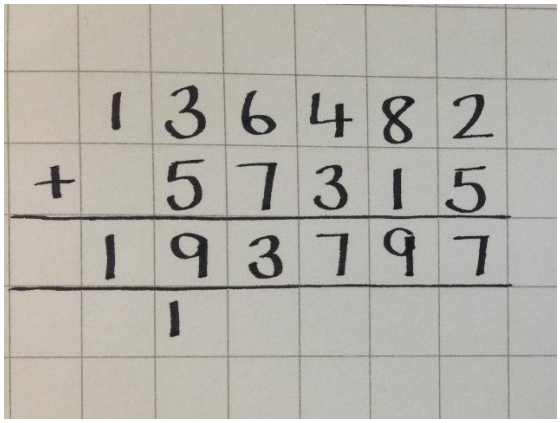
Addition +

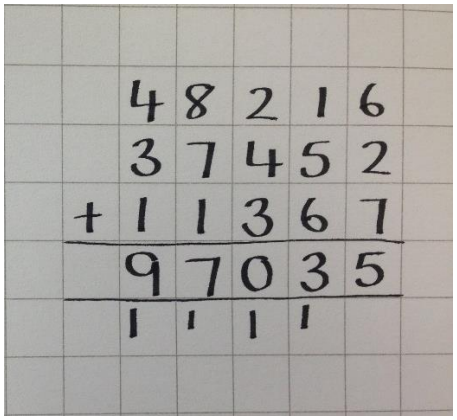
Key skills for Year 5 Addition –

- Add whole numbers with more than 4 digits, including using formal written methods (columnar addition)
- Add numbers mentally with increasingly large numbers
- Use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy
- Solve addition multi-step problems in contexts, deciding which operations and methods to use and why
- Add fractions with the same denominator and multiples of the same number
- Solve problems involving numbers up to three decimal places

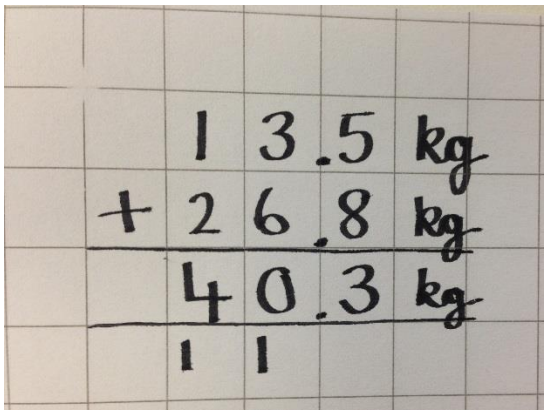
Strategies

Formal column method with hundreds of thousands

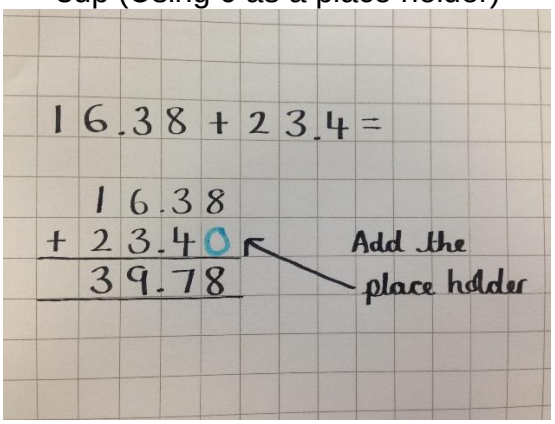




Formal column method with decimals in the context of measures



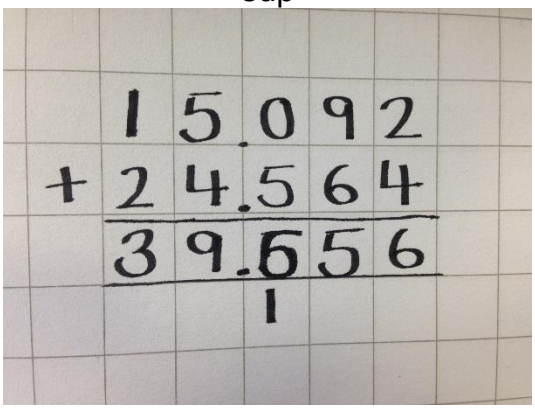
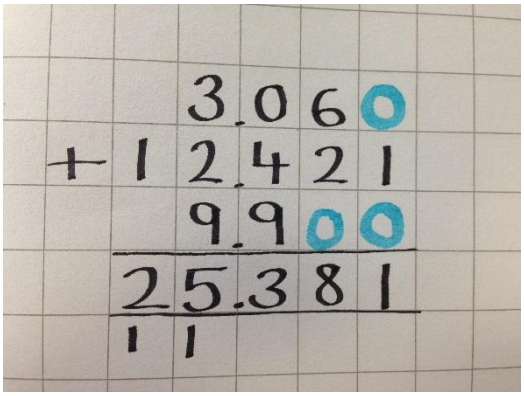
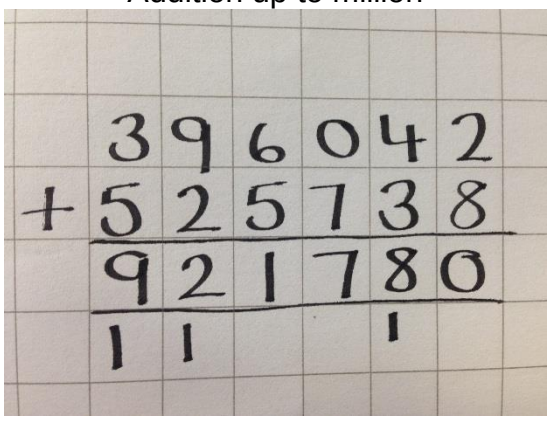
Formal column method with decimals with 3dp (Using 0 as a place holder)



Addition +

Key skills for Year 6 Addition –

- Solve addition multi-step problems in contexts, deciding which operations and methods to use and why
- Solve problems involving addition
- Use estimation to check answers to calculations and determine, in the context of a problem, levels of accuracy.
- Add fractions with different denominators and mixed numbers, using the concept of equivalent fractions

Strategies	
Formal column method with decimals with 3dp  	Adding more than one decimals number 
Addition up to million  	

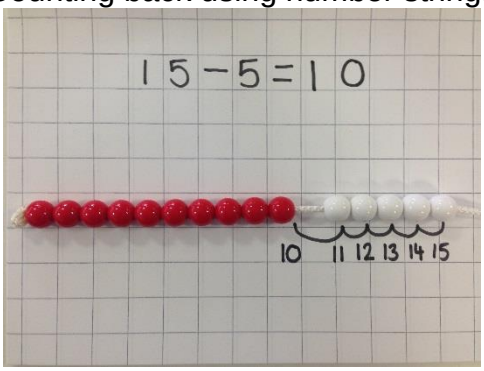
Subtraction -

Key skills for Year 1 Subtraction –

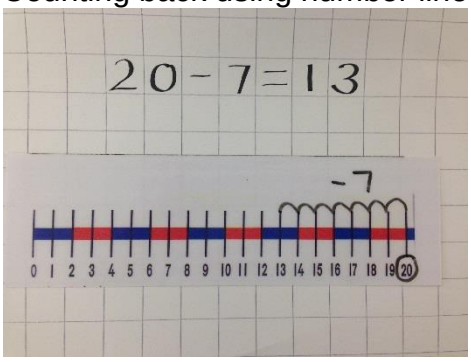
- Read, write and interpret mathematical statements involving subtraction (-) and equals (=) signs
- Subtract one-digit and two-digit numbers to 20, including zero
- Represent and use number bonds and related subtraction facts within 20
- Solve one-step problems that involve subtraction, using concrete objects and pictorial representations
- Missing number problems such as 7 = □ - 9

Strategies

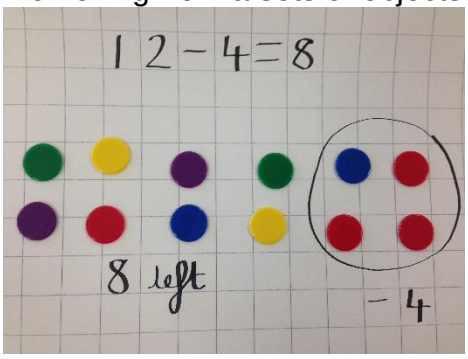
Counting back using number strings



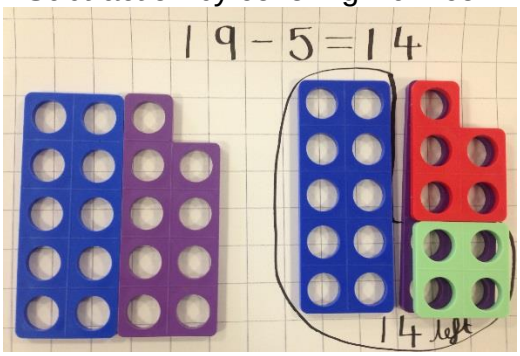
Counting back using number line



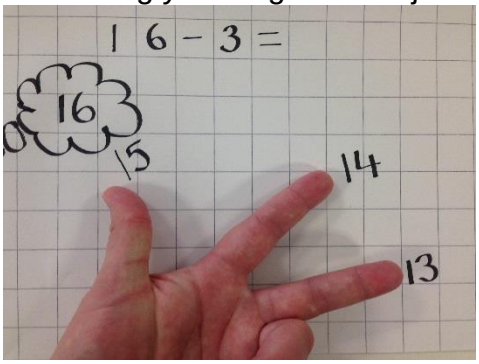
Removing from a sets of objects



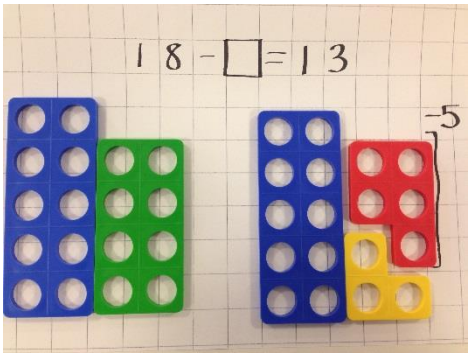
Subtraction by covering Numicon



Hold a number in your head and count back using your fingers or objects



Missing numbers using Numicon – difference



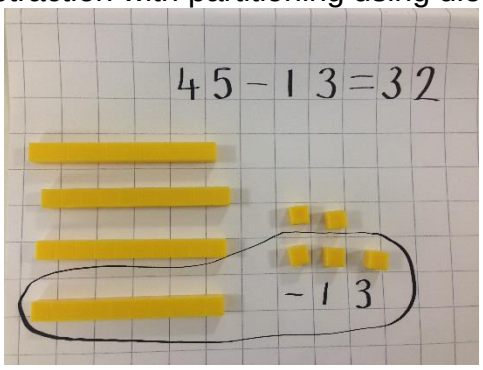
Subtraction -

Key skills for Year 2 Subtraction –

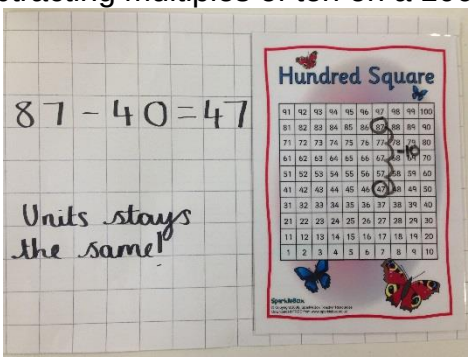
- Solve problems with subtraction using concrete objects and pictorial representations, including those involving numbers, quantities and measures
- Recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100
- subtract numbers using concrete objects, pictorial representations, and mentally, including:
  - a two-digit number and ones
  - a two-digit number and tens
  - two two-digit numbers
- Show that addition of two numbers can be done in any order (commutative) and subtraction of one number from another cannot
- Recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems.

Strategies

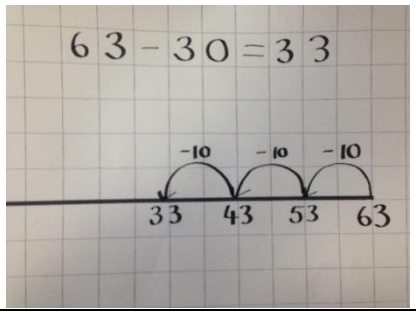
Subtraction with partitioning using dienes



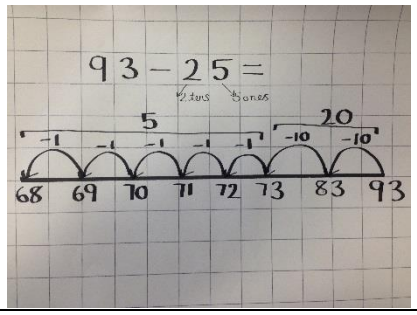
Subtracting multiples of ten on a 100 sq



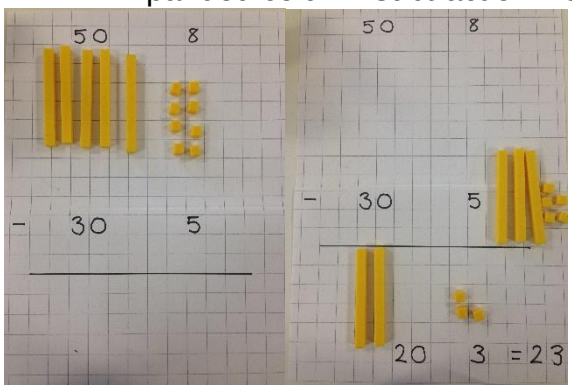
Subtracting multiples of ten on blank number line

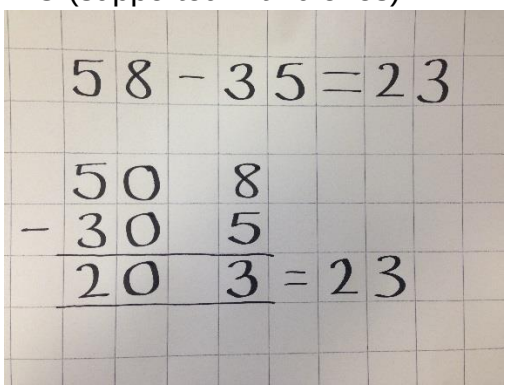


Subtracting TO on blank number line



Expanded column subtraction TO - TO (supported with dienes)





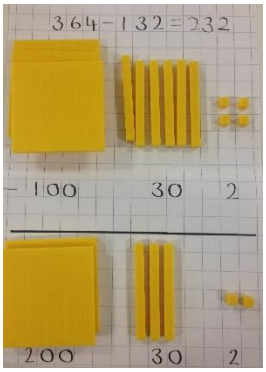
Subtraction -

Key skills for Year 3 Subtraction –

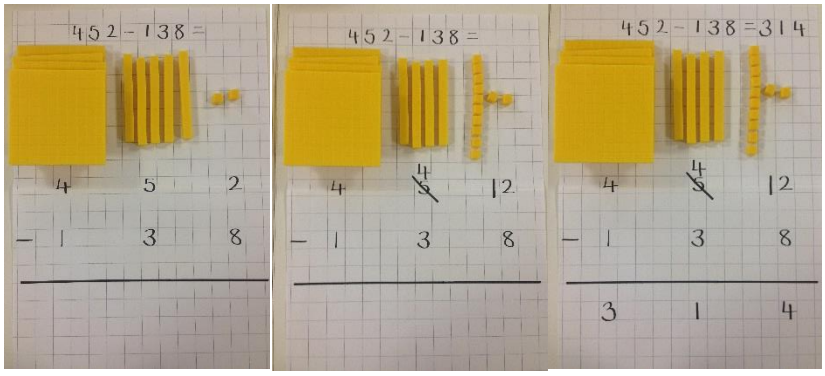
- Subtract numbers mentally, including
  - a three-digit number and ones
  - a three-digit number and tens
  - a three-digit number and hundreds
- Subtract numbers with up to three digits, using formal written methods of columnar subtraction
- Estimate the answer to a calculation and use inverse operations to check answers
- Solve problems, including missing number problems, using number facts, place value, and more complex subtraction
- Subtract fractions with the same denominator within one whole (e.g $^{6}/_{7} - {}^{5}/_{7} = {}^{1}/_{7}$)

Strategies

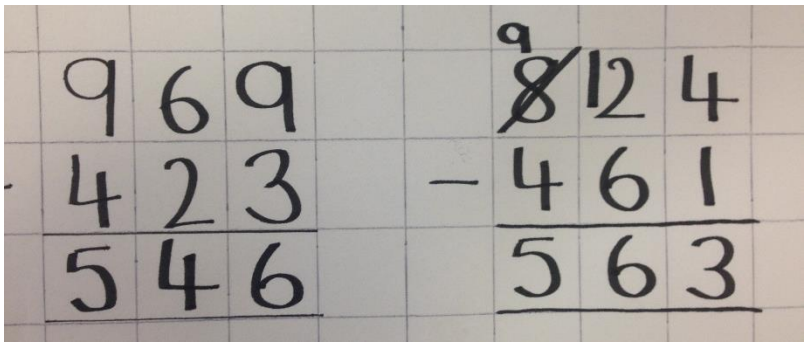
Column method with dienes



Column method with dienes (including exchanging)



Formal column method HTO - HTO



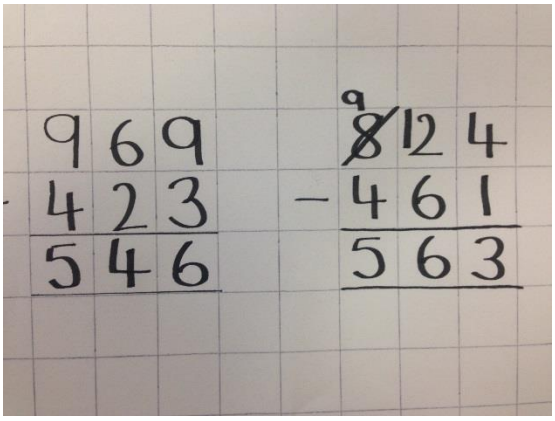
Subtraction -

Key skills for Year 4 Subtraction –

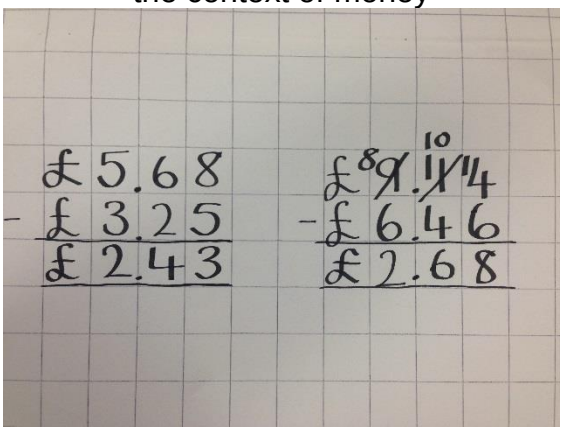
- Subtract numbers with up to 4 digits using the formal written methods of columnar subtraction where appropriate
- Estimate and use inverse operations to check answers to a calculation
- Solve subtraction two-step problems in contexts, deciding which operations and methods to use and why
- Subtract fractions with the same denominator

Strategies

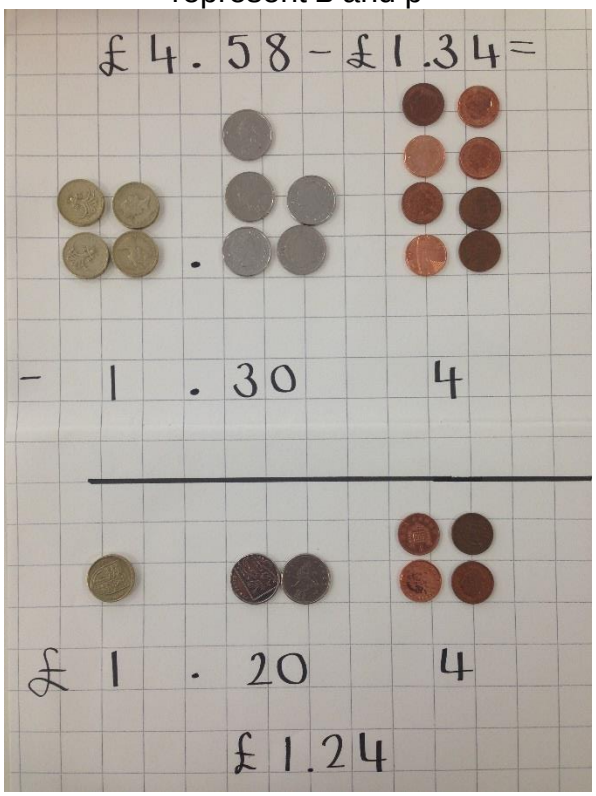
Column Method ThHTO - ThHTO



Formal column method with decimals in the context of money



Column method with coins using to represent £ and p



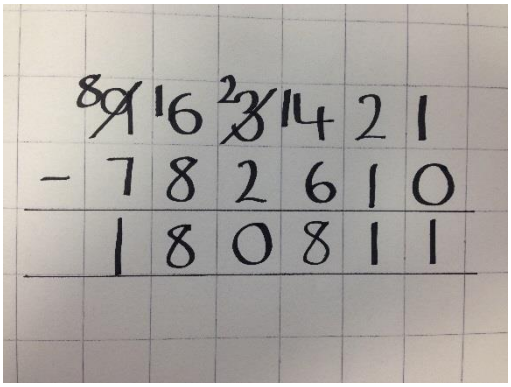
Subtraction -

Key skills for Year 5 Subtraction –

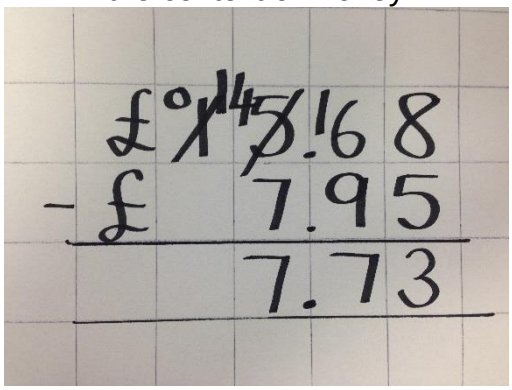
- Subtract whole numbers with more than 4 digits, including using formal written methods (columnar subtraction)
- Subtract numbers mentally with increasingly large numbers
- Use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy
- Solve subtraction multi-step problems in contexts, deciding which operations and methods to use and why
- Subtract fractions with the same denominator and multiples of the same number
- Solve problems involving numbers up to three decimal places

Strategies

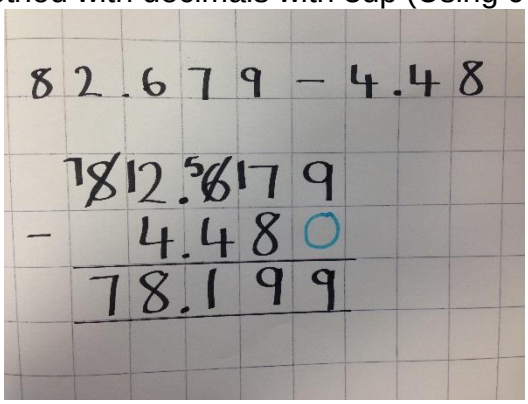
Formal column method with hundreds of thousands



Formal column method with decimals in the context of money



Formal column method with decimals with 3dp (Using 0 as a place holder)



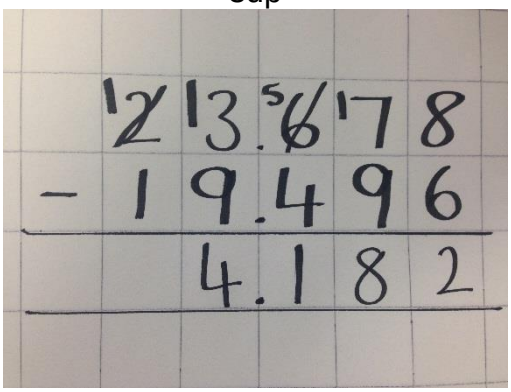
Subtraction -

Key skills for Year 6 Subtraction –

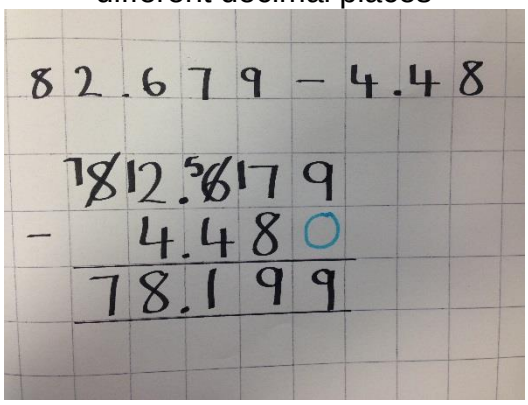
- Solve subtraction multi-step problems in contexts, deciding which operations and methods to use and why
- Solve problems involving subtraction,
- Use estimation to check answers to calculations and determine, in the context of a problem, levels of accuracy.
- Subtract fractions with different denominators and mixed numbers, using the concept of equivalent fractions

Strategies

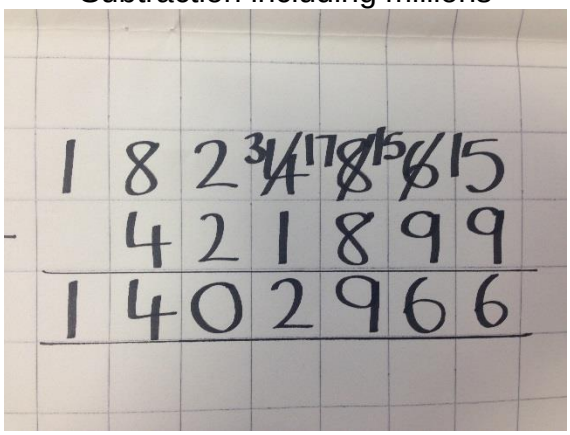
Formal column method of decimals with 3dp



Formal column method with decimals of different decimal places



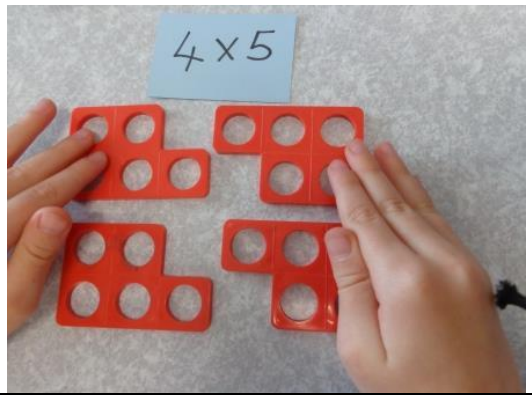
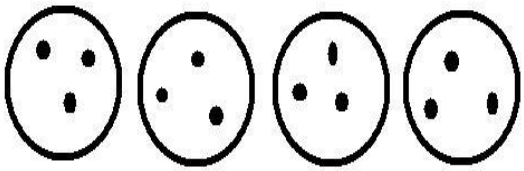
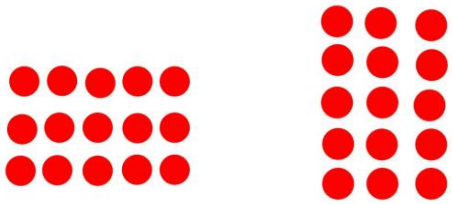
Subtraction including millions



Multiplication X

Key skills for Year 1 Multiplication –

- Solve one-step problems involving multiplication by calculating the answer using concrete objects, pictorial representations and arrays

Strategies	
Combining groups of Numicon 	Combining groups of counters 
Pictorial representations 	Drawing arrays 

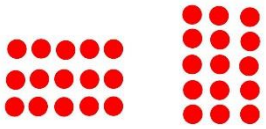
Multiplication X

Key skills for Year 2 Multiplication –

- Calculate mathematical statements for multiplication within the multiplication tables and write them using the multiplication (×), division (÷) and equals (=) signs
- Show that addition of two numbers can be done in any order (commutative) and subtraction of one number from another cannot
- Solve problems involving multiplication using materials, arrays, repeated addition, mental methods, and multiplication, including problems in contexts

Strategies

Drawing arrays

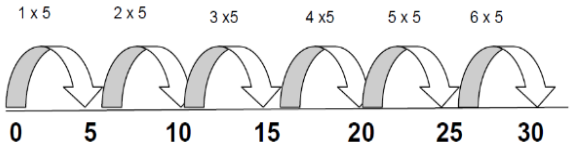


Repeated addition with numicon

Repeated addition with Cuisenaire rods and tracks

Repeated addition on a blank number line

6 x 5 = 30



Make the link to repeated addition.

Multiplication X

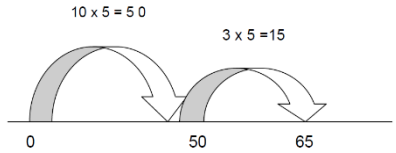
Key skills for Year 3 Multiplication –

- Write and calculate mathematical statements for multiplication using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods (appears also in Mental Methods)

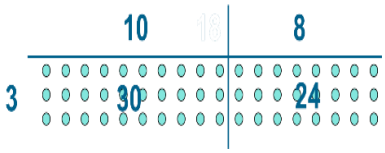
Strategies

Demonstrate the partitioning method using a number line

13 x 5 = 65



Grid method with an array



Grid method with numbers

13 x 8 = 104

X	10	3
8	80	24

80 + 24 = 104

This will lead to expanded short multiplication

13 x 8 = 104

10 + 3
x 8
24 (3 x 8)
+ 80 (10 x 8)
104

Include an addition symbol when adding partial products.

Refine the recording in preparation for formal short multiplication

1 3
X 8
1 0 4
2

Ensure that the digit 'carried over' is written under the line in the correct column.

Use the language of place value to ensure understanding.

Multiplication X

Key skills for Year 4 Multiplication –

- Multiply two-digit and three-digit numbers by a one-digit number using formal written layout
- Solve problems involving multiplying and adding, including using the distributive law to multiply two digit numbers by one digit, integer scaling problems and harder correspondence problems such as n objects are connected to m objects

Strategies

Multiplying HTO x O
If necessary return to the grid method and/ or the expanded method first

127 x 6 = 762

x	100	20	7
6	600	120	42

600 + 120 + 42 = 762 (add the partial products)

This leads to expanded short multiplication

127 x 6 = 762

```
  1 2 7
  x   6
    4 2   (6x7)
+ 1 2 0   (6x20)
  6 0 0   (6x100)
  7 6 2
```

This will lead into short multiplication (formal method)

```
1 2 7
x   6
7 6 2
1   4
```

Use the language of place value to ensure understanding.

Ensure that the digits 'carried over' are written under the line in the correct column.

NB If, at any time, children are making significant errors, return to the previous stage in calculation.

Multiplication X

Key skills for Year 5 Multiplication –

- Multiply numbers up to 4 digits by a one- or two-digit number using a formal written method, including long multiplication for two-digit numbers
- Multiply whole numbers and those involving decimals by 10, 100 and 1000
- Solve problems involving multiplication and division including using their knowledge of factors and multiples, squares and cubes
- Solve problems involving addition, subtraction, multiplication and division and a combination of these, including understanding the meaning of the equals sign
- Solve problems involving multiplication including scaling by simple fractions and problems involving simple rates
- Multiply proper fractions and mixed numbers by whole numbers, supported by materials and diagrams

Strategies

Grid method (two-digit number multiplied by a teen- number):

X	20	3
10	200	30
3	60	9

230
+ 69
299

23 x 13 = (20 + 3) x (10 + 3) = 299

Add the partial products (200 + 30) + (60 + 9) = 299

Expanded long multiplication (two-digit numbers multiplied by a teen- number):

23 x 13 = 299

23
X 13
9 (3 x 3)
60 (3 x 20)
+ 30 (10 x 3)
200 (10 x 20)
299

Compact long multiplication (formal method)

23 x 13 = 299

23
X 13
+ 69 (3 x 23)
230 (10 x 23)
299

Use the language of place value to ensure understanding.

Add the partial products.

Extend to larger two-digit numbers:

56 x 27 = (50 + 6) x (20 + 7) = 1512

When children are confident extend to HTO x TO using the grid method first if necessary

124 x 26 = 3224

124
X 26
$7^{1}4^{2}4$ (6x124)
+ 2480 (20x124)
3224
1 1

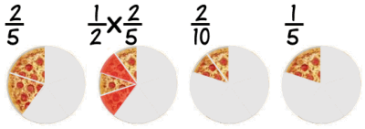
Use the language of place value to ensure understanding.

Add the partial products.

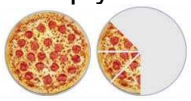
The prompts (in brackets) can be omitted if children no longer need them.

Multiply proper fractions by whole numbers

$\frac{2}{5}$ $\frac{1}{2} \times \frac{2}{5}$ $\frac{2}{10}$ $\frac{1}{5}$



Multiply mixed no's by whole no's



$1\ ^{3}/_{8}$ is 1 pizza and 3 eighths of another pizza.

First, convert the mixed fraction ($1\ ^{3}/_{8}$) to an an improper fraction ($^{11}/_{8}$):

Cut the whole pizza into eighths and how many eighths do you have in total?

1 lot of 8, plus the 3 eighths = 8+3 = 11 eighths.

Multiplication X

Key skills for Year 6 Multiplication –

- Multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication
- Use estimation to check answers to calculations and determine, in the context of a problem, levels of accuracy
- Solve problems involving addition, subtraction, multiplication and division
- Multiply one-digit numbers with up to two decimal places by whole numbers
- Multiply simple pairs of proper fractions, writing the answer in its simplest form (e.g. $^{1}/_{4} \times {}^{1}/_{2} = {}^{1}/_{8}$)
- Solve problems which require answers to be rounded to specified degrees of accuracy

Strategies

The grid method (decimal number multiplied by a two-digit number)

53·2 x 24 = 1276·8

x	50	3	0·2	
20	1000	60	4	1064·0
4	200	12	0·8	212·8
				1276·8

The formal written method of long multiplication

```
  53·2
x 24·0
 212·8   (53·2 x 4)
1064·0   (53·2 x 20)
1276·8
```

It is an option to include ·0 in this example, but not essential.

The prompts (in brackets) can be omitted if children no longer need them.

NB If, at any time, children are making significant errors, return to the previous stage in calculation.
Our aim is that by the end of Y6 children use mental methods (with jottings) when appropriate, but for calculations that they cannot do in their heads, they use an efficient formal written method accurately and with confidence

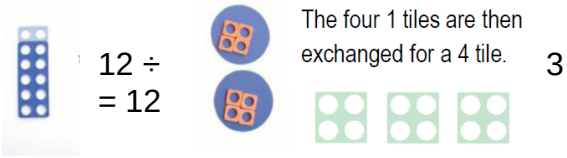
Division ÷

Key skills for Year 1 Division –

- Solve one-step problems involving division, by calculating the answer using concrete objects, pictorial representations and arrays

Strategies

Sharing Numicon



Sharing counters

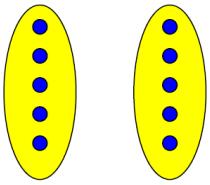
Pictorial representations

Can you share 6 spots onto 3 ladybirds?

Sharing - arrays

10 ÷ 2 = 5

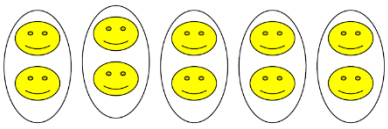
10 dots shared between 2 = 5 dots



Grouping – arrays

10 ÷ 2 = 5

10 faces into groups of 2 = 5



'Five groups of two'

Sharing and grouping:

'30 crayons shared equally between three pots.' (Sharing)
'We have 30 crayons and put ten crayons in each pot.
How many pots do we need?' (Grouping)

30 ÷ 3 = 10

30 ÷ 10 = 3

Division ÷

Key skills for Year 2 Division –

- Calculate mathematical statements for division within the multiplication tables division (÷) and equals (=) signs
- Solve problems involving division, using materials, arrays, repeated addition, mental methods, and multiplication and division facts, including problems in contexts

Strategies

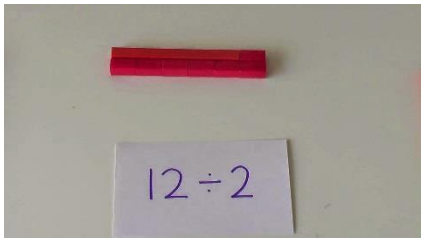
Drawing arrays

How many groups of 3?
How many groups of 5?
15 shared between 3 people is…?
15 shared between 5 people is…?

15 ÷ 3 = 5
15 ÷ 5 = 3

Repeated subtraction with numicon

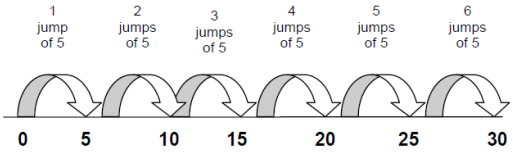
Repeated subtraction with Cuisenaire rods and tracks



When children are ready, use an empty number line to count forwards

30 ÷ 5 = 6

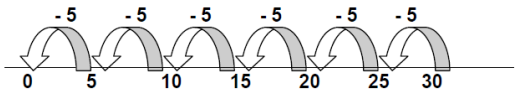
'How many jumps of five make thirty?'



Also jump back to make the link with repeated subtraction

30 ÷ 5 = 6

'How many groups of five?'



NB If, at any time, children are making significant errors, return to the previous stage in calculation

Division ÷

Key skills for Year 3 Division –

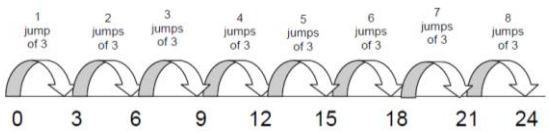
- Write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers divided by one-digit numbers, using mental and progressing to formal written methods
- Solve problems, including missing number problems, involving division, including positive integer scaling problems and correspondence problems in which n objects are connected to m objects

Strategies

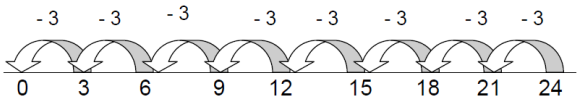
Use an empty number line to count forwards

24 ÷ 3 = 8

'How many threes in 24?'



…also jump back from 24 to make the link with repeated subtraction.



'How many groups of three in 24?'

Introduce the formal short method for known multiplication facts

24 ÷ 3 = 8

This can also be recorded as…

$$3 \overline{)\,24}\quad 8$$

'Twenty four divided by three equals eight.'

'How many threes are there in twenty four?'

NB If, at any time, children are making significant errors, return to the previous stage in calculation.

Division ÷

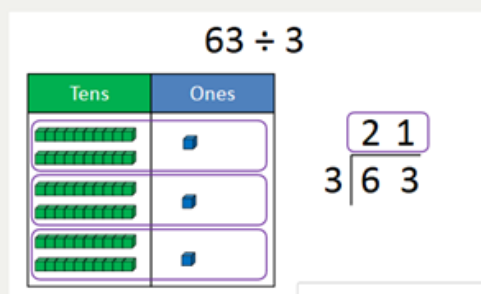
Key skills for Year 4 Division –

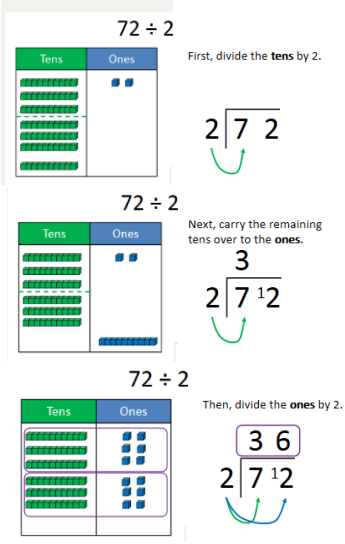
- Short division TO ÷ O with no remainders (Not in the statutory guidance but implied within the non-statutory guidance)
- Find the effect of dividing a one- or two-digit number by 10 and 100, identifying the value of the digits in the answer as ones, tenths and hundredths

NB Ensure that children are confident with the methods outlined in the previous

Strategies

Short division with dienes

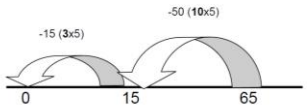




Division using partitioning

Continue to use **empty number lines**, as appropriate, using multiples of the divisor:

65 ÷ 5 = 13



65 ÷ 5 = 13

65 = 50 + 15 Partition 65 into 50 and 15

50 ÷ 5 = 10
15 ÷ 5 = 3
10 + 3 = 13

NB Children will need to practise partitioning in a variety of ways.

98 = 70 + 28 Partition 98 into 70 and 28

70 ÷ 7 = 10
28 ÷ 7 = 4
10 + 4 = 14

This could be modelled on an empty number line to further develop understanding.

NB Children will need to practise partitioning in a variety of ways.

98 ÷ 7 = 14

'We have partitioned 98 into 70 and 28 (90 = 70 + 28).

Seven 'goes into' 70 ten times and seven 'goes into' 28 four times.
Ten add four equals 14'

$$7 \overline{)\ 70 + 28}\quad 10 + 4 = 14$$

This will lead into the formal written method of short division:

98 ÷ 7 = 14

$$7 \overline{)\ 9^{2}8}\quad 14$$

Use the vocabulary of place value to ensure understanding and make the link to partitioning.

Continue to practise the formal method of short division throughout Y4.

Division ÷

Key skills for Year 5 Division –

- Divide numbers up to 4 digits by a one-digit number using the formal written method of short division and interpret remainders appropriately for the context
- Divide whole numbers and those involving decimals by 10, 100 and 1000
- Solve problems involving division including using their knowledge of factors and multiples, squares and cubes
- Solve problems involving addition, subtraction, multiplication and division and a combination of these, including understanding the meaning of the equals sign
- Solve problems involving division, including scaling by simple fractions and problems involving simple rates

Strategies

Short division

Continue to practise the formal written method of short division with whole number answers…

184 ÷ 8 = 23

$$\begin{array}{r} 23 \\ 8\overline{)184} \end{array}$$

Use the language of place value to ensure understanding.

Make the link to the partitioning method (see Y4 guidance)

…and with remainders:

432 ÷ 5 = 86 r2

$$\begin{array}{r} 86\text{ r }2 \\ 5\overline{)432} \end{array}$$

The remainder can also be expressed as a fraction, $\frac{2}{5}$ (the remainder divided by the divisor): **$432 \div 5 = 86\frac{2}{5}$**

Continue to practise, develop and extend the formal method of short division, with and without remainders. Interpret and express remainders according to the context.

NB If, at any time, children are making significant errors, return to the previous stage in calculation.

Division ÷

Key skills for Year 6 Division –

- Divide numbers up to 4-digits by a two-digit whole number using the formal written method of short division
- Where appropriate for the context divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division, and interpret remainders as whole number remainders, fractions, or by rounding, as appropriate for the context
- Use estimation to check answers to calculations and determine, in the context of a problem, levels of accuracy
- Solve problems involving addition, subtraction, multiplication and division
- Solve problems which require answers to be rounded to specified degrees of accuracy
- Use written division methods in cases where the answer has up to two decimal places

Strategies

Continue to practise the formal method of short division, with and without remainders, using the language of place value to ensure understanding (see Y5 Guidance).

496 ÷ 11 = 45 r1

```
        4 5 r 1
11  ) 4 9 ⁵6
```

The remainder can also be expressed as a fraction, $\frac{1}{11}$ (the remainder divided by the divisor)

Dividing by a two-digit number using a formal method of long division:

```
         4 5 r 1
11  )  4 9 6
     - 4 4 0   (40 x 11)
         5 6
     -   5 5   (5 x 11)
           1   (remainder)
```

Multiples of the divisor (11) have been subtracted from the dividend (496)

'40 (lots of 11) + 5 (lots of 11) = 45 (lots of 11)'

'1 is the remainder'

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

Standard short division does not help with the following calculation. However, it can be solved using long division (by repeated subtraction using multiples of the divisor):

144÷ 16 = 9

```
           9
16  )  1 4 4
       - 6 4  (4 x 16)
         8 0
       - 6 4  (4 x 16)
         1 6
       - 1 6  (1 x 16)
           0
```

Multiples of the divisor (16) have been subtracted from the dividend (144)

'4 (lots of 16) + 4 (lots of 16) + 1 (lot of 16) = 9 (lots of 16)

There is no remainder'

Children will need to select the most effective method for each calculation/problem
they meet, including whether to use the standard, formal written method of long division:

32 ÷ 15 = 28 r12

```
        2 8 r12
l5  )  4 3 2
       3 0 0  (20 x 15)
       1 3 2
       1 2 0  (8 x 15)
         1 2  (remainder)
```

Multiples of the divisor (15) have been subtracted from the dividend (432)

'20 (lots of 15) + 8 (lots of 15) = 28

12 is the remainder'

The remainder can also be expressed as a fraction, 12/15 (the remainder divided by the divisor) or as a decimal, 0.8

This is an alternative way of recording:

432 ÷ 15 = 28·8

```
          2 8 · 8
15  )  4 3 2 · 0
       3 0 ↓
       1 3 2
       1 2 0
         1 2 0
         1 2 0
             0
```