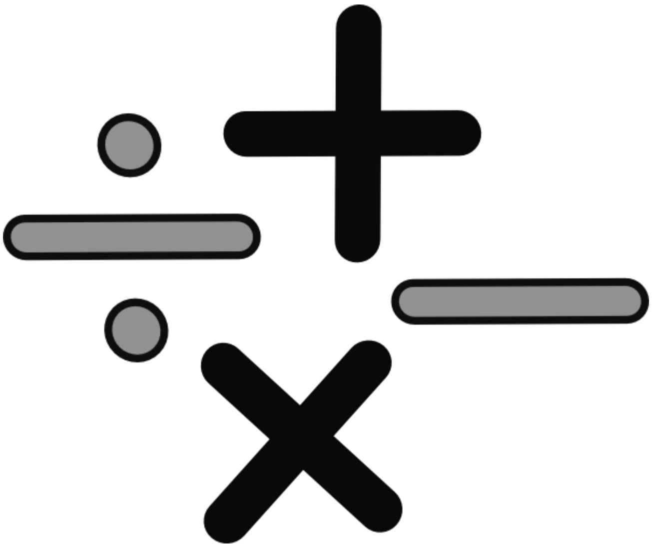
# Cawston CE Primary Academy



Helping your child in maths

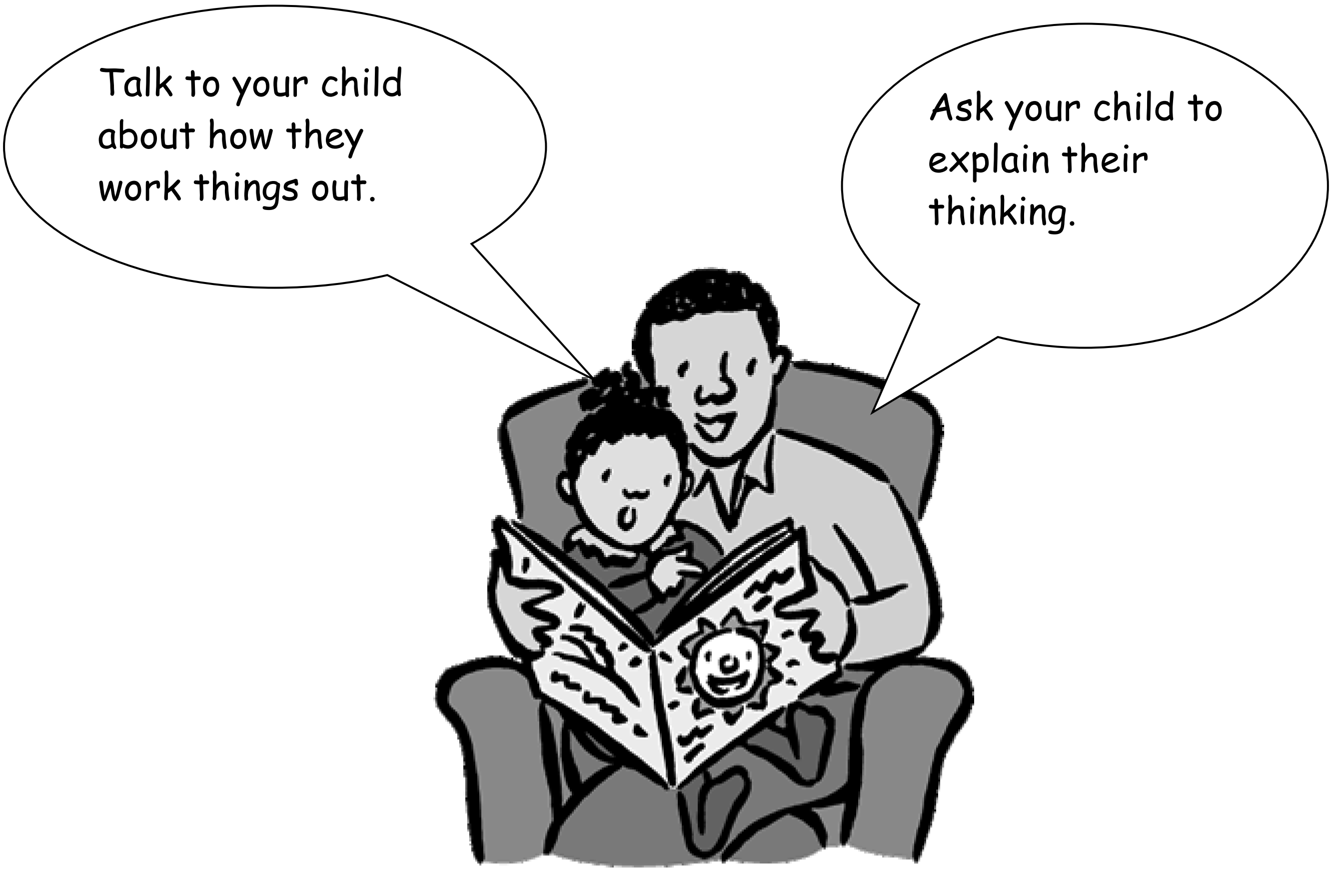
# Calculation Policy
# Autumn Term 2018

# CALCULATION

**The maths work your child is doing at school may look very different to the kind of 'sums' you remember. This is because children are encouraged to work mentally where possible, using personal jottings to help their thinking. Even when children are taught more formal written methods (from late Year 3 onwards), they are only encouraged to use these methods for calculations that they cannot solve in their heads.**

**This policy shows the expected progression for each operation during the primary phase. We would greatly appreciate your support by following the guidelines contained in this document.**

**Discussing the efficiency and suitability of different strategies is an important part of maths lessons.**



# PROGRESSION THROUGH CALCULATIONS FOR ADDITION

## MENTAL CALCULATIONS

These are a **selection** of mental calculation strategies:

**Mental recall of number bonds**

| | |
|---|---|
| 6 + 4 = 10 | □ + 3 = 10 |
| 25 + 75 = 100 | 19 + □ = 20 |

**Use near doubles**

6 + 7 = double 6 + 1 = 13

**Addition using partitioning and recombining**

34 + 45 = (30 + 40) + (4 + 5) = 79

**Counting on or back in repeated steps of 1, 10, 100, 1000**

86 + 57 = 143 (by counting on in tens and then in ones)
460 - 300 = 160 (by counting back in hundreds)

**Add the nearest multiple of 10, 100 and 1000 and adjust**

24 + 19 = 24 + 20 – 1 = 43
458 + 71 = 458 + 70 + 1 = 529

**Use the relationship between addition and subtraction**

| | |
|---|---|
| 36 + 19 = 55 | 19 + 36 = 55 |
| 55 – 19 = 36 | 55 – 36 = 19 |

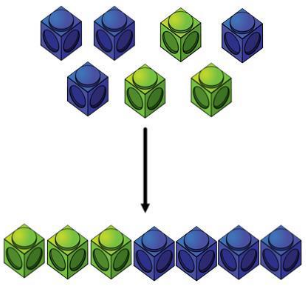
**Key Language:**

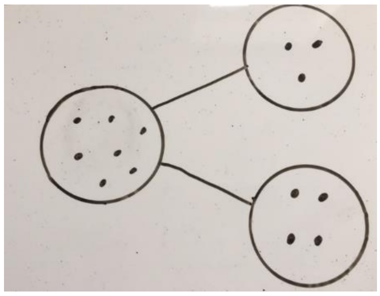
sum, total, parts and wholes, plus, add, altogether, more, ‘is equal to’, ‘is the same as’.

# PROGRESSION THROUGH CALCULATIONS FOR ADDITION

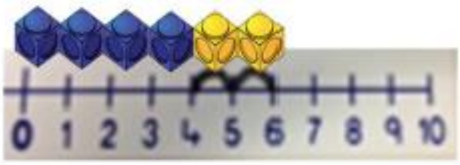
Children are encouraged to develop a mental picture of the number system in their heads to use for calculation.

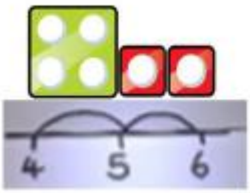
- Combining two parts to make a whole (use other resources too e.g. shells, teddy bears, cars etc.)

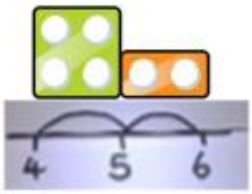




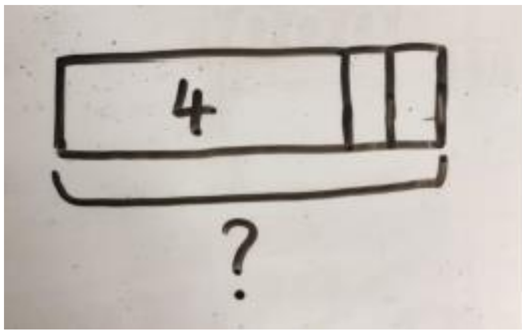
- Counting on using numberlines in concrete form involve multilink or Numicon.



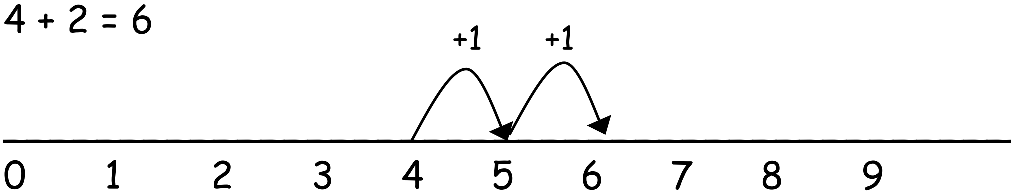




The Bar Model is a pictorial form which helps to count on.



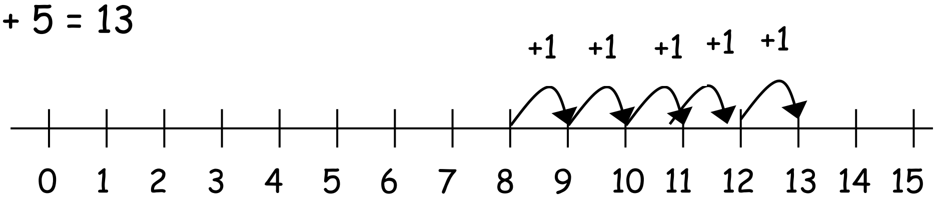

- These lead into the abstract number line form.

4 + 2 = 6

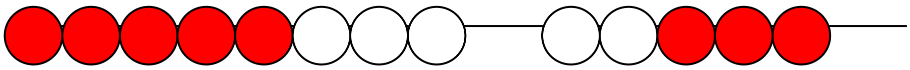



- Children then begin to use numbered lines to support their own calculations using a numbered line to count on in ones.

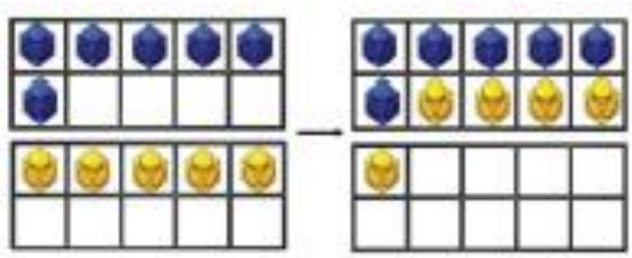
8 + 5 = 13

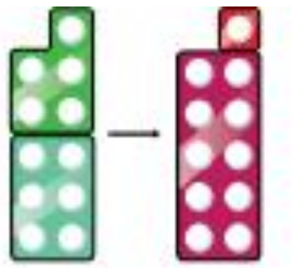


- Bead strings or bead bars can be used to illustrate addition including bridging through ten by counting on 2 then counting on 3.

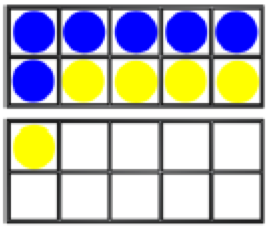


- Regrouping to make 10; using ten frames and counters/cubes or using Numicon.





- Children to draw the ten frame and counters/cubes.



Children to develop an understanding of equality e.g.

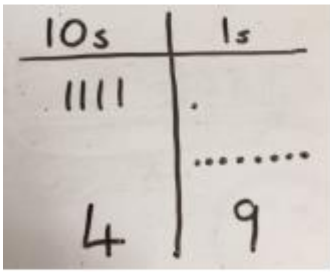
$$6 + \square = 11$$
$$6 + 5 = 5 + \square$$
$$6 + 5 = \square + 4$$

- T= Tens; O= Ones (units)

TO + O using base 10. Continue to develop understanding of partitioning and place value using concrete equipment.

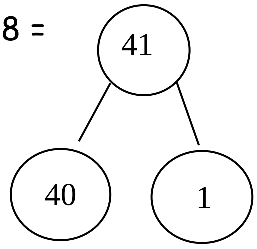
41 + 8

Children to represent the base 10 e.g. lines for tens and dot/ crosses for ones in a pictorial form.



- An understanding of partitioning underpins the abstract formal written method.

41 + 8 =

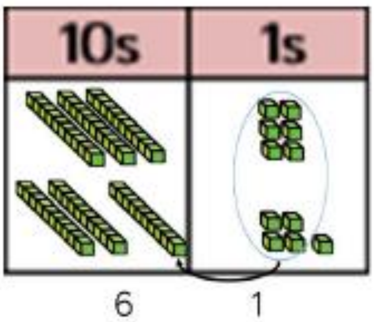


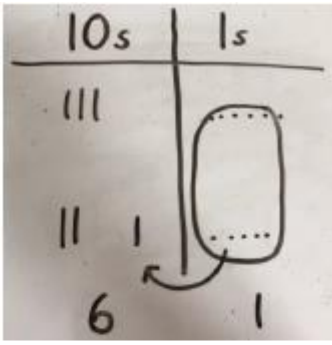

1 + 8 = 9
40 + 9 = 49

$$\begin{array}{r} 41 \\ +\ \ 9 \\ \hline \\ \hline \end{array}$$

- TO + TO using base 10. Continue to develop understanding of partitioning and place value.

Children look for ways to make 10.




36 + 25=

1 5

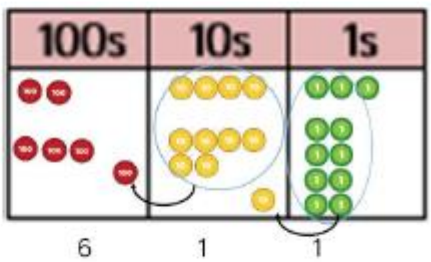
30 + 20 = 50
5 + 5 = 10
50 + 10 + 1 = 61

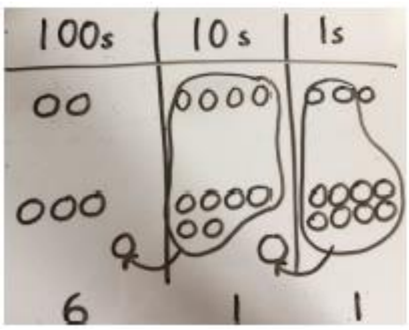
Formal method:

$$\begin{array}{r} 36 \\ +25 \\ \hline 61 \\ \hline {\scriptstyle 1} \end{array}$$

- Use of place value counters to add HTO + TO, HTO + HTO etc. When there are 10 ones in the 1s column- we exchange for 1 ten, when there are 10 tens in the 10s column- we exchange for 1 hundred.

Children to represent the counters in a place value chart, circling when they make an exchange.




$$\begin{array}{r} 243 \\ +368 \\ \hline 611 \\ \hline 1\ \ 1\ \ \end{array}$$

Questions to be asked in a variety of ways to develop conceptual understanding.

- Front **end method** - Adding most significant digits first, then moving to adding least significant digits.

$$\begin{array}{rl} 67 & \\ +\ 24 & \\ \hline 80 & (60 + 20) \\ 11 & (\ 7 + \ 4) \\ \hline 91 & \\ \hline \end{array}$$

$$\begin{array}{rl} 267 & \\ +\ 85 & \\ \hline 200 & \\ 140 & (60 + 80) \\ 12 & (\ 7 + \ \ 5) \\ \hline 352 & \\ \hline \end{array}$$

- Moving to adding the least significant digits first in preparation for 'carrying'.

$$\begin{array}{rl} 67 & \\ +\ 24 & \\ \hline 11 & (\ 7 + \ \ 4) \\ 80 & (60 + 20) \\ \hline 91 & \\ \hline \end{array} \qquad\qquad \begin{array}{rl} 267 & \\ +\ 85 & \\ \hline 12 & (\ 7\ +\ 5) \\ 140 & (60 + 80) \\ \underline{200} & \\ \underline{352} & \end{array}$$

- Carrying

789 + 642 becomes

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

Answer: 1431

# PROGRESSION THROUGH CALCULATIONS FOR SUBTRACTION

## MENTAL CALCULATIONS

**Mental recall of addition and subtraction facts**

| | |
|---|---|
| 10 – 6 = 4 | 17 - □ = 11 |
| 20 - 17 = 3 | 10 - □ = 2 |

**Find a small difference by counting up**

82 – 79 = 3

**Counting on or back in repeated steps of 1, 10, 100, 1000**

86 - 52 = 34 (by counting back in tens and then in ones)

460 - 300 = 160 (by counting back in hundreds)

**Subtract the nearest multiple of 10, 100 and 1000 and adjust**

24 - 19 = 24 - 20 + 1 = 5

458 - 71 = 458 - 70 - 1 = 387

**Use the relationship between addition and subtraction**

| | |
|---|---|
| 36 + 19 = 55 | 19 + 36 = 55 |
| 55 – 19 = 36 | 55 – 36 = 19 |

***MANY MENTAL CALCULATION STRATEGIES WILL CONTINUE TO BE USED. THEY ARE NOT REPLACED BY WRITTEN METHODS.***

**Key Language:**

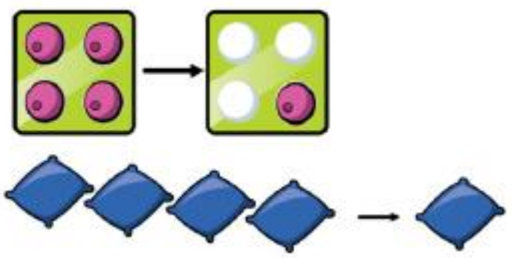
take away, less than, the difference, subtract, minus, fewer, decrease.

# PROGRESSION THROUGH CALCULATIONS FOR SUBTRACTION

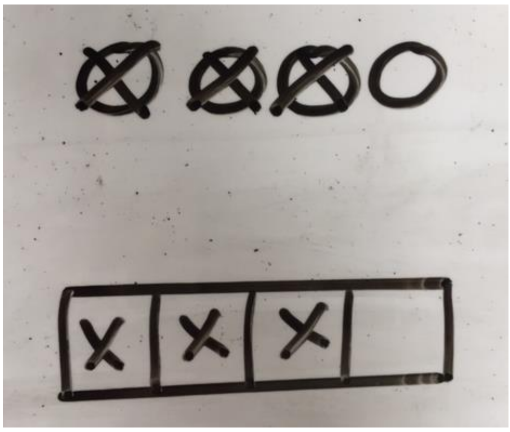
Children are encouraged to develop a mental picture of the number system in their heads to use for calculation.

- Physically taking away and removing objects from a whole (ten frames, Numicon, cubes and other items such as beanbags could be used).

**4 – 3 = 1**



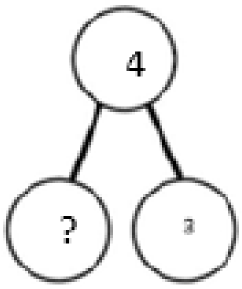
Children to draw the concrete resources they are using and cross out the correct amount. The bar model can also be used.



4- 3 =

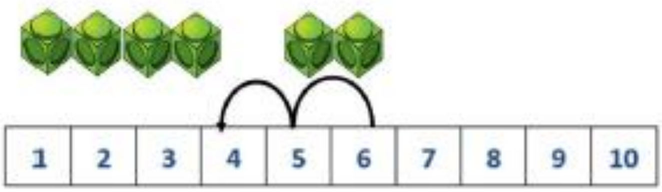
$\square$ = 4 - 3

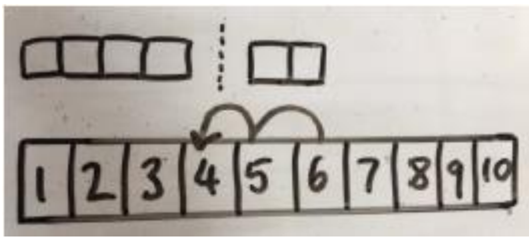
| 4 | |
|---|---|
| 3 | ? |



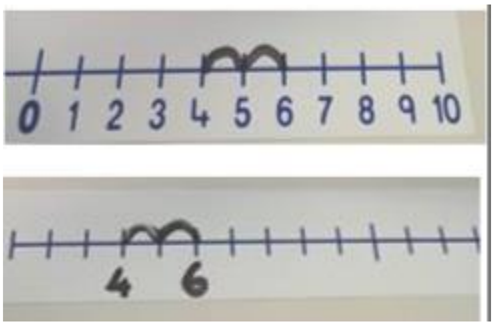

- Counting back (using number lines or number tracks) children start with 6 and count back 2.

Children represent this pictorially.

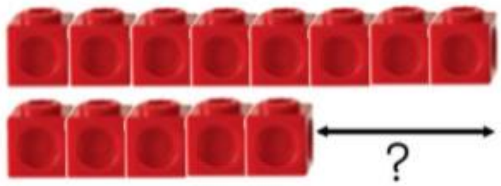


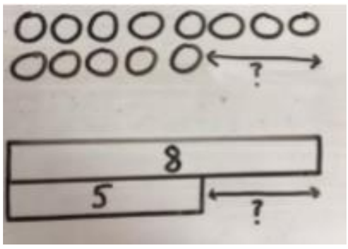
- Children then begin to use numbered lines to support their own calculations using a numbered line to count back in ones. Encourage use of empty numberlines.




- Finding the difference (using cubes, Numicon or Cuisenaire rods, other objects can also be used).
  Calculate the difference between 8 and 5.




- Children to draw the cubes/other concrete objects which they have used or use the bar model to illustrate what they need to calculate.



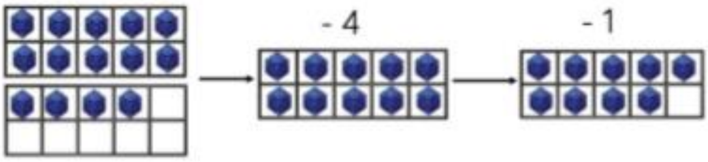

- Find the difference between 8 and 5.

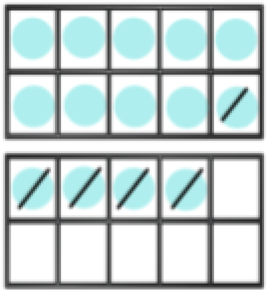
  8 – 5, the difference is $\square$

  Children to explore why 9 - 6 = 8 – 5 = 7 – 4 have the same difference.

- Making 10 using ten frames.
  14 - 5

Children to present the ten frame pictorially and discuss what they did to make 10.



- Children to show how they can make 10 by partitioning the subtraction number.

14 – 5 = 9

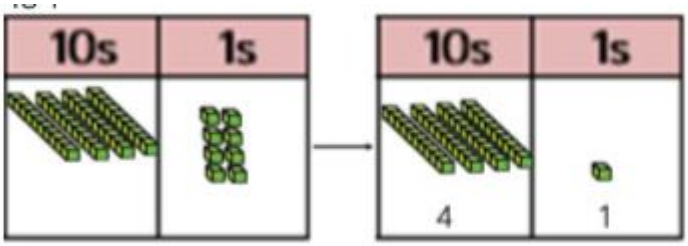
4 1

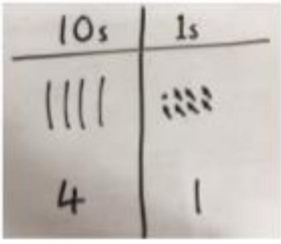
14 – 4 = 10

10 – 1 = 9

- Column method using base 10.
  48 – 7

Children to represent the base 10 pictorially.



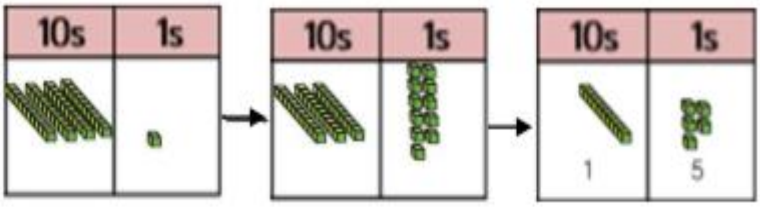



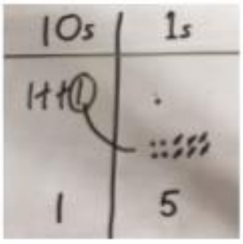

- Column method or children could count back 7.

$$\begin{array}{r} 48 \\ -\ \ 7 \\ \hline 41 \\ \hline \end{array}$$

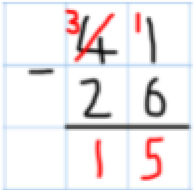
- Column method using base 10 and having to exchange.
  41 – 26

Pictorial representation

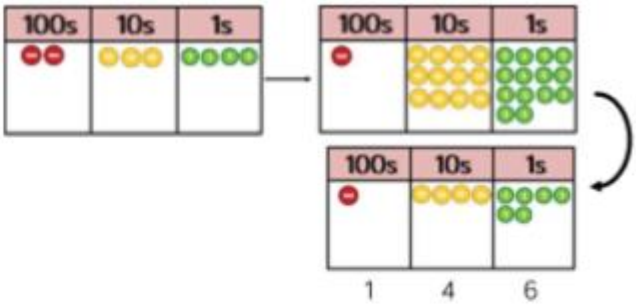


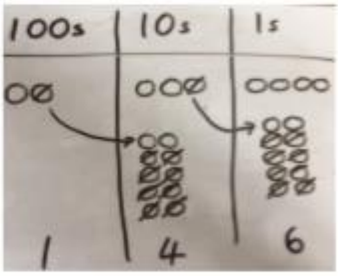
- Formal column method. Children must understand that when they have exchanged the 10 they still have 41 because 41 = 30 + 11.



- Column method using place value counters.




Pictorial method shows exchange.




- Formal column method. Children must understand what has happened when they have crossed out digits.

$$\begin{array}{rccc} & 1 & 12 & 1 \\ & \cancel{2} & \cancel{3} & 4 \\ - & & 8 & 8 \\ \hline & 1 & 4 & 6 \\ \hline \end{array}$$

- From this the children will begin to exchange. (Year 3)

$$\begin{array}{r} 71 \\ \underline{-\ 46} \end{array} \quad =$$

Step 1

$$\begin{array}{rcrcr} & 70 & + & 1 \\ - & \underline{40} & \underline{+} & \underline{6} \end{array}$$

Step 2

$$\begin{array}{rcrcrcl} & 60 & + & 11 & & \\ - & \underline{40} & \underline{+} & \underline{6} & & \\ & 20 & + & 5 & = & 25 \end{array}$$

The calculation should be read as e.g. take 6 from 1.

This would be recorded by the children as

$$\begin{array}{rcrcrcl} & \overset{60}{\cancel{70}} & + & {}^{1}1 & & \\ - & \underline{40} & \underline{+} & \underline{6} & & \\ & 20 & + & 5 & = & 25 \end{array}$$

- Partitioning and decomposition (Year 4)

$$\begin{array}{r} 754 \\ -\ \ 86 \\ \hline \end{array} \quad =$$

Step 1
$$\begin{array}{rrrrrr} & 700 & + & 50 & + & 4 \\ - & & & 80 & + & 6 \\ \hline \end{array}$$

Step 2
$$\begin{array}{rrrrrr} & 700 & + & 40 & + & 14 \\ - & & & 80 & + & 6 \\ \hline \end{array}$$ *(adjust from T to O)*

Step 3
$$\begin{array}{rrrrrrrr} & 600 & + & 140 & + & 14 & & \\ - & & & 80 & + & 6 & & \\ \hline & 600 & + & 60 & + & 8 & = & 668 \end{array}$$ *(adjust from H to T)*

This would be recorded by the children as

$$\begin{array}{rrrrrrrr} & \overset{600}{\cancel{700}} & + & \overset{140}{\cancel{50}} & + & {}^{1}4 & & \\ - & & & 80 & + & 6 & & \\ \hline & 600 & + & 60 & + & 8 & = & 668 \end{array}$$

- To know that decimal points should line up under each other. (Year 5)

*For example:*

$$\begin{array}{rcrrrrrr} £8.95 & = & & 8 & + & 0.9 & + & 0.05 \\ -£4.38 & & - & 4 & + & 0.3 & + & 0.08 \\ \hline \end{array}$$

leading to

$$\begin{array}{rrrrrrr} = & & 8 & + & 0.8 & + & 0.15 \\ & - & 4 & + & 0.3 & + & 0.08 \\ \hline & & 4 & + & 0.5 & + & 0.07 \end{array}$$ *(adjust from T to U)*

$$\begin{array}{r} {}^{1} \\ 8.85 \\ -\ 4.38 \\ \hline \end{array}$$

= £4.57

Alternatively, children can set the amounts to whole numbers, i.e. 895 – 438 and convert to pounds after the calculation.

- Decomposition (Year 6)

874 – 523 becomes

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

Answer: 351

932 – 457 becomes

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

Answer: 475

932 – 457 becomes

$$\begin{array}{rrrr} & 9 & \overset{1}{3} & \overset{1}{2} \\ - & \underset{5}{\cancel{4}} & \underset{6}{\cancel{5}} & 7 \\ \hline & 4 & 7 & 5 \\ \hline \end{array}$$

Answer: 475

# PROGRESSION THROUGH CALCULATIONS FOR MULTIPLICATION

## MENTAL CALCULATIONS

**Doubling and halving**
Applying the knowledge of doubles and halves to known facts.
e.g. 8 x 4 is double 4 x 4

**Using multiplication facts**

***Tables should be taught weekly from Y2 onwards, either as part of the mental oral starter or other times as appropriate within the day.***

| | | | |
|---|---|---|---|
| Year 1 | 2 times table | Year 2 | 2 times table |
| | 5 times table | | 3 times table |
| | 10 times table | | 4 times table |
| | | | 5 times table |
| | | | 6 times table |
| | | | 10 times table |

Year 3 & 4 Derive and recall quickly all multiplication facts up to 12 x 12

Years 5 & 6 Use and apply all multiplication and division facts up to 12 x 12.

**Using and applying division facts**
Children should be able to utilise their tables knowledge to derive other facts.
e.g. If I know 3 x 7 = 21, what else do I know?
30 x 7 = 210, 300 x 7 = 2100, 3000 x 7 = 21 000, 0.3 x 7 = 2.1 etc

**Use closely related facts already known**
13 x 11 = (13 x 10) + (13 x 1)
= 130 + 13
= 143

**Multiplying by 10 or 100**
Knowing that the effect of multiplying by 10 is a shift in the digits one place to the left.
Knowing that the effect of multiplying by 100 is a shift in the digits two places to the left.

**Partitioning**
23 x 4 = (20 x 4) + (3 x 4)
= 80 + 12
= 102

**Use of factors**
$8 \times 12 = 8 \times 4 \times 3$

*MANY MENTAL CALCULATION STRATEGIES WILL CONTINUE TO BE USED. THEY ARE NOT REPLACED BY WRITTEN METHODS.*

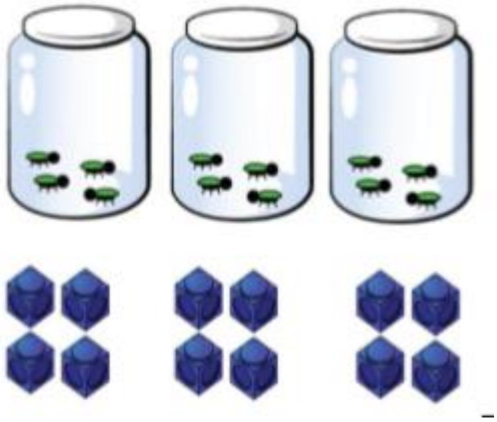
**Key Language:**
double, times, multiplied by, the product of, groups of, lots of, equal groups

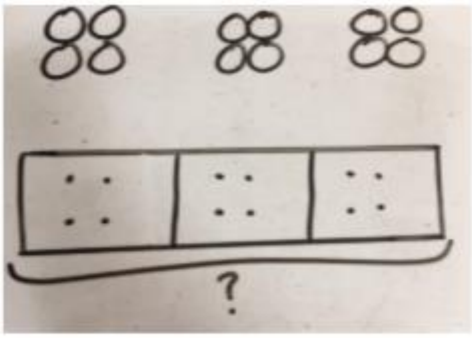
**PROGRESSION THROUGH CALCULATIONS FOR MULTIPLICATION**

- Repeated grouping/repeated addition

  3 × 4

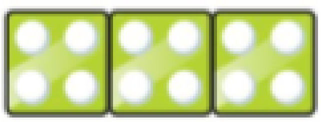
  4 + 4 + 4 There are 3 equal groups, with 4 in each group.

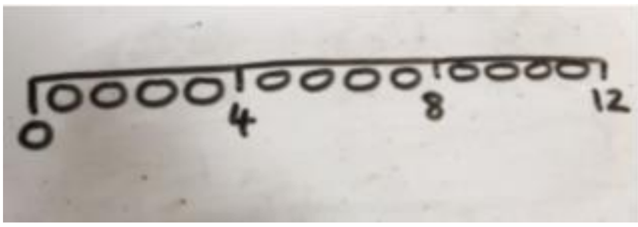





- Use numberlines to show repeated groups

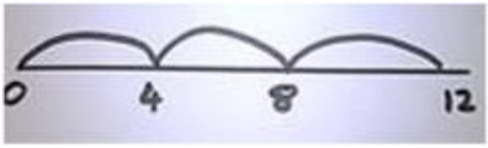
  Concrete Pictorial





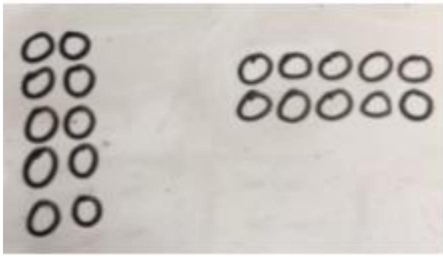

Cuisenaire Rods can be used as well

- Abstact number line show 3 jumps of 4
  3 x 4 = 12




- Use arrays to illustrate commutativity counters and other objects can also be used.
  2 × 5 = 5 × 2

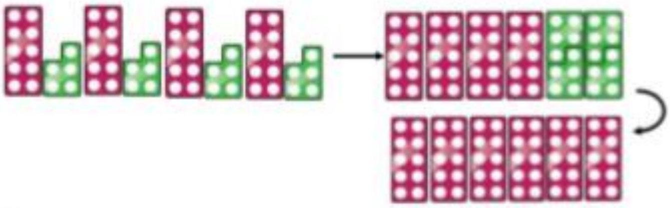
2 lots of 5    5 lots of 2

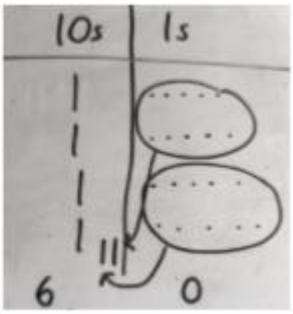


- Children to be able to use an array to write a range of calculations e.g.

  10 = 2 x 5
  2 x 5 = 10
  2 + 2 + 2 + 2 + 2 = 10
  10 = 5 + 5

- Partition to multiply using Numicon, base 10 or Cuisenaire rods.
  4 × 15



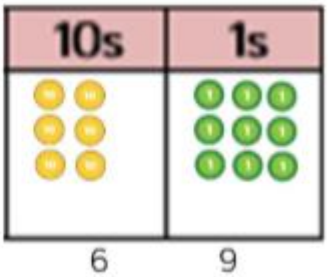


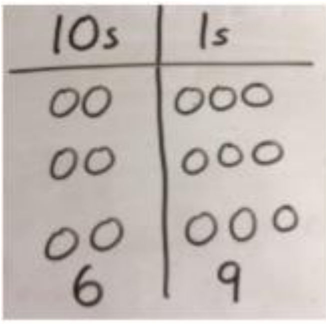

4 x 15 =

10    5

4 x 10 = 40
5 x 4 = 20
40 + 20 = 60

- Formal column method with place value counters (base 10 can also be used.)
  3 × 23



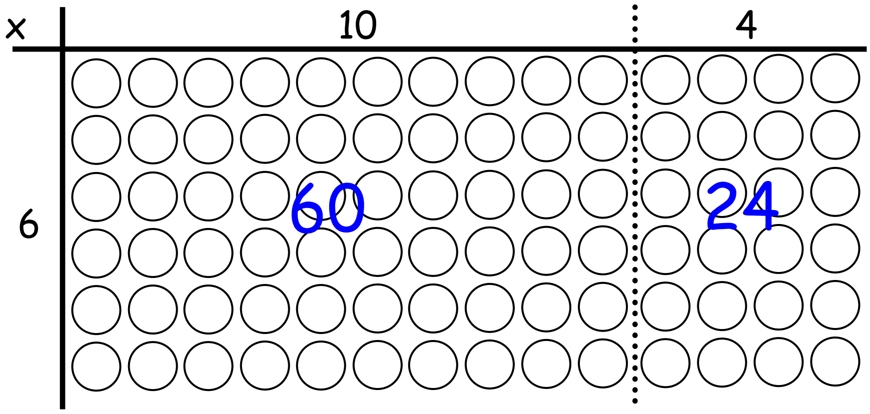




3 x 23
20 3

3 x 20 = 60
3 x 3 = 9
60 + 9 = 69

$$\begin{array}{r} 23 \\ \times\ \ 3 \\ \hline 69 \\ \hline \end{array}$$

- Children will continue to use arrays where appropriate leading into the grid method

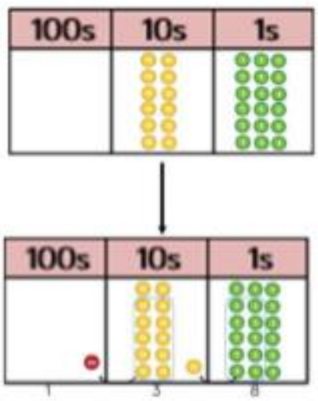


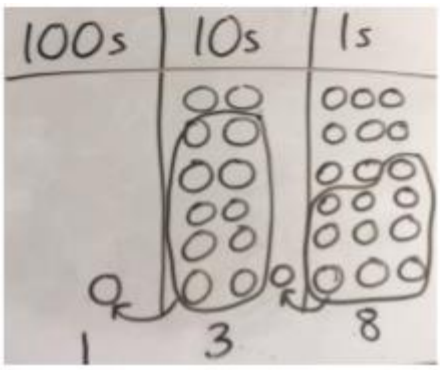

(6 x 10) + (6 x 4)

60 + 24

84

- Short multiplication – (multiplication by a single digit **TO x O)**
  23 x 6




6 x 23 =

$$\begin{array}{r} 23 \\ \times\ \ 6 \\ \hline 138 \\ \hline {}_{1\ 1} \end{array}$$

Children will approximate first
23 x 6 is approximately 25 x 6 = 150

| | | | | | |
|---|---|---|---|---|---|
| x | 20 | 3 | | | |
| 6 | 120 | 18 | | | 120 |
| | | | | | + 18 |
| | | | | | 138 |

- Short multiplication – (multiplication by a single digit **HTO x O)**
  346 x 9

  Children will approximate first
  346 x 9 is approximately 350 x 10 = 3500

| | | | | | | |
|---|---|---|---|---|---|---|
| x | 300 | 40 | 6 | | | |
| 9 | 2700 | 360 | 54 | | | 2700 |
| | | | | | | + 360 |
| | | | | | | + 54 |
| | | | | | | 3114 |

1 1

- Long multiplication – (multiplication by more than a single digit **TO x TO**)
  72 x 38
  Children will approximate first
  72 x 38 is approximately 70 x 40 = 2800

| | | | | | |
|---|---|---|---|---|---|
| x | 70 | 2 | | | |
| 30 | 2100 | 60 | | | 2100 |
| 8 | 560 | 16 | | | + 560 |
| | | | | | + 60 |
| | | | | | + 16 |
| | | | | | 2736 |

1

*Using similar methods, they will be able to multiply decimals with one decimal place by a single digit number, approximating first. They should know that the decimal points line up under each other.*

e.g. 4.9 x 3
Children will approximate first
4.9 x 3 is approximately 5 x 3 = 15

| x | 4 | 0.9 | | | |
|---|---|---|---|---|---|
| 3 | 12 | 2.7 | | | 12 |
| | | | | | + 2.7 |
| | | | | | 14.7 |

**Short multiplication**

24 × 6 becomes

| | | | |
|---|---|---|---|
| | | 2 | 4 |
| × | | | 6 |
| | 1 | 4 | 4 |
| | | 2 | |

Answer: 144

342 × 7 becomes

| | | | | |
|---|---|---|---|---|
| | | 3 | 4 | 2 |
| × | | | | 7 |
| | 2 | 3 | 9 | 4 |
| | | 2 | 1 | |

Answer: 2394

2741 × 6 becomes

| | | | | | |
|---|---|---|---|---|---|
| | | 2 | 7 | 4 | 1 |
| × | | | | | 6 |
| | 1 | 6 | 4 | 4 | 6 |
| | | 4 | 2 | | |

Answer: 16 446

**Long multiplication**

24 × 16 becomes

| | | | |
|---|---|---|---|
| | | 2 | |
| | | 2 | 4 |
| × | | 1 | 6 |
| | 2 | 4 | 0 |
| | 1 | 4 | 4 |
| | 3 | 8 | 4 |

Answer: 384

124 × 26 becomes

| | | | | |
|---|---|---|---|---|
| | | 1 | 2 | |
| | | 1 | 2 | 4 |
| × | | | 2 | 6 |
| | 2 | 4 | 8 | 0 |
| | | 7 | 4 | 4 |
| | 3 | 2 | 2 | 4 |
| | 1 | 1 | | |

Answer: 3224

124 × 26 becomes

| | | | | |
|---|---|---|---|---|
| | | 1 | 2 | |
| | | 1 | 2 | 4 |
| × | | | 2 | 6 |
| | | 7 | 4 | 4 |
| | 2 | 4 | 8 | 0 |
| | 3 | 2 | 2 | 4 |
| | 1 | 1 | | |

Answer: 3224

# PROGRESSION THROUGH CALCULATIONS FOR DIVISION

## MENTAL CALCULATIONS

**Doubling and halving**
Knowing that halving is dividing by 2

**Deriving and recalling division facts**

| | |
|---|---|
| Year 2 | Recall and use multiplication and division facts for the 2, 5 and 10 multiplication tables, including recognising odd and even numbers. |
| Year 3 | Recall and use multiplication and division facts for the 3, 4 and 8 multiplication tables. |
| Year 4,5 & 6 | Derive and recall quickly division facts for all tables up to 12 x 12 |

**Using and applying division facts**
Children should be able to utilise their tables knowledge to derive other facts.
e.g. If I know 3 x 7 = 21, what else do I know?
30 x 7 = 210, 300 x 7 = 2100, 3000 x 7 = 21 000, 0.3 x 7 = 2.1 etc

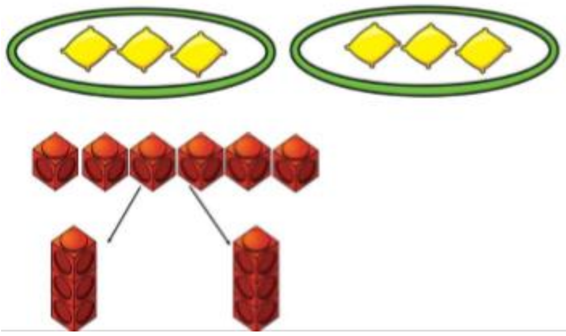
**Dividing by 10 or 100**
Knowing that the effect of dividing by 10 is a shift in the digits one place to the right.
Knowing that the effect of dividing by 100 is a shift in the digits two places to the right.

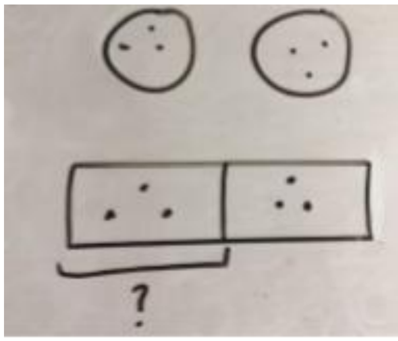
**Use of factors**
378 ÷ 21    378 ÷ 3 = 126    378 ÷ 21 = 18    126 ÷ 7 = 18
**Use related facts**
Given that 1.4 x 1.1 = 1.54
What is 1.54 ÷ 1.4, or 1.54 ÷ 1.1?

**Key Language:**
share, group, divide, divided by, half

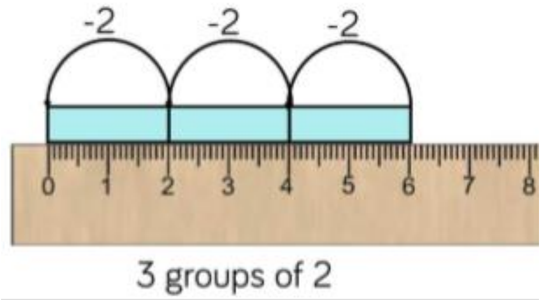
# PROGRESSION THROUGH CALCULATIONS FOR DIVISION

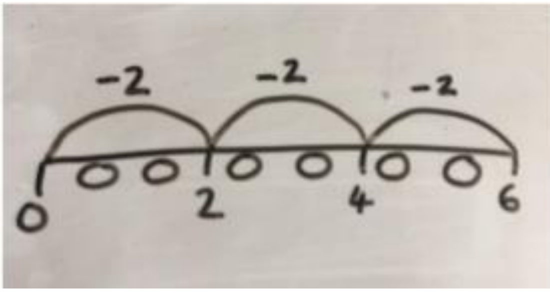
- Sharing using a range of objects. 6 ÷ 3



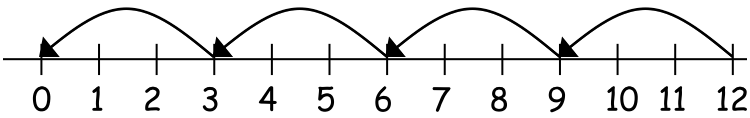


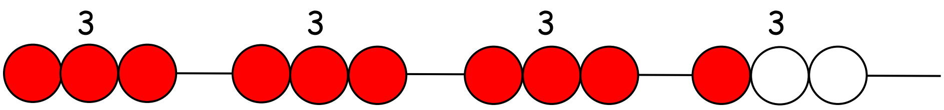

- Repeated subtraction using Cuisenaire rods above a ruler.  6 ÷ 3




- Repeated subtraction using a number line or bead bar.  12 ÷ 3 = 4



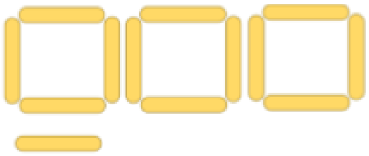

The bead bar will help children with interpreting division calculations such as 10 ÷ 5 as 'how many 5s make 10?'

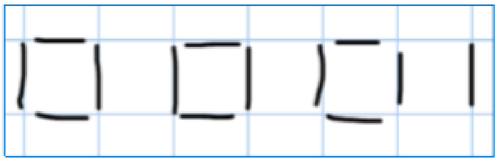
- Using symbols to stand for unknown numbers to complete equations using inverse operations

☐ ÷ 2 = 4        20 ÷ △ = 4        ☐ ÷ △ = 4

- TO ÷ O with remainders using lollipop sticks. Cuisenaire rods, above a ruler can also be used.

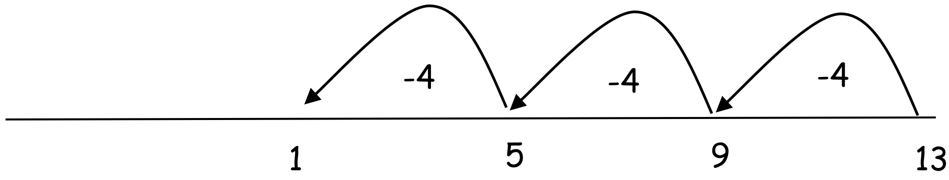
13 ÷ 4  Use of lollipop sticks to form wholes- squares are made because we are dividing by 4.



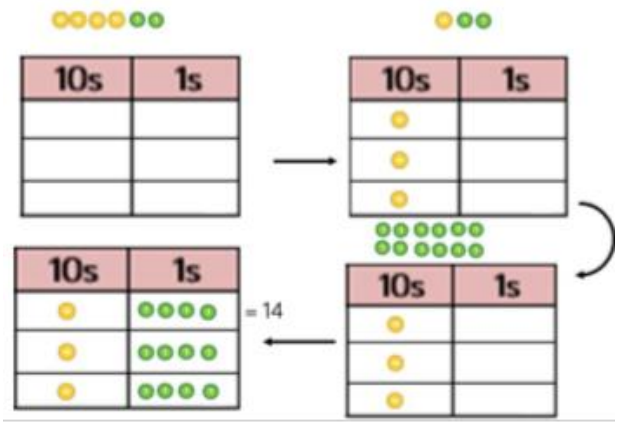


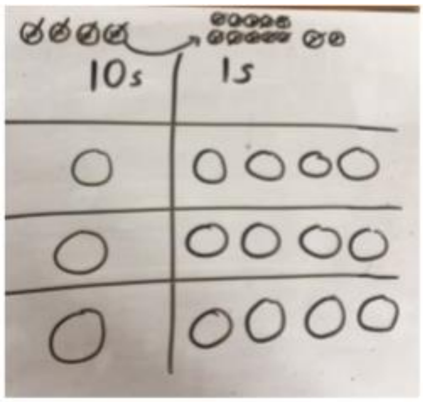
13 ÷ 4 = 3 r 1

- Children should be encouraged to use their times table facts; they could also represent repeated addition on a number line.
  '3 groups of 4, with 1 left over'




- Sharing using place value counters. 42 ÷ 3 = 14

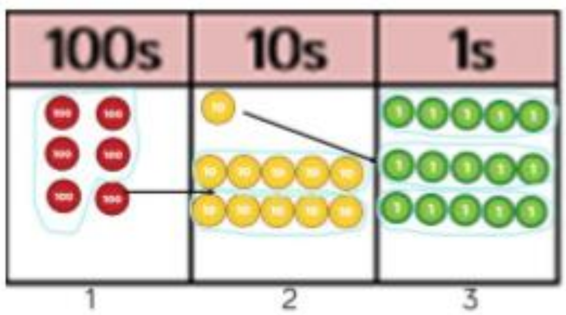


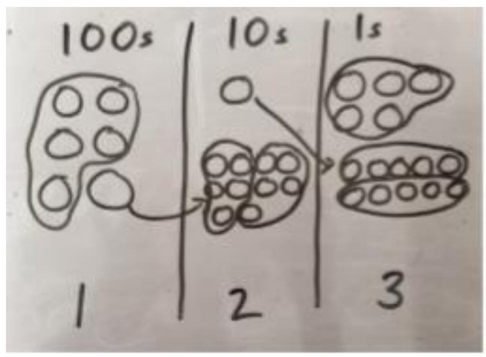




42 ÷ 3

42 = 30 + 12        30 ÷ 3 = 10        12 ÷ 3 = 4        10 + 4 = 14

- Short division using place value counters to group. 615 ÷ 5



1. Make 615 with place value counters.
2. How many groups of 5 hundred can you make with 6 hundred counters?
3. Exchange 1 hundred for 10 tens.
4. How many groups of 5 tens can you make with 11 ten counters?
5. Exchange 1 ten for 10 ones.
6. How many groups of 5 ones can you make with 15 ones?

$$\begin{array}{r} 123 \\ 5\overline{)6\,{}^{1}1\,{}^{1}5} \end{array}$$

Children to the calculation using the short division scaffold.

- Vertical method: **Short division TO ÷ O**

72 ÷ 3

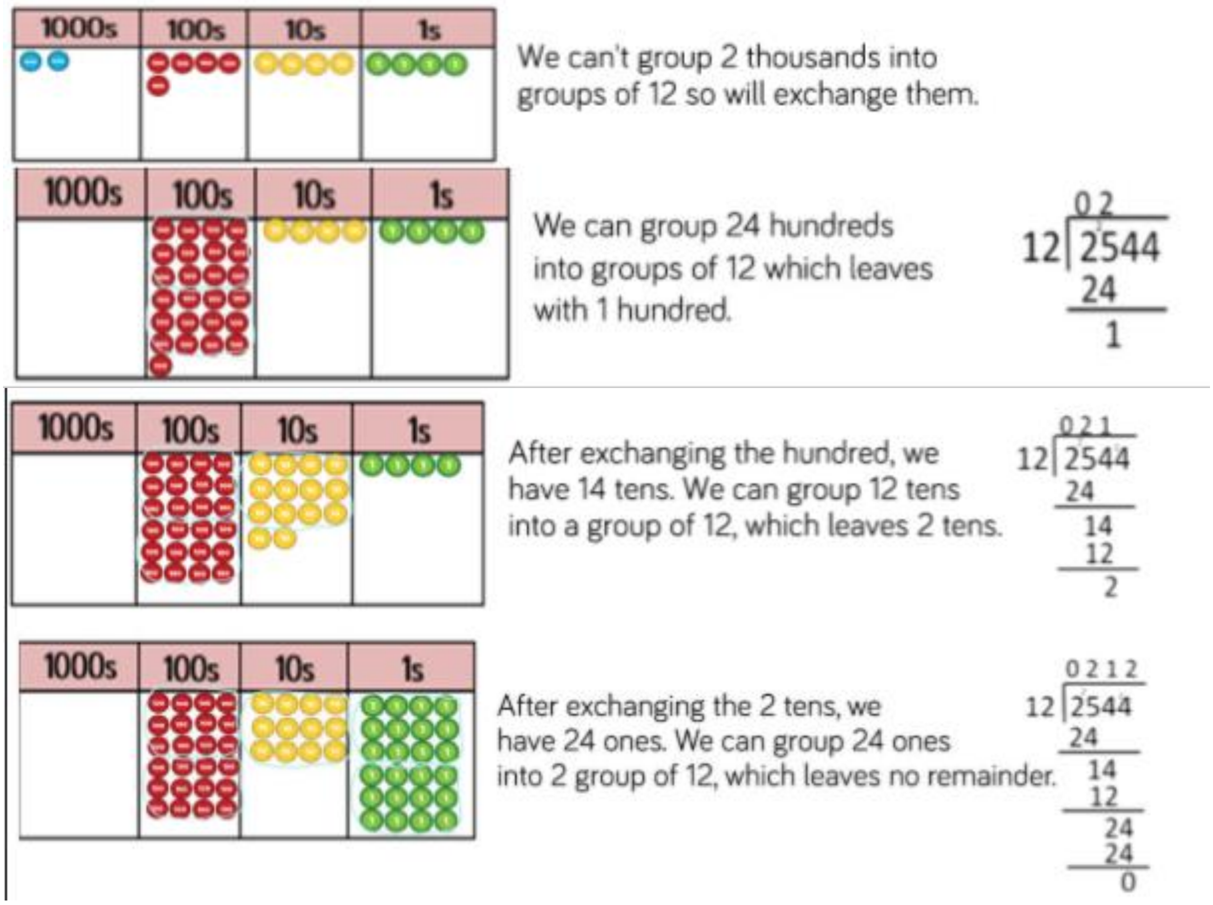
```
3 ) 72
  -  30     10x
     42
  -  30     10x
     12
  -   6      2x
      6
  -   6      2x
      0
Answer :    24
```

- Children need to be able to decide what to do after division and round up or down accordingly. They should make sensible decisions about rounding up or down after division. For example 62 ÷ 8 is 7 remainder 6, but whether the answer should be rounded up to 8 or rounded down to 7 depends on the context.

e.g. I have 62p. Sweets are 8p each. How many can I buy?
Answer: 7 (the remaining 6p is not enough to buy another sweet)

Apples are packed into boxes of 8. There are 62 apples. How many boxes are needed?
Answer: 8 (the remaining 6 apples still need to be placed into a box)

- Long division using place value counters 2544 ÷ 12




2544 ÷ 12

```
        0212
12 )  2544
     - 2400      200x
        144
     -  120       10x
         24
         24  ↓     2x
          0
     Answer :     212
```

- Any remainders should be shown as fractions, i.e. if the children were dividing 32 by 10, the answer should be shown as $3\ ^{2}/_{10}$ which could then be written as $3\ ^{1}/_{5}$ in it's lowest terms.

- Extend to decimals with up to two decimal places. Children should know that decimal points line up under each other.
  87.5 ÷ 7

```
        12.5
   7 )  87.5
      -  70.0     10x
         17.5
      -  14.0      2x
          3.5
      -   3.5      0.5x
            0
```

Answer : 12.5

- NC Appendix 1

432 ÷ 15 becomes

```
          2  8  r 12
 1  5 | 4  3  2
        3  0  0
        1  3  2
        1  2  0
           1  2
```

Answer: 28 remainder 12

432 ÷ 15 becomes

```
          2  8
 1  5 | 4  3  2
        3  0  0    15×20
        1  3  2
        1  2  0    15×8
           1  2
```

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

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

432 ÷ 15 becomes

```
          2  8 · 8
 1  5 | 4  3  2 · 0
        3  0
        1  3  2
        1  2  0
           1  2  0
           1  2  0
                 0
```

Answer: 28·8

**By the end of Year 6, children will have a range of calculation methods, mental and written. Selection will depend upon the numbers involved.**

**Children should not be made to go onto the next stage if:**

**1) they are not ready.**

**2) they are not confident.**

**Children should be encouraged to consider if a mental calculation would be appropriate before using written methods.**
**Children should be encouraged to approximate their answers before calculating.**
**Children should be encouraged to check their answers after calculation using an appropriate strategy.**