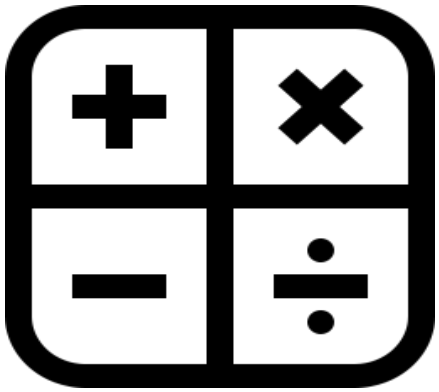
Key Stage 2 - Written Calculation Policy



(Aligned with the 2014 National Curriculum)
<Year 3 Progression from 'Inspire Maths' in KS1>
<Year 4 onwards progression from National Curriculum in KS1>

Written Methods adapted from a policy written by Diane Andrews, Maths Consultant
(diane@countonmeconsultancy.co.uk)

Bar Method Methods adapted from the Oxfordshire Maths Teams

Policy Approved: MAY 2018

Policy Review: JULY 2019

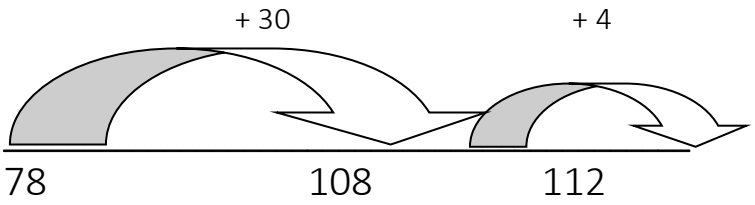
Addition

Addition - Year Three

Number Line Method

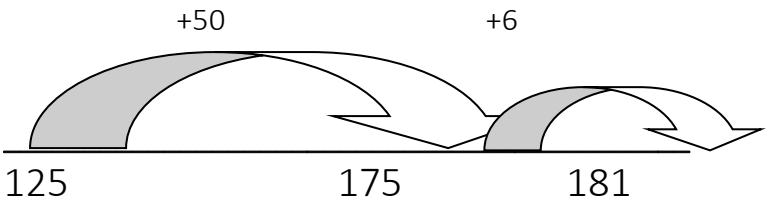
Introduce **empty number line strategy.**

78 + 34 = 112



Further develop with addition of a three-digit and a two -digit number:

125 + 56 = 181



Formal Written Method (2 digits + 2 digits, 3 digits + 3 digits)

Continue to build on understanding from 'Inspire Maths' using **Formal Written Method.**

1) No carrying required (TU+TU)
2) Carrying required (TU+TU)
3) Carrying required (HTU+HTU)

The digits that have been ‘carried’ should be recorded under the line in the correct column.

1) 27+12=

$$\begin{array}{r} 27 \\ +12 \\ \hline 39 \end{array}$$

2) 44+76=

$$\begin{array}{r} 44 \\ +76 \\ \hline 120 \\ {\scriptstyle 1} \end{array}$$

3) 476 + 147 = 623

$$\begin{array}{r} 4\,4\,7 \\ + \;\; 1\,7\,6 \\ \hline 6\,2\,3 \\ {\scriptstyle 1\quad 1} \end{array}$$

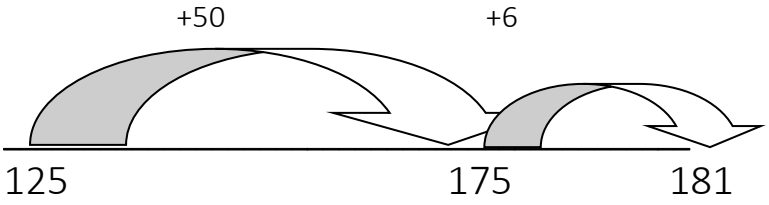
‘Seven add six equals 13. Write three in the units column and ‘carry’ one across into the tens column (10).
40 add 70 and the ten that we carried equals 120. Write 2 in the tens column (20) and ‘carry’ 1 across into the hundreds column (100).
400 add 100 and the 100 that has been carried equals 600. Write 6 in the hundreds column (600). The total is 623.

Addition - Year Four

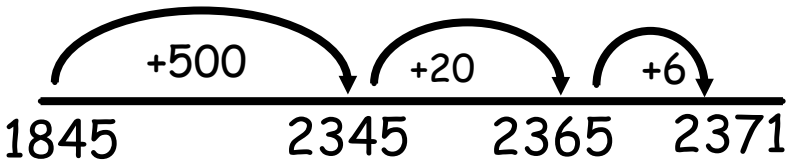
Number Line Method

Introduce **empty number line strategy (**see Year3).

125 + 56 = 181



1,845 + 526 = 2,371



Partitioning (building towards the Formal Written Method)

Initially use calculations where it is not necessary to bridge across the tens or hundreds:

63 + 32 = 95

60 + 3
\+ 30 + 2
90 + 5 = 95

6 3
\+ 3 2
5 (3 + 2)
9 0 (60 + 30)
9 5

Formal Written Method (2 digits + 2 digits)

Introduce the Formal Written Method.

1) No carrying required (TU+TU)
2) Carrying required (TU+TU)
3) Carrying required (HTU+HTU)

The digits that have been 'carried' should be recorded under the line in the correct column.

1) 63+32 =

$$\begin{array}{r} 6\ 3 \\ +\ 3\ 2 \\ \hline 9\ 5 \end{array}$$

2) 44+76=

$$\begin{array}{r} 44 \\ +76 \\ \hline 120 \\ {\scriptstyle 1\ 1} \end{array}$$

'Three add two equals five. Write five in the ones/units column. 60 add 30 equals 90. Write 9 (90) in the tens column. The total is 95.

3) 476 + 147 = 623

$$\begin{array}{r} 4\ 4\ 7 \\ +\ 1\ 7\ 6 \\ \hline 6\ 2\ 3 \\ {\scriptstyle 2\quad 1} \end{array}$$

'Seven add six equals 13. Write three in the units column and 'carry' one across into the tens column (10).
40 add 70 and the ten that we carried equals 120. Write 2 in the tens column (20) and 'carry' 1 across into the hundreds column (100).
400 add 100 and the 100 that has been carried equals 600. Write 6 in the hundreds column (600). The total is 623.'

When children are confident, introduce addition of a four-digit number and a three- digit number:

1,845 + 526 = 2,371

$$\begin{array}{r} 1\ 8\ 4\ 5 \\ +\ \ 5\ 2\ 6 \\ \hline 2\ 3\ 7\ 1 \end{array}$$

1 1

Continue to develop with addition of 2 four-digit numbers and with decimal numbers, in the context of money or measurement. Ensure that the decimal points line up.

£45·65 + £ 28·50 = £74·15

```
  4 5·6 5
+ 2 8·5 0
  7 4·1 5
  1  1
```

Addition - Year Five & Year 6 (Revision)

Introduce the use of **empty number lines** with larger numbers and decimal numbers, as appropriate.

Continue to develop the **formal written method for addition** with larger numbers (and decimal numbers) and with the addition of three or more numbers:

21,848 + 1,523 = 23,371

```
  21848
+  1523
 23371
  1 1
```

Ensure that the digits that have been 'carried' are recorded under the line in the correct column.

Use **the formal written method** for the addition of decimal numbers:

£154·75 + £233·82 = £388·57

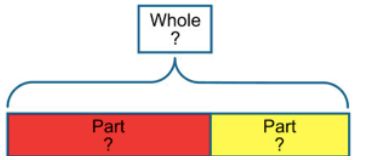
```
  154·75
+ 233·82
 388·57
   1
```

Ensure that the decimal points line up.

Continue to practise and apply the formal written method throughout Y5, including the addition of more than two numbers.

Bar Method (Year 3-6)

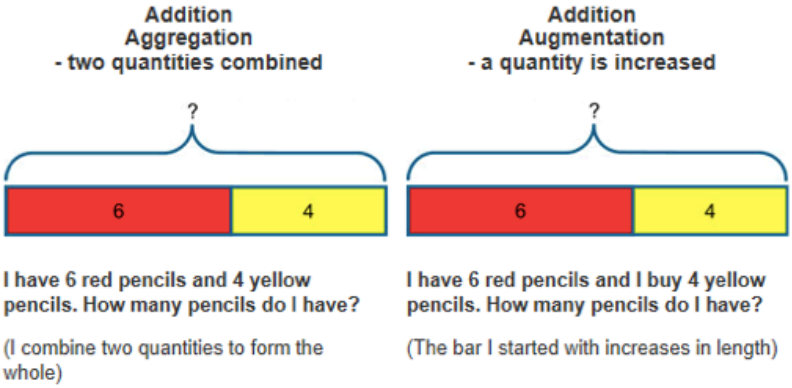
Continue to build on understanding from Inspire Maths (Year 3 only) or introduce the bar method (Year 4-6).
Review understanding of part + part = whole.



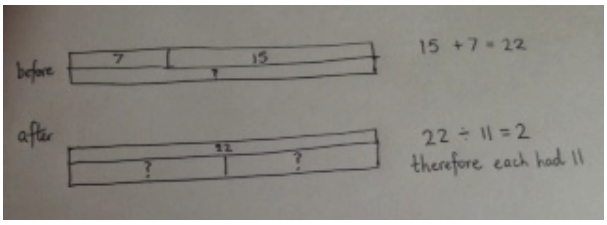
This diagram encapsulates all of the following relationships;

$a = b + c$; $a + c + b$; $a - b = c$; $a - c = b$

For one-step problems/missing number problems, review bar model strategies for **aggregation** and **augmentation**:



For two-step/multi-operational problems, review before (step 1) and after (step 2) strategies.



Aiden has seven marbles and Harvey has fifteen. They decide to share them equally between them. How many do they get each?

For two-step/multi-operational problems/decimal problems, review before (step 1) and after (step 2) strategies.

A tub contains £24.00. Saj takes £5.00. Joss takes £10.00 coins. How much money is left in the tub?

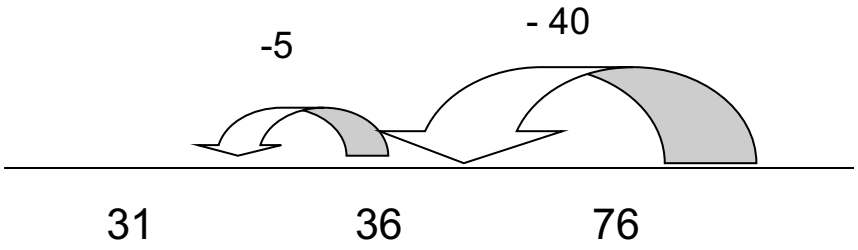
Subtraction

Subtraction - Year Three

Number Line Method

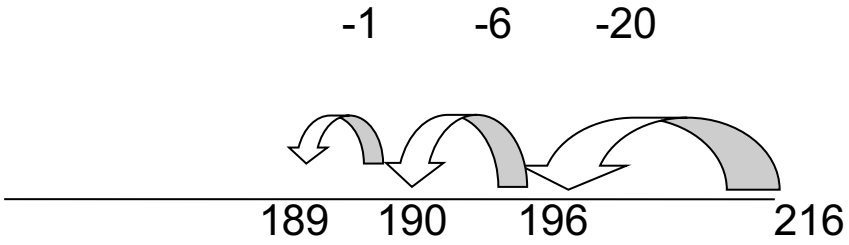
Introduce **empty number line strategy.**

76 – 45 = 31



Extend with larger numbers by counting back…

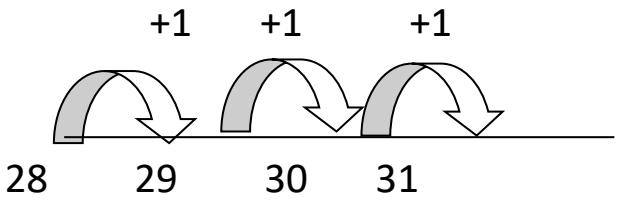
216 – 27 = 189



Finding a Small Difference

Use complementary addition to find differences (only use for **small** differences). **Count up** from the smallest number to the largest to **find the difference**.

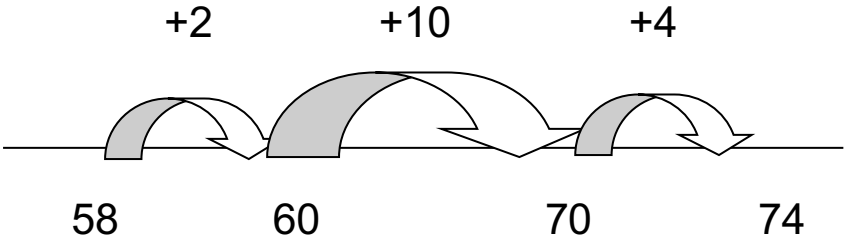
31- 28 = 3



'The difference between 28 and 31 is 3.'

If children are confident, further develop this method to find the difference, using more efficient jumps:

74 – 58 = 16



'The difference between 58 and 74 is 16.'

Formal Written Method (2 digits - 2digits, 3 digits - 3 digits)

Continue to build on understanding from 'Inspire Math's using Formal Written Method.

1) No exchanging required (TU-TU)
2) Exchanging required (TU-TU)
3) Exchanging required (HTU-HTU)

The digits that have been 'exchanged' should be recorded at the top of the calculation.

1) 78- 23 =

```
  7 8
-2 3
-----
  5 5
```

'Eight subtract three is five, seventy subtract twenty is fifty. The answer is fifty-five'

2) 73- 27 =

```
    6 1
  ~~7~~ ~~3~~
- 2 7
-------
  4 6
```

'We can't subtract seven from three, so we need to exchange a ten for ten ones to give us 60 + 13.' 73 is partitioned into 60+13 in order to calculate 73-27.

3) 235-127=

```
    2 1
  2 ~~3~~ ~~5~~
- 1 2 7
-------
  1 0 8
```

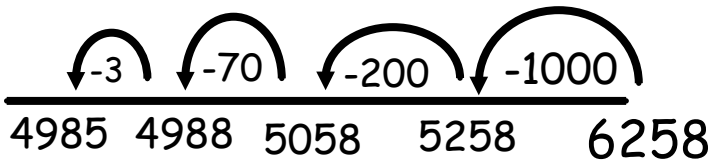
In this example it has only been necessary to exchange from the tens column.

Subtraction - Year Four

Number Line Method (3d/4d)

Introduce **empty number line strategy** and review Year 3 method (3d or 4d).

6258-1273 = 185



Formal Written Method (3d/4d)

The digits that have been 'exchanged' should be recorded at the top of the calculation.

```
  5 1
  6 3 7
- 2 5 2
  3 8 5
```

When children are confident, develop further with four- digit numbers and decimal numbers, in the context of money and measures. Ensure that the decimal points line up.

3,625 – 1,219 = 2,406

```
   1 1
  3 6 2 5
- 1 2 1 9
  2 4 0 6
```

£56·75 - £34·80 = £21·95

```
    5  1
  5 6· 7 5
- 3 4 ·8 0
  2 1 ·9 5
```

Subtraction - Year Five & Year 6 (Revision)

Introduce the use of **empty number lines** with larger numbers and decimal numbers, as appropriate.

Formal Written Method (4 digits/decimals)

Continue to develop the formal written method for subtraction with larger numbers (and decimal numbers) and with the subtraction of three or more numbers:

12,731 – 1,367 = 11,364

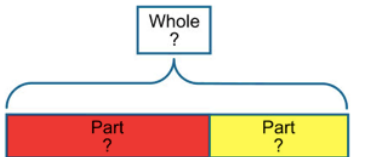
$$\begin{array}{r} {\scriptstyle 6\ \ 2\,1} \\ 1\,2\,\cancel{7}\,\cancel{3}\,\cancel{1} \\ -\ \ 1\,3\,6\,7 \\ \hline 1\,1\,3\,6\,4 \end{array}$$

£166·25 – £83·72 = £82.53

$$\begin{array}{r} {\scriptstyle 1\ \ 5\ \ 1} \\ \cancel{1}\,6\,\cancel{6}\cdot\,\cancel{2}\,5 \\ -\ 8\,3\cdot\,7\,2 \\ \hline 8\,2\cdot\,5\,3 \end{array}$$

Bar Method (Year 3-6)

Continue to build on understanding from Inspire Maths (Year 3 only) or introduce the bar method (Year 4-6). Review understanding of part + part = whole.

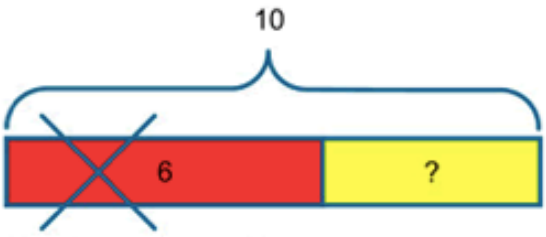


This diagram encapsulates all of the following relationships;

$a=b+c; a+c+b; a-b=c; a-c=b$

For one-step problems/missing number problems, review bar model strategies for **Take Away** and **Comparison/Difference:**

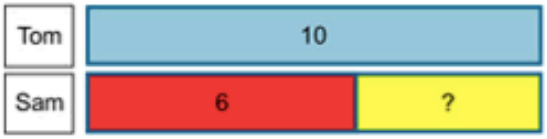
Subtraction
- Take Away



I had 10 pencils and I gave 6 away, how many do I have now?

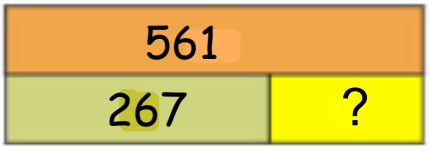
(This time we know the whole but only one of the parts, so the whole is partitioned and one of the parts removed to identify the missing part)

Subtraction
- Comparison or Difference



Tom has 10 pencils and Sam has 6 pencils. How many more does Tom have?

(The bar is particularly valuable for seeing the difference between the two quantities)



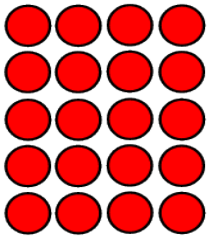
There are 561 cars in a supermarket car park. 267 cars leave. How many cars are left?

Multiplication

Multiplication - Year Three

Arrays

Continue to build on understanding from 'Inspire Math's **arrays** to support multiplication, as appropriate.



4 x 5 = 20

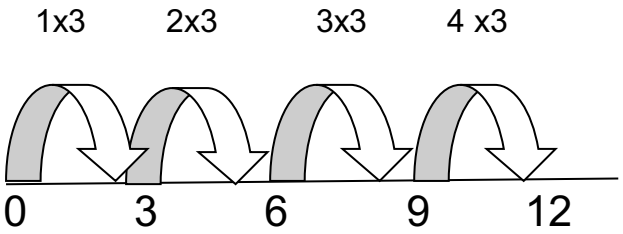
5 x 4 = 20

Number Line Method

Introduce empty number line strategy to count on:

4 x 3 = 12

'0, 3, 6, 9, 12'



Partitioning

Introduce partitioning to support grid method (multiplication) and chunking (division).

13 x 5 = 65 (Partition 13 into 10 + 3)

10 x 5 = 50
3 x 5 = 15

50 + 15 = 65

Grid Method (2dx1d)

Support children with construction of the grid.

13 x 8 = 104

X	10	3
8	80	24

'Partition 13 into 10 + 3 then multiply each number by 8. Add the partial products (80 and 24) together.'

80 + 24 = 104

Children to use mental addition to re-combine the partial products.

36 x 4 = 144

X	**30**	**6**
4	120	24

120 + 24 = 144 (add the partial products)

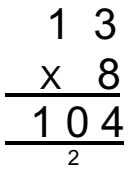
Expanded Short Multiplication (2dx1d)

Introduce **expanded short multiplication** to support formal short method of multiplication and chunking (division).

13 x 8 = 104

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

Formal Short Multiplication(2dx1d)



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

Multiplication - Year Four

If necessary, return to the grid method and/or expanded short or formal method first. Introduce additional 'hundreds' column to each strategy.

Grid Method (3dx1d)

If necessary, return to the grid method and/or expanded method first:

127 x 6 = 762

x	100	20	7
6	600	120	42

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

600
120
+ 42
762

Children to use mental addition to recombine the partial products OR column addition to add partial products.

Expanded Short Multiplication (3dx1d)

127 x 6 = 762

```
  1 2 7
x   6
    4 2   (6 x 7)
+ 1 2 0   (6 x 20)
  6 0 0   (6 x 100)
  7 6 2
```

Formal Short Multiplication (3dx1d)

1 2 7
x 6
7 6 2
1 4

Multiplication - Year Five

If necessary, return to the grid method and/or expanded short or formal method first. Introduce additional 'thousands' column to each strategy – and the additional row for the 2dx2d grid method.

Formal Short Multiplication (4dx1d)

1,256 x 4 = 5,024

1 2 5 6
x 4
5 0 2 4
1 2 2

Grid Method (2dx2d)

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

X	**20**	**3**
10	200	30
3	60	9

=

2 3 0
+ 6 9
2 9 9

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

Expanded Long Multiplication (2dx2d)

Introduce **expanded long multiplication** to support formal short method of multiplication and chunking (division).

23 x 13 = 299

```
  2 3
x 1 3
    9   (3 x 3)
  6 0   (3 x 20)
+ 3 0   (10 x 1)
2 0 0   (10 x 20)
2 9 9
```

Compact Long Multiplication (2dx2d)

56 x 27 = 1,512

```
    5 6
  x 2 7
    3 9 4 2   (7 x 56)
+1 1 1 2 0    (20 x 56)
  1 5 1 2
    1
```

In this example there are digits that have been 'carried' over in the partial products.

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

Short Multiplication (2dx2d)

3,256 x 4 = 13,024

```
  3 2 5 6
  x     4
 1 3 0 2 4
   1 2 2
```

Multiplication - Year Six (Revision)

Short Multiplication (2dx2d)

3,256 x 4 = 13,024

```
  3 2 5 6
x       4
-------
 1 3 0 2 4
  1 2 2
```

Expanded Long Multiplication (decimals)

Introduce the formal written method of long multiplication using decimals**.**

53·2 x 24 = 1,276·8

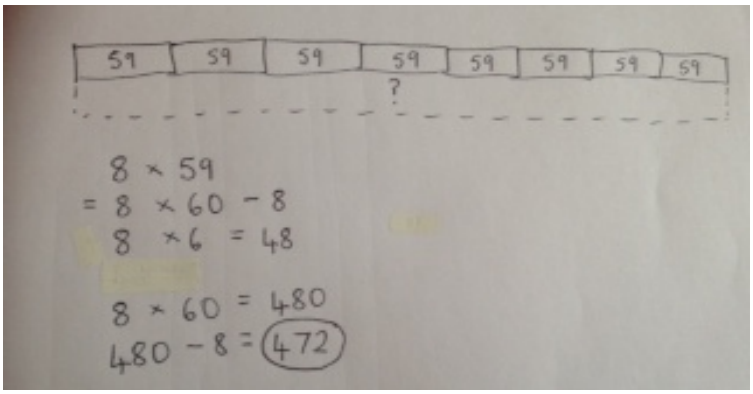
```
    5 3·2
x     2 4
-------
  2 1 1 2 ·8    (53·2 x 4)
1 0 6 4 ·0      (53·2 x 20)
-----------
1 2 7 6 ·8
```

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

Bar Method (Year 3-6)

Continue to build on understanding from Inspire Maths (Year 3 only) or introduce the bar method (Year 4-6).

Groups/Sets/Lots/Repeated Addition (Groups/Sets/Lots)



8 children each download 59 songs to play on their iPod. How many songs do they have altogether?

Integer Scaling

Peter has 4 books
Harry has five times as many books as Peter.
How many books has Harry?

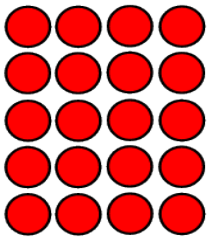
4 × 5 = 20
Harry has 20 books

Division

Division - Year Three

Arrays

Continue to use **arrays** to support multiplication, as appropriate.



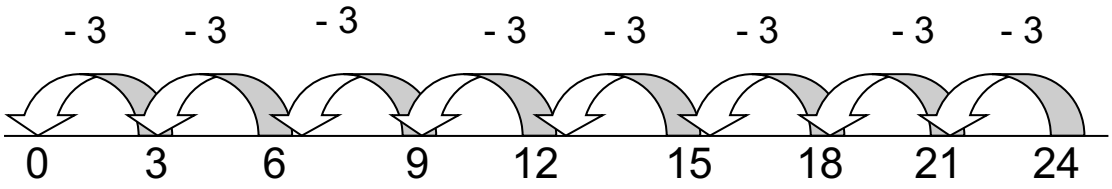
20 ÷ 5 = 4

20 ÷ 4 = 5

Number Line Method

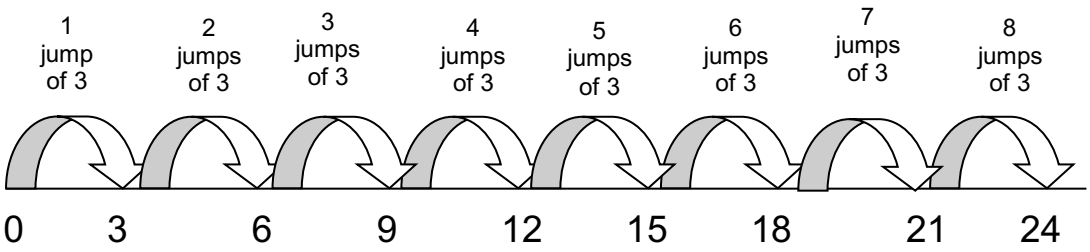
Introduce **empty number line strategy** to jump back to make the link with repeated subtraction

24 ÷ 3 = 8



Introduce **empty number line strategy** to count forwards…

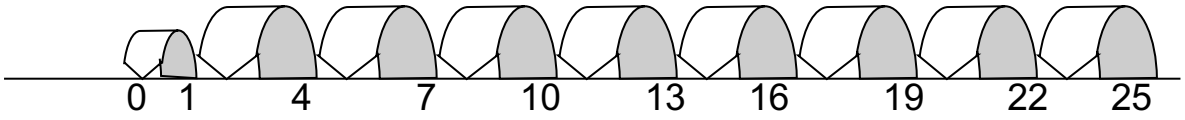
'How many threes are there in 24?'



Begin to determine **remainders**:

25 ÷ 3 = 8 r1

Eight jumps of three and one left over.'



Alternatively, you could jump forwards in multiples of three from zero to twenty-four ('and one more makes 25')

Formal Written Method (Bus Stop/Division Bar)

24 ÷ 3 = 8

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

'Twenty four divided by three equals eight.'
'How many threes are there in twenty four?'

33 ÷ 8 = 4 r1

$$8\overline{)33} \quad 4\ r\ 1$$

This could be modelled using an empty number line to ensure understanding, if needed (See Y3 guidance)

Division - Year Four

Partitioning (2d ÷ 1d)

65 ÷ 5 = 13

65 = 50 + 15 Partition 65 into 50 and 15

50 ÷ 5 = 10
15 ÷ 5 = 3
10 + 3 = 13

Partitioning using formal layout (2d ÷ 1d)

98 ÷ 7 = 14

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

'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'

Chunking using formal layout (2d ÷ 1d)

144 ÷ 16 = 9

```
        9
    ┌─────
16  │ 144
    │ -64   (4 x 16)
    │  80
    │ -64   (4 x 16)
    │  16
    │ -16   (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).

The answer is nine.

There is no remainder'

Formal Written Method of Short Division

98 ÷ 7 = 14

```
      14
    ┌────
7   │ 9 28
```

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

132 ÷ 6 = 22

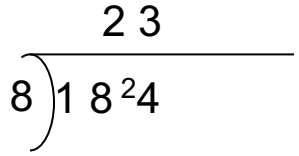
```
      22
    ┌─────
6   │ 13 12
```

Use the language of place value to ensure understanding.

Division - Year Five

Formal Written Method of Short Division (with remainders)

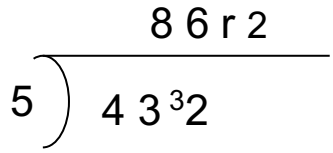
184 ÷ 8 = 23



Use the language of place value to ensure understanding.

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

432 ÷ 5 = 86 r2



The remainder can also be expressed as a fraction, 2/5 (the remainder divided by the divisor): 432 ÷ 5 = 86 2/5 or 86.4

Division - Year Six

Formal Written Method of Short Division (with remainders) (3d÷2d)

496 ÷ 11 = 45 r1

```
      4 5 r 1
   ┌──────
11 │ 4 9 6
```

Formal Written Method of Long Division (with remainders) (3d÷2d)

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

Long division using decimal remainders

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
```

Only teach this method when children are completely secure with the previous method.

The remainder is expressed as a decimal.

Alternative/Revision Chunking using formal layout (2d ÷ 2d)

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).

The answer is nine.

There is no remainder'

Chunking using formal layout (3d ÷ 2d with remainders)

432 ÷ 15 = 28 r12

```
      2 8  r12
    ┌──────
15  │ 4 3 2
    │ 3 0 0   (20 x 15)
    │ 1 3 2
    │ 1 2 0   (8 x 15)
    │     1 2 (remainder)
```

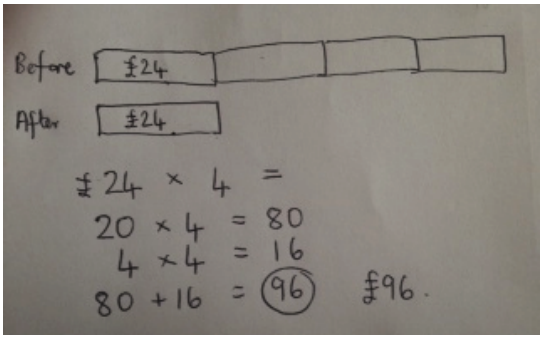
Multiples of the divisor (15) have been subtracted from the dividend (432)

'20 (lots of 15) + 8 (lots of 15) = 28
12 is the remainder'

The remainder can also be expressed as a fraction, 12/15 which can be simplified to 4/5, or as a decimal, 0.8 (See next example)

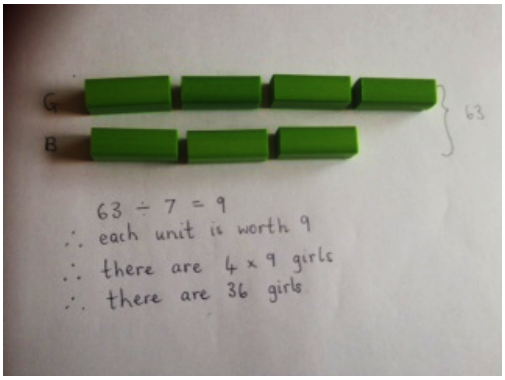
Bar Method (Year 3-6)

Fractions



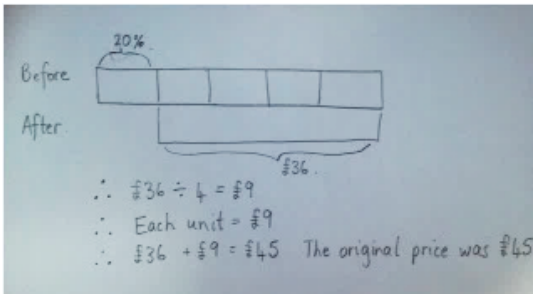
e.g. A computer game is £24 in the sale. This is one quarter of its original price. How much did it

Ratio



e.g. At a dance there are 4 girls to every 3 boys. There are 63 children altogether? How many

Percentages



e.g. There is 20% off in a sale. The reduced price of the jeans is £36. What was the original price?