Old Catton C of E Junior School Calculation Policy

The following calculation policy has been devised to meet requirements of the National Curriculum 2014 for the teaching and learning of mathematics, and is also designed to give pupils a consistent and smooth progression of learning in calculations across the school.

As children progress at different rates, some children need to use the strategies from previous or future year groups.

It is important that any type of calculation is given a real life context or problem solving approach to help build children's understanding of the purpose of calculation, and to help them recognise when to use certain operations and methods when faced with problems. This must be a priority within calculation lessons.

We want our children to be able to select an efficient method of their choice (whether this be mental or written) that is appropriate for a given task. They will do this by always asking themselves:

- Can I do this in my head?
- Can I do this mentally, with drawings or jottings to help me?
- Do I need to use a written method?

Our long-term aim is for children to be able to select an appropriate method of calculation and know that they have a reliable, written method to which they can turn when the need arises. This policy sets out the progression in written recordings from informal methods to expanded methods that are staging posts to a compact method, for each of the four number operations.

The policy promotes standard written methods that are efficient and work for any calculations including those that involve whole numbers or decimals.

<u>**Addition**</u>

the process of calculating the total of two or more numbers or amounts.

<u>Prior skills required</u>
To add successfully, children need to be able to:

- recall all the complements of 10;
- recall all addition pairs to 9 + 9
- add mentally a series of one-digit numbers, such as 5 + 8 + 4;
- add multiples of 10 (such as 60 + 70) or of 100 (such as 600 + 700) using the related addition fact, 6 + 7, and their knowledge of place value;
- partition two-digit and three-digit numbers into multiples of 100, 10 and 1 in different ways.

The addition strategies taught from years 3 to 6 form a progression. Each method builds upon the preceding strategy.

The horizontally expanded addition method:

Not crossing the ten-barrier:	Crossing the ten-barrier:
72 + 25 = 70 + 2 20 + 5 90 + 7 = 97	58 + 64 = 50 + 8 60 + 4 110 + 12 = 122

The vertically expanded method of addition:

Using whole numbers:	Using decimals:
58 + 64 = 58 + 64 12 110 122	54.38 + 76.94 = 54.38 + 76.94 0.12 1.20 10.00 120.00 131.32 Zeros are used as place holders

Compact column method of addition:

Using whole numbers:	Using decimals:
58 + 64 = 58 + 64 122 1	54.38 + 76.94 = 54.38 + 76.94 131.32 11 1

Subtraction

Taking one quantity away from another
Finding the difference between two quantities

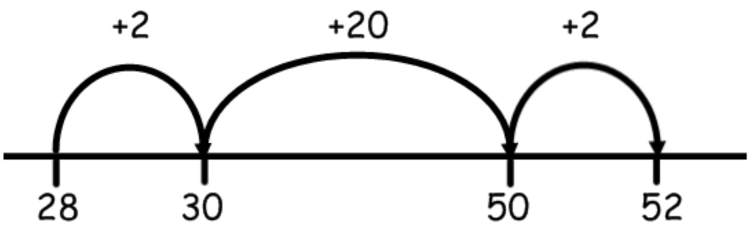
Prior skills required
To subtract successfully, children need to be able to:

- recall all addition and subtraction facts to 20;
- subtract multiples of 10 (such as 160 – 70) using the related subtraction fact, 16 – 7, and their knowledge of place value;
- partition two-digit and three-digit numbers into multiples of one hundred, ten and one in different ways (e.g. partition 74 into 70 + 4 or 60 + 14).

The subtraction strategies taught from years 3 to 6 form a progression. Each method builds upon the preceding strategy.

The numberline method of subtraction:

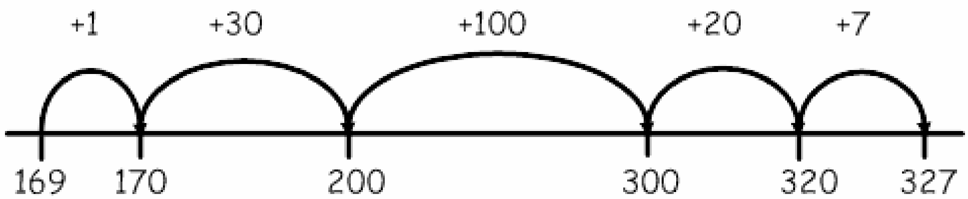
52 – 28 =



52 – 28 = 20 + 2 + 2 = <u>24</u>

The numberline method of subtraction using larger numbers:

327 – 169 =



327 – 169 = 100 + 30 + 20 + 1 + 7 = <u>158</u>

Once children are confident subtracting using the numberline, they can progress onto the expanded vertical method of subtraction.

The expanded vertical method of subtraction (directly linked to the numberline method):

327 – 169 =

$$
\begin{array}{rccccl}
 & 3 & 2 & 7 & & \\
- & 1 & 6 & 9 & & \\
\hline
 & & & 1 & & (170) \\
 & & 3 & 0 & & (200) \\
 & 1 & 0 & 0 & & (300) \\
 & & 2 & 0 & & (320) \\
 & & & 7 & & (327) \\
\hline
 & 1 & 5 & 8 & & \\
\hline
\end{array}
$$

Horizontally expanded decomposition method of subtraction:

327 – 169 =

$$
\begin{array}{rccccccl}
 & \cancel{300}^{200} & + & \cancel{20}^{110} & + & {}^{1}7 & & \\
- & 100 & + & 60 & + & 9 & & \\
\hline
 & 100 & + & 50 & + & 8 & = & 158 \\
\hline
\end{array}
$$

Decomposition method of subtraction:

327 – 169 =

$$
\begin{array}{rccc}
 & {}^{2}\cancel{3} & {}^{11}\cancel{2} & {}^{1}7 \\
- & 1 & 6 & 9 \\
\hline
 & 1 & 5 & 8 \\
\hline
\end{array}
$$

An explanation of this method and how this can be taught using Dienes can be seen in Appendix 1.

This method can be extended to numbers of any size and numbers with decimals.

Multiplication

Repeated addition, e.g. a x b, means add b lots of a

Prior skills required

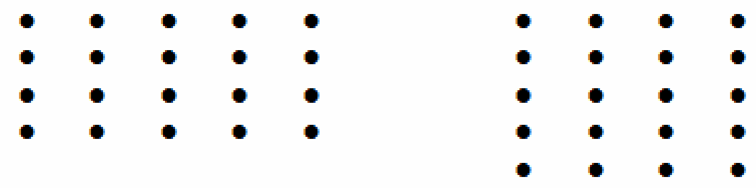
To multiply successfully, children need to be able to:

- recall all multiplication facts to 12 × 12 (by the end of Year 4);
- partition number into multiples of one hundred, ten and one;
- work out products such as 70 × 5, 70 × 50, 700 × 5 or 700 × 50 using the related fact 7 × 5 and their knowledge of place value;
- add two or more single-digit numbers mentally;
- add multiples of 10 (such as 60 + 70) or of 100 (such as 600 +700) using the related addition fact, 6 + 7, and their knowledge of place value;
- add combinations of whole numbers using the column method.

The multiplication strategies taught from years 3 to 6 form a progression. Each method builds upon the preceding strategy.

Children should use **arrays** when starting multiplication, as it is very visual and they can count the dots to calculate or check answers:

4 x 5 = 20

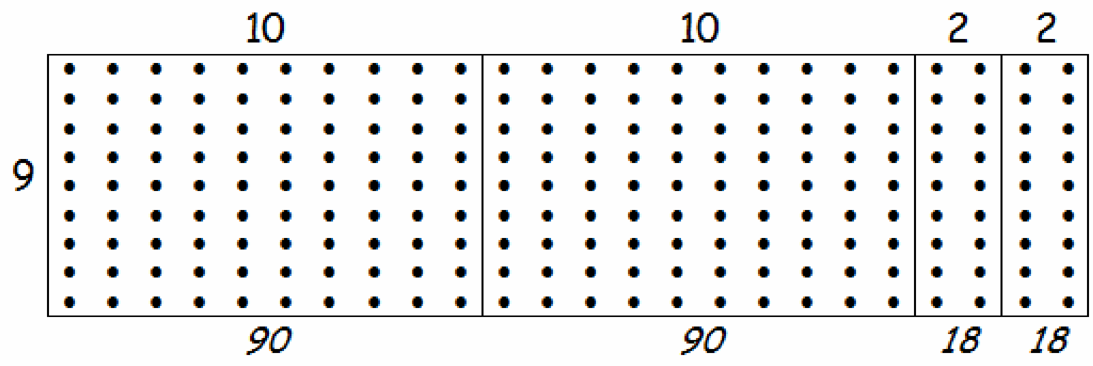


When the arrays get too large to count then the grid can be introduced.

The grid method for multiplication:

24 x 9 =

24 can be partitioned into more manageable numbers, e.g. 10 + 10 + 2 + 2



So, 24 x 9 = 90 + 90 + 18 + 18 = 216

This method holds for larger numbers:

34 x 21 =

	10	10	1
10	10 x 10 = **100**	10 x 10 = **100**	10x1 =**10**
10	10 x 10 = **100**	10 x 10 = **100**	10x1 =**10**
10	10 x 10 = **100**	10 x 10 = **100**	10x1 =**10**
3	10 x 3 = **30**	10 x 3 = **30**	3x1 =**3**
1	10 x 1 = **10**	10 x 1 = **10**	1x1=**1**

So, 34 x 21 = 100 + 100 + 100 + 100 + 100 + 100 + 30 + 30 + 10 + 10 + 10 + 10 + 10 + 3 + 1 = 714

This method holds for however the numbers are partitioned; so children can partition numbers into multiplication tables that they are confident with.

The grid method can become more efficient as the children partition the numbers into tens and ones:

24 x 9 =

	20	4
9	9 x 20 = **180**	9 x 4 = **36**

So, 24 x 9 = 180 + 36 = <u>216</u>

34 x 21 =

	30	4
20	20 x 30 = **600**	20x4 = **80**
1	1 x 30 = **30**	1x4 = **4**

So, 34 x 21 = 600 + 80 + 30 + 4 = <u>714</u>

For year 5 and 6 children who struggle to grasp and understand the grid method an alternative method (the Lattice method) can be found in Appendix 2.

The grid method progresses to **expanded multiplication** (grid method without the grid):

24 x 9 = 216

		2	4	
x			9	
	1	8	0	(20 x 9)
		3	6	(4 x 9)
	2	1	6	
	1			

34 x 21 = 714

		3	4	
x		2	1	
	6	0	0	(30 x 20)
		8	0	(4 x 20)
		3	0	(30 x 1)
			4	(4 x 1)
	7	1	4	
	1			

This method then progresses to **short multiplication**:

24 x 9 = 216

		2	4
x			9
	2	1	6
		3	

And then onto **long multiplication**:

34 x 21 = 714

		3	4	
x		2	1	
	6	8	0	*(34 x 20)*
		3	4	*(34 x 1)*
	7	1	4	
	1			

These methods can also be extended to 4-digit numbers and decimals:

4512 x 24 = 108288

$$
\begin{array}{cccccccl}
 & & & 4 & 5 & 1 & 2 & \\
\times & & {\scriptstyle 1} & {\scriptstyle 2} & & 2 & 4 & \\
\hline
 & & 9 & 0 & 2 & 4 & 0 & (4512 \times 20) \\
 & & 1 & 8 & 0 & 4 & 8 & (4512 \times 4) \\
\hline
 & 1 & 0 & 8 & 2 & 8 & 8 & \\
\hline
\end{array}
$$

54.27 x 8 = 434.16

$$
\begin{array}{cccccc}
 & 5 & 4 & . & 2 & 7 \\
\times & & & & & 8 \\
\hline
4 & 3 & 4 & . & 1 & 6 \\
\hline
 & {\scriptstyle 3} & {\scriptstyle 2} & & {\scriptstyle 5} & \\
\end{array}
$$

Division

Sharing, e.g. 12 ÷ 3, means 12 shared equally between 3 people
Grouping, e.g. 12 ÷ 3, means how many groups of 3 can you make out of 12

Prior skills required
To divide successfully, children need to be able to:

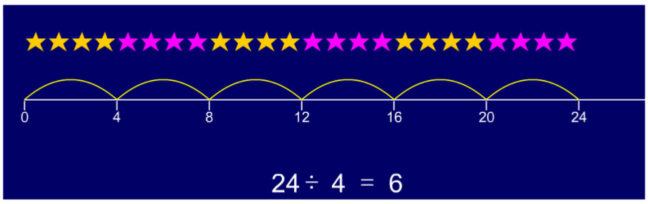
- understand and use the vocabulary of division – for example in 18 ÷ 3 =6, the 18 is the dividend, the 3 is the divisor and the 6 is the quotient;
- partition two-digit and three-digit numbers into multiples of 100, 10 and 1 in different ways;
- recall multiplication and division facts to 12 × 12, recognise multiples of one-digit numbers and divide multiples of 10 or 100 by a single-digit number using their knowledge of division facts and place value;
- know how to find a remainder working mentally – for example, find the remainder when 48 is divided by 5;
- understand and use multiplication and division as inverse operations.
- understand division as repeated subtraction;
- estimate how many times one number divides into another – for example, how many sixes there are in 47, or how many 23s there are in 92;
- multiply a two-digit number by a single-digit number mentally;
- subtract numbers using the column method.

The division strategies taught from years 3 to 6 form a progression. Each method builds upon the preceding strategy.

Grouping on a numberline method of division:

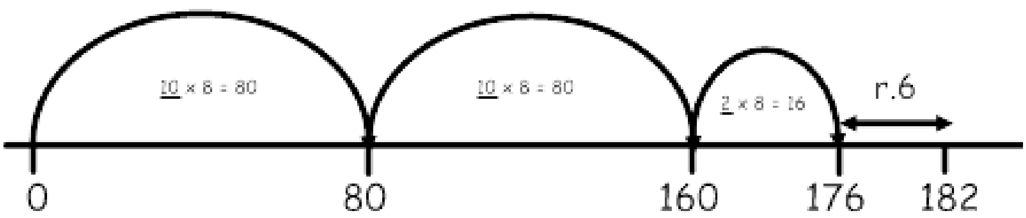
Using the Grouping ITP:

24 ÷ 4 =



This method can also be used for larger numbers and questions that involve remainders:

182 ÷ 8 =



So, 182 ÷ 8 = 10 + 10 + 2, remainder 6 = 22 r.6

When children are confident with this method they can progress to the bus-stop method (short division).

The bus-stop method of division (short division):

825 ÷ 3 = 275

$$\begin{array}{rl} & \;\;2\;\;7\;\;5 \\ 3 & \overline{\big)\,8\;{}^{2}2\;{}^{1}5} \end{array}$$

547 ÷ 3 = 182 r.1

$$\begin{array}{rl} & \;\;1\;\;\;8\;\;\;2\quad r.1 \\ 3 & \overline{\big)\,5\;\;{}^{2}4\;\;7} \end{array}$$

A full explanation of this method using base 10 (dienes) to ensure children understand the method, rather than just use it can be found in Appendix 3.

As children understand this method, the divisor can increase to 2-digits and then long-division will need to be used.

Long-division:

425 ÷ 25 = 17

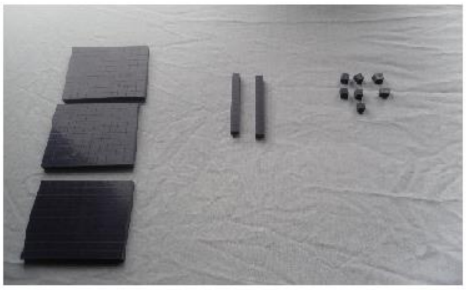
$$\begin{array}{r|ccc} & 0 & 1 & 7 \\ \hline 25 & 4 & 2 & 5 \\ & 0 & \downarrow & \downarrow \\ \hline & 4 & 2 & \\ - & 2 & 5 & \\ \hline & 1 & 7 & 5 \\ - & 1 & 7 & 5 \\ \hline & 0 & 0 & 0 \\ \hline \end{array}$$

A full explanation of this method can be seen in Appendix 4.

Appendix 1

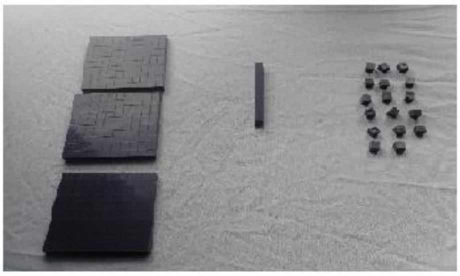
1.

$$\begin{array}{rccc} & 3 & 2 & 7 \\ - & 1 & 6 & 9 \\ \hline & & & \\ \hline \end{array}$$



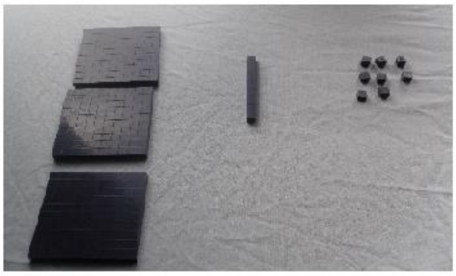
2. Start with the ones: 7 – 9 = negative number, so convert one of the tens into ones:

$$\begin{array}{rccc} & 3 & {}^{1}\cancel{2} & {}^{1}7 \\ - & 1 & 6 & 9 \\ \hline & & & \\ \hline \end{array}$$



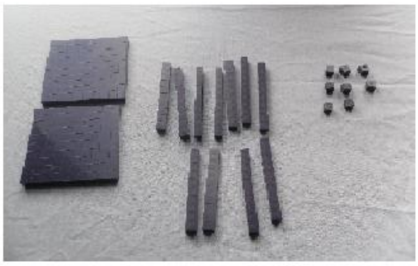
3. So now, 17 – 9 = 8:

$$\begin{array}{rccc} & 3 & {}^{1}\cancel{2} & {}^{1}7 \\ - & 1 & 6 & 9 \\ \hline & & & 8 \\ \hline \end{array}$$



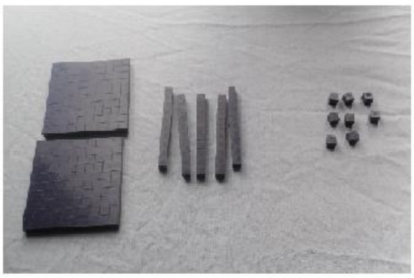
4. Now look at the tens. 10 – 60 = negative number, so convert one of the hundreds into tens:

$$\begin{array}{rccc} & {}^{2}\cancel{3} & {}^{11}\cancel{2} & {}^{1}7 \\ - & 1 & 6 & 9 \\ \hline & & & 8 \\ \hline \end{array}$$



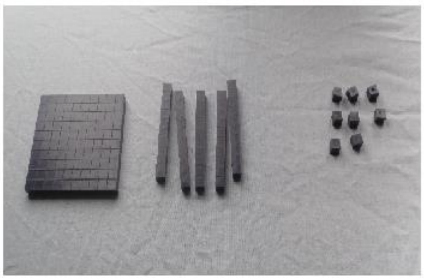
5. So now, 110 – 60 = 50:

$$\begin{array}{rccc} & {}^{2}\cancel{3} & {}^{11}\cancel{2} & {}^{1}7 \\ - & 1 & 6 & 9 \\ \hline & & 5 & 8 \\ \hline \end{array}$$



6. Now look at the hundreds, 200 – 100 = 100:

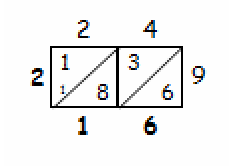
$$\begin{array}{rccc} & {}^{2}\cancel{3} & {}^{11}\cancel{2} & {}^{1}7 \\ - & 1 & 6 & 9 \\ \hline & 1 & 5 & 8 \\ \hline \end{array}$$



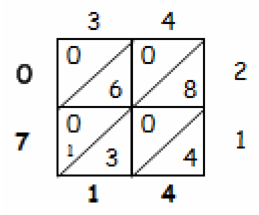
Appendix 2

The Lattice method for multiplication:

24 x 9 = 216

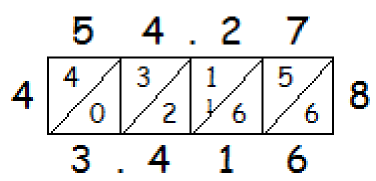


34 x 21 = 714

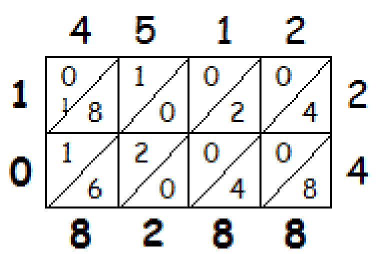


This method also holds for larger numbers and decimals:

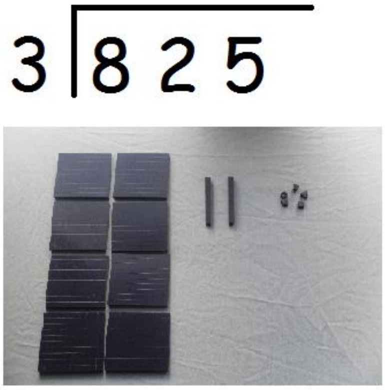
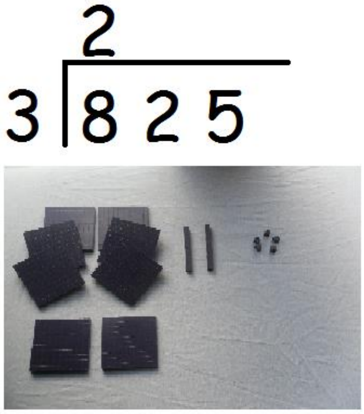
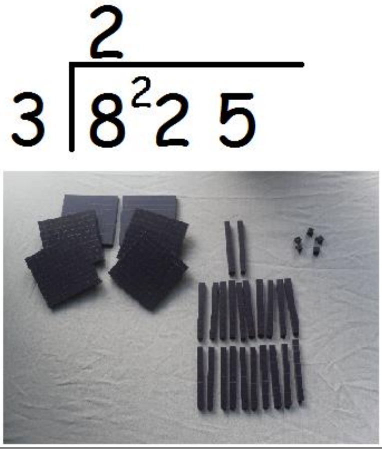
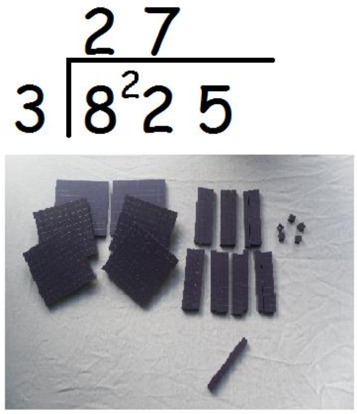
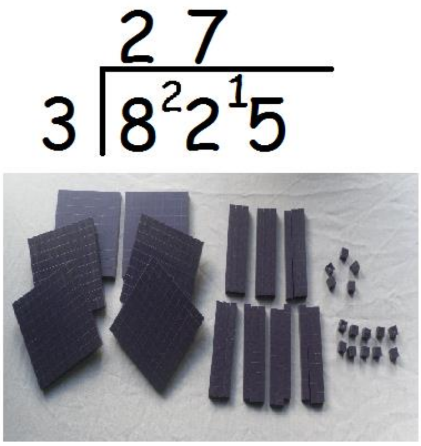
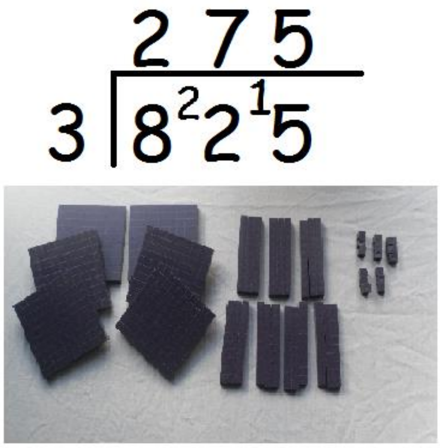
54.27 x 8 = 434.16



4512 x 24 = 108288

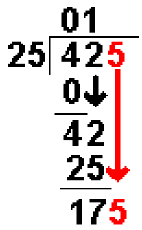
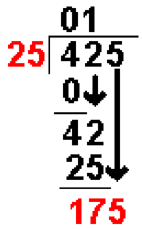
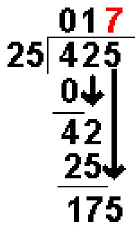
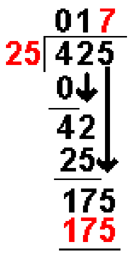
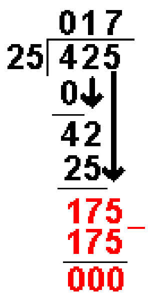


Appendix 3

1. 825 ÷ 3 = 	2. Ask how many groups of 300 can you make out of 800? 
3. Convert the 2 remaining hundreds into tens: 	4. Ask how many groups of 30 can you make out of 220? 
5. Convert the 1 remaining ten into ones: 	6. Ask how many groups of 3 can you make out of 15? 

Appendix 4

$25\overline{)425}$	4 ÷ 25 = 0 remainder 4	The first digit of the dividend (4) is divided by the divisor.
$\begin{array}{r} 0 \\ 25\overline{)425} \end{array}$		The whole number result is placed at the top. Any remainders are ignored at this point.
$\begin{array}{r} 0 \\ 25\overline{)425} \\ \underline{0} \end{array}$	25 × 0 = 0	The answer from the first operation is **multiplied** by the divisor. The result is placed under the number divided into.
$\begin{array}{r} 0 \\ 25\overline{)425} \\ \underline{0} \\ 4 \end{array}$	4 – 0 = 4	Now we **subtract** the bottom number from the top number.
$\begin{array}{r} 0 \\ 25\overline{)425} \\ \underline{0\downarrow} \\ 42 \end{array}$		Bring down the next digit of the dividend.
$\begin{array}{r} 0 \\ 25\overline{)425} \\ \underline{0\downarrow} \\ 42 \end{array}$	42 ÷ 25 = 1 remainder 17	**Divide** this number by the divisor.
$\begin{array}{r} 01 \\ 25\overline{)425} \\ \underline{0\downarrow} \\ 42 \end{array}$		The whole number result is placed at the top. Any remainders are ignored at this point.
$\begin{array}{r} 01 \\ 25\overline{)425} \\ \underline{0\downarrow} \\ 42 \\ \underline{25} \end{array}$	25 × 1 = 25	The answer from the above operation is **multiplied** by the divisor. The result is placed under the last number divided into.
$\begin{array}{r} 01 \\ 25\overline{)425} \\ \underline{0\downarrow} \\ 42 \\ \underline{25} \\ 17 \end{array}$	42 – 25 = 17	Now we **subtract** the bottom number from the top number.

		Bring down the next digit of the dividend.
	175 ÷ 25 = 7 remainder 0	**Divide** this number by the divisor.
		The whole number result is placed at the top. Any remainders are ignored at this point.
	25 × 7 = 175	The answer from the above operation is **multiplied** by the divisor. The result is placed under the number divided into.
	175 – 175 = 0	Now we **subtract** the bottom number from the top number.
		There are no more digits to bring down. The answer must be 17