Methods of Calculation at Queen's Park Academy

February 2022

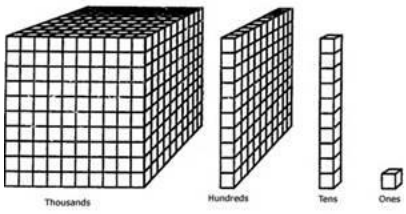
We encourage pupils to represent calculations in different ways within lessons, in order to deepen their understanding and to represent the purpose of the calculations that they are undertaking. Alongside the teaching of the four operations, addition, subtraction, multiplication and division, pupils also develop an understanding of place value – learning the value each digit represents in a number. Children build on secure foundations in calculation, and develop fluency, accuracy and flexibility in their approach to the four operations. They work with whole numbers and adapt their skills to work with decimals, and they continue to develop their ability to select appropriate, accurate and efficient operations.

thousands	hundreds	tens	ones	.	tenths	hundredths
1000	100	10	1	.	0.1	0.01

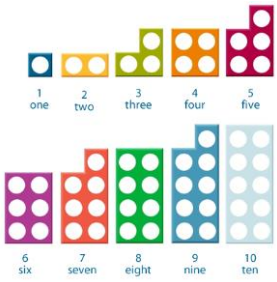
Children are also encouraged to partition numbers in different ways, for example understanding that 200 (2 hundreds) could also be represented as 20 tens. Or that 254 = 200 + 50 + 4

Addition

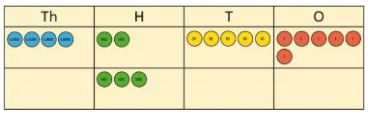
- Before using a formal written method of addition, children will work with a variety of informal methods. For example, they will use number lines to 'count in steps of' and will use mathematical tools such as Numicon and Base 10 equipment to physically add numbers. All of these strategies help children develop an understanding of addition, based on secure place value understanding, before any formal written methods are used. Children use place value equipment to support their understanding, but not as a substitute for thinking.



Base 10 (Dienes)



Numicon



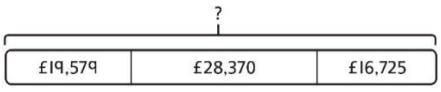
Place Value Equipment

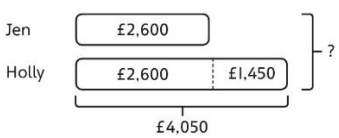
- The formal written method of addition that we use is the column method:

TTh	Th	H	T	O
	1	9	1	7	5
+	1	8	4	1	7
	3	7	5	9	2
		1		1	

Children should not begin 'carrying' until their knowledge of place value is secure. Children will carry below the calculation for addition.

Bar models are also used to represent the addition of two or more numbers in the context of problem solving.





Th	H	T	O
2	6	0	0
+ 1	4	5	0
4	0	5	0
		1	

Th	H	T	O
2	6	0	0
+ 4	0	5	0
6	6	5	0

- We will extend learning in the following ways, as per the 2014 curriculum:
  -up to 3 digits (Year 3)
  -up to 4 digits and decimals to 2 decimal places (Year 4)
  -more than 4 digits and decimals to 3 decimal places (Year 5)

  This can also be developed by:
  -adding 3 or more numbers
  -adding decimal numbers including money in problem solving
  -adding different sized numbers e.g. ThHTO and HTO
  -adding near multiples e.g. 37829+ 3998
  - comparing written and mental methods alongside place value representations
  -identifying common mistakes in calculations

Children also need to be encouraged to think about when a mental method is more appropriate than a written method. Use place value and unitising (see below example) to support mental calculations with larger numbers.

195,000 + 6,000 = ?

195 + 5 + 1 = 201

195 thousands + 6 thousands = 201 thousands

So, 195,000 + 6,000 = 201,000

Subtraction

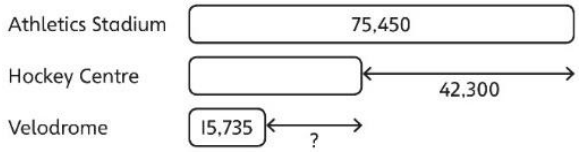
- As with addition, children will begin by using informal methods and mathematical equipment to secure their understanding of subtraction. Only once this is embedded will children be encouraged to use a formal written method.

- The formal written method of subtraction that we use is the column method:

	TTh	Th	H	T	O
	$^{5}\not{6}$	$^{11}\not{2}$	$^{1}0$	9	7
−	1	8	5	3	4
	4	3	5	6	3

- We use the term ‘exchanging’ to describe decomposition taking from the digit to our left, on the top row of the calculation.

- This should not be introduced until place value is secure and children understand subtraction mentally. Again bar models will be used to support children with this.



- We will extend learning in the following ways, as per the curriculum:
  -up to 3 digits (Year 3)
  -up to 4 digits and decimals to 2 decimal place (Year 4)
  -more than 4 digits and decimals to 3 decimal places (Year 5)

  This can also be developed by;

-subtracting decimal numbers including money and length in problem solving
-subtracting different sized numbers e.g. ThHTO and HTO
-subtracting numbers from numbers with multiple 0s e.g. 5000-387
-subtracting near multiples e.g. 34857 – 4998.

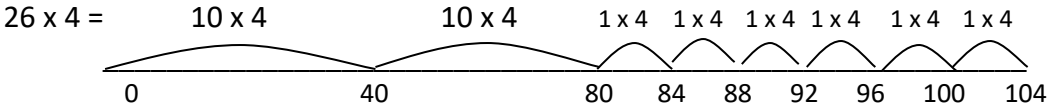
Children also need to be encouraged to think about when a mental method is more appropriate than a written method.

Multiplication

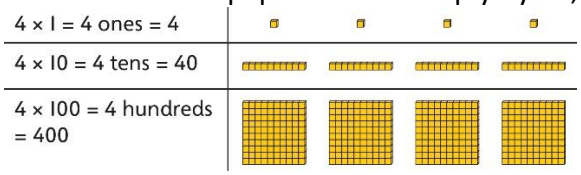
- Year groups calculate multiplication in the following ways:

  Y3- Informal methods (e.g. number line, arrays or partitioning) using times tables knowledge, progressing to a formal written method as appropriate.
  Y4- Formal short written method (extended as necessary to model the steps in the process)
  Y5- Formal long written method (multiplying a 2-digit number by a 2-digit number)
  Y6- Formal long written method (multiplying up to a 4-digit number by a 2-digit number)

- Number line method example:

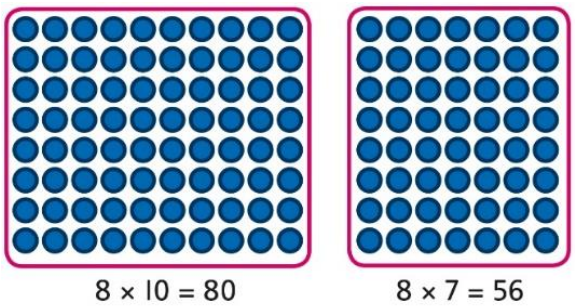


- Use of base 10 equipment to multiply by 10, 100 and 100 through unitising.



- Children will explore how to use partitioning to multiply efficiently.

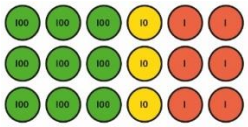
8 × 17 = ?



80 + 56 = 136

So, 8 × 17 = 136

- Use place value equipment alongside a column method for multiplication of up to 3-digit numbers by a single digit.



$$\begin{array}{r} 3\ 1\ 2 \\ \times\quad\ 3 \\ \hline 9\ 3\ 6 \end{array}$$

- Extended formal written method example:

26 x 4 =

$$\begin{array}{rl} 26 & \\ \times\ 4 & \\ \hline 24 & (4 \times 6) \\ +\ 80 & (4 \times 20) \\ \hline 104 & \end{array}$$

- Formal written method example:

$$\begin{array}{r} 1\ 3\ 6 \\ \times\quad\ 6 \\ \hline 8\ 1\ 6 \\ \hline 2\ 3 \end{array}$$

Note any carrying will be completed below the calculation

- Use an area model and add the parts also referred to as the grid method.

28 × 15 = ?

	20 m	8 m
10 m	20 × 10 = 200 m^2	8 × 10 = 80 m^2
5 m	20 × 5 = 100 m^2	8 × 5 = 40 m^2

$$\begin{array}{r} H\ T\ O \\ \hline 2\ 0\ 0 \\ 1\ 0\ 0 \\ \quad 8\ 0 \\ +\quad 4\ 0 \\ \hline 4\ 2\ 0 \\ \hline 1 \end{array}$$

28 × 15 = 420

- Long multiplication – when multiplying TO or HTO x TO etc.

$$\begin{array}{rl} \quad 3\ 4 & \\ \times\ 2\ 7 & \\ \hline 2\ 3\ {}^{2}8 & 34 \times 7 \\ 6\ 8\ 0 & 34 \times 20 \\ \hline 9\ 1\ 8 & 34 \times 27 \\ \hline 1 & \end{array}$$

- The progression and extension of learning in multiplication will look like this:
  - O X O
  - O X TO
  - TO X TO
  - TO X HTO etc
  - Decimals x O
  - Decimals x TO
  - Decimals x HTO etc

To multiply decimals, children need to have a secure understanding of place value and relative values, e.g. they should know that:

3 x 8 = 24

so 0.3 x 8= 2.4

Multiplying decimals

- To multiply decimals, we line up numbers as if the decimal point is not there, not under usual place value headings. This can be explained to the children with place value knowledge:

- Use known facts to multiply decimals.

4 × 3 = 12
4 × 0·3 = 1·2
4 × 0·03 = 0·12

- *Use a place value grid to understand the effects of multiplying decimals.*

	H	T	O	•	Tth	Hth
2 × 3			6	•		
0·2 × 3			0	•	6	
0·02 × 3				•		

Division

- The year groups calculate division in the following ways:

  Y3- Informal methods (e.g. number line, place value equipment, base 10 equipment, arrays or partitioning) using times tables knowledge progressing to written method of short division as appropriate
  Y4- Short division
  Y5- Short division up to 4 digits.
  Y6- Short & Long division as appropriate (knowing when to select)

- Understand how and why the digits change on a place value grid when dividing by 10, 100 or 1,000.

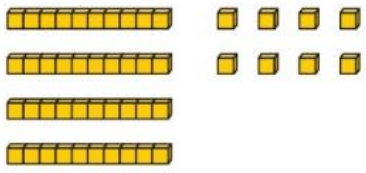
Th	H	T	O
3	2	0	0

3,200 ÷ 100 = ?

3,200 is 3 thousands and 2 hundreds.
200 ÷ 100 = 2
3,000 ÷ 100 = 30
3,200 ÷ 100 = 32

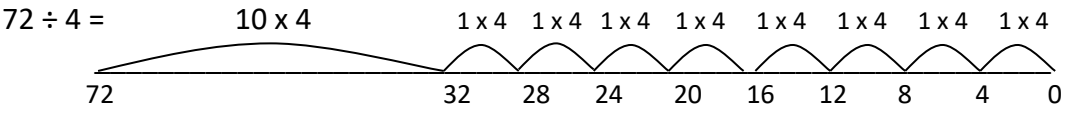
So, the digits will move two places to the right.

- Children explore dividing 2-digit numbers by using place value equipment.

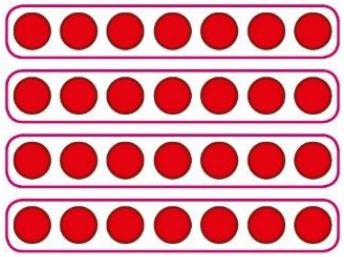


48 ÷ 2 = ?

- Number line example:
  (Start with highest number and go down to 0)

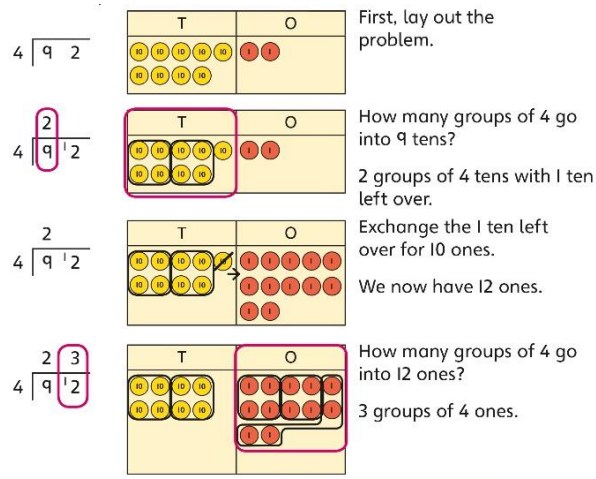


- Short division supported with an array.

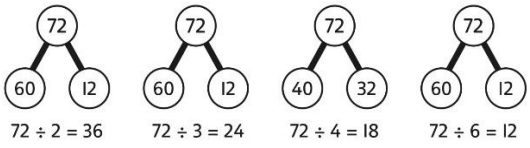


28 ÷ 7 = 4

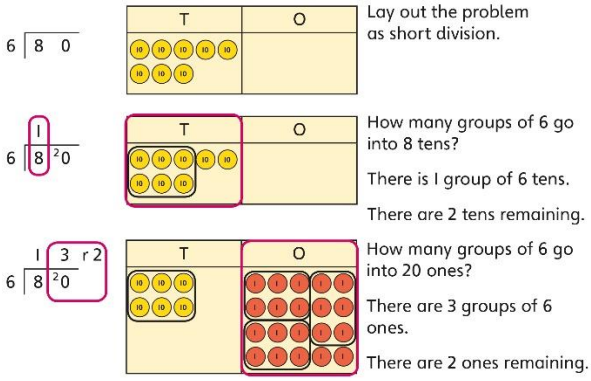
- Short division method example supported with place value grid:



- Children will also make decisions about appropriate partitioning based on the division required.



- As children become more confident in their division, they will learn to do the following:
  - Calculating remainders:



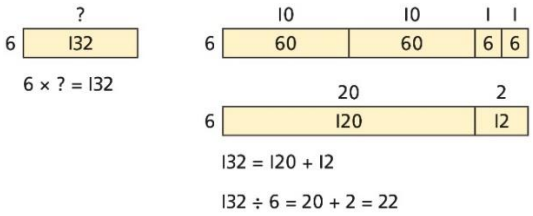
  - Calculating remainders as fractions of the divisor:

653 ÷ 4 = 164 ¼

- Calculating the remainder as a decimal.

$$4 \overline{)\,6\,^{2}5\,^{1}3\,.\,^{1}0\,^{2}0} \quad 1\,6\,4\,.\,2\,5$$

- Use the inverse to check their answers as well as to link their understanding of multiplication and division.



- Calculating using long division (used for large 2-digit divisors):

543 ÷ 34 =

$$34 \overline{)\,5\,4\,3\,.\,0\,0\,0} \quad 1\,5\,.\,9\,7\,0$$

$$\begin{array}{r} 34 \\ \underline{3\,4} \\ 2\,0\,3 \\ \underline{1\,7\,0} \\ 3\,3\,0 \\ \underline{3\,0\,6} \\ 2\,4\,0 \\ \underline{2\,3\,8} \\ 2\,0 \\ \underline{0} \\ 2\,0 \end{array}$$

34
68
102
136
170
204
238
272
306
340

A list of multiples to 10x will help children with the calculation.

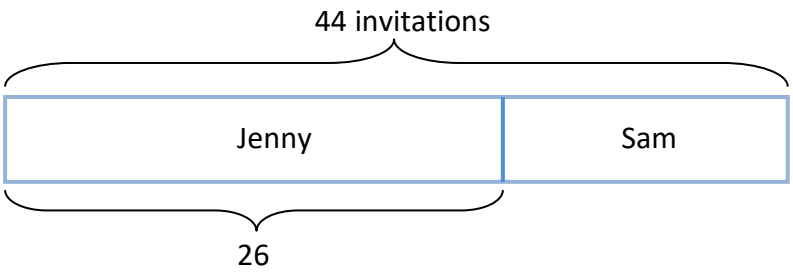
Problem Solving

Throughout all of our teaching, we provide children with opportunities to apply their skills in context and solve a variety of different problems.

When solving problems, children are encouraged to think about what they know and how they can use this to calculate.

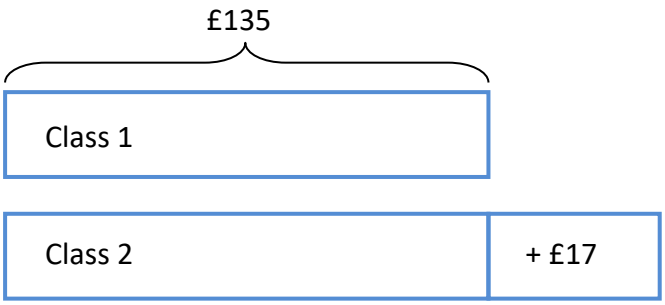
Children are introduced to bar modelling as part of our 'Power Maths' curriculum. This involves displaying what they know as a bar, either as a part or a whole bar. This visual display can then be manipulated to help children understand what the problem involves and what they can calculate to help them solve the problem.

Jenny and Sam have some invitations for their party. Jenny has 26 invitations. They are allowed to invite 44 children altogether. How many invitations can Sam send?



26 + ? = 44
44 – 26 = <u>18</u>

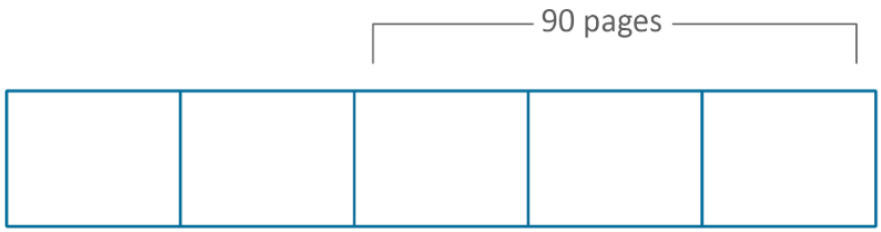
Kerry and Amir collect the money from year 3. The first class they collect from has raised £135. The second class they collect from has raised £17 more. How much money has the second class raised?



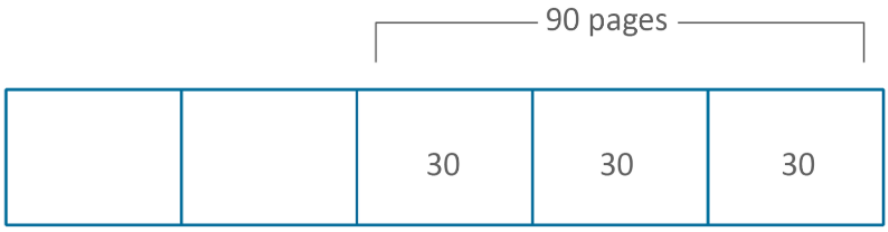
Class 2 = £135 + £17 = <u>£152</u>

This strategy can also be used for an end of KS2 problem.

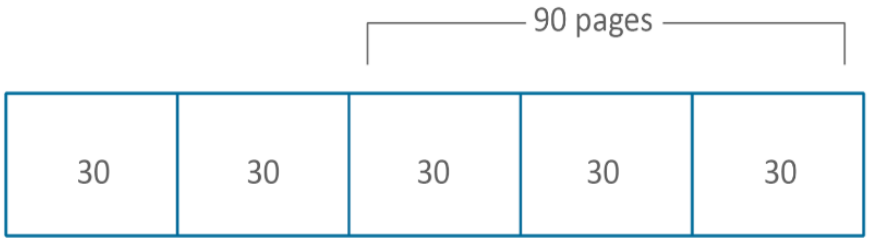
On Saturday Lara read two fifths of her book. On Sunday, she read the other 90 pages to finish the book. How many pages are there in Lara's book?



Pupils will then see that they can divide 90 by 3:



As fractions are 'equal parts' they know that the other 2 fifths (Saturday's reading) will be 30 pages each:



Then they can calculate 30 x 5 = <u>150 pages</u>