

The Romero Catholic Academy

Written Calculation

Policy





ENSURE ALL EARLIER METHODS ARE SECURE.

Readiness for formal written methods

- ◆ Know the place value of digits in whole numbers and decimals
- ◆ Know by heart all addition facts for numbers up to 20
- ◆ Add at least 3 single digits mentally
- ◆ Understand zero as a place holder
- ◆ Add a pair of two digit numbers mentally
- ◆ Know the approximate size of the answer

Ask yourself:

- ◆ Can I do it in my head using a mental strategy?
- ◆ Could I use some jottings?
- ◆ Should I use a written method?

Year 3

Year 4

Concrete → Pictorial → Abstract

In maths, any new concepts and methods of calculating should be introduced using a range of concrete resources and manipulatives (dienes, bundling straws etc) as well as pictorial representations, in order to help to build a conceptual understanding. Please see the Appendix attached to this document for support with this.

- Add and subtract numbers with up to 3 digits, using formal written methods of columnar addition and subtraction.

- Add and subtract numbers with up to 4 digits, using the formal written methods of columnar addition and subtraction where appropriate.

Expanded Method

This method using 2, and then 3-digit numbers, helps to build conceptual understanding. Leading quickly to...

67 + 56
+ 67
<u>56</u>
13
<u>110</u>
<u>123</u>

267 + 156
+ 267
<u>156</u>
13
110
<u>300</u>
<u>423</u>

Formal written method: Columnar Addition (See Appendix 1)

65 + 24
No
+ 24
<u>89</u>

265 + 224
265
+ 224
<u>489</u>

65 + 26
One
+ 26
<u>91</u>

362 + 193
362
+ 193
<u>555</u>

25 + 96
Two
+ 96
<u>121</u>

267 + 489
267
+ 489
<u>756</u>

Also include:

652 + 86
+ 86
<u>738</u>

362 + 98
+ 98
<u>460</u>

Formal written method: Columnar Addition

5682 + 2317
No
+ 2317
<u>7999</u>

5682
+ 2317
<u>7999</u>

4279 + 2450
One
+ 2450
<u>6729</u>

4279
+ 2450
<u>6729</u>

2673 + 4894
Two
+ 4894
<u>7567</u>

2673
+ 4894
<u>7567</u>

2362 + 3798
Three
+ 3798
<u>6160</u>

2362
+ 3798
<u>6160</u>

Also include:

3758 + 413
+ 413
<u>4171</u>

3778 + 483
+ 483
<u>4261</u>

351 + 234 + 423
351
+ 234
<u>423</u>
<u>1008</u>

355 + 234 + 473
355
+ 234
+ 473
<u>1062</u>

£22.43 + £14.72 = £37.15

Decimal addition in the context of money (numbers up to 4 digits)

£22.43
+ £14.72
<u>£37.15</u>

Across Lower Key Stage 2, provide plenty of opportunities to use and apply written methods in a range of contexts.

- Find all the totals you can make with any of these numbers: 56, 79, 832, 674, 6724, 8976
- Find two 3-digit numbers with a sum of 465.
- What are the missing numbers in this calculation?
- Use five of these numbers to make the calculation correct: 4, 4, 4, 5, 5, 5

23□1
+ 9□25
<u>11816</u>

□□□
+ □□□
<u>909</u>

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- Add and subtract whole numbers with more than 4 digits, including using formal written methods (columnar addition and subtraction).

- Pupils practise addition, subtraction...for larger numbers, using the efficient written methods of columnar addition and subtraction.

Formal Written Method: Columnar Addition

$$\begin{array}{r} 77234 \\ + 35479 \\ \hline 112713 \\ \hline \end{array}$$

1 1 1 1

$$\begin{array}{r} 326781 \\ + 93802 \\ \hline 420583 \\ \hline \end{array}$$

1 1 1

Also include:

$$\begin{array}{r} 2318 \\ + 925 \\ + 53 \\ \hline 3296 \\ \hline \end{array}$$

1 1

$$\begin{array}{r} 23.14 \\ + 560.83 \\ + 46.71 \\ \hline 630.68 \\ \hline \end{array}$$

1 1 1

Decimal addition in the context of money and measures.

Formal Written Method: Columnar Addition

$$\begin{array}{r} 4276259 \\ + 68068 \\ + 6843 \\ \hline 4351170 \\ \hline \end{array}$$

1 2 1 1 2

427.6 + 6.08 + 68.431 = 502.111

Numbers with different decimal places.

$$\begin{array}{r} 427.600 \\ + 6.080 \\ + 68.431 \\ \hline 502.111 \\ \hline \end{array}$$

1 2 1 1

Across Upper Key Stage 2, provide plenty of opportunities to use and apply written methods in a range of contexts.

- The population of Coventry in 2014 was approximately 329,810 and the population of Birmingham was approximately 1,123,000. What is the total population of people in Coventry and Birmingham?
- Find the different totals you can make by using any three of these numbers: **1.07, 0.3, 37.03, 17.73, 31.7**
- Find three numbers with a sum of **4.65**
- Use five of these numbers to make this calculation correct: **4, 4, 4, 9, 9, 9** + $\begin{array}{r} \square \square \square \\ \square \square \\ \hline 1043 \end{array}$
- What are the missing numbers in this calculation? $\begin{array}{r} 231\square \\ + 92\square5 \\ \hline 3 \\ \hline 11596 \\ \hline \end{array}$
- Can you spot the mistake and correct it? $\begin{array}{r} 12.3 \\ + 9.8 \\ \hline 21.11 \end{array}$



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- Add and subtract numbers with up to 3 digits, using formal written methods of columnar addition and subtraction.

- Add and subtract numbers with up to 4 digits, using the formal written methods of columnar addition and subtraction where appropriate.

Expanded Method

58 - 24 = 34

2 and 3- digit numbers.
No exchanges.

$$\begin{array}{r} 50 + 8 \\ - 20 + 4 \\ \hline 30 + 4 = 34 \end{array}$$

745 - 219 = 526

2 and 3-digit numbers.
One exchange.

$$\begin{array}{r} 700 + 40 + 5 \\ - 200 + 10 + 9 \\ \hline 500 + 20 + 6 = 526 \end{array}$$

Formal written method: Columnar Subtraction (see Appendices 2A and 2B)

65 - 24 = 41 **465 - 224 = 241**

No exchanges

$$\begin{array}{r} 65 \\ - 24 \\ \hline 41 \end{array}$$

$$\begin{array}{r} 465 \\ - 224 \\ \hline 241 \end{array}$$

65 - 26 = 39 **367 - 193 = 174**

One exchange

$$\begin{array}{r} 65 \\ - 26 \\ \hline 39 \end{array}$$

$$\begin{array}{r} 367 \\ - 193 \\ \hline 174 \end{array}$$

923 - 756 = 167

Two exchanges

$$\begin{array}{r} 923 \\ - 756 \\ \hline 167 \end{array}$$

603 - 247 = 356

Including zero

$$\begin{array}{r} 603 \\ - 247 \\ \hline 356 \end{array}$$

Also Include:

465 - 24 = 441 **474 - 85 = 389**

$$\begin{array}{r} 465 \\ - 24 \\ \hline 441 \end{array}$$

$$\begin{array}{r} 474 \\ - 85 \\ \hline 389 \end{array}$$

Formal written method: Columnar Subtraction

5837 - 1324

No exchanges

$$\begin{array}{r} 5837 \\ - 1324 \\ \hline 4513 \end{array}$$

4767 - 2392

One exchange

$$\begin{array}{r} 4767 \\ - 2392 \\ \hline 2375 \end{array}$$

9238 - 7563

Two exchanges

$$\begin{array}{r} 9238 \\ - 7563 \\ \hline 1675 \end{array}$$

6234 - 2479

Three exchanges

$$\begin{array}{r} 6234 \\ - 2479 \\ \hline 3755 \end{array}$$

6043 - 4781

Including zero

$$\begin{array}{r} 6043 \\ - 4781 \\ \hline 1262 \end{array}$$

Also Include:

1534 - 254 **3155 - 536**

$$\begin{array}{r} 1534 \\ - 254 \\ \hline 1280 \end{array}$$

$$\begin{array}{r} 3155 \\ - 536 \\ \hline 2619 \end{array}$$

Decimal subtraction in the context of money and measures to 3 d.p.

Across Lower Key Stage 2, provide plenty of opportunities to use and apply written methods in a range of contexts.

- The Smith family has saved £675 towards their summer holiday. The cost of the holiday is £2019. How much more do they need to save?
- A coat costs £32.45. In the sale, it is reduced to £18.96. By how much has it been reduced?
- Two numbers have a difference of 134. One of the numbers is 456. What is the other number? Is this the only possibility?
- At the beginning of a cricket match 742 people were watching. By the end, 218 people had gone home. How many people were still watching at the end?
- Use the digits 1, 2, 3, 4, 5, 6, 9 once each to make this calculation correct:

$$\begin{array}{r} \square \square \\ - \square \square \\ \hline \square \square \end{array}$$



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- Add and subtract whole numbers with more than 4 digits, including using formal written methods (columnar addition and subtraction).

Formal Written Method

$$75,365 - 32,539 = 42,826$$

Various exchanges.

$$\begin{array}{r} 75,365 \\ - 32,539 \\ \hline 42,826 \end{array}$$

Also include:

$$75,366 - 627 = 74,739$$

$$20,439 - 5,247 = 15,192$$

Decimal subtraction in the context of money and measures to 3 d.p.

- Pupils practise addition, subtraction...for larger numbers, using the efficient written methods of columnar addition and subtraction.

Efficient Written Method

$$327.5 - 62.63 = 264.87$$

Numbers with different decimal places.

$$\begin{array}{r} 327.50 \\ - 62.63 \\ \hline 264.87 \end{array}$$

$$645.287 - 351.8 = 293.487$$

$$\begin{array}{r} 645.287 \\ - 351.800 \\ \hline 293.487 \end{array}$$

Decimal subtraction in the context of money and measures to 3 d.p.

Across Upper Key Stage 2, provide plenty of opportunities to use and apply written methods in a range of contexts.

- The Smith family sold their house for £363,590 and bought their new house for £456,908. How much extra did they need to put towards the price of the new house?
- At the beginning of a football match 742,679 people were watching. By the end, 21,008 people had gone home. How many people were left watching at the end?
- Two numbers have a difference of 1.34. One of the numbers is 4.56. What is the other number? Is this the only answer?
- Use the digits **0, 1, 2, 3, 4, 5, 6, 7, 8, 9** to make this calculation correct:

$$\begin{array}{r} \square\square\square.\square\square \\ - \square\square\square.\square\square \\ \hline 108.41 \end{array}$$



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- Write and calculate mathematical statements for multiplication and division using the multiplication tables that they know, including for two-digit numbers times one-digit numbers, using mental and progressing to formal written methods.

Grid Method (See Appendix 3A)

$23 \times 3 = 69$

X	20	3	60
3	60	9	+ 9
			69

$24 \times 4 = 96$

X	20	4	80
4	80	16	+ 16
			96

$32 \times 8 = 256$

X	30	2	240
8	240	16	+ 16
			256

- Multiply two-digit and three-digit numbers by a one-digit number using formal written layout.

Grid Method (See Appendix 3B)

$145 \times 3 = 435$

X	100	40	5	300
3	300	120	15	+ 15
				435

Expanded Method

Expanded method using 2 then 3-digit numbers helps to build a conceptual understanding. Leading quickly to...

$24 \times 3 = 72$

x	24
	3
	12
+	60
72	

Formal Written Method: Short Multiplication

$42 \times 3 = 126$

No exchanges

	42
x	3
126	

$36 \times 4 = 144$

One exchange

	36
x	4
144	
2	

$312 \times 6 = 1,872$

One exchange

	312
x	6
1872	
1	

$273 \times 7 = 1,911$

Two exchanges

	273
x	7
1911	
52	

Across Lower Key Stage 2, provide plenty of opportunities to use and apply written methods in a range of contexts.

- How many days are there in 35 weeks?
- What is the total mass of 235 screws each weighing 6g?
- Find the area of a swimming pool which is 25m long and 7m wide.
- I buy 6 kg of apples. They cost 65p per kg. how much do I pay?
- How many different answers can be made by using the digits 2, 3 and 4 in this calculation?
 $\square \square \times \square$
- Organise the digits 9, 7, 5 and 3 in to this calculation to give the greatest odd number answer:
 $\square \square \square \times \square$
- Which is closer to 100: 5×17 or 7×15 ? Use written methods to prove your answer.
- Abbie says that 23×5 will be bigger than 53×2 . Is she correct?
- An can of drink holds 330ml. How much do 6 cans hold?



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- Multiply numbers up to 4 digits by a one-digit or two-digit number using a formal written method, including long multiplication for two-digit numbers.

Formal Written Method: Short Multiplication

$$2741 \times 6 = 16,272$$

$$\begin{array}{r} 2741 \\ \times \quad 6 \\ \hline 16272 \end{array}$$

$$6579 \times 8 = 52,632$$

$$\begin{array}{r} 6579 \\ \times \quad 8 \\ \hline 52632 \end{array}$$

Formal Written Method: Long Multiplication

$$27 \times 34 = 918$$

$$\begin{array}{r} 27 \\ \times 34 \\ \hline 108 \\ + 810 \\ \hline 918 \end{array}$$

$$78 \times 64 = 4,992$$

$$\begin{array}{r} 78 \\ \times 64 \\ \hline 312 \\ + 4680 \\ \hline 4992 \end{array}$$

$$124 \times 26 = 3,224$$

$$\begin{array}{r} 124 \\ \times 26 \\ \hline 744 \\ + 2480 \\ \hline 3224 \end{array}$$

$$2374 \times 32 = 75,968$$

$$\begin{array}{r} 2374 \\ \times 32 \\ \hline 4748 \\ + 71220 \\ \hline 75968 \end{array}$$

- Across Upper Key Stage 2, provide plenty of opportunities to use and apply written methods in a range of contexts.**
- A can of drink contains 0.33 litres. How many litres are in 15 cans?
 - A car park has 17 rows each with space for 32 cars. How many cars can park? □ × □ =
 - How many hours are there in 1 year?
 - Find the area of a swimming pool which is 25m long and 7.5m wide. □ × □ =
 - I buy 1.6 kg of apples. They cost 65p per kg. How much do I pay?
 - How many different answers can be made by using the digits 2, 3 and 4 in this calculation? □ × □ =
 - Organise the digits 9, 7, 5 and 3 into this calculation to give the greatest possible product □ × □ =
 - Which is closer to 100: 5.2 × 17 or 7.2 × 15? Use written methods to prove your answer.

- Multiply multi-digit numbers up to 4 digits by a 2-digit whole number using the formal written method of long multiplication.
- Multiply one-digit numbers with up to 2 decimal places by whole numbers.

Formal Written Method: Long Multiplication

$$6027 \times 34 = 204,918$$

$$\begin{array}{r} 6027 \\ \times 34 \\ \hline 24108 \\ + 180810 \\ \hline 204918 \end{array}$$

$$4378 \times 73 = 319,594$$

$$\begin{array}{r} 4378 \\ \times 73 \\ \hline 13134 \\ + 306460 \\ \hline 319594 \end{array}$$

$$8.7 \times 6 = 52.2$$

$$\begin{array}{r} 8.7 \\ \times 6 \\ \hline 52.2 \end{array}$$

$$8.68 \times 7 = 60.76$$

$$\begin{array}{r} 8.68 \\ \times 7 \\ \hline 60.76 \end{array}$$

Also include (choose either of the following):

$$784.9 \times 6 = 4709.4$$

$$\begin{array}{r} 784.9 \\ \times 6 \\ \hline 4709.4 \end{array}$$

Option 1: The multiplier is placed in the ones column.

$$41.68 \times 7 = 291.76$$

$$\begin{array}{r} 41.68 \\ \times 7 \\ \hline 291.76 \end{array}$$

Option 2: The multiplier is placed in the right hand column.

$$47.3 \times 62 = 2932.6$$

$$\begin{array}{r} 47.3 \\ \times 62 \\ \hline 94.6 \\ + 2838.0 \\ \hline 2932.6 \end{array}$$

or

$$31.56 \times 23 = 725.88$$

$$\begin{array}{r} 31.56 \\ \times 23 \\ \hline 94.68 \\ + 631.20 \\ \hline 725.88 \end{array}$$



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Progression for WRITTEN DIVISION

Year 3

Year 4

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- Pupils develop reliable written methods for ... division, starting with calculations of two-digit numbers by one-digit numbers and progressing to the formal written methods of ... short division.

Partitioning

$39 \div 3 = 13$

$$\begin{array}{r} 10 + 3 \\ 3 \overline{) 30 + 9} \\ \underline{30} \\ + 9 \\ 9 \\ 0 \end{array} = 13$$

Model using manipulatives prior to and alongside the teaching of the written method for partitioning. (See appendix)

$84 \div 6 = 14$

$$\begin{array}{r} 10 + 4 \\ 6 \overline{) 60 + 24} \\ \underline{60} \\ + 24 \\ 24 \\ 0 \end{array} = 14$$

Model using manipulatives prior to and alongside the teaching of the written method for partitioning. (See appendix)

$72 \div 3 = 24$

$72 = 60 + 12$

$$\begin{array}{r} 20 + 4 \\ 3 \overline{) 60 + 12} \\ \underline{60} \\ + 12 \\ 12 \\ 0 \end{array} = 24$$

- Pupils practise to become fluent in the formal written method of ... short division with exact answers.

Partitioning

$72 \div 3 = 24$

$72 = 60 + 12$

$$\begin{array}{r} 20 + 4 \\ 3 \overline{) 60 + 12} \\ \underline{60} \\ + 12 \\ 12 \\ 0 \end{array} = 24$$

Short Division See Appendices 4A and 4B)

$63 \div 3 = 21$

$$\begin{array}{r} 21 \\ 3 \overline{) 63} \\ \underline{63} \\ 0 \end{array}$$

Model using manipulatives prior to and alongside the teaching of the written method for partitioning.

$84 \div 6 = 14$

$$\begin{array}{r} 14 \\ 6 \overline{) 84} \\ \underline{84} \\ 0 \end{array}$$

Model using manipulatives prior to and alongside the teaching of the written method for partitioning.

Across Lower Key Stage 2, provide plenty of opportunities to use and apply written methods in a range of contexts.

- In PE, the class are split into 3 groups. There are 39 children in the class. How many children are in each group?
- Pencils come in boxes of 8. There are 32 children in the class. How many boxes does the teacher need to buy so that everyone has a pencil?
- Work out whether or not 6 is a factor of 82.
- What is the missing digit in the calculation $3 \square \div 7 = 5$
- Rupert saves the same amount of money each day. In one week he had saved 91p. How much did he save every day?
- There are 48 animals at a zoo and only 6 cages to keep them all in. If there are an equal number of animals in each cage, how many animals are there in every cage?

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- 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.

Formal written method: Short Division

$$161 \div 7 = 23$$

$$\begin{array}{r} 23 \\ 7 \overline{) 161} \\ \underline{14} \\ 21 \\ \underline{21} \\ 0 \end{array}$$

$$992 \div 8 = 124$$

$$\begin{array}{r} 124 \\ 8 \overline{) 992} \\ \underline{8} \\ 19 \\ \underline{16} \\ 32 \\ \underline{32} \\ 0 \end{array}$$

$$1446 \div 6 = 241$$

$$\begin{array}{r} 241 \\ 6 \overline{) 1446} \\ \underline{12} \\ 24 \\ \underline{24} \\ 6 \\ \underline{6} \\ 0 \end{array}$$

$$9415 \div 7 = 1345$$

$$\begin{array}{r} 1345 \\ 7 \overline{) 9415} \\ \underline{7} \\ 24 \\ \underline{21} \\ 31 \\ \underline{28} \\ 35 \\ \underline{35} \\ 0 \end{array}$$

There are 421 children at a sports event. How many teams of 9 can we make?

$$9 \overline{) 421} = 46 \text{ r } 7$$

2019 tickets were sold for a concert. There are 7 seats per row. How many rows are needed?

$$7 \overline{) 2019} = 288 \text{ r } 3$$

Across Upper Key Stage 2, provide plenty of opportunities to use and apply

- Work out whether or not 29 is a factor of 811.
- Coaches have 53 seats. How many coaches are needed to transport 276 passengers?
- Calls from my mobile costs 18p per minute. If I put £5 on my phone, how many minutes can I speak for?
- The area of a rectangular games hall is 384 square metres. If the length is 24m, how wide is it?
- 3 bags of crisps weigh 130.5g in total. What is the weight of one?
- What is the missing digit in the calculation $37\Box \div 17$ when there is a remainder of 5?
- Rupert saves the same amount of money each month. He saved £149.40 in a year. How much did he save each month?
- Pencils come in packs of 12. There are 546 children in our school. How many packs do the school need to buy so that each child has a pencil?

- Divide numbers up to 4 digits by a two-digit number using the formal written method of short division...
- Divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division...
- Use written division methods in cases where the answer has up to 2 decimal places.

Formal written method: Short Division

$$11 \overline{) 495} = 45$$

$$12 \overline{) 4332} = 361$$

Formal written method: Long Division (Choose EITHER method 1 or 2)

Method 1:

$$26 \overline{) 3432} = 132$$

26 x 100 = 2600
26 x 30 = 780
26 x 2 = 52

No need to write this when secure with the

Method 2:

$$26 \overline{) 3432} = 132$$

26
52
78
104
130
156
182
208
234
260

Pupils are advised to list the multiples before beginning written method.

Express answers as remainders, fractions and decimals.

$$15 \overline{) 432} = 28 \text{ r } 12$$

$$15 \overline{) 432} = 28 \frac{12}{15}$$

or $\frac{4}{5}$

$$15 \overline{) 432.0} = 28.8$$

432 ÷ 15 = 28 r 12 432 ÷ 15 = 28 $\frac{12}{15}$ or $\frac{4}{5}$ 432 ÷ 15 = 28.8

Also include:

$$343.56 \div 6 = 57.26$$

$$\begin{array}{r} 57.26 \\ 6 \overline{) 343.56} \\ \underline{18} \\ 16 \\ \underline{12} \\ 43 \\ \underline{42} \\ 15 \\ \underline{12} \\ 36 \\ \underline{36} \\ 0 \end{array}$$

Appendices

Concrete → **Pictorial** → **Abstract**

In maths, any new concept should be introduced using a range of concrete resources and manipulatives (dienes, bundling straws, Numicon, counters etc.) as well as different pictorial representations. This is fundamental for helping children to build a conceptual understanding of otherwise very abstract ideas. Children must be allowed plenty of opportunity to explore concepts practically using manipulatives, and must be taught to represent their mathematics work and models pictorially.

Written methods are no exception. These methods are very abstract ideas and even though some children may grasp the procedures very quickly, it does not necessarily mean they have a secure conceptual understanding of what they are doing and why they are doing it. This can lead to children having big gaps in their mathematical understanding which obviously will cause problems as they proceed in maths.

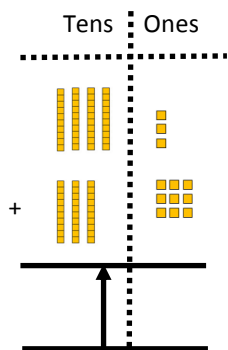
Therefore it is crucial that we allow the pupils to work practically with manipulatives when learning the written methods and that we make the links between their practical and pictorial representations very explicit.

This Appendices demonstrates how manipulatives (dienes or bundling straws) could be used to support the teaching of written methods in the 4 operations.

Appendix 1 : Using manipulatives to support written methods for addition.

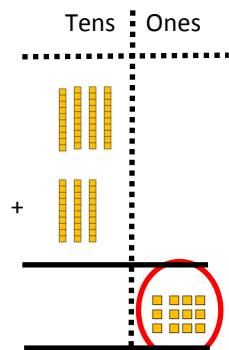
The diagrams below model step-by-step how manipulatives can be used alongside the columnar method for addition.

$43 + 39 = 82$



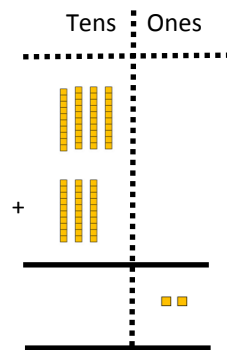
First lay the dienes or the bundling straws out to represent both numbers in the correct columns on a PV chart one on top of the other.

$$\begin{array}{r} 43 \\ + 39 \\ \hline \hline \end{array}$$



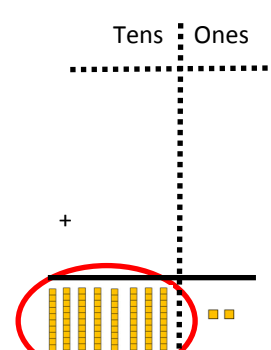
Now model how the ones are combined first in order to find the total. Move the counters into the 'equals sign' at the bottom.

$$\begin{array}{r} 43 \\ + 39 \\ \hline \hline \end{array}$$



Next model how we exchange ten ones for one ten when the total number of ones crosses the tens boundary, and then how we 'carry' this to the tens column. This is important in helping the children to understand the value of the '1' they carry.

$$\begin{array}{r} 43 \\ + 39 \\ \hline 2 \\ \hline 1 \end{array}$$



Finally combine all of the tens, including any that were carried, by moving them into the 'equals sign'.

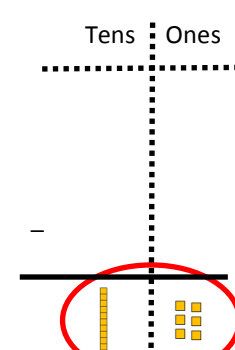
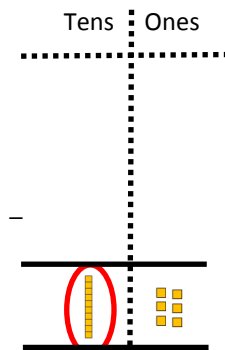
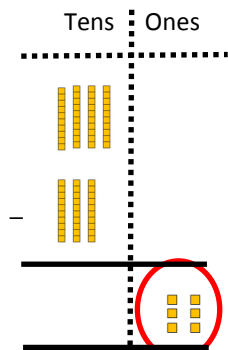
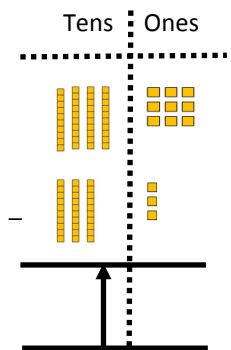
$$\begin{array}{r} 43 \\ + 39 \\ \hline 82 \\ \hline 1 \end{array}$$

When children are secure with this, allow them to use the same approach to explore adding two 3-digit numbers and also adding more than 2 numbers together.

Appendix 2A : Using manipulatives to support written methods for subtraction (without decomposition)

The diagrams below model step-by-step how manipulatives can be used alongside the columnar method for subtraction without decomposition.

$$49 - 33 = 16$$



First lay the dienes or the bundling straws out to represent both numbers in the correct columns on a PV chart one on top of the other.

Now model how the ones on the bottom are subtracted from the ones on top. Physically remove these away from the PV chart so the children can see the decreasing nature of the operation. Move the ones that are left into the 'equals sign at the bottom.

Next model how the tens on the bottom are subtracted from the tens on top. Again, physically remove the tens that you have taken away and move the rest into the large equal sign. Link to the written method, showing how we only write the digit '1' because it is in the tens column.

Finally total all of the tens and ones inside the equals sign at the bottom .

$$\begin{array}{r} 49 \\ - 33 \\ \hline \\ \hline \end{array}$$

$$\begin{array}{r} 49 \\ - 33 \\ \hline 6 \\ \hline \end{array}$$

$$\begin{array}{r} 49 \\ - 33 \\ \hline 16 \\ \hline \end{array}$$

$$\begin{array}{r} 49 \\ - 33 \\ \hline 16 \\ \hline \end{array}$$

When children are secure with this, allow them to use the same approach to explore subtraction of two 3-digit numbers. After mastering this both practically and using the formal written method, children will be ready to use formal written methods with larger numbers and with decomposition.

Appendix 2B: Using manipulatives to support written methods for subtraction (with decomposition)

The diagrams below model step-by-step how manipulatives can be used alongside the columnar method for subtraction with decomposition.

$$73 - 39 = 34$$

Diagram 1: The PV chart shows 7 tens rods and 3 ones units in the top row, and 3 tens rods and 9 ones units in the bottom row. The written method shows $73 - 39$. Text box: "First lay the dienes or the bundling straws out to represent both numbers in the correct columns on a PV chart one on top of the other."

Diagram 2: One ten rod from the top row is moved to the ones column, becoming ten ones units. The written method shows a red '1' above the 3 in the ones column and a red '6' above the 7 in the tens column. Text box: "Now subtract the ones on the bottom from the ones on top. Although it is possible to subtract 9 from 3, it is not possible in this method as it takes us below '0'. Instead, we 'borrow' one of the tens from the Tens column."

Diagram 3: The ten rod from the top row is broken into ten ones units. The written method shows a red '1' above the 3 in the ones column and a red '6' above the 7 in the tens column. Text box: "Because the ten we 'borrowed' is now in the Ones column, it can be exchanged for ten ones."

Diagram 4: Nine ones units from the top row are removed. The written method shows a red '4' in the ones column. Text box: "Now there are enough ones from which to subtract 9 ones. Physically remove the subtracted ones and move the remaining ones into the large 'equals' at the bottom."

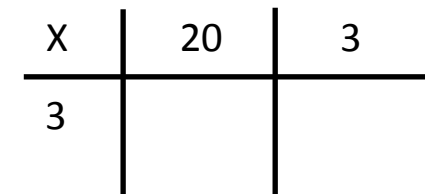
Diagram 5: Three tens rods from the top row are removed. The written method shows a red '3' in the tens column. Text box: "Finally subtract the tens on the bottom from the tens on top. Again physically remove the subtracted tens from the PV chart and move the rest into the 'equals' at the bottom. Total the tens and ones to give the final answer."

After mastering this both practically and using the formal written method, children will be ready to use formal written methods with larger numbers.

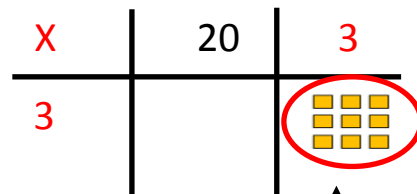
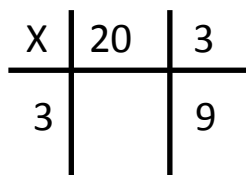
Appendix 3A : Using manipulatives to support written methods for multiplication.

The diagrams below model step-by-step how manipulatives can be used alongside the grid method for multiplication of two-digit numbers by a single digit.

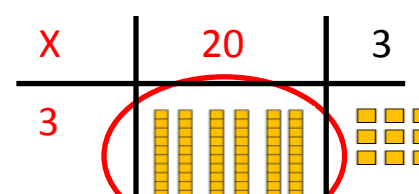
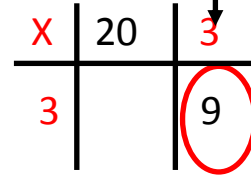
$$23 \times 3 = 69$$



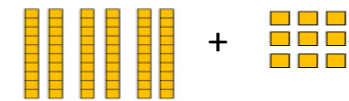
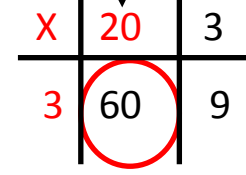
First draw out the grid and write the numbers into the correct boxes, partitioning the 2-digit number into



Next multiply the digit in the Ones column by the single digit number. Place ones counters in the relevant box to show this answer.



Now multiply the Tens column by the single digit number, and place the correct number of tens rods in the relevant box.



Finally combine the tens and ones to find the total. In the written grid method, encourage children to choose an efficient written method of addition for this final step. At first this should be columnar addition, but may move onto mental method when secure.

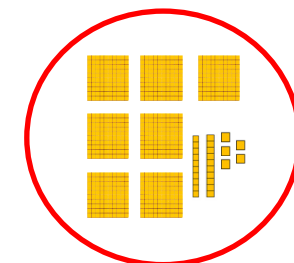
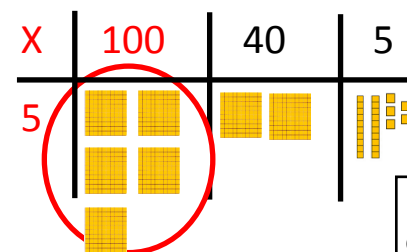
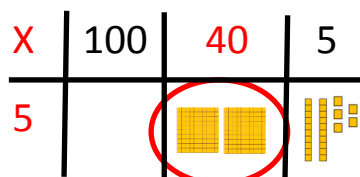
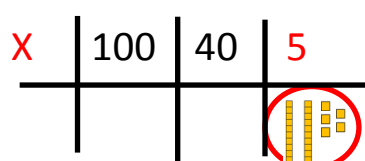
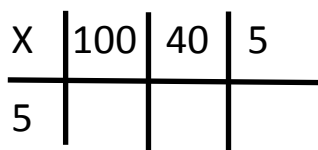
$$\begin{array}{r} 60 \\ + 9 \\ \hline 69 \end{array}$$

When children are secure with this, allow them to use the same approach to explore multiplication of a 3-digit number by a one-digit number (see Appendix 3B).

Appendix 3B: Using manipulatives to support written methods for multiplication.

The diagrams below model step-by-step how manipulatives can be used alongside the grid method for multiplication of three-digit numbers by a single digit.

$145 \times 5 = 725$



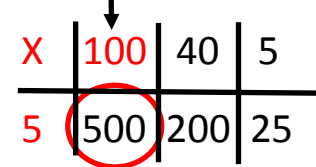
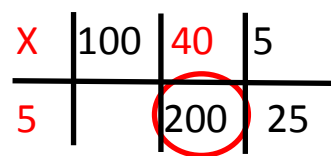
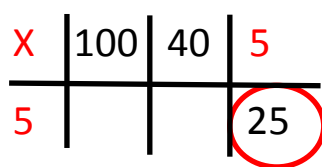
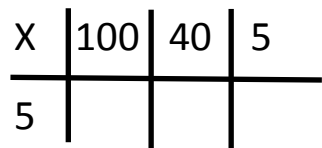
First draw out the grid and write the numbers into the correct boxes, partitioning the 3-digit number into Hundreds, Tens and Ones.

Next multiply the digit in the Ones column by the single digit number. Place ones counters in the relevant box to show this answer.

Now multiply the Tens column by the single digit number, and place the correct number of tens rods in the relevant box.

Then multiply the Hundreds column by the single digit number, and place the correct number of hundreds blocks in the relevant box.

Finally combine the hundreds, tens and ones to find the total. In the written grid method, encourage children to choose an efficient written method of addition for this final step. At first this should be columnar addition, but may move onto mental method when secure.



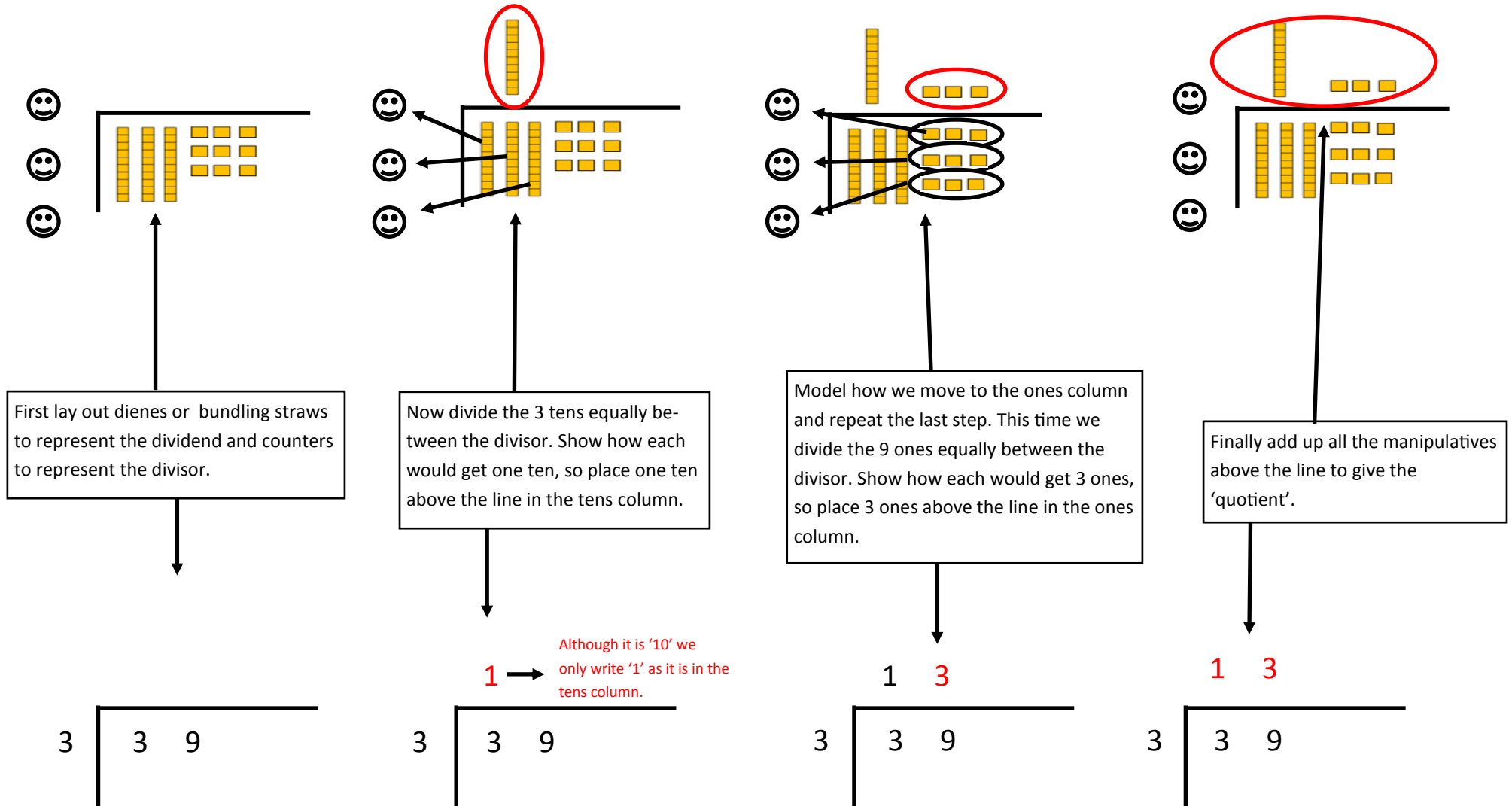
$$\begin{array}{r}
 500 \\
 200 \\
 + 25 \\
 \hline
 725
 \end{array}$$

When children are secure with this, move them onto the next step (expanded method).

Appendix 4A : Using manipulatives to support written methods for division.

The diagrams below model step-by-step how manipulatives can be used alongside the formal written method for division.

$$39 \div 3 = 13$$



When children are secure with this, allow them to use the same approach to explore dividing HTO by O. When beginning to divide with remainders, children will need to return to the concrete resources as this is a very challenging concept which will be made much easier if children can visualise it.

Appendix 4B : Using manipulatives to support written methods for division with remainders.

The diagrams below model step-by-step how manipulatives can be used alongside the formal written method for division.

$$49 \div 3 = 16 \text{ r } 1$$

