Corsham Regis Primary Academy

Calculation Policy

The following is an outline of the objectives and calculation methods that make up the New Mathematics Curriculum (2014).

The new curriculum aims that all children:

- **become fluent** in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.
- can **reason mathematically** by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language.
- can **solve problems** by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and perservering in seeking solutions.

The key to this calculation policy is to thoroughly underpin mathematical learning by providing full immersion in the concepts before moving to procedures.

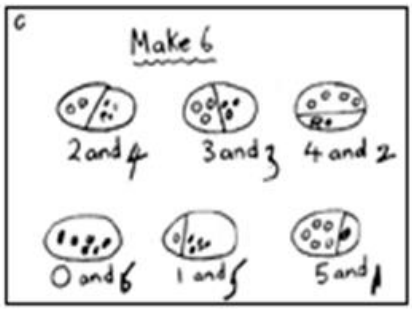
"Dependence on facts and procedures alone cannot ensure competence with arithmetic at the required level; competence also depends on identifying, understanding and acting on the underlying relations, equating and estimating quantities." ACME Report on Primary Arithmetic, Dec. 2010

The objectives are laid out in single year groups and will need to be adapted accordingly in mixed year classes.

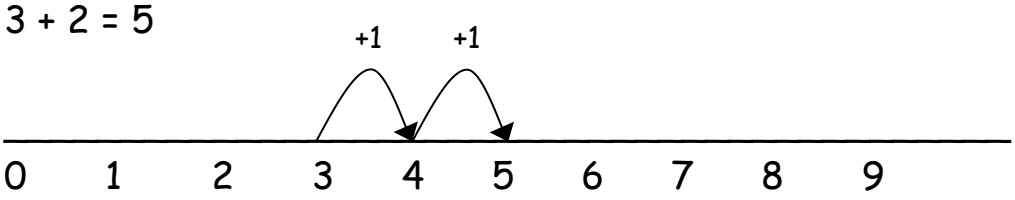
Addition & Subtraction

FS2

Use quantities and objects to add and subtract two single digit numbers and count on or back to find the answer.

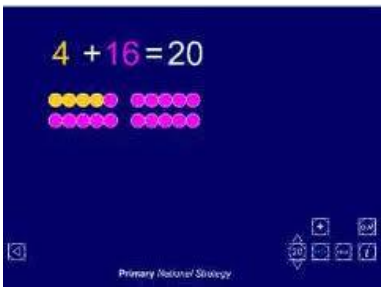


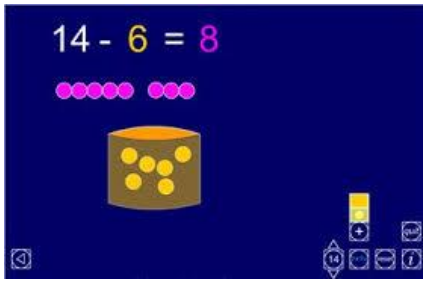
3 + 2 = 5



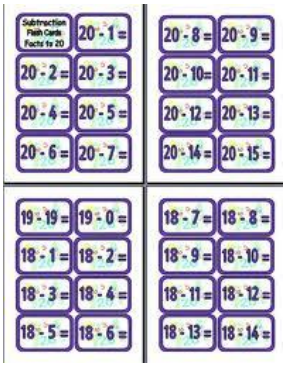
Year 1

Read, write and interpret maths statements including +, -, =.

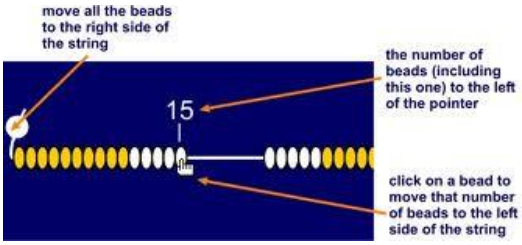


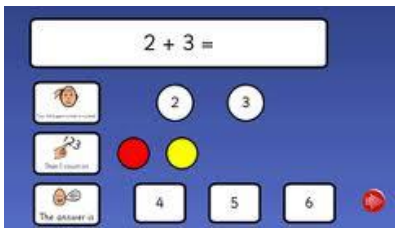


Represent and use number facts within 20.

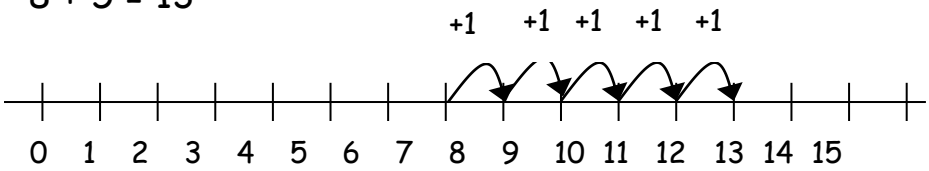


Add and subtract one and two-digit numbers to 20 including 0.

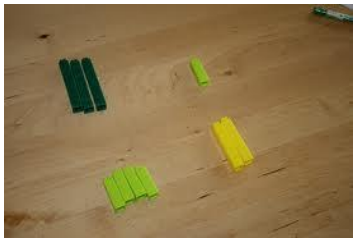


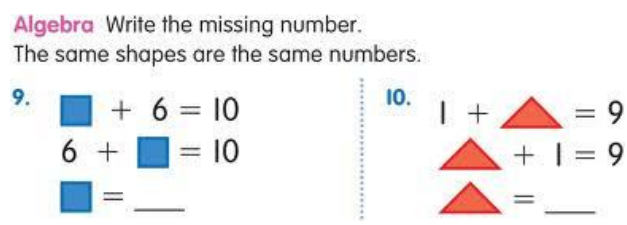


8 + 5 = 13



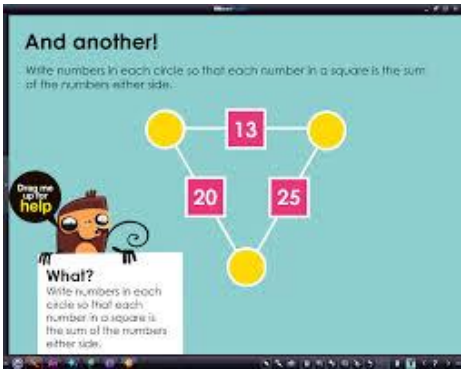
Solve one step problems that involve addition and subtraction using concrete objects and pictorial representations, and missing number problems.



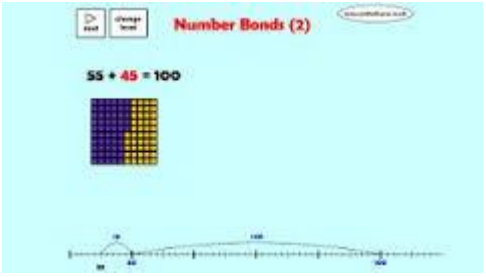


Year 2

Solve problems with addition and subtraction using concrete objects, pictorial representations, including those involving numbers, quantities and measures



Recall and use addition and subtraction facts to 20 fluently and derive and use related facts to 100.



Add and subtract numbers using number lines/partitioning …. and mentally including:

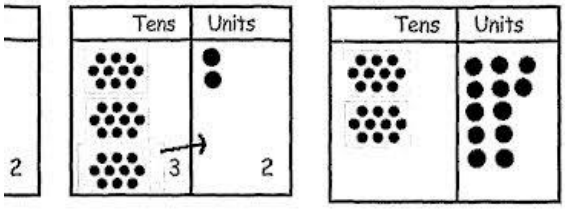
2 digit number and units 39 + 5 = ? 56 – 5 = ?

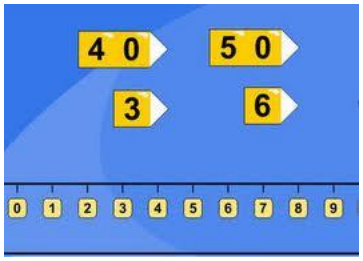
Counting on in head Counting back from largest number

2 digit number and tens 57 + 20 =? 72 – 30 = ?

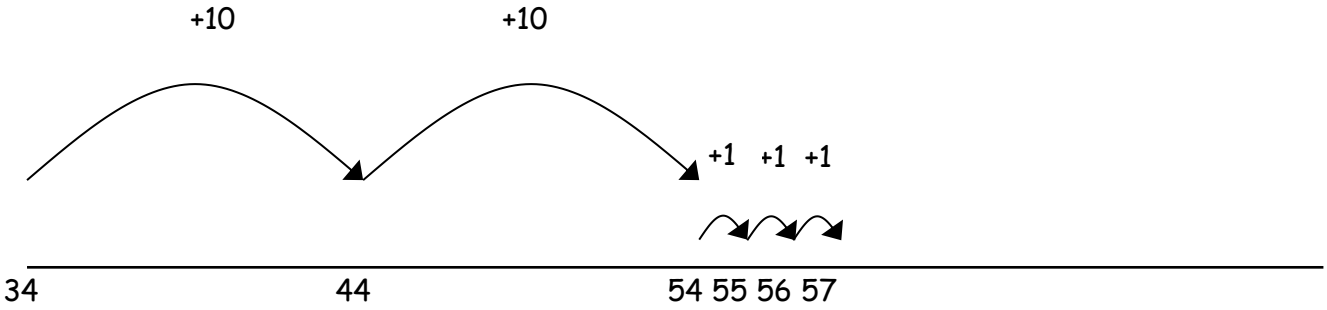
Understanding the value of the tens column and the fact that the units do **NOT** change.

Two 2 digit numbers

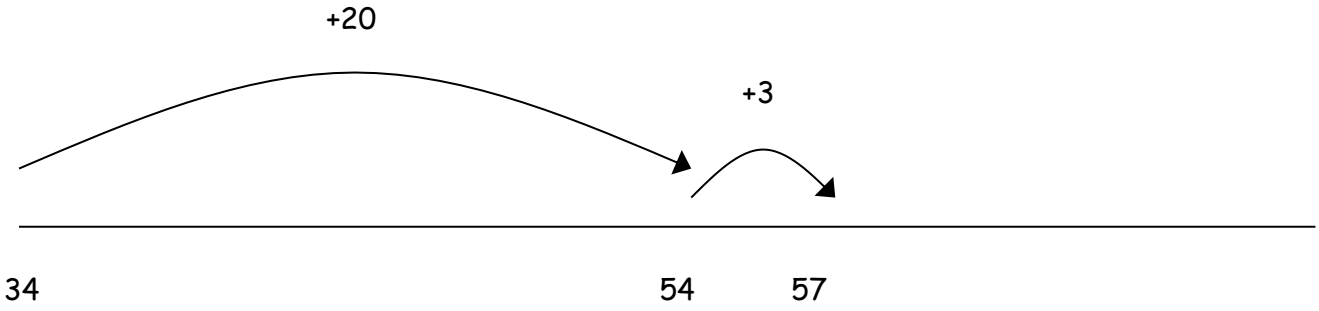


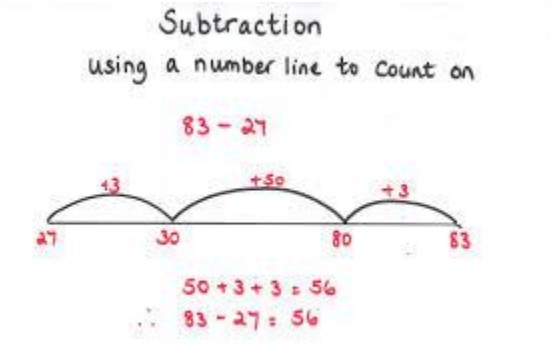


34 + 23 = 57



34 + 23 = 57





We will focus on counting **on** to find the **difference**

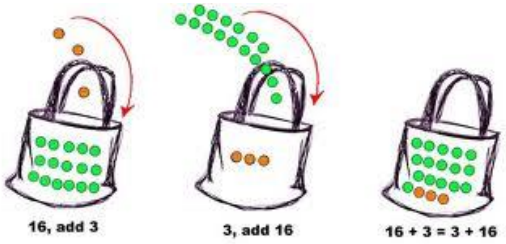
- starting at the smallest number and counting on to the bigger number.

Adding three 1 digit numbers - spotting number bonds to 10 where possible to aid speed of calculation.

3 + 7 + 5 = ?

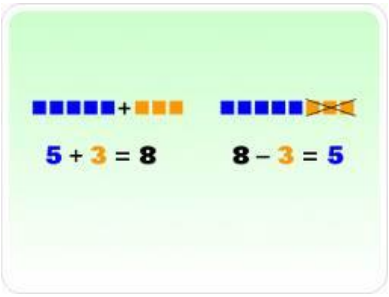
9 + 1 + 5 =?

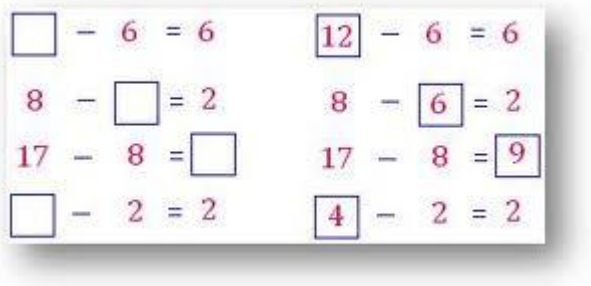
Show addition can be done in any order but subtraction cannot



7-3 = 4 but 3-7 = will not solve our calculation

Recognise and use the inverse relationship between addition and subtraction and use this to check calculations and solve missing number problems.





Introduce formal methods of columnar addition and subtraction (not actually in Framework)

$$\begin{array}{rcl} 25 & = & 20 + 5 \\ +\ 48 & & 40 + 8 \\ & & 60 + 13 = 73 \end{array}$$

then move to recording as below

$$\begin{array}{rcll} 91 & = & {}^{80}\cancel{90} + {}^{1}1 & 80 + {}^{1}1 \\ -\ 35 & & -\ 30 + 5 & -30 + 5 \\ & & & 50 + 6 \end{array}$$

then move to recording as below

$$\begin{array}{r} 25 \\ +\ 48 \\ \hline 73 \\ {\scriptstyle 1} \end{array} \qquad \begin{array}{r} 83 \\ -\ 42 \\ \hline 41 \end{array} \qquad \begin{array}{r} {}^{8}\cancel{9}\,{}^{1}1 \\ -\ 35 \\ \hline 56 \end{array}$$

Year 3

Add and subtract numbers mentally, including:

A 3 digit number and units

393 + 5 = ? 567 – 5 = ?

Counting on in head Counting back from largest number

A 3 digit number and tens

517 + 20 =? 742 – 30 = ?

Understanding the value of the tens column and the fact that the units do **NOT** change although the hundreds **might** if the boundary is crossed

A 3 digit number and 100s

347 + 200 = ? 561- 300 =?

Understanding the value of the hundreds column and the fact that the tens/units do **NOT** change.

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

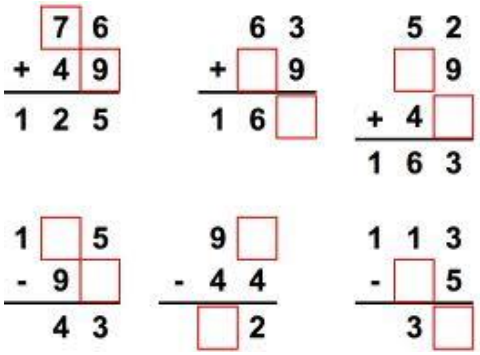
$$\begin{array}{r} 625 \\ +\ 48 \\ \hline 673 \\ \scriptstyle 1 \end{array} \qquad \begin{array}{r} 783 \\ +\ 42 \\ \hline 825 \\ \scriptstyle 1 \end{array} \qquad \begin{array}{r} 536 \\ +\ 85 \\ \hline 621 \\ \scriptstyle 1\ 1 \end{array}$$

Estimate the answer to a calculation and use *repeat of the same operation* or inverse operations to check answers

576 + 347 =

Estimate 570 + 350 = 920 Actual answer = 923

Solve problems, including missing number problems, using number facts, place value, and more complex addition and subtraction.



Year 4

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

```
  587          3587
+ 475        +  675
 1062         4262
 1 1          1 1 1
```

Correct column alignment is key!

```
  614 1
  7 5 4
-   86
  668
```

Estimate and use inverse operations to check answers to a calculation.

See above

Solve addition and subtraction two step problems in contexts, deciding which operations and methods to use and why.

Amir and Lara buy some fruit.

Grapes	Pineapples	Peaches
		
£2.50 per kg	£1.40 each	£1.99 for 1 kg

Amir buys 2 pineapples and a kg of peaches. How much does he pay?

Lara buys half a kilogram of grapes and one pineapple. How much change does she get from £5?

Year 5

Add and subtract numbers with more than 4 digits using formal written methods.

37648	6584	42
+ 414 86	+ 5848	6432
79134	12432	786
1 1 1	1 11	3
		+ 4681
		11944
		1 2 1

Add and subtract numbers mentally with increasingly large numbers.

Use rounding to check answers to calculations and determine, in the context of a problem, levels of accuracy.

Solve addition and subtraction multi-step problems in contexts, deciding which operations and methods to use and why.

Emily, Ben and Nisha collect money for charity.
Emily collects £2.75 more than Nisha.
Ben collects £15. Nisha collects £7 less than Ben.
Altogether how much money do the three children collect?

□ and ○ each stand for a different number.
□ = 34
□ + □ = ○ + ○ + □
What is the value of ○?

Tina has read the first 85 pages in a book that is 150 pages long.

Which number sentence could Tina use to find the number of pages she must read to finish the book?

A 150 + 85 = □
B □ – 85 = 150
C 150 ÷85 = □
D 150 – 85 = □

Year 6

Solve addition and subtraction multistep problems in contexts, deciding which operations and methods to use and why.

Example -

185 people go to the school concert.

They pay £l.35 each.

How much ticket money is collected?

Programmes cost 15p each.

Selling programmes raises £12.30.

How many programmes are sold?

Solve problems involving addition and subtraction.

6 green apples cost 75p. 10 red apples cost 90p.

Jason bought some bags of green apples and some bags of red apples.

He spent £4.20. How many bags of each type of apples did he buy?

Nika says, 'I bought more apples than Hassan, but I spent less money.'

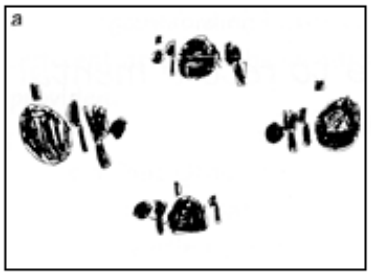
Explain how this is possible.

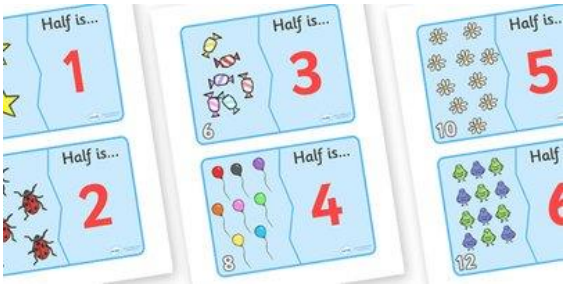
Use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy.

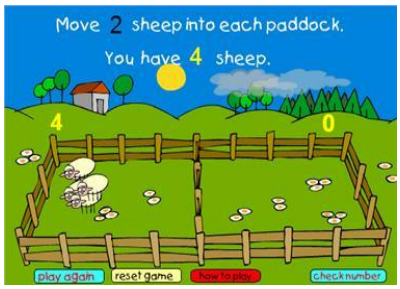
Multiplication & Division

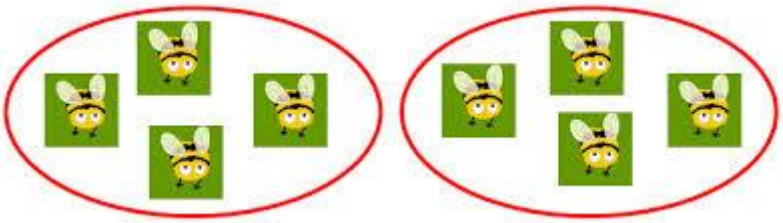
FS2

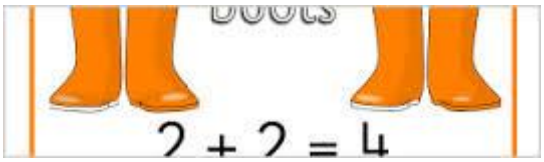
Solve problems including doubling, halving and sharing.





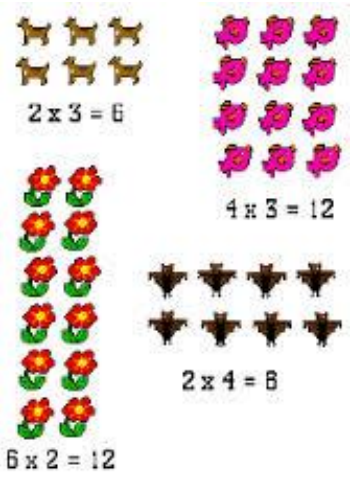


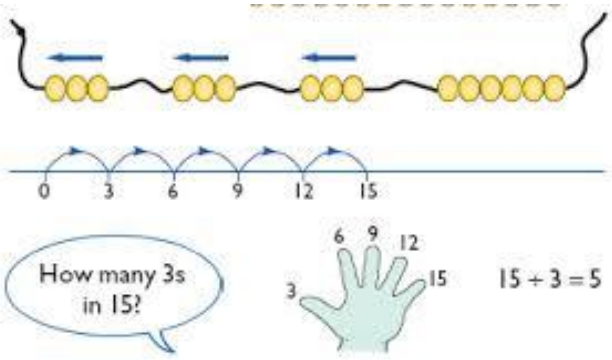




Year 1

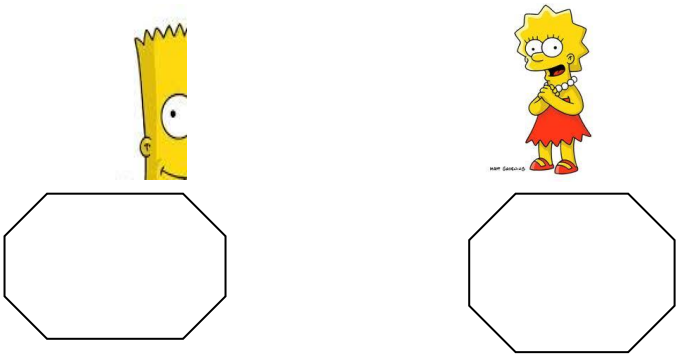
Solve one step problems involving multiplication and division, calculating the answer using concrete objects, pictorial representations and arrays with the support of the teacher.





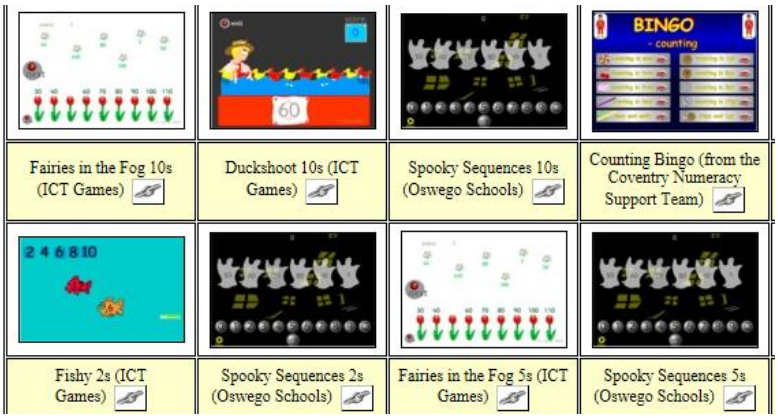
Bart and Lisa have 18 sweets. How many can they eat each?

18 ÷ 2 =_____



Year 2

Recall and use x and ÷ facts for 2, 5 and 10 tables including recognising odd and even numbers.



Calculate mathematical statements for x and ÷ within the multiplication tables and write them using the x, ÷ and = signs.

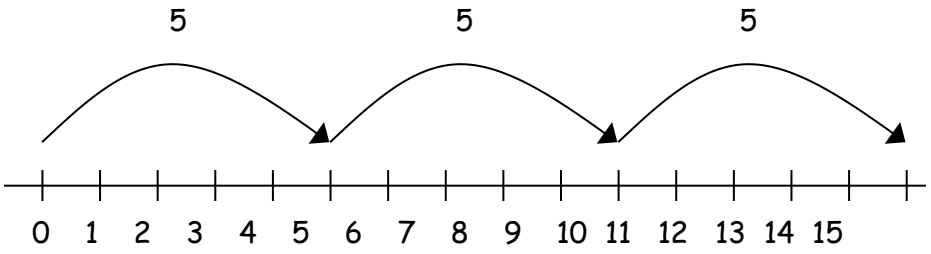
Children will develop their understanding of multiplication and use jottings to support calculation:

Repeated addition

3 times 5 is 5 + 5 + 5 = 15 or 3 lots of 5 or 5 x 3

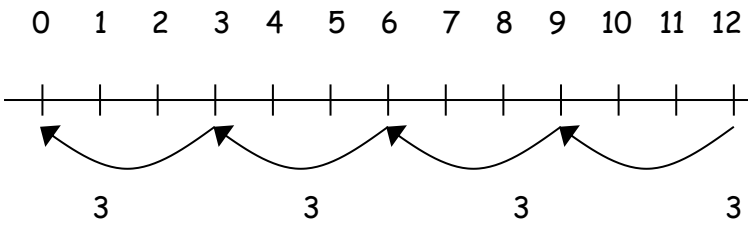
Repeated addition can be shown easily on a number line:

5 x 3 = 5 + 5 + 5

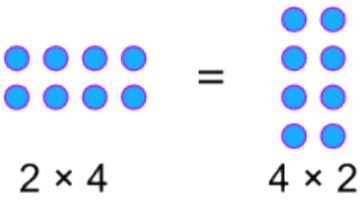


Repeated subtraction using a number line or bead bar

12 ÷ 3 = 4



Show multiplication can be done in any order (commutative) and division cannot.



12 ÷ 4 = 3 but 12 ÷ 3 = 4 therefore it is not associative either

Solve problems involving multiplication and division, using materials, arrays, repeated addition, mental methods and x and ÷ facts including problems in context.

Worded problems: There are 5 dinosaurs in the forest. Each of them has 4 legs. How many legs are there altogether?

7 children go to the Natural History Museum. Each child buys 6 pencils in the shop. How many pencils do they buy altogether?

A box of bananas has 12 bananas in it.

How many bananas would there be in 5 boxes?

Example from KS 1 SAT paper:

Ella's dad washes some cars.

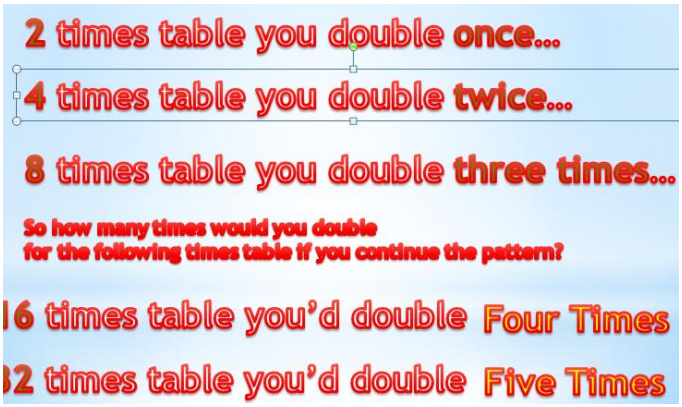
He uses 12 buckets of water.

Each bucket has 5 litres of water.

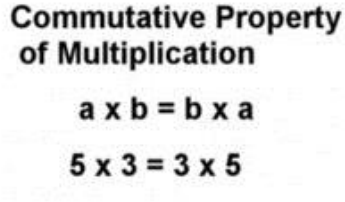
How many litres of water does he use altogether?

Year 3

Pupils continue to practise their mental recall of multiplication tables when they are calculating mathematical statements in order to improve fluency. Through doubling, they connect the 2, 4 and 8 multiplication tables.



Pupils develop efficient mental methods, for example, using commutativity and associativity (for example, 4 × 12 × 5 = 4 × 5 × 12 = 20 × 12 = 240) and multiplication and division facts (for example, using 3 × 2 = 6, 6 ÷ 3 = 2 and 2 = 6 ÷ 3) to derive related facts (for example, 30 × 2 = 60, 60 ÷ 3 = 20 and 20 = 60 ÷ 3).



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

Grid method

TU x U

(Short multiplication – multiplication by a single digit)

23 x 8

Children will approximate first

23 x 8 is approximately 25 x 8 = 200

x	20	3
8	160	24

160

+ 24

184

HTU x U

(Short multiplication – multiplication by a single digit)

346 x 9

Children will approximate first

346 x 9 is approximately 350 x 10 = 3500

x	300	40	6
9	2700	360	54

2700

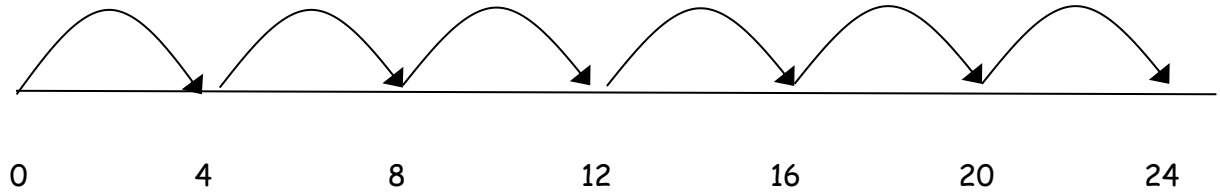
\+ 360

\+ 54

3114

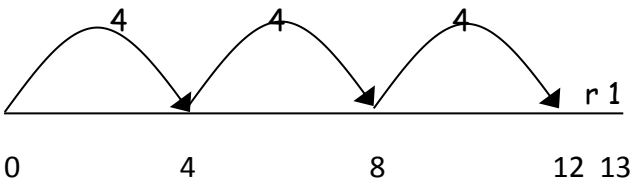
Children will use an empty number line to support their calculation.

24 ÷ 4 = 6



Children should also move onto calculations involving remainders.

13 ÷ 4 = 3 r 1



Pupils solve simple problems in contexts, deciding which of the four operations to use and why. These include measuring and scaling contexts, (for example, four times as high, eight times as long etc.) and correspondence problems in which m objects are connected to n objects.

Scaling

e.g. Find a ribbon that is 4 times as long as the blue ribbon

5 cm 20 cm

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

□ x 5 = 20 3 x △ = 18 □ x O = 32

One battery weighs the same as **60** paperclips.

One pencil sharpener weighs the same as **20** paperclips.

How many pencil sharpeners weigh the same as one battery?

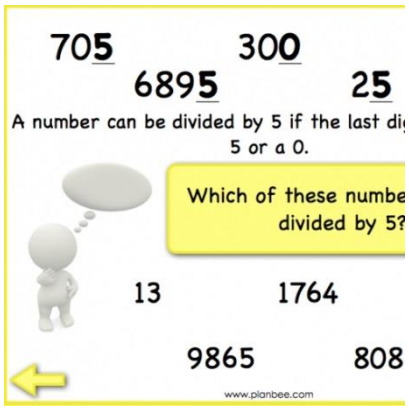
How many paperclips weigh the same as **2** batteries and **4** pencil sharpeners together?

KS2 2009 Paper A level 3

Year 4

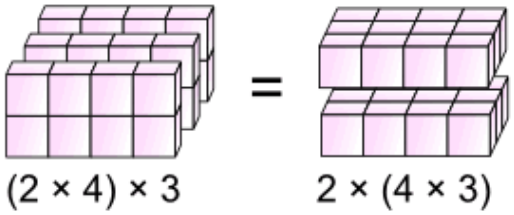
Recall multiplication and division facts for multiplication tables up to 12 × 12.

Use place value, known and derived facts to multiply and divide mentally, including: multiplying by 0 and 1; dividing by 1; multiplying together 3 numbers.



Recognise and use factor pairs and commutativity in mental calculations.

$$(a \times b) \times c = a \times (b \times c)$$



Examples:

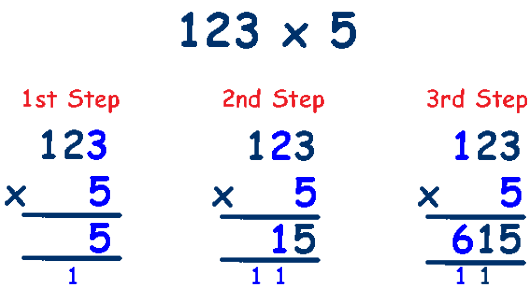
This:	**(2 + 4)** + 5 = **6** + 5 = **11**
Has the same answer as this:	2 + **(4 + 5)** = 2 + **9** = **11**
This:	**(3 × 4)** × 5 = **12** × 5 = **60**
Has the same answer as this:	3 × **(4 × 5)** = 3 × **20** = **60**

The Commutative Law does **not** work for division:

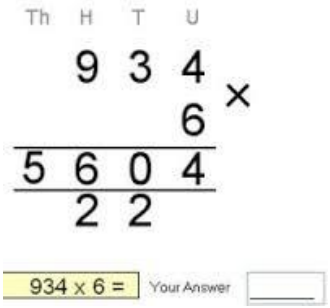
Example:

- 12 / 3 = **4**, but
- 3 / 12 = **¼**

Multiply 2 digit and 3 digit numbers by a 1 digit number using formal written layout.

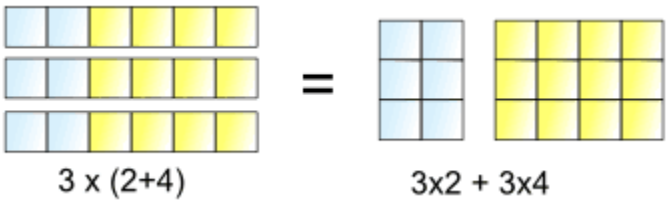


n



Solve problems involving multiplying and adding, using the distributive law to multiply 2 digit numbers by 1 digit, integer scaling problems and harder correspondence problems such as n objects are connected to m objects.

Distributive Law



3 lots of **(2+4)** is the same as **3 lots of 2** plus **3 lots of 4**

So, the **3×** can be "distributed" across the **2+4**, into **3×2** and **3×4**

And we write it like this:

$$a \times (b + c) = a \times b + a \times c$$

- $3 \times (\mathbf{2 + 4}) = 3 \times \mathbf{6} = 18$
- $3\times2 + 3\times4 = 6 + 12 = 18$

Either way gets the same answer.

Uses:

Sometimes it is easier to break up a difficult multiplication:

Example: What is 6 × 204 ?

$$6 \times 204 = 6\times200 + 6\times4 = 1{,}200 + 24 = 1{,}224$$

Or to combine:

Example: What is 16 × 6 + 16 × 4?

$$16 \times 6 + 16 \times 4 = 16 \times \mathbf{(6+4)} = 16 \times \mathbf{10} = 160$$

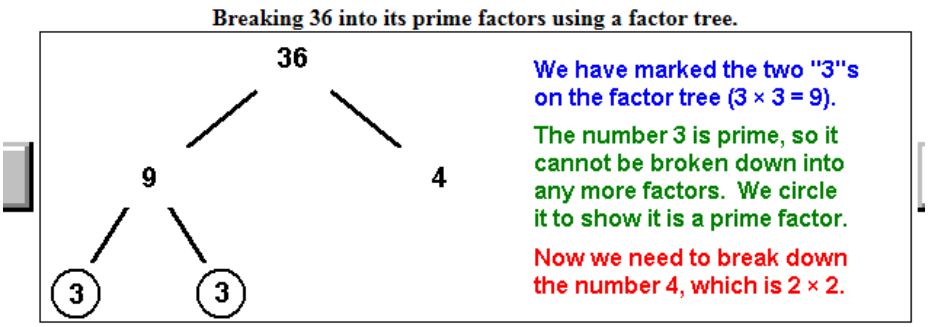
Year 5

Identify multiples and factors, including finding all factor pairs of a number, and common factors of two numbers.

E.g 3 x 4 = 12
3 and 4 are both factors of 12
12 is a multiple of both 3 and 4.

Know and use the vocabulary of prime numbers, prime factors and composite (non-prime) numbers.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100



Example: is 6 a Prime Number or Composite Number?

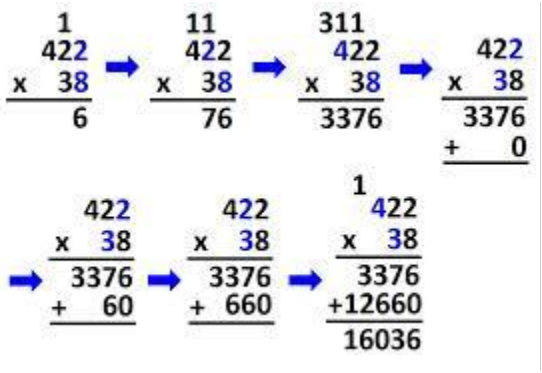
6 can be divided evenly by 2, or by 3, as well as by 1 or 6:

$$6 = 1 \times 6$$
$$6 = 2 \times 3$$

So 6 is a **Composite Number**

Establish whether a number up to 100 is prime and recall prime numbers up to 19.

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



Multiply and divide numbers mentally drawing upon known facts.

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.

Short division HTU ÷ U

196 ÷ 6

```
      32 r 4
    ________
6 ) 196
  - 180
    ----
     16
   - 12
    ----
      4
```

Answer : 32 remainder 4 or 32 r 4

```
      3 2  r4
    ________
6 ) 1¹9 ¹6
```

Multiply and divide whole numbers and those involving decimals by 10, 100 and 1000.

Multiplying by 10

When you multiply a decimal number by 10 you move all the digits **one place to the left**. The number becomes **10 times bigger**.

Example: 2.63 × 10 = 26.3

You can see from the answer that the digits move to the left - units move to tens and the others follow like this:

H	T	U		$\frac{1}{10}$	$\frac{1}{100}$
		2	**.**	**6**	**3**
	2	**6**	**.**	**3**	

H = hundreds
T = tens
U = units

Multiplying by 100

When you multiply a decimal number by 100 you move all the digits **two places to the left**. The number becomes **100 times bigger**.

Example: 2.63 × 100 = 263

Th	H	T	U		$\frac{1}{10}$	$\frac{1}{100}$
			2	**.**	**6**	**3**
	2	**6**	**3**			

Th = thousands
H = hundreds
T = tens
U = units

Multiplying by 1,000

When you multiply a decimal number by 1,000 you move all the digits **three places to the left**. The number becomes **1,000 times bigger**.

Example: 2.63 × 1,000 = 2,630

TTh	Th	H	T	U		$\frac{1}{10}$	$\frac{1}{100}$
				2	**.**	**6**	**3**
	2	**6**	**3**	**0**			

TTh = tens of thousands
Th = thousands
H = hundreds
T = tens
U = units

Dividing by 10

When you divide a decimal number by 10 you move all the digits **one place to the right**. The number becomes 10 times **smaller**.

Example: 3,502 ÷ 10 = 350.2

You can see that the digits move along to the right. Thousands move to hundreds, and the others follow like this:

Th	H	T	U		$\frac{1}{10}$	$\frac{1}{100}$
3	5	0	2			
	3	5	0	.	2	

Th = thousands
H = hundreds
T= tens
U = units

Dividing by 100

When you divide a decimal number by 100 you move all the digits **two places to the right**. The number becomes **100 times smaller**.

Example: 3,502 ÷ 100 = 35.02

Th	H	T	U		$\frac{1}{10}$	$\frac{1}{100}$
3	5	0	2			
		3	5	.	0	2

Th = thousands
H = hundreds
T= tens
U = units

Dividing by 1,000

When you divide a decimal number by 1,000 you move all the digits **three places to the right**. The number becomes **1,000 times smaller**.

Example: 3,502 ÷ 1,000 = 3.502

Th	H	T	U		$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$
3	5	0	2				
			3	.	5	0	2

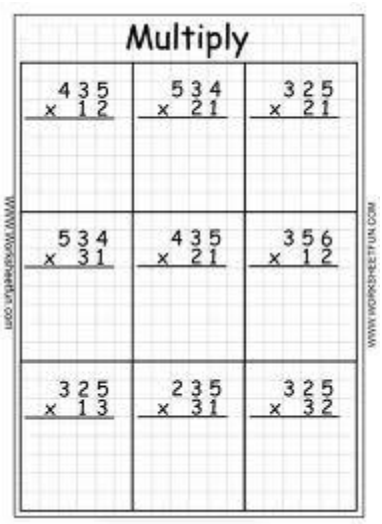
Th = thousands
H = hundreds
T= tens
U = units

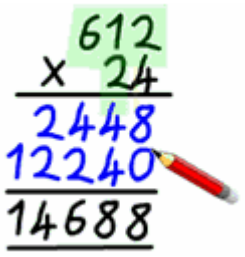
To understand the meaning of the = sign

E.g 8 + 4 = 3 x 4 66 – 2 = 8 x ? 125 - ? = 10^2

Year 6

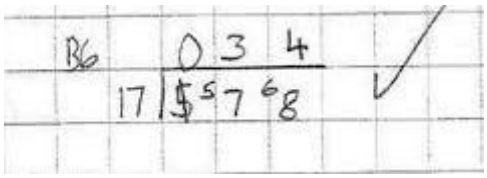
Multiply multi-digit numbers up to 4 digits by a two-digit whole number using the formal written method of long multiplication.





Same method applies to x 4 digit number

Divide numbers up to 4 digits by a two-digit whole number using the formal written method of long division, and interpret remainders as whole number remainders, fractions, or by rounding, as appropriate for the context.



$$25\overline{)4^{4}3^{18}5} \quad 017$$

$$25\overline{)4^{4}3^{18}5.^{10}0} \quad 017.4$$

$$30\overline{)4^{4}3^{13}5^{15}7} \quad 0145\ r\ 7/30$$

Divide numbers up to 4 digits by a two-digit number using the formal written method of short division where appropriate, interpreting remainders according to the context.

This sequence of numbers goes up by 40 each time.
40 80 120 160 200 …
This sequence continues. Will the number 2140 be in the sequence? Circle Yes or No. Explain how you know.

KS2 2000 Paper A level 5

Perform mental calculations, including with mixed operations and large numbers

Calculate 31.6 × 7.

KS2 2004 Paper A level 5

Identify common factors, common multiples and prime numbers.

Write the three prime numbers which multiply to make 231.
□ × □ × □ = 231
KS2 2001 Paper B level 5

Write all the numbers between 50 and 100 that are factors of 180.

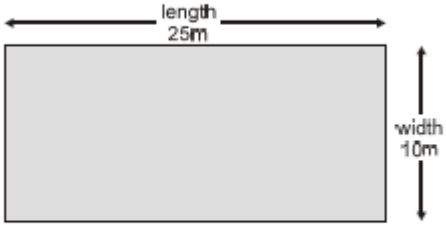
KS2 2009 Paper A level 5

Solve problems involving multiplication and division.

Emily makes 250 grams of a snack mixture. 15% of the weight is raisins, 25% is banana chips and the rest is peanuts. How many grams of peanuts does she use?

KS2 2008 Paper A level 5

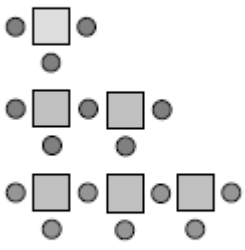
A rectangular swimming pool is 25 metres long and 10 metres wide.



David swims 5 lengths.
Rosie swims 12 widths.
How much further does David swim than Rosie?

KS2 2006 Paper A level 4

Here is a sequence of patterns made from squares and circles.



Number of squares	Number of circles
1	3
2	5
3	7

The sequence continues in the same way.
Calculate how many squares there will be in the pattern which has 25 circles.

KS2 2001 Paper A level 5

Use estimation to check answers to calculations and determine, in the context of a problem, an appropriate degree of accuracy.

Mark's patio has 84 rows of square tiles. There are 57 tiles in each row.

Which of these is the BEST way to estimate how many tiles there are altogether?

A 100 × 50 = 5000

B 90 × 60 = 5400

C 80 × 60 = 4800

D 80 × 50 = 4000

Order of Operations

B O D M A S

B	**B**rackets first
O	**O**rders (ie Powers and Square Roots, etc.)
DM	**D**ivision and **M**ultiplication (left-to-right)
AS	**A**ddition and **S**ubtraction (left-to-right)

Order of Operations

- **Do things in Brackets First.** Example:

  ✓ $6 \times (5 + 3) = 6 \times 8 = 48$

  ✘ $6 \times (5 + 3) = 30 + 3 = 33$ (wrong)

- **Exponents (Powers, Roots) before Multiply, Divide, Add or Subtract.** Example:

  ✓ $5 \times 2^2 = 5 \times 4 = 20$

  ✘ $5 \times 2^2 = 10^2 = 100$ (wrong)

- **Multiply or Divide before you Add or Subtract.** Example:

  ✓ $2 + 5 \times 3 = 2 + 15 = 17$

  ✘ $2 + 5 \times 3 = 7 \times 3 = 21$ (wrong)

- **Otherwise just go left to right.** Example:

  ✓ $30 \div 5 \times 3 = 6 \times 3 = 18$

  ✘ $30 \div 5 \times 3 = 30 \div 15 = 2$ (wrong)