

Whole School Written Calculation Policy
Pencil and Paper Procedures
Key Stages 1 - 2
BSM
Summer 2008

Adopted from the Leicestershire Numeracy Team
Whole School Written Calculation Policy

Pencil and paper procedures

$$83 + 42 = 125$$

$$\begin{array}{r} 80 + 3 \\ +40 + 2 \\ \hline 120 + 5 = 125 \end{array}$$

$$\begin{array}{r} 83 \\ + 42 \\ \hline 120 \\ \quad 5 \\ \hline 125 \end{array}$$

$$\begin{array}{r} 83 \\ + 42 \\ \hline 120 \\ \quad 5 \\ \hline 125 \end{array}$$

Addition

Year 4

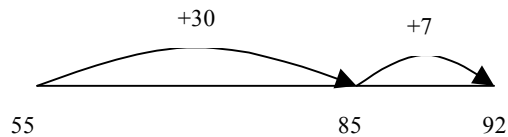
+ = signs and missing numbers

Continue using a range of equations as in Year 1 and 2 but with appropriate numbers.

Partition into tens and ones and recombine

Either partition both numbers and recombine or partition the second number only e.g.

$$\begin{aligned} 55 + 37 &= 55 + 30 + 7 \\ &= 85 + 7 \\ &= 92 \end{aligned}$$



Add the nearest multiple of 10, then adjust

Continue as in Year 2 and 3 but with appropriate numbers e.g. $63 + 29$ is the same as $63 + 30 - 1$

Year 5

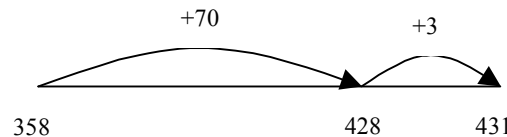
+ = signs and missing numbers

Continue using a range of equations as in Year 1 and 2 but with appropriate numbers.

Partition into hundreds, tens and ones and recombine

Either partition both numbers and recombine or partition the second number only e.g.

$$\begin{aligned} 358 + 73 &= 358 + 70 + 3 \\ &= 428 + 3 \\ &= 431 \end{aligned}$$



Add or subtract the nearest multiple of 10 or 100, then adjust

Continue as in Year 2, 3 and 4 but with appropriate numbers e.g. $458 + 79 =$ is the same as $458 + 80 - 1$

Year 6

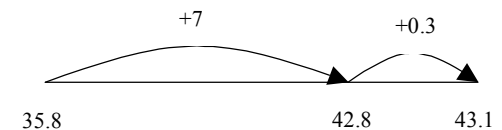
+ = signs and missing numbers

Continue using a range of equations as in Year 1 and 2 but with appropriate numbers.

Partition into hundreds, tens, ones and decimal fractions and recombine

Either partition both numbers and recombine or partition the second number only e.g.

$$\begin{aligned} 35.8 + 7.3 &= 35.8 + 7 + 0.3 \\ &= 42.8 + 0.3 \\ &= 43.1 \end{aligned}$$



Add the nearest multiple of 10, 100 or 1000, then adjust

Continue as in Year 2, 3, 4 and 5 but with appropriate numbers including extending to adding 0.9, 1.9, 2.9 etc

Pencil and paper procedures

$358 + 73 = 431$

$$\begin{array}{r} 300+50+ 8 \\ + \quad 70+ 3 \\ \hline 300+120+11 = 431 \\ \quad 11 \\ \quad 120 \\ \quad \underline{300} \\ \quad 431 \end{array}$$

Extend to decimals in the context of money (vertically)

$\text{£ } 2.50 + \text{£ } 1.75 = \text{£ } 4.25$

$$\begin{array}{r} \text{£ } 2.50 \\ + \text{£ } 1.75 \\ \hline \text{£ } 4.25 \\ \quad 1 \end{array}$$

More able

Show carried numbers underneath, but must ensure thorough understanding of reasons for carrying

$$\begin{array}{r} 358 \\ + 73 \\ \hline 431 \\ \quad 11 \end{array}$$

(Revert to expanded methods if the children experience any difficulty.)

Pencil and paper procedures

Leading to formal method, showing numbers carried underneath

$$\begin{array}{r} 358 \\ + 73 \\ \hline 431 \\ \quad 11 \end{array}$$

Extend to numbers with at least four digits

$3587 + 675 = 4262$

$$\begin{array}{r} 3587 \\ + 675 \\ \hline 4262 \\ \quad 111 \end{array}$$

Revert to expanded methods if the children experience any difficulty.

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

Pencil and paper procedures

Extend to numbers with any number of digits and decimals with 1 and 2 decimal places.

$124.9 + 117.25 = 242.15$

$$\begin{array}{r} 124.9 \\ + 117.25 \\ \hline 242.15 \\ \quad 11 \end{array}$$

Revert to expanded methods if the children experience any difficulty.

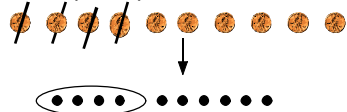
Extend to decimals (either one or two decimal places).

Subtraction

Year 1

Pictures / marks

Sam spent 4p. What was his change from 10p?

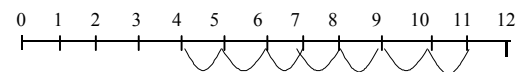


- = signs and missing numbers

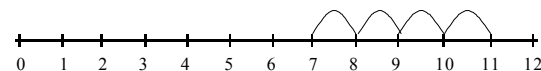
$$\begin{array}{ll} 7 - 3 = \square & \square = 7 - 3 \\ 7 - \square = 4 & 4 = \square - 3 \\ \square - 3 = 4 & 4 = 7 - \square \\ \square - \nabla = 4 & 4 = \square - \nabla \end{array}$$

Number lines (numbered)

11 - 7
(Counting back)



The difference between 7 and 11
(Counting up)



Recording by - drawing jumps on prepared lines
- constructing own lines

(Teachers model jottings appropriate for larger numbers)

Year 2

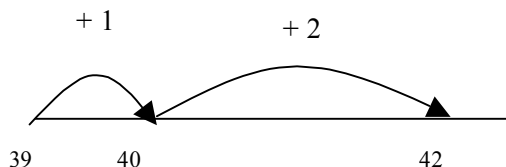
- = signs and missing numbers

Continue using a range of equations as in Year 1 but with appropriate numbers.

Extend to $14 + 5 = 20 - \square$

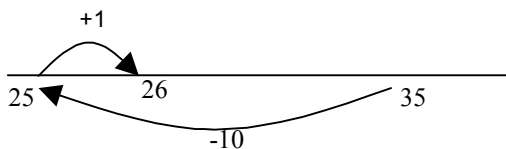
Find a small difference by counting up

$$42 - 39 = 3$$



Subtract 9 or 11. Begin to add/subtract 19 or 21

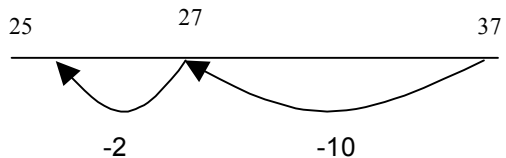
$$35 - 9 = 26$$



Use known number facts and place value to subtract

(partition second number only)

$$\begin{aligned} 37 - 12 &= 37 - 10 - 2 \\ &= 27 - 2 \\ &= 25 \end{aligned}$$



Year 3

- = signs and missing numbers

Continue using a range of equations as in Year and 2 but with appropriate numbers.

Find a small difference by counting up

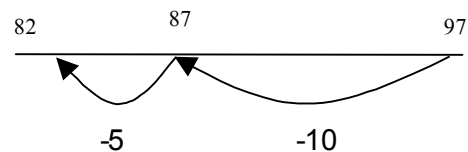
Continue as in Year 2 but with appropriate numbers
e.g. $102 - 97 = 5$

Subtract mentally a 'near multiple of 10' to or from a two-digit number

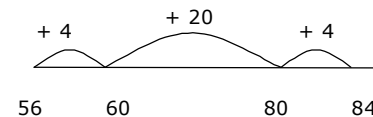
Continue as in Year 2 but with appropriate numbers
e.g. $78 - 49$ is the same as $78 - 50 + 1$

Use known number facts and place value to subtract

Continue as in Year 2 but with appropriate numbers
e.g.
 $97 - 15 = 72$



Complementary addition
 $84 - 56 = 28$



Subtraction

Year 4

- = signs and missing numbers

Continue using a range of equations as in Year 1 and 2 but with appropriate numbers.

Find a small difference by counting up

e.g. $5003 - 4996 = 7$

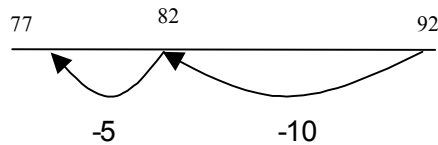
This can be modelled on an empty number line (see complementary addition below).

Subtract the nearest multiple of 10, then adjust.

Continue as in Year 2 and 3 but with appropriate numbers.

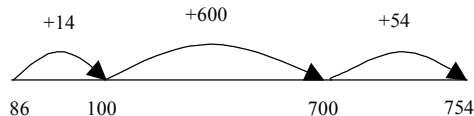
Use known number facts and place value to subtract

$92 - 15 = 77$



Complementary addition

$754 - 86 = 668$



Year 5

- = signs and missing numbers

Continue using a range of equations as in Year 1 and 2 but with appropriate numbers.

Find a difference by counting up

e.g. $8006 - 2993 = 5013$

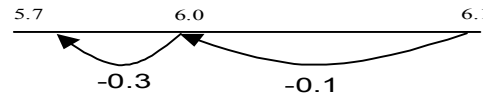
This can be modelled on an empty number line (see complementary addition below).

Subtract the nearest multiple of 10 or 100, then adjust.

Continue as in Year 2, 3 and 4 but with appropriate numbers.

Use known number facts and place value to subtract

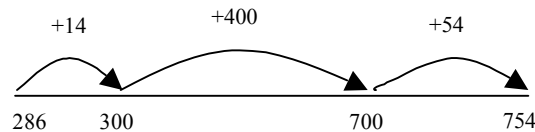
$6.1 - 0.4 = 5.7$



Pencil and paper procedures

Complementary addition

$754 - 286 = 468$



Pencil and paper procedures

Decomposition for more able children when really secure on number line

Year 6

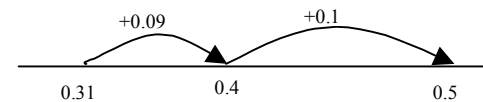
- = signs and missing numbers

Continue using a range of equations as in Year 1 and 2 but with appropriate numbers.

Find a difference by counting up

e.g. $0.5 - 0.31 = 0.19$

This can be modelled on an empty number line (see complementary addition below).



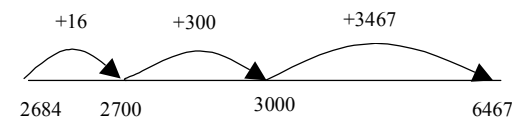
Subtract the nearest multiple of 10, 100 or 1000, then adjust

Continue as in Year 2, 3, 4 and 5 but with appropriate numbers.

Use known number facts and place value to subtract
Continue as year 5

Complementary addition

$6467 - 2684 = 3783$



Pencil and paper procedures

Decomposition when children are ready – less able may not be ready for this – it is preferable they are really secure with above method

$$\begin{array}{r} \overset{4}{5} \overset{15}{6} \overset{1}{1} \\ - 2 \ 8 \ 5 \\ \hline 2 \ 7 \ 6 \end{array}$$

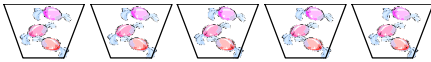
$$\begin{array}{r} \overset{4}{5} \overset{15}{6} \overset{1}{1} \\ - 2 \ 8 \ 5 \\ \hline 2 \ 7 \ 6 \end{array}$$

Multiplication

Year 1

Pictures and symbols

There are 3 sweets in one bag.
How many sweets are there in 5 bags?



(Recording on a number line modelled by the teacher when solving problems)

Year 2

x = signs and missing numbers

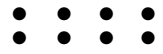
$$7 \times 2 = \square \quad \square = 2 \times 7$$

$$7 \times \square = 14 \quad 14 = \square \times 7$$

$$\square \times 2 = 14 \quad 14 = 2 \times \square$$

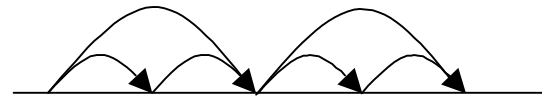
$$\square \times \nabla = 14 \quad 14 = \square \times \nabla$$

Arrays and repeated addition


 4×2 or $4 + 4$
 2×4

or repeated addition

$$2 + 2 + 2 + 2$$



0 1 2 3 4 5 6 7 8

Doubling multiples of 5 up to 50

$$15 \times 2 = 30$$

Partition

$$15 \times 2$$

$$\begin{array}{r} 10 \\ + 5 \\ \hline 20 + 10 = 30 \end{array}$$

OR

$$\begin{array}{r|l|l} x & 10 & 5 \\ \hline 2 & 20 & 10 \end{array}$$

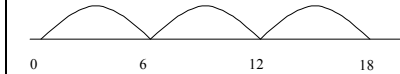
Year 3

x = signs and missing numbers

Continue using a range of equations as in Year 2 but with appropriate numbers.

Number lines

$$6 \times 3$$



Arrays and repeated addition

Continue to understand multiplication as repeated addition and continue to use arrays (as in Year 2).

Doubling multiples of 5 up to 50

$$35 \times 2 = 70$$

Partition

$$\begin{array}{r|l|l} x & 30 & 5 \\ \hline 2 & 60 & 10 \end{array}$$

Use known facts and place value to carry out simple multiplications

Use the same method as above (partitioning), e.g. $32 \times 3 = 96$

$$\begin{array}{r|l|l} x & 30 & 2 \\ \hline 3 & 90 & 6 \end{array}$$

Multiplication

| Year 4 | Year 5 | Year 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--------|--------|----|---|-----|----|---|----|---|----|------|----|---|-----|----|---|---|----|---|---|-----|----|----|-----|-----|----|---|----|----|------------|--------------|--------------------------------------|---|-----|----|---|----|------|------|----|---|------|-----|---|
| <p><u>x = signs and missing numbers</u> Continue using a range of equations as in Year 2 but with appropriate numbers</p> <p><u>Partition</u> 23 x 4 = 92</p> $23 \times 4 = (20 \times 4) + (3 \times 4)$ $= (80) + (12)$ $= 92$ <p style="text-align: center;">OR</p> <p>Use the grid method of multiplication (as below)</p> <p><u>Pencil and paper procedures</u></p> <p>Grid method 23 x 7 is approximately 20 x 10 = 200</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">x</td> <td style="border-right: 1px solid black; padding: 5px;">20</td> <td style="padding: 5px;">3</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">7</td> <td style="border-right: 1px solid black; padding: 5px;">140</td> <td style="padding: 5px;">21</td> </tr> </table> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">x</td> <td style="border-right: 1px solid black; padding: 5px;">70</td> <td style="padding: 5px;">2</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">30</td> <td style="border-right: 1px solid black; padding: 5px;">2100</td> <td style="padding: 5px;">60</td> </tr> <tr style="border-top: 1px solid black;"> <td style="border-right: 1px solid black; padding: 5px;">8</td> <td style="border-right: 1px solid black; padding: 5px;">560</td> <td style="padding: 5px;">16</td> </tr> </table> | x | 20 | 3 | 7 | 140 | 21 | x | 70 | 2 | 30 | 2100 | 60 | 8 | 560 | 16 | <p><u>x = signs and missing numbers</u> Continue using a range of equations as in Year 2 but with appropriate numbers</p> <p><u>Partition</u> 47 x 6 = 92</p> $47 \times 6 = (40 \times 6) + (7 \times 6)$ $= (240) + (42)$ $= 282$ <p style="text-align: center;">OR</p> <p>Use the grid method of multiplication (as below)</p> <p><u>Pencil and paper procedures</u></p> <p>TU x U - use grid method as below</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">x</td> <td style="border-right: 1px solid black; padding: 5px;">20</td> <td style="padding: 5px;">3</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">7</td> <td style="border-right: 1px solid black; padding: 5px;">140</td> <td style="padding: 5px;">21</td> </tr> </table> <p style="text-align: center;">OR for more able children with thorough knowledge of place value and tables, may move onto formal method involving carrying below</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="padding: 5px;">23</td> </tr> <tr> <td style="padding: 5px;">x 7</td> </tr> <tr style="border-top: 1px solid black;"> <td style="padding: 5px;">161</td> </tr> <tr> <td style="padding: 5px;">12</td> </tr> </table> | x | 20 | 3 | 7 | 140 | 21 | 23 | x 7 | 161 | 12 | <p><u>x = signs and missing numbers</u> Continue using a range of equations as in Year 2 but with appropriate numbers</p> <p><u>Partition</u> 87 x 6 = 522</p> $87 \times 6 = (80 \times 6) + (7 \times 6)$ $= (480) + (42)$ $= 522$ <p style="text-align: center;">OR</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="padding: 5px;">87</td> </tr> <tr> <td style="padding: 5px;">X6</td> </tr> <tr> <td style="padding: 5px;">42 (6 x 7)</td> </tr> <tr> <td style="padding: 5px;">480 (6 x 80)</td> </tr> <tr> <td style="padding: 5px;">522 (units, then tens, hundreds etc)</td> </tr> </table> <p style="text-align: center;">OR</p> <p>Use the grid method of multiplication</p> <p><u>Pencil and paper procedures</u></p> <p><u>Grid method</u></p> <p>372 x 24 is approximately 400 x 20 = 8000</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">x</td> <td style="border-right: 1px solid black; padding: 5px;">300</td> <td style="border-right: 1px solid black; padding: 5px;">70</td> <td style="padding: 5px;">2</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">20</td> <td style="border-right: 1px solid black; padding: 5px;">6000</td> <td style="border-right: 1px solid black; padding: 5px;">1400</td> <td style="padding: 5px;">40</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">4</td> <td style="border-right: 1px solid black; padding: 5px;">1200</td> <td style="border-right: 1px solid black; padding: 5px;">280</td> <td style="padding: 5px;">8</td> </tr> </table> | 87 | X6 | 42 (6 x 7) | 480 (6 x 80) | 522 (units, then tens, hundreds etc) | x | 300 | 70 | 2 | 20 | 6000 | 1400 | 40 | 4 | 1200 | 280 | 8 |
| x | 20 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 140 | 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| x | 70 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 2100 | 60 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | 560 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| x | 20 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | 140 | 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| x 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 161 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 87 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| X6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 (6 x 7) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 480 (6 x 80) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 522 (units, then tens, hundreds etc) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| x | 300 | 70 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | 6000 | 1400 | 40 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | 1200 | 280 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

And HTU x U

346 x 9 is approximately 350 x 10 = 3500

$$\begin{array}{r} 346 \\ \times 9 \\ \hline 3114 \\ 45 \\ \hline \end{array}$$

Grid method for TU x TU

72 x 38 is approximately 70 x 40 = 2800

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

Extend to simple decimals with one decimal place.

$$\begin{array}{r} 12.5 \\ \times 2 \\ \hline 1.0 \quad (2.0 \times 0.5) \\ 4.0 \quad (2.0 \times 2.0) \\ \hline 20.0 \quad (2.0 \times 10.0) \\ 25.0 \end{array}$$

Moving to formal methods of multiplication for decimals for more able, carrying numbers underneath.

Average and more able children with thorough knowledge of place value and tables, may move onto formal method of multiplying HTU by TU as shown below

$$\begin{array}{r} X \quad \quad \quad 5 \quad 6 \\ \quad \quad \quad \underline{2 \quad 7} \\ 1 \quad 1_1 \quad 2 \quad 0 \\ \quad \quad \quad \underline{3 \quad 9_4 \quad 2} \\ \hline 1 \quad 5 \quad 1 \quad 2 \\ 1 \end{array}$$

Extend to decimals with up to two decimal places.

$$\begin{array}{r} 12.5 \\ \times 2.5 \\ \hline 1.25 \quad (2.5 \times 0.5) \\ 5.0 \quad (2.5 \times 2.0) \\ \hline 25.0 \quad (2.5 \times 10.0) \\ 31.25 \end{array}$$

Moving to formal methods of multiplication for decimals. Carrying numbers underneath.

Division

Year 1

Pictures / marks

12 children get into teams of 4 to play a game.
How many teams are there?



Year 2

÷ = signs and missing numbers

$$6 \div 2 = \square \qquad \square = 6 \div 2$$

$$6 \div \square = 3 \qquad 3 = 6 \div \square$$

$$\square \div 2 = 3 \qquad 3 = \square \div 2$$

$$\square \div \nabla = 3 \qquad 3 = \square \div \nabla$$

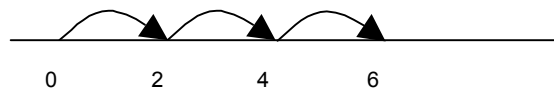
Understand division as sharing and grouping

Sharing – 6 sweets are shared between 2 people. How many do they have each?



$6 \div 2$ can be modelled as:

Grouping – There are 6 sweets. How many people can have 2 each? (How many 2's make 6?)



Year 3

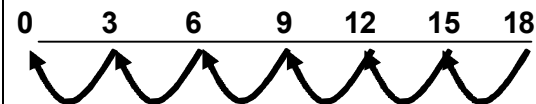
÷ = signs and missing numbers

Continue using a range of equations as in Year 2 but with appropriate numbers.

Understand division as sharing and grouping

$18 \div 3$ can be modelled as:
Sharing – 18 shared between 3 (see Year 2 diagram)

OR



Or

Grouping - How many 3's make 18?



Remainders

$16 \div 3 = 5 \text{ r}1$
Sharing - 16 shared between 3, how many left over?
Grouping – How many 3's make 16, how many left over?
e.g.



Division

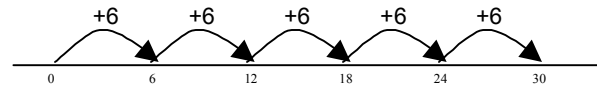
Year 4

÷ = signs and missing numbers

Continue using a range of equations as in Year 2 but with appropriate numbers.

Sharing and grouping

30 ÷ 6 can be modelled as:
grouping – groups of 6 taken away and the number of groups counted e.g.

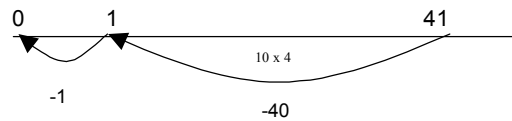


sharing – sharing among 6, the number given to each person

Remainders
 $41 \div 4 = 10 \text{ r}1$



OR



OR $41 = (10 \times 4) + 1$

Year 5

÷ = signs and missing numbers

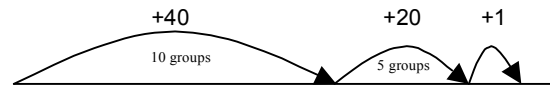
Continue using a range of equations as in Year 2 but with appropriate numbers.

Sharing and grouping

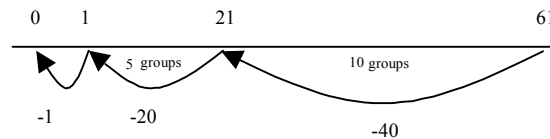
Continue to understand division as both sharing and grouping (repeated subtraction).

Remainders

Quotients expressed as fractions or decimal fractions
 $61 \div 4 = 15 \frac{1}{4}$ or 15.25



OR



Pencil and paper procedures

The more able Yr 5 children with a thorough understanding of place value and tables will be taught the more formal algorithm as shown below

$$\begin{array}{r} 141 \text{ R}5 \\ 7 \overline{) 929} \end{array}$$

Year 6

÷ = signs and missing numbers

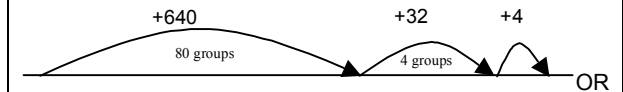
Continue using a range of equations as in Year 2 but with appropriate numbers.

Sharing and grouping

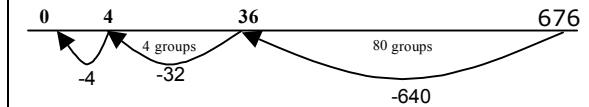
Continue to understand division as both sharing and grouping (repeated subtraction).

Remainders

Quotients expressed as fractions or decimal fractions
 $676 \div 8 = 84.5$



OR



Pencil and paper procedures

The average and more able children will be taught the more formal algorithm as shown below

$$\begin{array}{r} 141 \text{ R}5 \\ 7 \overline{) 929} \end{array}$$

The more able children will be taught a more formal method of long division for dividing HTU by TU

$$\begin{array}{r} \underline{21} \text{ r } 12 \\ 15 \overline{) 327} \\ \underline{- 30} \\ 27 \\ \underline{- 15} \\ 12 \end{array}$$

$$\begin{array}{r} 15 \quad 15 \\ \underline{\times 2} \quad \underline{\times 3} \\ 30 \quad 45 \end{array}$$